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LOW-DENSITY URBANISM IN THE GULF LOWLANDS OF VERACRUZ

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Abstract

The concept of low-density urbanism has developed in archaeology over the past 20 years to characterize settlements that display the same types of features as nucleated cities (monumental architecture, services provided for a hinterland, division of labor, class differences) but lack dense populations. Ancient cities that emerged in tropical regions typically resemble a distributed urban network (Scarborough and Isendahl 2020) with interconnected and regularly spaced urban centers scattered among dispersed residential and agricultural land. We demonstrate that the Gulf lowlands of Mexico exemplifies this type of urbanism, and we highlight a number of its features related to land use, governance, and sustainability. Given the formidable challenges of understanding a distributed urban network, we advocate approaches that do not impose hierarchical interpretations or discrete territories but, rather, explore the characteristics of the network of places.

Keywords: urbanism, governance, agriculture, Mesoamerica, Gulf lowlands, settlement patterns

Introduction

Today, over half the global human population lives in cities (Ritchie and Roser 2018), many sprawling out through “low-density” suburbs. Researchers attempt to extrapolate future consequences of modern low- versus high-density urbanism from growth patterns observed in the recent past (e.g., Artmann et al. 2019; Coq-Huelva et al. 2019; Hayden 2004; Inostrosa et al. 2013). Archaeological research provides a much deeper history of different types of urbanism, including ancient low-density varieties that bear some similarities to recent urban sprawl (Fletcher 2009). We add to the comparative study of low-density agrarian urbanism through this review of recent archaeological research in the Gulf lowlands of Veracruz, Mexico.

We synthesize continuous architectural data over 53,000 sq km in Veracruz, Mexico, traditionally subdivided at the Papaloapan River into south-central Veracruz to the northwest and southern Veracruz to the southeast (Figure 1). Our functional approach prioritizes the services provided in formal architectural complexes (FACs) for surrounding occupations. The study area features the repetitious use of particular earthen architectural arrangements, for which reasonable functional interpretations can be made. We employ an architectural attribute analysis (S2.1, S2.2) to highlight zones of interaction and boundaries within this distributed urban network (Scarborough and Isendahl 2020).

In what follows, we note views of urbanism that emphasize the services that central places provide to their hinterlands, examine how low-density urbanism has been characterized, and provide a substantive review of Gulf urbanism using both published literature and extensive satellite and LiDAR remote sensing. We present the development of urbanism over two major

periods: the Formative and Classic (Table 1). Information is most abundant for the Classic period (a peak of urbanism) for which we discuss urban services, architectural arrangements, and regional and macroregional patterns. Finally, we address interpretive themes, including the generous spacing of Gulf settlements in relation to agricultural practices, what urban patterns and other evidence disclose about governance, economic production and trade, and the longevity of low-density Gulf cities – with implications for sustainability.

We conclude with the following five points. (1) The Gulf lowlands are consistent with definitions of agrarian low-density urbanism. (2) Gulf cities grew outward from relatively few early centers through a proliferation of new monumental foci in their hinterlands during the Classic period, especially the Middle and Late Classic. We liken this to jurisdictional proliferation seen in many modern cities (Freemark et al. 2020), where centralized administration is subdivided over time, and to the formation of a distributed urban network of local decision-making bodies (Scarborough and Isendahl 2020). (3) At the macroregional scale, Classic architectural constructions shared standardized planning and other evidence of interaction across dozens of political domains, implying permeable boundaries and cooperative relationships among urban epicenters. (4) We observe a mix of both collective and authoritarian strategies of governance (Blanton and Fargher 2008) that shifts over time. (5) Many of the largest cities boasted continuous development sustained over 2000 years, but those urban traditions ended near the close of the Classic period (Stark and Eschbach 2018).

Table 1. Chronology of the Gulf Lowlands. Periodization varies among researchers.

Period	Date Range
Early Formative	1500-900 BC
Middle Formative	900-400 BC
Late Formative	400 BC-AD 1
Protoclassic	AD 1-300
Early Classic	AD 300-450
Middle Classic*	AD 450-650
Late Classic	AD 650-900
Early Postclassic	AD 900-1200
Middle Postclassic	AD 1200-1325
Late Postclassic	AD 1325-1519

* Some researchers do not distinguish a Middle Classic, instead only recognizing an Early (AD 300-600) and Late (AD 600-900) Classic.

Figure 1. Map of the study region showing pedestrian survey areas (numbers correspond to citations in the legend) and major rivers that we reference in the text. The large polygon surrounding the region shows the limit of LiDAR remote sensing. Basemap reflects elevation: darker areas are more elevated. Inset map shows the study region portion of the state of Veracruz.

The Conceptual Backdrop

The debate about whether low-density settlements truly are cities has deep roots. Wirth's (1938) definition of cities as large, dense, and socially heterogeneous noted a shift from face-to-

face contacts to more impersonal ones. Such settlements were linked to the emergence of ancient complex societies by early scholars (e.g., Childe 1950). Traits of “civilization” became synonymous with traits of cities. Wirth created a definitional division that has proven troublesome to this day. Nowhere was this more problematic than in Mesoamerica, where large relatively nucleated cities in the Mexican highlands contrasts with contemporaries in the Maya lowlands. The latter were eventually described as agrarian “low-density urbanism” (Fletcher 2009, 2012). Also nettlesome were earlier Olmec centers in the Gulf lowlands: renowned for impressive sculpture, monumental constructions, complex iconography and ritual, and extensive trade, but not “Wirthian cities”.

Some scholars categorized cities in terms of prominent functions (e.g., Sjoberg 1955; Weber 1958, pp. 65-80). Fox (1977, p. 21) recognizing regal-ritual, administrative, mercantile, industrial, and colonial cities, with the first three important in preindustrial times (see related debates for Mesoamerica by Chase et al. 1990; Sanders and Webster 1988, 1989; Smith 1989).

We approach urban function without typological modes because they carry the risk of overriding variability. In Blanton’s (1976, p. 253; 1982, p. 428) view, any region’s highest-order central places are cities. The focus is regional – cities have a co-dependent hinterland and draw people together through a variety of “services”. We build on this definition because of its neutrality about the specific functions of central places. Architectural consistency across the Gulf region speaks to a shared tradition of urban planning (*sensu* Smith 2007; Rapoport 1990) that we interrogate to understand multiscalar interactions.

Low-Density Urbanism

Two related concepts help to characterize urbanism in the ancient Gulf lowlands as opposed to urban types found elsewhere. (1) Agrarian “low-density urbanism” refers to cities that display high levels of monumentality, regional functionality, and urban planning, but lack dense populations and neatly bounded urban-rural distinctions (Evans et al. 2007; Fletcher 2009; Isendahl and Smith 2013). (2) Monumental epicenters in the Gulf lowlands are nodes within a distributed urban network (Scarborough and Isendahl 2020) that exerted a gravitational pull drawing dispersed regional populations into a centripetal pattern of habitual movement. We elaborate on these two points in this section.

Tropical cities feature low-density populations with some variation across the settlement system (e.g., Evans et al. 2013; Stark 2014, pp. 385-389) (S1.1). Low population density is not the only defining feature of tropical cities. Lucero et al. (2015, pp. 1140-1141) view tropical low-density urbanism in terms of both settlement and surrounding landscape: “the urban-rural population was simultaneously agriculturally based and civically integrated.” Similarly, Fletcher (2012:285) states the “hinterland is incorporated in the urban fabric.” These statements highlight interspersed zones of residence, agriculture, and civil architecture distributed across all settlement segments.

Tropical environments present nearly ubiquitous resources critical for agricultural subsistence, but the nature of the agricultural/settlement interface contributes to distributed nature of cities. Drennan (1988) links the difference between dispersed and compact settlement to contrastive time and space demands of agricultural systems. Isendahl and Smith (2013) stress the effect of a range of agricultural practices within cities as a factor. Agricultural pursuits

included extensive varieties, such as swidden. In areas where more intensive agriculture was added, erosion from torrential wet-season rains came with high annual maintenance demands that were more efficiently handled by local cooperative arrangements than a centralized government (Comptour et al. 2018; Scarborough and Lucero 2010; Stoner et al. 2021). The seasonal discrepancy in rainfall, with as much as 95 percent of annual precipitation falling over five-months' time, created a need for storage techniques to keep water close to fields (Evans et al. 2007; Scarborough and Gallpin 1991; Scarborough et al. 2012; Stark and Ossa 2007; Stoner et al. 2021).

Water and agricultural management strategies fostered a decentralized agricultural network: families lived close to their fields, which were distributed across the settlement system. Additionally, long-term storage was difficult in these humid environments, so productive efforts shifted to seasonal abundances focused at different locations and landforms over the course of the year. As a result, outlying settlements were often separated from monumental epicenters by great distances, making daily interactions with centralized services offered there costly to maintain. Tropical cities in lowland Mesoamerica and southeast Asia exhibit proliferations of civic and religious complexes in outlying areas, bringing key services closer to their sprawling hinterland populations (e.g., Chase and Chase 2001; Iannone et al. 2018; Klassen and Evans 2020; Stoner et al. 2021). Extra-household collective projects were likely coordinated at these local facilities, including cooperation to build reservoirs and canal networks (Scarborough and Lucero 2010; Stoner et al. 2021) (S1.2). Even at Angkor, where massive reservoirs, canals, and causeways were constructed at the behest of a centralized authority, most fields possessed smaller reservoirs situated nearby that were potentially managed through interactions at district-level temple groups (Klassen and Evans 2020).

Monumental nodes exerted a gravitational pull drawing the dispersed regional population into a centripetal pattern of periodic movement to engage with a variety of services. Smith et al. (2021) show that low-density Maya cities exhibit features of urban scaling, but only with adjustments to the model parameters compared to methods employed among more nucleated cities. They propose periodic social mingling, when large populations came together at monumental epicenters, rather than continuous interactions as at more nucleated cities. Freidel (1981) provides an early argument for Maya pilgrimage-fairs as an integrative institution, indicated in part through intersite masonry roads (e.g, Hutson and Welsh 2021) that have not yet been identified in the Gulf lowlands. In the study region, economic, ritual, and administrative services and a persistent set of broadly shared politico-ritual principles maintained distributed integrative relationships across the region.

Increasing evidence points to marketplaces fostering periodic centripetal movement to Maya cities (Chase and Chase 2014; Fry 1979, 1980; King 2015; Shaw 2012) and at Classic and Postclassic Gulf centers (Ossa 2011; Pool and Stoner 2008; Stark and Ossa 2010; Stoner 2013). In Central Mexico, ethnohistoric data show periodic markets were coordinated in part by calendar cycles (Blanton 1996; Hassig 1982; Smith 1979). Aspects of the Mesoamerican calendar may have very early roots in the Gulf region (see Inomata et al. 2020 about vegetismal aspects of some Formative architectural layouts; see Justeson and Kauffman 1993, 1997, 2008 and Houston and Coe 2003 about the Long-Count calendar and writing evidence in the Papaloapan basin during the Protoclassic and Early Classic periods; see Coe 2011, p. 62-64 for an introduction to Mesoamerican calendrics).

The Mesoamerican ballgame also served an important integrative mechanism. In both south-central and southern Veracruz, ball courts are common features at primary and secondary

centers (Daneels 2016; Urcid and Killion 2008). Ballgames were more than competitive sport. The game was symbolic of ritual cycles of death and renewal (Daneels 2008; Scott 2009; Wilkerson 1991). Games could have mediated social and political relations as well (Agüero and Daneels 2009; Gillespie 1991, pp. 342-344; Koontz 2008). Late documents regarding the Aztecs attest to gambling on outcomes, and some reallocations of resources (Santley et al. 1991, pp. 14-17).

We propose that the distributed nature of residences, agriculture, and civic architecture in the Gulf lowlands of Mesoamerica reflects a pattern of urbanism that differs from territorially bounded kingdoms (Rosenswig 2021) or city-states (Hansen 2000; Charlton and Nichols 1997). Politics were small, numerous, functionally redundant, and rather evenly distributed across the landscape. The small areas serviced by polity capitals would not have granted direct access to the various ecological niches that characterize the region. Scarborough and Isendahl (2020) suggest that distributed urban networks feature cooperative exchanges among specialized settlements to span resource variability, often across social and political units. Smith (2017) draws on behavioral ecology (Dyson-Hudson and Smith 1978) to describe similar non-territorial “home-range systems”. In such systems, boundaries were permeable, offering access to non-local productive niches. At broader scales, interconnectivity among nodes was fostered through shared symbols, values, and institutions (see Coe 1961). We argue that such broad-based cooperation across a diversified resource landscape was underwritten in the Gulf lowlands by shared architectural configurations and their corresponding civic and religious institutions.

Urban Beginnings: Early and Middle Formative

In this section, we (1) highlight the Formative roots of later architectural developments, and (2) establish a baseline for discussing diachronic trends in urban planning. We first consider information about two major successive Olmec centers in southern Veracruz.

San Lorenzo

Olmec San Lorenzo and neighboring settlements in the Coatzacoalcos Basin of southern Veracruz present the earliest evidence of labor mobilization for large-scale projects (Cyphers 1997). These include transport of multi-ton blocks from the volcanic Tuxtla Mountains for carving monuments (Gillespie 1994; Hazell and Brodie 2012; Williams and Heizer 1965), the creation of sacred places that likely represent the earliest central places (Ortíz and Rodríguez 2000), and the use of statuary to construct a narrative of both social and supernatural relationships (Pool and Loughlin 2017).

San Lorenzo was constructed atop a natural plateau with significant levelling and terracing (Cyphers 1997; cf. Coe and Diehl 1980, p. 28) (Figure S1.3.1). Cyphers' (2012, pp. 47-50) auger testing demonstrates that its inhabitants used an estimated 1.3 million cubic meters of fill to level the natural plateau. Arieta and Cyphers (2017) estimate a peak population between 7,920 and 12,907 people covering the top, terraces, and periphery of the plateau. This equates to a density of 13.4 per ha, higher than our Classic period estimates below.

The detailed contour map of San Lorenzo (Breiner and Coe 1972; Cyphers 2012:39) and more recent LiDAR analysis (Inomata et al. n.d.) reveal clear signs of anthropogenic construction, including a massive rectangular plaza (approximately 800 m north-south and 280 m east-west) surrounded by large rectangular platforms (Figure S1.3.1). The San Lorenzo plateau presents architectural similarities with numerous sites as far away as Aguada Fénix in eastern Tabasco (Inomata et al. 2020, n.d.). The replication of large plazas across a broad region shows a developing macroregional tradition.

San Lorenzo Groups C and D form a western wing extending from the medial section of the main plaza where the rulers of San Lorenzo likely lived. The “Red Palace”, named for the color of its bentonite floors, was situated at the eastern end of Group D along the western edge of the plaza and likely represents the residence of a powerful family (Cyphers 2012, pp. 56-60; cf. Flannery and Marcus 2000, p. 6). Auger testing identified additional red floors around the margins of the plaza (Arieta and Cyphers 2017).

Positioning of stone monuments further demonstrates planning. Ten multi-ton colossal heads depicting the visages of individual leaders were arrayed along the margins of the plaza (Cyphers 2004). The original intent was clearly a gallery to be experienced as one walked through the plaza (Cyphers 1997, p. 234; Cyphers and Di Castro 2009, pp. 28-29; Grove 1999). This gallery and any accompanying oration established a historical narrative involving rulers both dead and living, a sequence used to legitimize authority (Pool and Loughlin 2017).

La Venta

Olmec La Venta, on an island near the Tonalá River at the border with Tabasco, rose as San Lorenzo declined. La Venta was among the first sites on the Gulf coast to construct vertically with the creation of a “sacred mountain”, Structure C-1 (Figure S1.4.1). This monumental structure might have been influenced by interactions with Chiapas and coastal Guatemala (Love 2002; Lowe 1959, 1998), but precedent for the sacred mountain ideology occurred much earlier at Cerro Manatí near San Lorenzo (Ortíz et al. 1997).

Structure C-1 at La Venta stands 30 m tall. Its fluted shape has been proposed to mimic volcanic mountains in the region, but more recent excavations have suggested that this pattern is due to erosion (González Lauck 1996, 1997; cf. Diehl 1981, p. 76; Morrison et al 1970, p. 1). Nevertheless, symbolism that associates conical/pyramidal temples in Mesoamerica with life-giving mountains is well established (e.g., Carballo 2016; Grove 1999; Ortiz and Rodríguez 2000, 2015; Reilly 1999; Tate 2008).

To the south of Structure C-1, the “front” plaza comprises Complexes B and D and conforms to the Middle Formative Grijalva (MFG) pattern identified by Inomata et al. (n.d.) (S2.3). Complexes B, C, and D together frame a large elongate plaza (Figure S1.4.1), with lateral edges enclosed by lines of platforms. The “Stirling Acropolis,” a monumental platform, delineates the eastern margin of Complex B. The western edge of the plaza is bordered by three low platforms. The south end of Complex B contains a long mound paired with a small conical mound to its west, which resembles the E-Group configuration found at later Maya cities. Many other Middle Formative Plaza Groups (MFPG) in the region display this E-Group configuration in the center of the plaza or along its edge (Inomata et al. n.d.). Its repeated use strongly supports it as an early shared principle of urban planning. To the north of Structure C-1, Complex A

(Gillespie 2011; González 2007) resembles the Long Plaza Group (LPG) that proliferated in the Late Classic period, but the large temporal gap requires more chronological information to demonstrate continuity.

Arrangements of stone monuments in the plaza – including thrones/altars, colossal heads, early-style stela, and other statuary – form a narrative that heavily references fertility and the lifecycle (e.g., Tate 2008). On the numerous thrones and stelae are references to leaders and their critical roles in ensuring continuous reproduction of the world.

Early and Middle Formative Regional Patterns

For more than 70 years, discussions of early the Gulf Olmec focused primarily on San Lorenzo and La Venta. Recent regional-scale analyses have greatly expanded that discussion.

Regional Pedestrian Survey

Through pedestrian survey, Symonds et al. (2002; Lunagómez 2011) identified 135 sites around San Lorenzo during the Early Formative. Of that total, 106 were located in the core near San Lorenzo, an area of 90 km². San Lorenzo exerted a gravitational pull attracting early settlement. The greatest concentration of sites was to the north between the plateau and the

Tatagapa River, which was likely a wetland at the time (Ramírez Núñez et al. 2019). Activities at artificial rises in those wetlands seem to be tied to intensive fisheries, which formed a major part of San Lorenzo's subsistence (Cyphers and Zurita 2012).

A settlement hierarchy developed by the Early Formative San Lorenzo phase (Symonds et al. 2002). Very few sites outside San Lorenzo contained monumental art or architecture. Symonds et al. (2002) identify Loma del Zapote (El Azuzul) and Las Camelias as tier 2 administrative centers, while Tenochtitlan to the north of San Lorenzo is a tier 3 site. The remainder of the settlement system consisted of small villages and hamlets. Settlements declined in the Middle Formative (45 sites, decline was mostly from the area surrounding the capital), along with the influence of San Lorenzo.

Pedestrian survey around La Venta identified sites dating to the Middle Formative with and without mounded architecture (Rust and Sharer 1988). La Venta had a sustaining hinterland that was divided into at least three tiers of administration, with La Venta alone at the top. San Andrés occupied a lower tier, but clearly exerted influence on the region by participating in long-distance trade networks and monumental construction (Pohl et al. 2002; von Nagy 1997). To the southwest of La Venta, Wendt conducted survey and excavation along the Pesquero River (Wendt and Lunagómez 2011). Like San Lorenzo, Early and Middle Formative sites documented near La Venta showed a bias toward exploitation of aquatic resources.

Remote Sensing

Remote sensing studies by Inomata et al. (n.d.) and by us have revealed a dramatically expanded picture of early monumental architecture and ceremonialism (Figure 2). We adopt the typology for Middle Formative Plaza Groups (MFPGs) presented by Inomata et al. (n.d.; for type descriptions see S2.3.). All types consist of large rectangular plazas framed by either a continuous rectangular linear embankment or segmented lines of long mounds or platforms. Based on our data in southern Veracruz, these plazas average 350 m long, 80 m wide, with an area of 3.19 km² (see Inomata et al. n.d. for a breakdown by type). About 33 percent of the Formative plazas in our database are oriented within five degrees of cardinal directions, and 50 percent within ten degrees. Those not oriented toward cardinal points instead align with local landscape features, such as rivers, floodplain terraces, or mesa tops.

Some Veracruz plazas had their own distinctive style (VC in Figure 2), with a rectangular wing extending perpendicularly from the mid-section of the plaza, like the way Group C and Group D extend from the main plaza at San Lorenzo. Others share characteristics with La Venta, including a plaza group located about 1 km south of the San Lorenzo plateau (FAC1110) that presents a temple mound at the north end of the plaza with segmented platforms delineating the lateral edges (Figures S1.3.1 and S2.3.2). Figure 2 notably shows a lack of geographic patterning among the different architectural types, demonstrating either 1) that early urban planning networks were not bounded, or 2) that architectural differences may reflect chronological changes over the 800+ year time frame in which they were built.

The broad sharing of architectural patterns in southern Veracruz, Chiapas, and Tabasco shows, at a minimum, communication about early architecture according to shared social and religious institutions. The spread of this architectural grammar was likely tied to prestige

exchange networks that exploded in scope across Mesoamerica during the late Early and Middle Formative (Pool 2007, pp. 179-242).

Figure 2. Map of Southern Veracruz showing the distribution of Middle Formative Plaza Groups. MFG, Middle Formative Gulf; MFC, Middle Formative Chiapas; MFU, Middle Formative Usumacinta; VC, Veracruz Ceremonial pattern. Typology adopted from Inomata et al. (n.d.) with some minor adjustments.

Functions of Early Plazas

The role of these early architectural plazas in structuring social relationships likely resembled what Carballo (2016, p. 141) calls “structures of inclusion and distinction”. The plaza areas were the largest continuous ceremonial spaces ever constructed in the Gulf lowlands. If plazas represent gathering spaces with an area directly proportional to crowd size, the large plazas of MFPGs followed a principle of inclusion that periodically drew in a scattered population for ceremony and to reaffirm social ties. At the same time, individuals featured in central roles would have distinguished themselves from the populace. Inomata et al. (2020) point out that despite the architectural similarities between San Lorenzo and Aguada Fénix, the two exhibit markedly different political structures, with the former much more hierarchically organized. The shared architectural principles therefore spanned a range of political contexts.

While we cannot securely date the 119 MFPGs in our database, their architectural coherence with a few excavated centers implies Early and Middle Formative construction. We propose as a subject for testing that many were built sequentially. If the goal was integration of a regional population through participatory labor tasks, the act of plaza construction was as important as the final product. As Middle Formative populations became more reliant on agriculture, marking territories with enduring symbols of group membership likely became increasingly important.

Some landforms supported several Formative plazas packed over a relatively small area (Figures S1.5.1 and S1.5.2). Based on their varied orientations, these were likely constructed and used at different times, perhaps by the same groups of people reusing the landform over generations. With regional population densities much lower than during the Classic period, we find it implausible that all structures on some packed landforms were used contemporaneously. Some MFPGs are little more than a large rectangular depression into a floodplain terrace that

could have been constructed in mere days. Other MFPGs show indications that auxiliary structures were added over time, especially those containing rows of low platforms arranged around the main plaza (Figure S1.5.1B). This configuration might have functioned to house periodic pilgrimage assemblies, not unlike what Sassaman (2005) has proposed for Poverty Point in Louisiana, or Silverman (1994) for Cahuachi in Peru. The Mapuche in Chile continue to build mounds today as a participatory activity to maintain social ties and link social membership to places on the landscape (Dillehay 1990). The Gulf plaza groups that did not leave substantial architectural remains may have been short-lived meeting places, not unlike the temporary ceremonial aggregations formed by the Mapuche during moundbuilding occasions.

Architectural Continuity and Change: Late Formative and Protoclassic

Later architectural elaborations began in other places in the Veracruz lowlands during the Late Formative period, but they are fewer and farther between. Architectural groups dating specifically to that time period are not well known, with the exception of Tres Zapotes, in part due to continued rebuilding that obscures earlier architectural patterns (e.g., Cerro de las Mesas [Stark 2021]).

One clear contrast between Formative and Classic period architecture concerns plaza size (Figure 3). MFPGs are very large ($\mu = 31,102 \text{ m}^2$) compared to the Classic period Long Plaza Groups (LPG; $\mu = 2309 \text{ m}^2$) built later in the same region. Likewise those of the Late Formative Tres Zapotes Plaza Group (TZPG; $\mu = 21,991 \text{ m}^2$) and Protoclassic Monumental Plazas ($\mu =$

24,476 m²) are several times larger than the plaza areas of the Classic period Standard Plan Plaza Groups (SPPG; $\mu = 4366$ m²) constructed later in the same areas.

Figure 3. Box-and-whisker plot (outliers not shown) of primary plaza areas (in square meters) arranged over time with the oldest on the left. MFP = Middle Formative Plaza; TZPG = Tres Zapotes Plaza Group; MP = Monumental Plaza; SPPG = Standard Plan Plaza Group; LPG = Long Plaza Group.

Aside from diminished plaza size, there are a number of similarities between Formative and Classic architectural configurations. Almost all Classic plaza groups continue a trend seen at La Venta or FAC1110 with a large temple occupying the proximal end of the plaza. In southern Veracruz, LPGs present rectangular plazas with lateral edges enclosed by long mounds that span

its length. The distal ends of LPGs are framed by transversely oriented long mounds, another temple mound, or other possibilities (S2.2 and 2.3). Monumental platforms often occur beside the medial segment of one of the lateral long mounds, similar to the position of “wings” of the VC pattern (Inomata et al. n.d.). As at La Venta, LPGs sometimes exhibit chains of secondary or tertiary plaza groups of diminishing sizes.

Farther west, the Tres Zapotes Plaza Group (TZPG) represents an independent architectural trajectory (Pool 2008; Pool and Loughlin 2015). Tres Zapotes overlaps with the occupations of San Lorenzo and La Venta (Pool et al. 2010), and there are clear indications of interaction among the three centers, including ceramic exchanges and categories of monumental art (Pool et al. 2017; Porter 1989). The TZPG consists of a large plaza with a conical temple mound at one end, a single long mound along one lateral edge (the other edge left open), and a pair of platforms aligned in sequence at the distal end. Three mound groups within Tres Zapotes present this pattern by the Late Formative period, but excavations there show construction reaching back to the Early Formative (Pool et al. 2010).

The pattern of a plaza enclosed by only one lateral long mound is not uncommon in the western Tuxtla mountains (Stoner 2011, pp. 313-314) or the Papaloapan Basin (Stark 2021), but the latter tend to date to the Late Classic (Stark 2021). In our remote sensing work, we have identified 15 possible TZPGs in the survey area outside Tres Zapotes itself, but they can be hard to distinguish from SPPGs with an open lateral (S1.6).

Other Late Formative architectural plans emerged in the Tuxtlas Mountains, including at Cruz de Vidaña in the southern Tepango Valley (Stoner 2011) and Chuniapan de Abajo in the Catemaco Valley (Santley et al. 1997; León 2016). Both of these architectural complexes

continued in use through the Classic period, but show peak occupation during the Late Formative and architectural ballcourts that may be among the earliest in the region.

Early examples of the Classic SPPG occur farther north. In the western lower Papaloapan Basin (WLPB); Central Cerro de las Mesas and some of its extensions (Cerro del Chivo, Ojochal North) had SPPGs associated with abundant Late Formative pottery (Stark 2021). In the Cotaxtla-Jamapa Basin (Daneels 2016), La Joya and Dos Bocas show similar developmental histories in that Classic plaza groups likely developed out of monumental construction extending back to the Late Formative.

Monumental Plazas consist of three monumental structures of similar sizes situated around a large open plaza (Daneels 2016, pp. 312-315). We identified 24 candidates that fit the general definition, but many of those are connected to Classic period architectural plans. Chalahuite in the extreme north of the study area, presents an enormous, roughly square plaza group that may have been under construction as early as the Middle Formative (Lira 1999; Figure S2.3.6). Monumental constructions at Cerro de las Mesas likely began during the Late Formative in the form of a Monumental Plaza that was later filled in with other structures (Stark 2021). Excavations of mounded architecture conducted by Daneels (2016) identified construction activities for a Monumental Plaza at La Joya dating at least as early as the Protoclassic period. Another candidate that lacks dates is the Tlalixcoyan Monumental Complex that consists of three monumental platforms arrayed around a large square plaza (Stoner et al. 2021).

Classic Period Urbanism in the Gulf Lowlands

In most regions of the Gulf lowlands, populations and monumental construction peaked during the Classic period (Daneels 2016; Killion and Urcid 2001; Loughlin 2012; Santley and Arnold 1996; Stark 2021; Stoner 2011). The exception is the Coatzacoalcos drainage where researchers propose an occupational hiatus for the Early and Middle Classic periods (Borstein 2001; Symonds et al. 2002; but see S1.7). We consider expanding scales of analysis to address Classic urbanism: individual structures and their services; arrangements of those structures; regional patterns that provided tiers of services within a settlement system; and macroregional patterns that reveal social networks and boundaries.

Structures and their Functions

We establish an inventory of structures and spaces that appear repeatedly in standardized architectural layouts. Although we discuss their primary functions, many likely were multi-functional. Architecture appears today as earthen mounds, but many originally possessed perishable superstructures.

Temple Mounds. Steep-sided conical or pyramidal mounds have an area on top too restricted for any structures aside from a small ritual structure. Temple mounds are tall ($\mu = 9$ m across the study area; $\sigma = 4.3$ m), but at small complexes they may be much lower, with their position in a standardized arrangement, indicating their function.

Temple mounds are widespread in Mesoamerica; their rituals had different periodicities in accord with sacred calendric cycles (e.g., Berdan 2005, pp.141-146; see S1.8). Individual temple mounds usually were associated with a particular supernatural in a pantheon, sometimes as a patron(s) for the community (e.g. Lucero 2007, p.409; Townsend 1987, p.375). Sponsorship of rituals and temple construction and maintenance had important social and economic repercussions for the social groups associated with them (Berdan 2007; Carmack 1981, pp. 224-231).

At Gulf centers, local elites or rulers likely orchestrated temple construction and rebuilding. Housing for attendants and priests may have been at other plaza structures or those contiguous to the main plaza; responsibility for maintenance may have fallen on religious personnel and on corporate groups. Temple rituals also had political roles through participation by rulers in ceremonies or investiture in office (e.g., Aztec investiture, Townsend 1987, pp. 380-407).

In the Maya area, some temples were funerary, commemorating a link between dynasts and sacred powers or their apotheosis (Coe 1956), but they are not in the majority (Lucero 2007, pp.412-413). In the Gulf area, excavations into temple mounds are scarce, but Daneels and Ruvalcaba (2012, p. 86) report a case of funerary use at the site of La Joya (see also Daneels 2016, pp. 129-131, 148).

Rituals at temple mounds and associated processions were particularly accessible to the populace because of the proximity to plaza assembly space. Overall, temple mounds provided a powerful attraction to periodic assemblies that could also coordinate with ballgames and markets.

Architectural Ballcourts. The ballgame was an institution with roots going back to the Early Formative. It had multiple layers of significance: a competitive sport, a sacred ritual of cosmic renewal (Tedlock 1996; Schildkraut n.d.; see S1.9), a framework for political interactions (Agüero and Daneels 2009; Daneels 2016; Scott 2009; Venter et al. 2019), and an event attracting observers and participants who may have wagered on outcomes with resulting circulation of resources (Fash and Fash 2007).

Architectural ballcourts consist of two elongated parallel mounds (sometimes with one or two end platforms forming a T- or I-shaped playing alley [Thompson et al. 2009])(S1.10). Early and Middle Formative courts have been confirmed on the Pacific Coast (Hill and Clark 2001), in the Basin of Mexico (Serra and Ramírez 2001), and in Oaxaca (Blomster and Sálazar 2020). Possible early Gulf ballcourts, not confirmed, have been noted for the site of Macayal, west of El Manatí (Rodríguez and Ortiz 2008, p. 459).

Analyses of angles of sight toward the playing field, considering crowd interference, show that many fewer people could watch the game compared to crowds accommodated in the main plazas (Stark and Stoner 2017). We suspect that initial and concluding ceremonies bracketing games were conducted outside the court in the main plaza and could be observed by more attendees. It is clear through the proliferation of ballcourts (389 confirmed in the study area), figurines of ballplayers (Cheetham 2009), stone depictions of individuals with ballplayer gear (Cyphers 2004), and ballgame paraphernalia (Ekholm 1946, 1949; Proskouriakoff 1954) that the game was a prominent attraction for the people of Classic Veracruz.

Long mounds. Primary plazas commonly feature elongate mounds on both sides, sometimes of different sizes, but some plazas possess only one. The functions of long mounds in the Gulf lowlands remains uncertain, but analogy to similar Maya structures suggest that they

might have supported multi-room buildings that served corporate and administrative functions (Stark 2016). Elongate council structures (*popol nah*) are present at some lowland Maya centers (Stomper 2001; Cheek 2003). Carmack (1981) provides highland Quiché Maya examples that were tied to lineages. Excavations at Tres Zapotes yielded some residential trash on the northern long mound of Mound Group 2 suggesting that they had either full-time or intermittent residents (Pool 2008, p. 133). We treat laterals as tied to corporate groups with some range of administrative and ritual roles.

Plazas. For our purposes, open areas framed by orthogonal arrangements of civic mounds are plazas. Many primary plazas contain additional plazas attached to them in two principal ways: chained and contiguous (S1.11). Chained plazas are laid out in a linear sequence of diminishing size along the axial line, common in southern Veracruz. Contiguous plazas extend from the main plaza laterally or from plaza corners. Contiguous plazas vary in their bounding structures and often are much smaller than the main plaza, suggesting that they might have catered to more restricted segments of the population.

Plaza space is flexible and likely multi-functional. Assemblies could conduct or witness political or ritual ceremonies, including those atop structures fronting the plaza. Processions, dances, and feasts also may have occurred there, along with periodic marketplaces. Plaza area is a guide to the maximum number of people who could be accommodated to witness or participate in civic and ritual affairs.

Monumental Platforms. Nearly square to more rectangular proportions characterize these large structures, which have flat tops that often support additional mounds. Monumental platform footprints are the largest of all mounds considered here. They can have heights ranging from

three (if covering a large area) to 29 meters. The volume of these platforms typically exceeds the volumes of temple mounds (S2.2.1).

The activities on monumental platforms were likely diverse. They may have been elite palatial residences, but also administrative locations of elite affairs involving landholdings and client families (Daneels 2008; Stark 1999). Many monumental platforms supported temples, long mounds, U-shaped structures, altars, or other structures that added functions beyond elite residence. Additionally, a large number of monumental platforms possess small plazas flanking one side that were likely used to entertain important guests or conduct socially restrictive rituals.

Other Platforms. A wide range of other platforms of different sizes and shapes occur throughout the region (S2.2.1). Most low mounds with rounded plans supported houses, but when incorporated into FACs, their function could have included non-residential services. Altar mounds, which also appear as low platforms, are occasionally identifiable along the centerline of formal plazas.

Marketplaces. Marketplaces may have been daily or periodic. Conclusive identification of marketplaces is challenging, and an active subject of research (Hirth 1998). Some Gulf studies for the Classic and Postclassic periods have identified goods distributions reflecting open exchanges (Hirth 1998; Ossa 2013; Stark and Ossa 2010). Chemical characterization of ceramics and obsidian have identified regional systems of production and exchange that imply market systems (Stark et al. 2016; Stoner 2013).

Classic Period Architectural Arrangements

Two predominant Classic-period arrangements have been identified through regional surveys (Figure 4; S2.3). For south-central Veracruz, Daneels identified a “Standard Plan” in her lower Cotaxtla-Jamapa survey (Daneels 2002, pp.175-178; 2016, pp. 207-215), originally defined as a nearly square plaza with a large temple at one end, long mounds framing one or two lateral edges, and a ballcourt across the plaza opposite the temple. Accompanying components are a secondary plaza group adjacent to the primary plaza and/or a monumental platform or a temple on a platform situated within 200 m of the plaza. Artificial ponds, borrow pits into clay-rich soils that then filled with water, typically surround parts of the main plaza. In our coding, we refer to a Standard Plan Plaza Group (SPPG), rather than the entire package of traits originally defined. A number of variants have been identified in south-central Veracruz, including one where the temple is replaced by a monumental platform (Daneels 2002, pp. 181-182; 2016, p. 216), and partial SPPGs that are missing one or more elements, particularly at lower ranked centers (Stark 2021).

The SPPG arrangements incorporate a principle of duality. The ballgame, with its two flanking mounds and two teams is one example. The two lateral mounds also present a dual principle, perhaps ranked because one lateral is almost always higher than the other; a moiety principle could be involved. Additionally, a cosmogram may be represented, with the temple at one end of the plaza as a sacred mountain ascending to the celestial realm, and, at the opposite end, the ballcourt, where the game symbolized life, death (entry into the underworld), and rebirth, with the intervening lateral structures tied to civic affairs of this world. Ponds that partially or fully surround major architectural groups also reference the underworld and

associated water deities (e.g., Cipactli) with above-ground structures mirrored in the water creating a parallel world below (Daneels 2020).

Figure 4. Idealized comparison between the Standard Plan Plaza Groups and Long Plaza Groups.

A related plaza group configuration has been characterized in southern Veracruz (Borstein 2005; Symonds et al. 2002, p. 110; Urcid and Killion 2008). We follow Urcid and Killion (2008) in referring to this configuration as the Long Plaza Group (LPG). The main differences from the SPPG include an elongated rectangular plaza framed by equally long lateral mounds; a single ballcourt mound positioned parallel to, and outside one of the lateral long mounds; and a platform, temple, or transverse-oriented long mound occupying the distal end. Monumental platforms tend to be contiguous to the core LPG mounds and conform to more regularized positioning in the core architectural grid than their counterparts in south-central Veracruz. Finally, the LPGs more often feature linear chains of plazas arrayed along the architectural axis, often decreasing in size with distance from the primary plaza.

Architectural Boundaries and Networks

We interrogate our database, compiled from both published maps and remote sensing data, to provide a continuous picture of architectural variation across space (see S2.4 and 2.5 for individual attributes). Here, we present zones of architectural similarity and difference among primary plaza groups. Through an iso-cluster procedure based on normalized kernel densities (see S2.5), we identify three clusters and three subclusters based on the distribution of 16 architectural attributes (Figure 5).

Figure 5. Map of the study region (excluding geographic outliers) showing the iso cluster solution (polygon areas). Triangles are major published centers for reference.

Architecture, like all material culture, is a form of non-verbal communication (Rapoport 1990). Further, the participatory nature of building and using public plaza groups subjects their planning to cultural constraints rooted in historical values shared among neighbors across the region. Architectural standardization across space provided leaders and ritual specialists with a setting known to their constituents, with parallel examples seen among modern religious

buildings (e.g., cathedrals or mosques). If people came from distant locations, a familiar grammar of structures and spaces would facilitate interactions and promote a sense of inclusion.

We argue that the high degree of conformity seen among neighboring temple plaza groups shared cultural values and a high degree of interaction. Families would have frequented the closest plaza group, but periodic attendance at those more distant might have satisfied a hierarchy of needs. With permeable boundaries, cross-cutting social ties could be maintained, whether kinship or commercial. In addition to standardization of architectural styles, this dynamic social landscape is indicated by other shared material culture styles across broad regions (e.g., Daneels 2016, pp. 320-324; Medellín 1960; Reyes 2014; Stoner and Pool 2015). Even where style boundaries are apparent, other data have shown cooperative economic exchanges across them (e.g., Stoner 2013).

Equally supportive of the cooperative nature of relationships over broad areas is the lack of evidence for systemic warfare. Defensive measures (fortifications, settlement buffer zones) were rare. Only a minority of plaza groups in our study were located on hilltops or prominences, and many of those likely were due more to the landforms available for construction than for defense. Less than one percent of Classic plaza groups display anything resembling a surrounding wall, and those low embankments would not function for defense without the addition of a wooden fence on top (untested) (S1.12). The vast majority of plaza groups prioritized centrality and ease of access: located in valley bottoms, along rivers, with common residential mounds clustered around them.

Two major zones of interaction thrived during the Classic period (S2.5). The first involves Subclusters 1.1 and 1.2 and moves from west to east, likely traversing the coastline rather than the swampy wetlands of the Papaloapan Basin. Budar (2017; Budar and Becerra

2019) has proposed a port of trade at La Perla on the northern coast of the Tuxtla Mountains, providing a rare glimpse at thriving coastal interactions. The southwest Tuxtlas Massif and the eastern lower Papaloapan Basin conforms rather closely to the architectural conventions found farther northwest. The second interaction zone consists of Subclusters 2.1, 2.2, and 2.3 covering the eastern portion of the study area.

Between the two major zones, Cluster 3 combines traits from both Clusters 1 and 2. This type of interpenetrated distance-decay pattern is expected of down-the-line interactions among neighboring peer polities (Renfrew 1977, 1994) with permeable boundaries between them.

Abrupt spatial transitions between architectural zones would signal social boundaries and reduced frequency of social interaction. An abrupt boundary transition appears between Clusters 1 and 2 along a segment of the Camarón River that connects a series of small lakes. This wetland landscape might have facilitated canoe transport along the river, but limited lateral travel. Likewise, a boundary zone appears on the north coast of the Tuxtla Mountains, where the western half conforms more to the SPPG architectural pattern (Cluster 1), and the eastern half more to the LPG (Cluster 2). Teotepec on the northern edge of Lake Catemaco incorporates aspects of both layouts (Arnold et al. 2016). From Lake Catemaco south, SPPG architecture is nearly absent. This represents a hard boundary marked by the very rugged volcanic terrain.

Jurisdictional Proliferation over the Classic Period

Classic-period settlement across the Gulf lowlands expanded from major Late Formative and Early Classic period centers. From north to south, Chalahuite, La Joya, Tlalixcoyan, Cerro de las Mesas, Tres Zapotes, Totocapan, Matacapán, Teotepēc, and Piedra Labrada all display relatively early occupations that developed into the largest and most monumental Classic period centers in their respective regions (Arnold et al. 2016; Budar and Becerra 2019; Daneels 2016; Lira 1999; Pool 2008; Santley and Arnold 1996; Stark 2021; Stoner 2011; Stoner et al. 2021).

A similar process later took place south and east of the Tuxtla Mountains. Urcid and Killion (2008) note an increase in monumental activity during the Middle and Late Classic. Symonds et al. (2002) and Borstein (2005) argue for a Late Classic reoccupation in the Coatzacoalcos Basin following a hiatus spanning the Late Formative through Early Classic. More recently, Ortíz (2016) recognized a minority of Early Classic ceramic types at Laguna de los Cerros, which might nudge back the reoccupation process.

We liken this pattern of center-out growth to jurisdictional proliferation (Freemark et al. 2020) seen in modern cities, in which urban zones are subdivided into localized administrative districts over time. Today, such processes keep decision-making and resources (e.g., taxes) closer to the stakeholders in neighborhoods or districts of cities. This process weakens centralized authorities to some degree and may lead to resource hoarding. The Gulf lowlands exhibited a similar process where relatively few early capitals later saw a proliferation of smaller plaza groups around them. This center-out pattern of growth spread through the popular SPPG and LPG architectural plans and, by association, the ballgame. In the western Papaloapan basin, proliferation seen in the hinterland surrounding Cerro de las Mesas contributed to its reduced political influence by the Late Classic. We explore other effects of this proliferation over the following sections.

Plaza Group Ranking and Service Areas

The Classic Gulf lowlands never hosted a territorially expansive state. Instead, relatively small polities rather closely conformed to physiographic boundaries, such as drainage basins (Figure 6). Given the lack of contextual and chronological control for remote sensing, we set our analysis at the largest-scale unit held in common among all data types considered: the plaza group.

We caution that the plaza group ranking does not necessarily map directly on to political territories. In some instances, multiple plaza groups should be considered part of a single site core (e.g., Tres Zapotes, Cerro de las Mesas, Totocapan).

We establish a ranking system for plaza groups that employs the area covered, relative monumentality, and building inventories (S2.6.1). Within ranks, plaza groups are functionally equivalent regarding the services that they provide to their hinterlands. Rank 1 plaza groups provided the most diverse and highest-order services as identified through building inventories and their relative monumentality. Rank 2 plaza groups provided the same services but likely targeted a more localized district judging from their smaller size and monumentality. Rank 3 and 4 plaza groups only provided a subset of the services because they lack one or more categories of buildings (e.g., ballcourts).

We present a map of the region with Rank 1 Classic period plaza groups allocated service areas using Thiessen polygons (S2.7). The median size of a Rank 1 plaza group's service area is

257 km². By way of comparison, Daneels (2016, p. 286) calculated polity territories as ranging from 55 to 96 km² (with extremes of 20 and 199 km²) for the Cotaxtla-Jamapa drainage in the Late Classic, and de Montmollin (1995, p. 257) described Late Classic Upper Grijalva tributaries as presenting microstate polities between 50 to 200 km². Our calculations are slightly larger due to the more distantly separated centers around the edges of the study area. A nearest-neighbor analysis reveals an average separation of Rank 1 plaza groups of 9.8 km (Average Nearest Neighbor Ratio: 0.95; z-score: -0.95; p-value: 0.34). The area of a 5 km radius circle is 79 km², inline with the other estimates.

A few areas with a sequence of multiple capitals and dense FACs have been described as “capital zones” (Stark 1999; S1.13; S2.6.2). We calculated the kernel densities of plaza groups surrounding each Rank 1 plaza group in the region at 1 km, 2 km, 4 km, 8 km, and 16 km radii and then expressed those values as an index of the number of plaza groups at different distance thresholds. We calculated two slopes, an inner slope within 4 km radius and an outer slope from 4-16 km radii. The cut off from inner-outer is near the average size of a Rank 1 service area: densities larger than 5 km reflect an overlap among closely spaced Rank 1 service territories. The two capital zones that have been named in the literature (the regions surrounding Cerro de las Mesas and Ajitos/Pitos) are quantitatively justified as they possess high densities of plaza groups at all distance thresholds, but they appear to be exceptional in the larger database. Rank 1 plaza groups in other regions, such as the Tuxtla Mountains, possess low inner and outer slopes, showing relatively discreet centers spread farther apart with few subordinate plaza groups in their hinterlands. The dominant trend elsewhere in southern Veracruz is a low-slope inner territory and a high-slope outer territory, which reflects closely packed Rank 1 plaza groups with few subordinate plazas within 4-km radius.

Figure 6. Primary plaza groups ranked according to monumentality, complexity, areal extent (S2.6.1). This is a palimpsest that does not consider chronological shifts in rank over time in due to a lack of dates for most regions. Territory color gradients represent a five-part classification of densities of FACs.

The distance calculated between Rank 1 plaza groups is significantly smaller than the distance between political capitals noted elsewhere. Hansen (2000) compiled cross-cultural data on city-states to demonstrate a 30-km rule for distance between political capitals. Rosenswig (2021) supports this finding for the Soconusco region on the Pacific Coast. Within the Gulf lowlands, Urcid and Killion (2008) argue that the distance between the largest Classic centers in southern Veracruz was 45 km.

Examples show how problems arise when inferred political boundaries are drawn from the top down: assuming a set territory surrounding a hypothesized political center (see also Montmollin 1995, 249-267 concerning microstates). Stoner notes in reaction to Urcid and Killion (2008, p. 272) that the territory allocated to Matacapán/Teotepēc ignores Totocapán at its northwest margin. Totocapán was a primary center using any criteria, and perhaps larger and more monumental than Matacapán. Stoner (2011, 2012; Stoner and Pool 2015) used XTENT modelling, geospatial analysis, rank-size graphs, and architectural and material culture styles to suggest that Totocapán, Matacapán, and Teotepēc were sovereign entities. The three centers were separated by an average of 8 km, far below either the 30 km rule or the 45 km threshold identified elsewhere.

Another example involves Laguna de los Cerros, which Urcid and Killion (2008) also identified as a primary center following a 45-km nearest neighbor model. Our remote sensing efforts identified two new centers 15 and 20 km from the site that were as large or nearly as large. Based on very close architectural similarities (Figure S1.14.1 compare A and C) one of these centers might fit within the same political network, but the other shows a very different, radial architectural pattern.

More than distance, it is important to consider that territories linked into a polity or political network should exhibit cultural similarities (de Montmollin 1995, 63-64; Rosenswig 2021). There are many cases where material culture delimits broad style zones that could be used to reconstruct social and political networks. The iso-cluster analysis presented above is one example. Treating each non-contiguous iso-cluster polygon individually, their average coverage is about 1700 sq km (range 248-5615 sq km). For reference, a circular territory of 15 km radius (30 km between capitals) covers 707 sq km.

We do not propose that our iso-cluster areas were synonymous with political territories. They are zones of shared architectural planning identified through our process of coding and clustering (multivariate analyses of artifact traits can play a similar role [e.g., Mills et al. 2013]). Each zone contains dozens of plaza groups, and in most cases no single plaza group could represent a capital of a territorially bounded polity. This situation contrasts with city-states – self-sufficient political territories with a sovereign capital town surrounded by a rural hinterland (Charlton and Nichols 1997, p1.) Gulf plaza groups are not towns in the usual sense but focal points drawing the dispersed regional populations into a habitual pattern of centripetal movement. Average distance from any household to a Rank 1 center is 5 km; average distance to a plaza group of any rank is 1.25 km.

Most households had only a short walk to access public services. However, the Gulf region is seasonally dynamic with a variety of productive ecological niches distributed over broad areas. The small areas covered by Rank 1 service polygons would not have provided direct and independent access to the full range of Gulf resources. We suggest that larger networks of interaction, as represented through shared architectural and material styles, maintained open

access to different productive niches. Low-density cities in the tropics might not fit into neatly defined political territories.

A variant approach to settlement hierarchies, also attribute sensitive, first considers how to group FACs into centers, then compares the sizes and inventory of structures, formality of arrangements, distances to other complexes, and any evidence of site boundaries (Stark 2021). A result for the western lower Papaloapan is a settlement hierarchy with an abundance of secondary centers, consonant with the evidence we present of a distributed urban network.

The Veracruz case suggests that archaeologists may need to change how they approach political hierarchies, territoriality, and patterns of interaction in this and perhaps other instances of low-density cities. Above, we describe architectural and communication networks: not political territories, kingdoms, or city-states. Among the Rank 1 plaza groups in the network, there is little to suggest that any one ruled its neighbors in most cases. The distributed urban network concept leaves notions of territoriality and sovereignty open but recognizes interconnectedness among nodes.

The rulers in these centers likely did not possess great coercive power, nor command a standing army. Their authority was presumably persuasive, oriented towards attracting the largest congregation possible. Open economic and kin relations would yield a situation in which a single family need not pertain to, or engage with, only one plaza group. Ultimately, these congregation nodes might have become the foundation of a more coercive type of power, but we have little evidence that this happened frequently during the Classic period. An emphasis on viewing territories from the top down assumes a relatively centralized system that challenges the distributed urban networks that characterize many low-density cities (Scarborough and Isendahl 2020). We return to this point later.

Integration through Plaza Group Hierarchies within Rank 1 Thiessen Service Areas

To emphasize subregions that exhibit the greatest investment in monumental architecture per unit area, we calculated join-counts of FACs (represented by points) within each Thiessen territory and normalized them to polygon area. We then classified the density of FACs within territories according to their standard deviation, resulting in five classes (represented as a color gradient in Figure 6). Lower density classes naturally display fewer centers of monumental construction per km². However, on average, each class displays a relatively equal representation of lower-order plaza groups across Ranks 2-4, showing that most polygons internally possessed an integrated hierarchy.

Drainages that exhibit packing of monumental complexes include the northern part of the study area from the Jamapa River through to the northern margin of the Papaloapan River floodplain (Daneels 2016; León 2015; Stark 2021; Stoner et al. 2021). The second area of monumental packing is to the south of the Tuxtla Mountains along the San Juan Evangelista River (Borstein 2001; Delgado 2014; Domínguez 2001; Urcid and Killion 2008). We caution that our ability to gain a clear picture of plaza group configurations is limited in some areas due to remote sensing resolution in heavy vegetation (S2.1).

The centralization of authority within Rank 1 service areas is difficult to demonstrate for the whole dataset without generating additional data. Daneels (2016) uses volume measures for mounds within her territories to construct rank-size curves. She determines for the Cotaxtla-

Jamapa basin that centers such as La Joya and Colonia Ejidal appear to have more centralized political control within their territories. Others, like Cerro de don Crispín and El Castillo, display an approximate log-normal distribution, indicating a well-integrated hierarchy. Some territories have too few points for a conclusive rank-size graph. None of the individual territories Daneels examines displays a convex curve above the log-normal distribution, which would indicate divided authority among multiple centers. Across her entire survey area, the bigger picture is of a segmented political landscape where Rank 1 centers served equivalent functions for their hinterlands (S1.15).

Using similar methods, Santley and Richards (2007) showed that Matacapán in the Tuxtla Mountains was a strongly primate center in the Catemaco Valley in terms of area, inferred population, and monumentality. In the neighboring Tepango Valley, Totocapán was also a primate center within its territory (Stoner 2011). Like the Cotaxtla-Jamapa basin, however, the southwestern Tuxtla Mountains at the broader scale present segmented authority among political peers that were networked together. Between the territories of Totocapán and Matacapán, Tilzapote (Rank 2) participated in the material culture styles of both larger centers, demonstrating permeable and overlapping boundaries open to movement of ideas, symbols, people, and goods (Stoner 2012, 2013; Stoner and Pool 2015).

By the Middle Classic period, the basic pattern across the Gulf lowlands consisted of core territories focused on a primary center that is clearly much larger than lower ranked plaza groups that surround it (with some exceptions). At a regional scale, however, neighboring polities present a networked landscape of functionally equivalent primary centers, inferred based on their similar building inventories and monumentality, but showing integration across service areas through shared material and architectural styles.

Plaza Size and Integration

Another way to address the integration of regional populations is through comparing plaza sizes at different ranks in the plaza group hierarchy. Given that plaza size is directly proportional to audience capacity, it provides an index for the population that each center could serve (but see Ossa et al. 2017 who describe a scaling issue across ranks). We hypothesize three alternative models to interpret plaza size distribution in a territory (S2.8). Model 1 features a *hierarchy of plaza sizes* according to plaza group rank, with progressively larger plazas designed to periodically accommodate people from surrounding lower-ranked plazas. Model 2a interprets *parity in plaza sizes* to indicate that each plaza group, regardless of rank, catered to its own service area immediately surrounding it. An alternative interpretation to plaza size parity is Model 2b, in which the Rank 1 plazas hosted their own populations plus a subset of subordinate populations, possibly elites or lineage heads.

There is a clear pattern of diminishing average plaza size across the region according to rank (Table 2). On average, however, the Rank 1 plaza size is only 40 percent larger than that for Rank 2 plazas. We are inclined to interpret this through Model 2b because primary plazas boasted greater capacities than subordinate centers, likely accommodating its own population plus important persons from other territories, but were not large enough to host the entire population of the subsidiary area (with a few exceptions). If the highest order services were

offered at the Rank 1 plaza, they were either intended for a restricted population from lower ranked jurisdictions or they could have hosted the larger population through sequential events.

Table 2. Plaza area in square meters presented by plaza group rank.

Rank	Average Plaza Area
1	5628.3
2	3988.3
3	2114.5
4	1785.7
Total	3439.1

When we break the dataset into individual service areas we can find examples of all the plaza models (Table S2.8.1). Several display areas for Rank 1 plazas capable of hosting over half the capacity of all subordinate centers summed. Laguna de los Cerros and FAC 158 possessed greater plaza capacities than their subordinate plaza groups combined. The main Cerro de las Mesas plazas equal an area of 85 percent of the sum of its 15 subordinate plazas. The Tlalixcoyan Monumental Complex plaza area is 68 percent of the sum of the 19 subordinate plazas (Stoner et al. 2021). These are the best examples of a Rank 1 plaza group capable of serving the general populace for large, inclusive events, supporting Model 1. We also note that a plaza of such great size at the TMC exceeded the space demands of the inferred population in the Tlalixcoyan Basin (see “*Population Densities*”).

At the bottom end of the range are Rank 1 plaza groups with capacities that are clearly not designed to be inclusive of the entire countryside. These tend to be where the greatest proliferation of subordinate centers occurs. El Calabozo in the southern Tuxtlas piedmont, determined by Urcid and Killion (2008) to be Rank 1 within their survey area (but likely

subordinate to Laguna de los Cerros), displays a relatively small plaza roughly equal to the size of others in its territory. Those Rank 1 plaza groups that fall on the low end of the range served only populations immediately surrounding them. At the regional scale, however, those plaza groups lacked hierarchical structure (Model 2a).

The majority of Thiessen service areas show intermediate plaza ratios: median value of 40 percent. This shows that most primary plazas could incorporate a little less than half the plaza capacities of all subordinate plazas summed. This could be interpreted through either Model 2a or 2b. We note, however, that Rank 1 plaza groups were likely constructed long before many of the subordinate plazas and might not reflect intentional region-wide planning.

Ballcourt Distribution and Control of the Ballgame

Santley et al. (1991) argued that the number and distribution of ballcourts is directly related to the degree of political centralization. A single centrally placed ballcourt in a region would indicate control of the game and associated rituals, whereas proliferation of ballcourts at local complexes would decentralize this crucial game, with implications for the dispersal of political authority.

We have identified 389 ballcourts in the study area, of which 300 were part of primary plaza groups that have been ranked into the plaza group hierarchy (Table 3; Figure S2.4.1.1; S2.9; see also S1.16). Only thirty-nine of those ballcourts were solo examples in their respective

Thiessen service areas. These could represent centralized polities, with some exceptions where low resolution of remote sensing information prevented thorough detection of ballcourts.

Conversely, where remote sensing and pedestrian survey provide a more complete reconstruction of ballcourt patterns, we see multiple ballcourts distributed throughout each Rank 1 service area. Better known examples include the Ajitos, Tlalixcoyan, El Calabozo, and Cerro de las Mesas territories, all of which are large centers that display a proliferation of ballcourts at lower ranked complexes surrounding them. Even very small, Rank-4 plaza groups have ballcourts in many regions (more common in southern Veracruz).

Table 3. Ballcourt position and frequency according to plaza group rank.

Ballcourt position	Rank 1	Rank 2	Rank 3	Rank 4	Total
Axial (SPPG)	23	60	28	6	117
Corner	5	6	2	2	15
Lateral (LPG)	47	56	52	12	167
Total	75	122	82	20	299

Daneels (2016, pp. 376-377) suggested that the popularity of the ballgame in south-central Veracruz spread through the proliferation of Standard Plans. We expand her statement to the entire study region, including the LPG in southern Veracruz. As architectural construction proliferated in the Middle and Late Classic, ballgame rituals became increasingly decentralized, and in parts of south-central Veracruz we observe a substantial pattern of ballcourts paired with palatial monumental platforms, which might indicate the elites' attempts to co-opt a public ritual institution (S1.16.1). While this could have weakened the authority of earlier centers, we do not currently understand what kinds of legitimacy rites that rulers in primary centers might have

managed for subordinates at lower-order plaza groups, a relationship better understood through inscriptions among the Maya (e.g., Demarest 2013).

Ballcourts across the study area have relatively standard sizes. We randomly selected a 10 percent sample from within strata defined by plaza group rank to record ballcourt length (30 percent at Rank 4 because of low sample size) (Table 4). Mean length of ballcourts found at Rank 4 plaza groups is only 11 m (20 percent) shorter than those at Rank 1 plaza groups. There is a subtle decline of ballcourt length with rank, but it is negligible compared to the great differential in total mound construction volume across those ranks. Ballcourt dimensions likely adhered more to certain regulatory principles than a desire to increase viewership. That is, ballgames at Rank 1 plaza groups did not host much larger viewerships than at Rank 4. Proliferation of plaza groups with ballcourts could represent an attempt to distribute the ballgame to a larger proportion of the population. Alternatively, it could represent a hierarchical pattern of aggregation in which only elites from lower order centers spectated the most important games at Rank 1 plaza groups. These alternatives are not mutually exclusive. Stark and Stoner (2017) showed that architectural ballcourts restrict visibility of the ballgame to a crowd size equal to about 10 percent of the capacity of primary plazas, so in no case was the ballgame a spectator sport to be viewed by large audiences simultaneously.

Table 4. Ballcourt length according to plaza group rank.

FAC Rank	Sample Ct.	Mean Length	Standard Deviation
1	7	57	9
2	11	50	7
3	8	47	5
4	6	46	7
Total	32	50	8

Population Densities

Population is hard to reconstruct for regions where families constructed perishable buildings directly on the ground surface. Where no architectural evidence of residences remains, researchers often derive population estimates by multiplying the area covered by a scatter of residential materials by some constant, such as five people per hectare. The limitation of such an approach is that population density is fixed. We provide two examples in which remote sensing or pedestrian survey enables identification of residential mounds, recognizing that (1) some residential mounds might have been missed or destroyed; and (2) some residences in those regions were likely not built atop earthen foundations.

Remote sensing allows a detailed reconstruction of residential mound densities in the Tlalixcoyan Basin (Stoner et al. 2021). Because this area is barely above sea level, building platforms up served a crucial role of keeping the house dry at times of intense flooding. Because non-mound residences were likely less common in this region, a tally of residential mounds provides a reasonable estimate of population. We calculate a range of 13,600-21,760 people in the region, or 2.46-3.34 people/ha (S2.10).

The area around Cerro de las Mesas presents a similar situation with houses situated atop low earthen mounds, and crews systematically counted surface sherds to identify artifact concentrations that could signal a residence even if no mound was present (Stark 2021). Using a

different set of assumptions, Stark (2021) arrived at populations for the central survey block of 12,000-15,000 people over 4,940 ha, resulting in density figures of 2.43-3.04 per ha (S2.10).

These densities are in line with estimates for some centers in the Maya Lowlands, but are at least ten to thirty times lower than highland centers and some other Maya cities (e.g., Drennan 1988; Feinman and Nicholas 2012; Smith et al. 2019). We cannot generalize these figures to the whole Gulf lowlands due to variable topographies and social contexts. In the Tuxtla Mountains, for example, settlement patterns are generally different due to topography: less continuous sprawl and more nucleation into sites (Santley and Arnold 1996). Conversely, the continuous sprawls of residential settlement across an area of 65 km² in the Tlalixcoyan Basin and 49.4 km² in the central Cerro de las Mesas survey block are much more expansive than many highland cities. Teotihuacan had a population density of about 53 people/ha over 20 km² (Smith et al. 2019).

Interpretive Issues Regarding Low-Density Urbanism in the Tropics

Given the general trajectory for Formative and Classic period urbanism we described, we next briefly address interpretive issues for low-density urbanism and the type of societies it fosters.

Environment and Agriculture in Relation to Gulf Urbanism

The Gulf tropical environment played a role in settlement dispersal, with implications for the low-density urbanism that developed there (Drennan 1988; Sanders 1971). Sanders (1971) pinned the limiting factor for high population densities in the tropics on the inability to intensify swidden agriculture due to the need to fallow and rotate plots. Swidden agriculture was likely practiced over the entire prehispanic sequence in the region, but many areas also exhibited more intensive agricultural production during the Classic period.

Most of the study area experiences a well-demarcated wet/dry seasonality. For the driest months, which combined received as little as five percent of annual precipitation (Gómez 1973), exclusive reliance on rainfall would have delayed the start of the agricultural cycle until June. Recessional agriculture, planting in moist fertile sediments as floodwaters receded, could have enabled cultivation during the early dry months. The lowest spots closest to the water table permitted cultivation even during the driest months, but only for a relatively small percentage of total land farmed (Stark and Ossa 2007).

Artificial reservoirs and natural sinks captured wet season water close to the fields for use into the dry season (Daneels 2020; Stark 2003; Stoner et al. 2021). Gravity irrigation over long distances was ineffective due to the relatively flat landscape, so water needed to be stored in or near fields. Water storage was facilitated by clay-rich vertisols that swell and become nearly impermeable when saturated. These soils helped trap the water at the surface where it was useful for “bucket”, splash, or localized canal irrigation. Larger artificial reservoirs constructed in axial alignment with monumental architecture, forming rectilinear ponds and moats, not only served ritual significance (Daneels 2020), but some of them fed into agricultural canal networks (Stoner

et al. 2021). Raised fields also functioned to trap water with the potential use of check dams (Daneels et al. 2005; Siemens 1998; Wilkerson 1997).

During the wet season, flood waters overwhelm the system. Across much of the Veracruz lowlands, prehispanic inhabitants mucked out sediment in grid or comb-shaped rectilinear patterns to form canals while raising the beds above the flood stage with fertile soils (Daneels 2020; Daneels et al 2005; Heimo et al. 2004; Schmidt et al. 1977; Siemens 1998; Wilkerson 1994). Stoner (2017) identified via satellite and LiDAR remote sensing 15,000 ha of raised fields scattered across the lowlands. Raised fields in the region were ideally located in slow drainage areas and along lower-order streams (Daneels 2020; Daneels et al. 2005; Siemens 1998; Stoner 2017, Stoner et al. 2021). Rapid runoff from higher-energy streams and rivers would have caused excessive erosion and increased labor demands for maintenance.

Based on a few radiocarbon dates and associations with temporally diagnostic architectural plans, the more intensive forms of agriculture do not appear until the Classic period (AD 300-800) (Heimo et al. 2004; Siemens 1998). Daneels (2020) argues that higher residential packing near monumental epicenters in the Cotaxtla-Jamapa drainage was an impetus for developing raised fields nearby. Stoner et al. (2021) also identify higher population densities closer to monumental architectural plaza groups, but in the Tlalixcoyan Basin raised fields were rather ubiquitous and not exclusively concentrated near architecture. In general, primary plaza groups occupied lower elevations, with a median elevation of 35 m AMSL and an interquartile range of 19-61 m AMSL. Geospatial correlations among raised fields, population packing, and monumental architecture in those regions support the notion that higher population densities could not be supported through swidden alone (Sanders 1971). We note, however, that monumental architecture and high inferred population densities occurred in some parts of the

Gulf lowlands without any evidence of intensified agriculture. There might have been alternatives, like ridged fields found at Catemaco and Matacapán (Santley 2007, p. 27), and hillside terraces overlooking the San Juan River (Sluyter and Siemens 1992).

The agricultural system carries implications for understanding the relatively open urban spacing. Reliance on extensive agricultural fields, with rotating fallow periods, and the emphasis on settlement proximity to fields spaced out residences across the landscape (see Smith et al. 2021). Critical resources are ubiquitous, with some exceptions, and not spatially or socially circumscribed (cf. Carneiro 1970). Common residential patterning involved houselots (Pool 1997) with ample space for activities surrounding the house (e.g., craft production, social gathering), surrounded by refuse disposal zones and kitchen gardens (Killion 1987; Pool 1997). Killion's (2013) ethnoarchaeological research on agriculture identified both infields and outfields at different distances from the houselot. Furthermore, the reliance on different landforms to take advantage of seasonal fluctuations in rainfall ensures that houselot farmers shifted geographic focus and agricultural techniques perhaps several times each year. Together, swidden, recessionary agriculture, and various intensifications could have sustained a large number of people in the Gulf lowlands, but their distributed nature contributed to dispersed settlement.

Governance

Initial overviews of political organization and principles in the Gulf lowlands were few and usually applied evolutionary stage concepts. Centers were evaluated in terms of chiefdom

and state concepts. Sanders (1971, p. 555-556) eventually posited small states in Tabasco during the Classic period, but elsewhere he thought Gulf centers were ceremonial, with religious and political activities; Wilkerson (1974, p. 91) proposed chiefdom organization until the Late Classic period. As the Olmec centers of San Lorenzo and La Venta became research preoccupations, debates became more pointed about whether they were seats of complex chiefdoms or early states (cf. Diehl and Coe 1995; Flannery and Marcus 2000).

A different approach to governance addresses political strategies. An initial formulation stressed corporate versus network (patron-client) principles (Blanton et al. 1996). Subsequently, Blanton and Fargher (2008) addressed collective action versus autocratic authority, with the sources of state revenues a decisive factor in which principle was emphasized. External or excludable sources of revenue led to autocratic opportunities, but internal resources produced by the populace meant people could influence governance via corporate groups and local actions.

We approach Gulf governance through discussion of these principles, but several caveats apply. First, we temper our expectations for how well principles can be reconstructed in cases lacking written documentation. Second, political strategies may vary according to rank in a hierarchy or across different social fields (e.g., subsistence economy, prestige economy, religion).

The Olmec era exemplifies the problems and advantages of considering political principles rather than evolutionary types. The colossal heads and other monuments at San Lorenzo, La Venta, and Tres Zapotes portray individual leaders with power to mobilize considerable labor. Leveling and construction on the San Lorenzo plateau and the construction of platforms and a temple mound at La Venta, along with offerings, suggest that secular power and ritual participation were facets of early leadership. For more local efforts, we have little

information apart from the offerings at Laguna Manatí, where wooden busts and polished axes show smaller-scale rituals within the scope of communities or extended kin groups. Cyphers (2008) notes that a few cases of smaller thrones/altars at secondary centers to San Lorenzo and La Venta suggest lower-level leaders subordinate to the main center and raise the possibility of delegation of authority, a process seen in segmentary state organization in which relatively loose ties link ritually prominent chiefs with lesser ones (Southall 1956).

Greater provision of public services is one monitor for collective action in governance (Blanton and Fargher 2008, p. 133). Two sources of data suggest limited provision of services other than rituals at Olmec centers. Recent obsidian analyses from San Lorenzo reveal household level variation in the mix of sources of this imported stone (Hirth et al. 2013). Consequently, the spheres of central power and rulers' activities do not appear to have permeated the economy. Instead, kin or other corporate groups seem to have developed and maintained their own procurement networks.

With remote sensing we now see a spectrum of Formative labor investment in large rectangular plazas, some with monumental construction but possibly without a residential population in the immediate vicinity. Orientations and amounts of construction vary and there is no signature of central control; instead, corporate groups (local or based across the region) seem the likely organizers (Inomata et al. 2020). Thus, the authoritarian, individualizing leadership emphasis at the top of southern Veracruz Olmec society co-existed with a substantial indication of communal collective actions in a wider framework and at lower settlement levels.

The still patchy and diverse data concerning the Late and Terminal Formative periods and the transition to the Classic period do not lend themselves to discussion of political principles, but we call attention to the indications of multiple similar-sized major structures in

the Monumental Plaza pattern, not a dominant structure that could suggest a single central authority. Three similar plaza groups at Tres Zapotes suggest important factions and diverse representation in decision-making (Pool 2008). During the Protoclassic to Early Classic period, Cerro de las Mesas likewise has multiple plazas, suggesting multiple corporate factions (Stark 2021).

During the Early Classic period, Cerro de las Mesas, despite the architectural indications of multiple factions, has carved stelae portraying important leaders (Stirling 1943), and the Protoclassic La Mojarra stela from a small center indicates this practice even earlier (Winfield Capitaine 1988). Other stelae, such as at El Mesón, also portray important leaders (stylistically likely Protoclassic). During the Late Classic, however, leader-themed stelae disappear, along with the Long-Count calendar frequently deployed in such sculpture. Late Classic imagery on some relief molded Río Blanco style vessels uses numbers and glyphs as names (possibly day signs, but not clear), but not the long-count (von Winning and Gutiérrez 1996, p. 124-125). Some Río Blanco style vessels show a file of important individuals, but most depict supernaturals or ballgame rituals, and scenes do not typically lionize leaders (von Winning and Gutiérrez 1996). Nevertheless, powerful elites continued throughout the Classic period, as testified by monumental palatial platforms, usually somewhat removed from main plazas (SPPG) or built into the main plaza group among both the SPPG and LPG format (Figure S1.17.1). In the Cotaxtla-Jamapa drainage, Daneels (2012) proposed dual leadership for one site based on the concurrent presence of two monumental platforms, one representing civil/political and the other religious authority.

The repeated SPPG and LPG arrangements continue evidence for both collective and autocratic principles through the Late Classic period, but with different emphases. Monumental

platforms were customarily separated from SPPGs (Daneels 2016; Stark 2021). For the most part, ruler's palaces (or those of other elites) are not directly associated with public religious, ballgame, and possibly market activities (Stoner et al. 2021). Laterals are candidates for corporate group representation positioned in the nexus of services. Analyses of the economy, especially widespread cotton and textile production in south-central Veracruz (Stark 2020), suggest that a central monopoly on a valued product suited to export would be hard to sustain. Cotton and textiles were a form of internal wealth production, which tends to be associated with more collective emphases in governance (Blanton and Fargher 2008, p. 251). Evidence of market exchanges also undermine the idea of a highly controlled economy (Blanton and Fargher 2010). Stoner and co-authors (2021) argue for the role of the SPPG in the collective management of raised fields, suggesting that the fields were common-pool resources. Several SPPGs in the Tlalixcoyan area were located along feeder canals that link reservoirs to the fields (Figure S1.18.1).

With the LPGs, monumental platforms are located in direct proximity to the service facilities, with standardized positions usually in the corners outside the main four mounds of the plaza. The direct association of palaces with public economic and ritual services suggests an authority more intrusive in the affairs of the populace. Nevertheless, multiple monumental platforms and replication of plazas sequentially within the same architectural complexes suggests factions within the society, which would act to curb an authoritarian principle. The linear mounds, as with the SPPG, are candidates to represent important corporate groups, and LPGs almost always possess two lateral long mounds of relatively equal size.

In sum, authoritarian governance was pursued throughout the Formative and Classic periods but in a (perhaps uneasy) balance with collective principles linked to corporate groups or

factions. Proliferation of plaza groups shows many local foci providing similar services that would decentralize authority. The spatial extent of the predominant layouts of centers suggests a relatively open network in which local actions and sponsorships played as large a role as any instigations or authorizations by leaders at primary centers.

As noted, changes occurred between the Early and Late Classic periods with an apparent waning of imagery focused on leaders. For the western lower Papaloapan Basin, Stark (2016) notes a Late Classic increment in plazas with a single lateral long mound, coinciding with a proliferation of monumental platforms; a shift in balance to more authoritarian or oligarchic organization may have occurred prior to the collapse processes and the end of the Classic architectural traditions. Nevertheless, the persistence of collective principles in governance and the extensive, open networks of similar layouts of plaza groups suggest that mixed governance contributed to the character and stability of Gulf cities.

Crafts and the Market Economy

Cities provide context for exchanges, and evidence of craft specialization and market exchanges is rapidly accumulating. By the Classic period, some evidence points to household or community-level economic specialization and market exchange.

Ceramics production at Matacapan reveals a diversified craft industry ranging from low-intensity production for household consumption to higher-intensity residential production for exchange (Pool 1990; Santley et al. 1989). Potters at Comoapan, the most intensive production

facility at Matacapan, built updraft kilns, rare in Mesoamerica, and they specialized in the production of Coarse Orange jars that were traded to many settlements in the region, including Matacapan's political peers, Teotepec and Totocapan (Pool 1990; Stoner 2013; Wilson 2016). In the western lower Papaloapan area during the Late Classic period, Fine Orange pottery was produced at Patarata 52 in the mangrove swamp (Stark 1989), and skewed percentages of orange-slipped bowls suggest their production to the west near Azuzules (Stark 2007).

Production of obsidian tools relied on import of obsidian cores. By the Late Formative period, long-distance obsidian exchange networks had become formalized, providing easy access to most regions of Mesoamerica (Blanton et al. 2005). In the western Papaloapan area, Stark and Ossa (2010) observe an absence of influence over blade distribution at Cerro de las Mesas, but Nopiloa and to a lesser extent Azuzules showed evidence of more centralized blade production. In the Tuxtla Mountains, obsidian processing at Ranchoapan (Barrett 2003) also points to a specialized community of tool producers.

The environmental diversity within the region would have further encouraged a diversified but interconnected economic network. Santley (2004) studied a community of salt producers at El Salado in the Tuxtlas. Seasonal wetlands presented one context for growing cotton (Daneels et al. 2005; Stark 2020). Lakes, estuaries, and the Gulf sea presented an abundance of aquatic resources.

Markets likely were established by the Early Classic, although market exchange need not have an architectural expression apart from plazas. Research in the Maya lowlands has suggested similar functions for plaza groups based on physical and geochemical data indicating the presence of stalls (e.g., Coronel et al. 2015), or other configurational, contextual, or distributional evidence (Chase and Chase 2014). Growing evidence for Gulf market exchanges (Pool and

Stoner 2008; Stark and Ossa 2010; Stoner 2013) provides another trait associated with stronger collective principles in governance (Blanton and Fargher 2010, 2016, p. 260).

Longevity and Collapse of Low-Density Urbanism in the Tropics

In this section, we highlight an apparent contradiction in the trajectory of urbanism in the Gulf lowlands. On one hand, cities were very successful, some boasting 2000 years of continuous growth. On the other hand, the Classic period Urban tradition rather suddenly ceased starting in some locations around AD 800.

The 2000-year period of continuous (in most cases) development highlights a successful pattern of urban growth compared to the durations of other contemporary cities in Mesoamerica. Rank 1 plaza groups in each region were typically located in the oldest centers and show deep occupational histories. Others display equally long occupations but with a short hiatus at some point during their settlement histories. Continuities at long-lived centers do not guarantee that substantial reorganizations did not occur. The point remains that considerable continuity in occupation is evident until near the end of the Classic Gulf architectural traditions. Just as scholars debate the demise of cities such as Teotihuacan or Monte Albán in the Mexican highlands, the circumstances surrounding the collapse of the Classic Gulf urban traditions are open to question and require focused research.

The dramatic disruption to the Classic period Gulf urban tradition highlights an inelasticity that must have plagued much of lowland Mesoamerica. We do not question the

resilience of the people that lived in the region, but that of the sociopolitical systems responsible for Classic period urbanism. The Standard Plan and the Long Plaza Group disappeared. Likewise, architectural ballcourts, perhaps the most prolific ritual institution of the Classic period, have not yet been identified in association with Postclassic monumental constructions (Stark and Eschbach 2018:102).

Studies of environmental change in Mesoamerica have noted periods of prolonged drought around the close of the Classic period with implications for the sustainability of agriculture (e.g., Luzzadder-Beach et al. 2012; Hodell et al. 2005; Lachniet et al. 2012; Rodríguez et al. 2015). Lozano et al. (2007, p. 16202-16203, 2010) conversely suggest, based on diatom, charcoal, and pollen abundances in sediment cores from Lago Verde at the western margin of the Tuxtlas, that a period of increased wetness began around AD 800 suggesting that broad drying trends might have been reversed in some localities by increased northerly storms across the Gulf of Mexico.

Other sediment cores have focused on the pollen history of the region. Sluyter and Domínguez (2006) use a sediment core from Laguna Catarina in the northern part of the study area to conclude that deforestation coincided with inferred population increases during the Late Formative through the Classic. This vegetation profile persisted through the modern era, showing that the region was never completely abandoned despite the cessation of the Classic urban tradition. The authors hypothesize that raised fields in the area were gradually abandoned, however. This signals to us a process of dramatic reorganization rather than collapse, whereby the inhabitants continued swidden agriculture through more dispersed settlement patterns.

Other regions show a more dramatic change in land use based on pollen reconstructions. Cores in Lakes Catemaco and Pompal in the Tuxtla Mountains show a return to forested

conditions between AD 750-850 (Byrne and Horn 1989; Goman and Byrne 1998). There were certainly low population densities that remained, but broader settlement comparison suggests subsequent displacement of population into foothills of the Tuxtlas (Venter 2016). This pattern also potentially supports the massive settlement migrations proposed for the extreme southeastern portion of the study area by some researchers (Borstein 2005; Symonds et al. 2002).

It is uncertain what effect the sprawl of low-density urbanism had on the environment. On one hand, growing in a center-out pattern taking advantage of ubiquitous abundances of critical resources lessened the impact on any one area. On the other hand, erosional effects of broad forest clearance might have accelerated displacement of sediment during the rainy season (see Goman et al. 2005 for a Pacific Coast parallel).

Environmental change alone is unlikely to explain the pervasive sociopolitical reorganization observed in the region (Stark and Eschbach 2018; Venter 2016). Parts of Veracruz, even during drier conditions, would have received sufficient rainfall for continued swidden cultivation. Even if swidden became unsustainable for parts of the region, we would expect to see a greater investment in raised fields in ample wetlands, not their abandonment as suggested by existing research (Heimo et al. 2004; Siemens 1998; Sluyter and Domínguez 2006; see Luzzader-Beach et al. 2012 for a lowland Maya parallel). It might be argued that major changes in the headwaters of Gulf rivers precipitated problems far downstream, but eroded soils deposited in the lowlands would renew lands there, and diminished river flows due to highland drought would still provide water in the lower reaches because the catchments are so large.

Other potential contributing factors of collapse/reorganization at the end of the Classic period are numerous. (1) The Classic political system that mobilized labor to build cities focused on the ritual authority of a small segment of the population. A shift in the environment might

have diminished the perceived effectiveness of leaders, causing a crisis of confidence. Possibly decentralization of authority contributed to the decline of the Classic urban tradition.

Jurisdictional proliferation was mechanical, in Durkheim's terms, or segmentary in Southall's terms, in that lower order centers replicated many of the same services as primary centers through shared architectural infrastructures.

(2) Evidence of highland migrations into south-central Veracruz at least by AD 1200 could have brought conflict, but evidence of overlap with local inhabitants is not conclusive (Daneels 2002:361; Daneels 2016, p. 183; Stark 2008; Stark and Eschbach 2018) (see S1.19 for additional Postclassic information). With a declining Gulf political system, highland groups had opportunities to move to Gulf locations and found settlements uncontested, which we see evidenced by the Middle Postclassic.

(3) There is, generally, little evidence of conflict or warfare during the Classic. Some later plaza groups show low rectangular embankments surrounding them (Daneels 2012, p. 360-361) (Figure S1.12.1), but their use for defending against raids is in doubt, and the population residing inside them would have been very small.

(4) Long-distance exchange patterns shifted at the end of the Classic, seen most clearly through obsidian. Perhaps disruptions external to the Gulf lowlands caused the collapse of traditional trade patterns (Stark et al. 2016).

(5) Finally, we must consider socioeconomic domino effects in a broader interregional context (Stark and Eschbach 2018:108). Much of Classic lowland Mesoamerica experienced collapse and reorganization around the same time span. It is not beyond reason to see a crisis in one or more regions affecting neighbors and the whole system.

Discussion: Urbanism of the Gulf Lowlands of Veracruz

By way of discussion, we return to five points raised in the introduction as descriptive of low-density urbanism.

(1) Consistent with definitions of low-density urbanism, where data were available, Gulf population densities occupied the low end of the range for Mesoamerican cities (but see Arieta and Cyphers 2017 for higher estimates at San Lorenzo). In areas with detailed survey data, residential mounds and artifact concentrations show continuous distributions. Settlement gaps are rare, preventing easy identification of “site” boundaries.

Monumental cores apparently drew dispersed regional populations into a centripetal relationship with their administrative, religious, and economic services, providing periodic social mingling. Green space pervaded all areas, penetrating into both monumental and residential zones. Swidden agriculture was likely practiced over the entire prehispanic sequence, requiring some fallow time. Perhaps more important was the diversity of agricultural techniques practiced in the Classic period, including raised fields, recessionary agriculture, inferred houselot kitchen gardens, and terracing hillsides (limited). This diversified agricultural system, combined with other subsistence pursuits (fishing, arboriculture, hunting), spread families’ productive efforts over a broad area.

(2) Previous research has identified two distinct, but related, architectural traditions across the study area: the Standard Plan Plaza Group (SPPG) northwest of the Papaloapan River, and the Long Plaza Group (LPG) to the southeast. The expanded architectural database compiled

from both pedestrian survey and remote sensing constitutes a major advance in our understanding of low-density urbanism in the region. The SPPG and LPG architectural groups show remarkable coherence in their configurations across the entire Classic Gulf region. The more detailed analysis of coded architectural attributes permitted better characterization of each in their geographic contexts. We also were able to identify subclusters within the larger areas previously recognized. Plaza groups in the lowlands generally lack features that would restrict access, and, to date, the region lacks any strong evidence of systemic warfare during the Formative or Classic periods. We propose that the mutually supportive distributed urban network was set up to maximize the number of people attracted to central services, rather than to keep people out. Due to the diversity of seasonally abundant resources across the region, the areas served by Rank 1 plaza groups were not likely self-sufficient. Access to resources across broader geographic areas was maintained through a network of closely spaced plaza groups. The standardization of architectural configurations within these broader zones provided a familiar setting to promote open network interactions.

(3) The principle of inclusion persists but becomes increasingly decentralized from the Early Formative through the Late Classic. Architectural plaza areas became smaller but proliferated over this 2000-year span. The consequences of jurisdictional proliferation for economic, ritual, and political administration in the Gulf lowlands presents an important avenue of future research. Currently, we suggest that the numerous plaza groups created outlying nodes that refocused authority as cities expanded out from the older monumental complexes in each region. We do not currently understand how this process affected the longevity of urban networks, but, in at least two well-studied cases, the older Rank 1 centers lost influence as a result.

(4) The Gulf lowlands presents both centralization and segmentation of political authority at different scales of analysis. Within Rank 1 plaza service areas, some centers (e.g., Matacapán, La Joya, Cerro de las Mesas, Totocapán) show centralization of authority. At the broader regional scale, the pattern conforms instead to a segmented politico-ritual landscape. Larger political aggregates were not common – a significant point that diverges from more centralized low-density cities at Angkor or the Maya lowlands. Rank 1 plaza groups provided equivalent functions for relatively small service areas (an average radius of 5 km). Larger kingdoms that integrated more expansive regions were rare, based on the muted differences in monumentality among Rank 1 nearest neighbors. We have likened this pattern instead to a distributed urban network and suggest that analyzing networks may be more appropriate for some cases of low-density urbanism than dissecting a region into “political territories”.

Another matter is the nature of leadership, for which recent research in the discipline has identified multiple pathways. Our data unequivocally show that whole societies cannot be characterized into political types. For the Formative period, leaders at the largest sites clearly exercised individualized and autocratic rule, indicated by control of prestige exchange, mobilization of labor, megalithic portraits of themselves, and elaborate tombs and palaces. At the same time, however, large rectangular plazas constructed at lower order centers appear to have emphasized participatory collective action and inclusion of a wide populace, although these structures require field study. Research at San Lorenzo shows that its autocratic elite had control over certain social fields, but this authority did not extend into the utilitarian economy.

By the Late Formative and Protoclassic periods, despite the continuation of sculpture featuring leaders, some influential centers (Tres Zapotes and Cerro de las Mesas) also show the dissection of authority into multiple corporate groups or factions. Eventually, sculpture, scripts,

and Long-Count dating developed earlier to exalt leaders disappeared, contrasting with the Maya area, which retained a focus on kingship. Rituals emphasized abstract principles of agriculture, fertility, the life cycle, and a pantheon of gods that ruled different elements of nature: features of more collective societies (Carballo and Feinman 2016). During the Classic period, authority was distributed across many nodes, and large-scale projects (e.g., raised fields) were locally managed and likely coordinated at SPPGs. These indicators of increasing collectivity, however, are countered by other data that show great differentials in individual or familial status and wealth (e.g., Late Classic proliferation of monumental palatial complexes, burials of elites in temple-mound tombs). In short, we do not find evidence that polities in the region exemplified a single dominant political principle.

(5) Most of the largest urban centers in the region show great longevity, with some cities spanning 2000+ years of continuous development. This shows that the low-density cities can be a successful mode of urban development. Nevertheless, longevity of the distributed network of central places dramatizes the demise of the system toward the close of the Classic period. Blanton (2010) discusses the possibility that more centralized collective governance has a greater propensity to dramatic collapse because of interdependencies internal to the society. The long-term record of a mix of political principles including prominent signs of collective participation, though not centralized, could support his argument, but the southern lowland Classic Maya, with a greater emphasis on dynastic authoritarian rule, also underwent collapse.

Of the varied possibilities for environmental problems that could account for the demise of the Gulf urban networks, none easily accounts for the disuse of agricultural land that would have remained viable if not critical in drought conditions, including zones of robust seasonal

rainfall, and the extensive wetlands where a variety of intensive agriculture practices could be continued or developed. More environmental data, including better dating, is a pressing need.

The cumulative effect of disruptions to trade and elite relations across a larger frame may have had strong local effects due to the open networks maintained across the Gulf lowlands. Individual centers were not well insulated from their neighbors. The distributed nature of urban networks and their balance of autocratic and collective principles might have prevented a strong centralized response to environmental and social change. We consider this an important challenge for future research.

Future Directions

A review of past research is informative, but a chief role is to stimulate new lines of inquiry. Here we identify some of the issues that should take priority and highlight the unique position of the region for advancing archaeological science.

The repetitive architectural patterns identified here present an ideal scenario to explore network analysis involving architectural attributes and other lines of data, like obsidian procurement (e.g., Golitko and Feinman 2012). Such data will be important to quantify the concept of distributed urban networks for cross-cultural comparisons. Future work should examine how networks among individual architectural groups, and their populations, map out within and across the zones we presented. We also urge development of more consistent procedures for defining settlement boundaries, hierarchies, and aggregations of multiple plaza

groups that form political capitals. Our analysis of plaza groups is useful at the macroregional scale, but regional settlement identification and hierarchies require other analytic work.

Jurisdictional proliferation seems to grow out from earlier centers, but we have only a few cases where this pattern is supported with solid dating. Studying this process may provide data to interpret pathways of urban growth and reasons for decline. Hierarchical relationships are assumed based on quantitative estimates of population size or architectural volume, with the larger plaza groups (sometimes with only subtle differences in monumentality) assumed to be of higher rank. In order to understand rank relationships, we need more studies that reconstruct commodity flows and examine ritual practices and material culture styles.

The proliferation of plaza groups over time coincided with shrinking plaza area over a period of 1800 years. Within this trend, we noted variation in how Rank 1 plazas related to subordinate plazas. Investigation of plaza activities and relationships among different ranked plaza groups will contribute to understanding local hierarchies.

Identification of 119 Middle Formative plazas in southern Veracruz presents an opportunity to advance Olmec archaeology through leaps and bounds. While continued investigations of the large centers remains important, studying the smaller plazas through survey and excavation will generate new data on their function, dating, duration of use, and governance that can be compared to the larger centers. Of particular importance is the apparent paradox of individualized rulership at the top ranks but a hypothesized more communal focus at smaller plaza groups.

The Late Formative period is critical for linking architectural styles initiated in the Early and Middle Formative to the architectural florescence in the Classic period. The areas where

LPGs dominate are crucial because the literature describes the Late Formative through Early Classic periods as a time of decline if not abandonment based on only limited dating.

An important question is whether social inequality was becoming more pronounced over time. Growing social inequality would be corrosive to the balance of governance principles and to participation in the hypothesized open networks among centers. Was the fabled wealth of the tropical lowlands -- cotton, colorful birds, bitumen, jaguars, cacao, along with food crops -- and the proximity of Gulf lands to trading partners in the central highlands a basis for relatively widespread household well-being and an influence on governance? Was the diversity of agricultural and subsistence practices a basis for broad household well-being or did it contribute to social inequality at a regional scale? We do not know if the standard of living of ordinary households was maintained through the Classic period, nor how it may have differed among localities with contrastive agricultural practices.

Finally, we highlight the Gulf lowlands of Veracruz as one of the ideal world regions where these questions can be addressed for low-density urbanism so that its contribution to comparative studies can be realized. The large database of repetitive architectural configurations presents a quantitative and qualitative testing ground for comparative urbanism.

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