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THE DEVELOPMENT OF LANDESQUE CAPITAL IN THE MAYA LOWLANDS DURING THE MIDDLE PRECLASSIC

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ABSTRACT

In this article, we argue that landesque capital was integral to the development of complexity in the Maya Lowlands. Such features involved permanent investments in the landscape that supported material and ideological practices, resulting in increased sustainability and well-being. We contend that these developments stemmed from accretional modifications to soils in the Preceramic/Early Preclassic, as well as intentional investments of labor in agricultural features, large public works, and select civic complexes during the Middle Preclassic. Capital improvements were particularly important during the Middle Preclassic, when sedentary occupations and civic life were established. The timing and location of the investments strongly correlate with other aspects of Middle Preclassic lifeways, such as the transition to sedentism, acquisition and control of resources, changes in lithic production, and the emergence of an elite class. We note that some of the largest investments in landscape management during the Middle Preclassic occurred in the Central Karstic Uplands, where substantial cities rose in the Late Preclassic. We conclude that during the Middle Preclassic an ontology of landesque capital developed, based on the synergistic fusing of daily and ritual practices with physical features, which provided a foundation for resilience, sustainability, and well-being in subsequent generations.

The development of Maya society during the Preclassic has been a trending topic in Maya scholarship during the past decade, and, in particular, the Middle Preclassic (1000–400/300 B.C.) has been the subject of numerous new investigations (Andrews V et al. 2018; Braswell 2012; Brown and Bey 2018; Estrada-Belli 2011, 2016; Gallareta Negrón 2018; Garber et al. 2004; Hansen 2016; Hohmann et al. 2018; Inomata et al. 2015; Rice 2015; Robles Castellanos and Ceballos Gallareta 2018; Triadan et al. 2017). This emphasis seems long overdue, as the changes that took place from 1000 to 300/400 B.C. are on an unrivaled scale. The period begins with inhabitants settling down and building permanent communities across the tropical landscape and ends with the rise of state-level political organizations and the emergence of centralized political authority in the form of rulers.

The articles in this special section present data and address specific issues from throughout the Lowlands, revealing the complex nature of the evolution of a complex society in the Maya region. In this article, we examine one aspect of this evolution, the relationship between the development of landesque capital and sociopolitical processes during the Middle Preclassic. The relationship between these two phenomena provides a foundation for understanding many of the transformations that ensued during the Middle Preclassic, as well as a backdrop for the contributions in this section.

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WHAT IS LANDESQUE CAPITAL?

Landesque capital was a concept originally proposed by economist Amartya Sen in 1959, defined as investments that increase the yield on parcels of land without replacing labor. According to Sen (1959: 280), these investments could include irrigation systems, fertilizers, and pest control. This original definition of landesque capital was expanded in the 1980s by Brookfield (Blaikie and Brookfield 1987; Brookfield 1984), who emphasized the permanent nature of land improvements and linked them to the notion that social actors (improvers) must be able to hold and control the results of the investment. More recently, scholars such as Clark and Huei-Min Tsai (2009) have centered the definition of landesque capital on the power to improve environmental conditions that affect soil fertility, biodiversity, land cover, carrying capacity, resilience, and other dimensions of sustainability. Crucially, these definitions encompass hydraulic systems that captured and stored rainwater, stabilizing water accessibility for both agriculture and consumption (Dunning et al. 2012; see also Wittfogel 1957).

Erickson (2008) also explored the concept and argued that material landscapes and social processes are both connected to the physical transformations that constitute landesque capital (see also Steward 1955). However, Erickson is clear in distinguishing between landesque capital and domesticated landscapes. Both are forms of anthropogenic landscapes, or *anthromes*, defined as the ecological patterns created by interactions between humans and ecosystems. According to Erickson (2006:241), domesticated landscape involves "non-genetic, intentional and unintentional practices and activities of humans that transform local and regional environments into productive physically patterned, cultural landscapes." Domesticated landscapes, then, may be transformed into landesque capital by investments in permanent improvements.

These permanent improvements are a materialization of banked labor—work that is completed in anticipation of payment or rewards later—and can be possessed by the individuals or groups (Fisher and Feinman 2005:64). This tenurial relation provides an incentive for allocating labor to such investments. Investments may be major, such as the construction of a reservoir, and represent systemic changes within the environment.

However, investments may also be minor and accretional, representing incremental changes in an environment. One example of incremental change involves soil enhancement and the improvements in irrigation systems carried out by smallhold farmers working within the *ejido* systems in Mexico, under which usufruct rights to the lands are conveyed by continual use (Doolittle 1984, 2001). Another case involves the creation of *terra preta* (Amazonian Dark Earth), the gradual accumulation of organic material in soils as a result of long-term food-processing practices by both hunter-forager and agricultural communities (Neves et al. 2003:41). Significantly, while many incremental changes are intentional, this is not always the case (Neves et al. 2003:35). Therefore, it is important to recognize that intentionality is not necessarily inherent in processes that create landesque capital.

Permanent investments in land that result in greater and more sustained yields or increased subsistence security qualify as capital as they provide benefits to social actors (investors) that exceed the labor banked within the investment. More specifically, landesque capital, such as irrigation systems and anthropogenic soils, qualifies as capital explicitly because it is integral to economic exchange and wealth accumulation (Håkansson 2014; Hornberg et al. 2014). Significantly, however, in contrast to capital as defined in Marxist economics, landesque capital remains embedded within culturally specific symbolism and local institutions in precapitalist economies. According to Blaikie and Brookfield (1987), skills, technology, and labor all contribute to innovations that create enduring land improvements, landesque capital. As each of these processes is culturally contingent, it is not possible to disengage the development of landesque capital from the evolution of political, religious, and social institutions (see Erickson and Walker 2009). Indeed, a positive correlation between intensifying landesque capital and increasing sociopolitical complexity appears to have been strong.

This relationship is best illustrated in a recent a study conducted among Austronesian-speaking social groups (Sheehan et al. 2018). Results of this study suggest that intensification of landesque capital investment and increasing hierarchy promoted each other, perhaps as part of a feedback loop. However, neither was a determinant of the other (Widgren 2007:72). Therefore, Oliver Sheehan and his colleagues found that while increasing investments in landesque capital and increasing social stratification co-evolved, they were not mutually dependent (Sheehan et al. 2018:3632).

Accordingly, the relationship between landesque capital and sociopolitical complexity may be characterized as co-evolutionary, yet the nature of the entanglement remains culturally and historically contingent. For example, in their study of historic societies in nineteenth-century East Africa, Håkansson and Widgren (2007:245) generally concluded that investments resulting in landesque capital occurred if agriculture were the primary source for long-term wealth accumulation, regardless of the presence of hierarchical political systems. However, external networks and local contingencies influenced specific choices regarding investments in enduring or short-term extraction strategies. Likewise, Morrison (2014) argues that political and religious institutions played a significant role in structuring Middle period agrarian landscapes in South India. Specifically, she argues that mid-level political elites sponsored the construction of reservoirs in areas with very poor investment returns, in part because of the ritual and political associations and prestige they could accrue through such patronages (Morrison 2010).

Bearing in mind such definitions, we contend that accretional and unintentional practices, along with substantive and intentional acts, created features of landesque capital that directly sustained populations, such as agricultural terraces or reservoirs. In addition, we argue that landesque capital also encompassed physical spaces that provided a venue for social processes, while also enhancing sustainability. Examples of spaces such as these would include civic-ceremonial complexes designed to direct the flow of water into reservoirs. Landesque capital, then, not only augmented potential yields and increased subsistence security in an environment, but also supported the ontological foundations of sustainable practices.

In the following pages, we will explore entanglement between landesque capital and sociopolitical complexity in the Maya Lowlands during the Middle Preclassic to better understand the nature of the significant transformations that occurred during this period.

EARLY ACCRETIONAL CHANGES IN THE MAYA LOWLANDS

Widgren (2007) states that given the enduring nature of landesque capital, people continue to benefit from past improvements. Indeed, the management of biomes prior to the Middle Preclassic influenced subsequent investment choices and practices. These earlier acts were incremental and cumulative, taking place over a long period of time and resulting in significant modifications that continued to benefit inhabitants of the Lowlands during the Middle Preclassic.

The notion that accretional changes led to major adaptations is not new in the Maya Lowlands: it was introduced by Scarborough (1993, 2007) to describe the development of water management systems. Scarborough (2007:55) states that only slow, incremental modifications were possible in the fragile tropical environment, as larger or rapid changes would result in disruptions to the natural flow of nutrients and energy. The concept of accretional modification was later employed by Dunning (Dunning et al. 1998) to characterize the evolution of agricultural terracing. In this section, we examine accretional changes during the Preceramic period that resulted in permanent land investments, which were advantageous for generations.

The Preceramic period in the Maya Lowlands has been identified as dating to 3400–1200/1000 B.C. (Andrews and Robles Castellanos 2018; Iceland 1997, 2005; Lohse 2010; Lohse et al. 2006), while the Initial/Early Formative in Mesoamerica dates from 2000 to 1000 B.C. (Doering 2014; Grove 2001; Pool 2007). During these periods, evidence throughout the Maya Lowlands suggests that aceramic, mobile populations occupied the same landscapes prior to the "settling down" of communities (Lohse 2010; Lohse et al. 2006). Paleoenvironmental studies (Beach et al. 2015:11, 2019; Cowgill and Hutchinson 1963) and pollen analyses suggest that the first significant human-influenced landscape modifications in the region took place before 2000 B.C., correlated with the emergence of horticultural practices (Leyden 2002; Lohse 2005) in central Peten (Cowgill and Hutchinson 1963; Islebe et al. 1996; Vaughan et al. 1985; Wahl et al. 2006), the southeastern zones (Rue 1989; Rue et al. 2002), and northern Yucatan (Whitmore et al. 1996).

The Early Preceramic

The early phase of the Preceramic dates from 3400 to 1500 B.C. and is characterized by mobile lifeways and the beginnings of horticulture, particularly maize and manioc cultivation (Andrews and Robles Castellanos 2018; Iceland 1997, 2005; Lohse 2010; Rosenswig 2015). Isotopic evidence from the bones of individuals recovered from rock shelters in southern Belize indicates that from 7600 to 2700 B.C., maize was already a minor part of the diet, which consisted primarily of plants and animals from a C_3-dominated neotropical forest (Kennett et al. 2020). C_3 pathways for carbon fixation are used by most trees, shrubs, and herbs in lowland tropical environments. Cultigens that use a C_3 pathway include squash (*Cucurbita* spp.) and manioc (*Manihot esculenta*).

C_4 pathways are used by many tropical grass species, including maize, and some other plants in warm and arid environments. The first evidence that maize constituted an important component in the diet (defined as more than 25 percent of total diet) occurs between 2750 and 2050 cal B.C. Overall, Kennett and colleagues (2020) deployed a multivariate analysis of δ^{15}Ncollagen, δ^{13}Ccollagen, and δ^{13}Capatite on burials recovered in rock shelters. Because the study included samples from the Paleolithic through the Classic periods, it allowed for a contextualization of the individuals dated to the Early Preceramic and demonstrated the transition from a mixed subsistence diet to one in which maize provided about 30 percent of total diet (Kennett et al. 2020:6). These data are consistent with evidence for increased forest burning and clearing, maize cultivation, and erosion across the Maya Lowlands, suggesting a greater commitment to maize horticulture between 2550 and 2050 cal B.C. In Belize, this marked increase in forest clearance began around 2500 B.C. (Pohl et al. 1996). Pollen in sediment cores from Lake Puerto Arturo, on the western edge of the Central Karstic Uplands in the northern Peten, also show deforestation-related taxa from ca. 4000–2000 B.C., with maize pollen recovered from a level that dates to 2650 B.C. (Wahl et al. 2006, 2007). In addition, one early date of 2910–2880 cal B.C. from Yaxnohcah in a secondary context suggests that mobile groups in this region may also have burned the forest for extensive horticulture. Simultaneously, the starch grain and phytolith analysis of Preceramic tools in northern Belize has identified maize, along with numerous other species, such as Capsicum (pepper), manioc, Fabaceae (bean), Cucurbitaceae (squash), and a type of unidentified root/tuber, perhaps macal (taro) (Rosenswig et al. 2014). Soil/sediment and pollen evidence from Cobweb Swamp demonstrates habitat disturbance, along with the appearance of cultigens, including manioc, by 3000 B.C. and maize by 2500 B.C. (Jacob 1995; Jones 1991, 1994). Pollen research at Cob Swamp near the Rio Hondo also confirms evidence for cultigens between 3400 and 3000 B.C., with maize appearing after 2400 B.C. (Pohl et al. 1996).

Other material evidence of Early Preceramic occupation has been especially robust in northern Belize. Located along and near Freshwater Creek, the sites of Caye Coco and Fred Smith revealed large horizontal occupations, 150 m^2 and 400 m^2, respectively. Excavations at Caye Coco also revealed two pits and a posthole carved into bedrock, along with the material remains of worked oyster shell (Rosenswig and Masson 2001). Three charcoal samples from the Caye Coco pit features yielded radiocarbon dates spanning from 6320 to 4610 cal B.C. and from 790 to 740 cal B.C. (Rosenswig et al. 2014). Even though Rosenswig and colleagues (2014:312) acknowledge that the early dates may be a result of the "old wood" effect, the recurrent occupation of this site for several millennia is remarkable.

Rosenswig and Masson (2001) also recovered numerous lithic tools associated with early horticulture and forest clearing, including a plano-convex biface from Caye Coco Pit #2, two bifaces from disturbed surface contexts at the Fred Smith site, an expedient biface from the Patt Work site, also from a disturbed context, a heavily used uniface from Laguna de On, and a constricted adze from Doubloon Bank Lagoon.

At Colha, also in northern Belize, excavations revealed a preceramic occupation adjacent to Cobweb Swamp (Lohse et al. 2006). Several constricted adzes were recovered dating to 3000–1000 B.C. Additional investigations in northern Belize have recovered a constricted adze dating to 1275 B.C. along the Rio Hondo, and a Lowe point dating to 2210 B.C. from Pulltrouser Swamp (Pohl et al. 1996).

The Late Preceramic

The Late Preceramic phase dates from 1500 to ca. 1200/1000 B.C. and is completely encompassed within the Early Formative period (1500–1000 B.C.) in Mesoamerica (Pool 2007:7). This period appears to have been a transitional period distinguished by widespread horticulture, increase in the number of sites, early ceramics, and an increase in lithic tools associated with horticulture, including constricted adzes (Lohse 2010). Indeed, the production of the constricted adze is one of the hallmarks of this period. Concentrated in northern Belize, but found in northwestern Belize as well as in Actun Halal (Lohse 2005, 2008, 2010:327), these specialized tools were associated with wood cutting and chopping, and other horticultural activities from 1500 to 1000 B.C. (Gibson 1991; Hudler and Lohse 1994; Lohse 2008). Other indicators of change during this period arise in central Belize, where an absence of macro-blade production from 2000 to 1000 B.C. (Awe et al. 2021) signals technological developments associated with changing subsistence practices or population movement at this time.

Pollen samples from cores taken throughout the Maya Lowlands demonstrate an increase in forest clearance after ca. 2000 B.C. (Leyden 2002:94). In the Peten Lakes region, pollen data from Lake Salpeten clearly illustrate that very little forest remained adjacent to the lake by about 2000 B.C. The Petenxil cores (Tsukada 1966) and the Quexil core (Vaughan et al. 1985) also indicate *Zea mays* cultivation and forest clearance between 2000 and 1000 B.C.

In the Petexbatun region, a core from Lake Tamarandito provides evidence of the emergence of horticulture beginning around 2000 B.C.: grass pollen (gramineae) increases, while deciduous tree pollen (*Moraceae-Urticaceae* and *Combretaceae*) decreases (Dunning et al. 1998). Finally, in Belize, pollen studies from cores taken in the Laguna de Cocos, near Albion Island, also indicate forest clearance beginning in 2000 B.C. (Hansen 1990).

Several isotopic studies of samples from the Maya Lowlands of northern and southern Belize and the Soconusco region of the Pacific Coast show the transition of maize from a minor part of the diet to a dietary staple between 2000 and 1000 B.C. (Blake et al. 1992; Kennett et al. 2020; Smalley and Blake 2003; Tykot et al. 1996). The study of 23 individuals dating from 2000–1000 B.C. recovered from rock shelters in southern Belize demonstrate the increased importance of maize in daily diets. In this sample, more than 50 percent of protein came from the consumption of C_4 plants or animals eating C_4 plants, a frequency that overlaps isotopically with commoner populations during the Classic period (Kennett et al. 2020).

In northern Peten, specifically the Central Karstic Uplands, evidence for the Preceramic occupation of the region is mounting. Beginning in 1450 B.C., there is an abrupt rise in grasses and weeds and an accelerated decline in forest taxa (Wahl et al. 2006). In addition, carbon samples from construction fill of the earliest deposits at Nakbe have yielded radiocarbon dates clustered between 1400 and 1000 B.C. (Hansen 1998:55–56, Table 1, 2005: 58, 62, Table 5.1). Likewise, three radiocarbon dates from the early deposits at Yaxnohcah also cluster between 1500 and 1280 B.C. These carbon samples were retrieved from construction fill, and therefore, it is highly likely that they reflect early burning associated with deforestation in the region near the Bajo Tomatal, prior to the appearance of permanent settlements or perhaps their ephemeral outset. Similar spans were also noted in three radiocarbon dates from Betz Landing, northern Belize, dating to 1500–900 B.C. (Zeitlin 1984).

Conspicuously absent is evidence of preceramic occupations in the northern Yucatan. One of the only radiocarbon dates associated with this period was recovered from Loltun Cave. A carbon sample dated to 1840 B.C. was recovered from the interstitial area between a ceramic level (El Toro, Level VII) and an aceramic level (El Toro, Level VIII). Level VIII contained 21 crude flaked tools, including used and retouched flakes, scrapers, gravers, knife-gravers, denticulated tools, and one point, and two core fragments, as well as bones of an extinct horse species. Archaeologists have concluded that the levels in these excavations were heavily mixed; however, the Early Formative date does suggest the presence of early populations in this region (Andrews and Robles Castellano 2004, 2018).

Creation of Landesque Capital through Accretional Practices

During the Preceramic and Early Formative periods, the creation of landesque capital resulted from accretional investments. Forest clearings were burned to expand areas for horticulture, which also resulted, at least initially, in soil enrichment—though, problematically, it also initiated accelerated soil erosion in some areas. It is likely that the practice of intensively managed mixed gardens (individualized mixes of seed, root, and tree crops) adjacent to residences was initiated from the outset of sedentism or semi-sedentism. Such gardening was dependent on the careful management of soil to limit erosion, maintain open space, limit weed competition, and maintain or enhance fertility over time—likely including intentional addition of organic matter in the form of human and kitchen waste, green mulching, and occasional re-burning after fallow (Evans et al. 2021). However, with the progressive removal of forest cover, the capture of both inorganic dust and ash from nearby burning, both integral to higher phosphorous levels, is reduced, and soil fertility declines sharply (Das et al. 2011).

The early inhabitants of the Maya Lowlands, therefore, established a delicately balanced cultivated landscape that eventually included significant amounts of forest cover within a mosaic of gardens and fields (see Dunning et al. 2012, 2018, 2020; Lentz et al. 2014; Turner and Sabloff 2012). Incremental investments in soils acted on cultigens, such as maize and manioc, resulting in higher yields (see Kirkby 1973:126), and by 2000 B.C. maize was a dietary staple in southern Belize (Kennett et al. 2020). Also, innovations in lithic tools, such as the appearance of constricted adzes, allowed for improvements in horticulture practices. Given the longevity of horticultural and agricultural systems that developed in the Maya Lowlands, this system likely had its roots in the formation of sedentary communities, and the knowledge derived from generations of experimentation expanded from early gardening to more extensive forms of farming. These early, carefully managed soil plots, although largely invisible today (except perhaps in the form of patchwork soil phosphate enrichment), were a form of landesque capital, passed down across generations and expanded accretionally throughout the landscape as populations and sedentism increased.

FROM GARDENING TO FARMING

Accretional modifications during the Preceramic period allowed for a pronounced shift at the beginning of the Middle Preclassic. During the period 1000–800 B.C., inhabitants of the Lowlands transitioned from horticulturalists/foragers to agriculturalists, reinforcing the importance of landesque capital in the Lowlands. In this section, we will discuss evidence for this transition and its consequences with a focus on landscape modifications and the built environment.

Environmental Proxies

Evidence for the transition to farming is indicated by numerous studies of environmental data. Geochemical analyses of soils from throughout the Maya Lowlands show a rise in phosphorous levels in soils after 1000 B.C. Higher phosphorous levels are considered a proxy for increased human activity, but the correlation is not always directly associated with agricultural intensification. Increased phosphorous in archaeological soils typically results from domestic activities. However, higher levels of phosphorous are noted in garden areas with human and other waste and in sediments derived from recently burned fields. Also, higher phosphorous levels in lake sediments are attributed to increases in human population density—and a concomitant increase in waste—in the catchment area, as well as rapid erosion and transport of topsoil into *bajos* and lake basins due to expanded vegetation clearance (e.g., Beach et al. 2015:11; Cowgill and Hutchison 1963; Dunning and Beach 2010).

Archaeological excavations of fields on wetland margins, along with pollen studies of samples recovered from these excavations, suggest an increase in plant cultivation and the adoption of a staple diet based on maize throughout the Lowlands between 1000 and 800 B.C. Increasingly extensive cultivation is also documented by the decrease of tree pollen and by isotopic 13C analysis of a core taken at La Joyanca (Carozza et al. 2007:206). Jacob

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(1995) argues that reticulated field features discovered along the margins of Cobweb Swamp in Northern Belize represent human modification of natural channels and islands to exploit the agricultural potential of the fertile swamp margin soil beginning ca. 800 B.C. In a related study, Jones (1994:208) identified abundant cultigen pollen, including maize, cotton, and possibly chiles, from a field zone in Cobweb Swamp that was dated to 1000–600 B.C. In the Peten, pollen recovered from sediments in the Aguada Tintal, situated on the edge of Bajo Donato near San Bartolo, indicates that Preclassic Maya farmers were cultivating maize, manioc, and cotton during this period (Dunning et al. 2014, 2022).

Macrobotanical remains recovered from Middle Preclassic midden and occupation deposits at Cahal Pech included maize, wild fig (*Ficus* sp.), a guava fruit cast (*Psidium guava*), ramon (*Brosium alicastrum*), coyol palm (*Acrocomia aculeata*), and cotton (*Gossypium* sp.) (Lawlor et al. 1995; Powis et al. 1999; Wiesen and Lentz 1997:14–16). Charred macroremains of root crops have been identified in Middle Preclassic household deposits from Cuello (Hather and Hammond 1994).

The geomorphological and ethnobotanical data for this period contrast, in part, with biomolecular analyses of human skeletal remains. While isotopic studies of human bone recovered from northern Belize and the Soconusco region of the Pacific slope demonstrate that the consumption of maize played a relatively minor role in the diet until the middle of the second millennium B.C. (Blake et al. 1992; Smalley and Blake 2003; Tykot et al. 1996), the study from southern Belize indicates that maize entered the diet as a staple in 2000 B.C. (Kennett et al. 2020). In sum, the analyses of environmental proxies for maize consumption and cultivation in the Lowlands substantiates the assertion of Pohl and colleagues that there was spatial variability in maize consumption throughout the Maya region as late as 900 B.C., even within specific regions such as northern Belize, underscoring the complexity that accompanied the adoption of maize cultivation (Pohl et al. 1996:368).

Lithic Tool Industry

The lithic tool industry also underwent changes during the early Middle Preclassic, likely reflecting a gradual change in subsistence patterns. Most notably, in northern Belize, hard-hammer macroblades and macroflakes, used blanks for tools during the Preceramic, were also produced during this period. However, inhabitants of the Eastern Maya Lowlands ceased to produce the constricted adze at roughly the point at which the transition to sedentism occurred, but oval biface production increased in importance (Lohse 2010). Early oval bifaces, produced by hard-hammer percussion flaking, were used for a variety of agricultural and construction activities (Andrieu 2014) and likely replaced the constricted adze. The T-shaped adze also appeared at Colha during the Middle Preclassic (800–300 B.C.; Shafer and Hester 1991).

Another indication of change at 1000 B.C. is the disappearance of soft-hammer percussion and pressure flaking in the stone tool industry of northern Belize (Potter 1991). Yet contemporaneously, further west along the Pasion River drainage, pressure flaking was used to produce chert prismatic blades at Ceibal (Aoyama 2017:283). Chert prismatic blades have also been recovered from early Middle Preclassic contexts at Tikal (Moholy-Nagy 2003:Table 2.30). Use-wear analysis by Aoyama (2017:285) suggests an array of activities on both chert and obsidian artifacts at Ceibal. Formal chert tools were used for cutting and scraping meat and hides, working unidentified material, woodworking, and shell or bone carving. Informal chert tools were used in similar activities to formal chert tools, but were frequently multifunctional and used for more than one type of task. On the other hand, obsidian prismatic blades were used almost exclusively for cutting material, such as meat, hides, and a type of material that has not yet been identified.

Sedentism

The gradual transition from a less mobile to a more sedentary lifeway was apparently not dependent on a major change in diet. This finding contrasts with previous explanations that favored a gradual timeline for the emergence of sedentism, concurrent with an increased reliance on maize agriculture, as discussed in studies focused on the Belize River Valley and northern Belize (Awe et al. 1990:4; Ebert et al. 2017; Estrada-Belli 2011; Garber 2004; Hammond 1991; McAnany and López Varela 1999). However, several recent investigations have explicitly challenged this singular model for the adoption of sedentary village life, highlighting, instead, an introduction of sedentism ca. 1200–1000 B.C., followed by a period of several hundred years when mobile and non-mobile groups were occupying a single landscape (Inomata et al. 2015, 2020; Lohse 2022; Lohse et al. 2006, Rosenswig 2011, 2022). Research focused on the earliest Middle Preclassic communities (1000–800 B.C.) suggests that they were more transient than previously expected. Architectural investment in residential structures was minimal, implying that inhabitants may have moved regularly (Inomata et al. 2015; Reese-Taylor 2022; Vázquez López et al. 2022). Early bedrock-level living surfaces, often with postholes, are found at Blackman Eddy (Brown 2003; Garber et al. 2004), Cahal Pech (Powis et al. 2009), Ceibal (Inomata et al. 2015), Cival (Estrada-Belli 2011), and Yaxnohcah (Reese-Taylor 2017; Reese-Taylor et al. 2019, 2020).

Alongside more transient architecture, early inhabitants also constructed low platforms of sediment and clay, often capped with a thin clay or tamped sascab floor, on which mostly perishable residential structures were placed. Examples were found in the Northern Lowlands at Komchen (Andrews V et al. 2018), in the Central Karstic Uplands at Nakbe (Hansen 1998) and Yaxnohcah (Reese-Taylor 2017), in the Pasion River area at Ceibal (Triadan et al. 2017), in northern Belize at Cuello (Hammond 1991), and in the Belize River Valley at Cahal Pech and Pacbitun (Powis et al. 2009). Not too surprisingly, each region made use of the most readily available materials to fill in the bedrock and create these early platforms. For instance, at Komchen, the earliest remains under one of the largest platforms consisted of a dark brown soil lying atop bedrock (Andrews V et al. 2018); at Yaxnohcah, the earliest platform in the E-Group was constructed by filling in the uneven bedrock with a sascab and clay mixture (Reese-Taylor 2017); while at Ceibal, the earliest plaza and E-Group were formed by scraping and leveling the soil surface and bedrock (Inomata et al. 2019).

Residential structures built atop these low-lying platforms formed the earliest permanent lowland settlements. Houses were apsidal or circular in shape, comprised of single courses of stone that supported wattle and daub walls; they often contained a hearth on either the inside or the outside of the structure, as exemplified by early structures at Colha (Potter et al. 1984). Permanent communities sprang up across the Maya Lowlands, in regions such as the Belize River Valley (Awe 1992; Ebert et al. 2017; Powis et al. 2009); northern Belize (Hammond 1991; Hester et al. 1982; McAnany and López Varela 1999; Potter et al. 1984;

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Valdez 1987), the Pasion River area (Adams 1971; Triadan et al. 2017), and the Central Karstic Uplands (Reese-Taylor et al. 2018). In the East Court at Ceibal, low platforms constructed principally of clay supported perishable structures by 1000–850 B.C. And while the timing of the first permanent settlements varied from region to region, by 800 B.C. sedentism appeared to be an established lifeway throughout the Southern Lowlands.

The transition to sedentism, therefore, did not coincide with a newfound reliance on maize as a dietary staple, but may have coincided with innovations in farming technology that resulted from a series of gradual changes. The increase in sedentary occupations taking place between 1000 and 800 B.C. implies that movement throughout a widespread landscape to take advantage of fertile soils was replaced by a greater investment in nearby agricultural lands. To maintain a level of productivity required by increasing populations, early settlers would have needed to innovate agricultural practices that produced higher yields and consistently replenished soil nutrients.

Such innovation and change can be identified based on developments in the chipped stone tool industry, particularly the replacement of the constricted adze by the more versatile oval biface. While the form of the constricted adze was ideal for cutting wood and gardening associated with horticulture, the oval biface served those and additional functions, such as removing soil and preparing bedrock for building platforms or structures or creating fields for agriculture, quarrying limestone for construction materials, and shaping limestone blocks. In addition, we see an array of special tools appearing associated with woodworking and bead making. All of this suggests that horticulture practices were giving way to agriculture, possibly resulting in more readily available surpluses that allowed community members to engage in other crafting activities, at least part-time.

Communal Architecture

Large-scale landscape modification was not tied to the emergence of farming or sedentism, although data point to a somewhat divergent timeline. Communal architecture in the form of massive platforms appeared as early as 1050 B.C., prior to the emergence of farming as the major subsistence practice and before sedentism became common (Inomata et al. 2020, 2021). During the early and late Middle Preclassic, communities cooperated to modify landscapes on a large scale. The main platform at Aguada Fénix, dated to 1050–800 B.C., has a calculated volume of 3,200,000–4,300,000 m^3 (Inomata et al. 2020:Extended Data Figure 9). At Cival, the calculated volume of the single Middle Preclassic plaza leveling project is 1,304,026 m^3 (Estrada-Belli 2011:75). The infilling volume at Ceibal, which included the fills of pyramids, supporting platforms, and other buildings was estimated to be 98,827 m^3 during the early Middle Preclassic, and 203,040 m^3 during the late Middle Preclassic (Inomata et al. 2019:Table 2). Examples of other massive platforms dating to the Middle Preclassic are known from sites such as Xunantunich (Brown et al. 2011; Rawski 2017), Cahal Pech (Awe et al. 1990), Nakbe (Hansen 1998), Yaxnohcah (Reese-Taylor et al. 2018), Kiuic (Andrews V et al. 2018), and Xocnaceh (Gallareta Negrón 2018), to name just a few. Indeed, these architectural constructs are so ubiquitous that they are a defining characteristic of the Middle Preclassic period, and highlight the emphasis on the voluminous, horizontal monumentality that permeated Mesoamerica at that time. Interestingly, investigations at Cuello and Nakum have identified sweat baths as an architectural feature embedded within large platforms during the early Middle Preclassic (Hammond and Bauer 2001; Źralka et al. 2022), suggesting that these platforms may embody numerous specialized spaces.

In addition to platforms and plazas, E-Groups emerged during the early Middle Preclassic and served as arenas for social, economic, political, and religious activities (Estrada-Belli 2011; Inomata 2017; Inomata et al. 2013, 2017). The earliest example of an E-Group in the Maya region is found at Aguada Fénix and dates to ca. 1050/1000 B.C., coeval with the construction of the massive platform (Inomata et al. 2020). This is followed closely thereafter by the E-Group from Ceibal, which dates to ca. 950 B.C. (Inomata et al. 2017). However, once the idea of the E-Group complex as a communal gathering space took root, it rapidly spread throughout eastern Mesoamerica (Aimers and Rice 2006; Blake 2013; Canuto and Estrada-Belli 2022; Chase and Chase 2017; Doyle 2012). For instance, early groups were constructed between 1000 and 600 B.C. along the Pacific Slope at La Blanca (Love and Guernsey 2011) and at Kaminaljuyu (Love 2022:19). In the Maya Lowlands, E-Group complexes appear at Cival (Estrada-Belli 2006), Nixtun Ch'ich' (Pugh et al. 2022; Rice and Pugh 2017; Rice et al. 2019), and Yaxnohcah (Reese-Taylor et al. 2018) by 900–800 B.C., and at Yaxuna (Stanton and Collins 2022) in the Northern Lowlands and Early Xunantunich in the Belize River Valley by 700 B.C., if not before (Brown 2017; Brown et al. 2018).

As early as 700 B.C., another architectural form appeared that eventually became linked with the concept of centralized rulership in the Lowlands. Middle Preclassic ballcourts have been documented at sites such as Paso de Macho (Gallareta Negrón et al. 2005), Nakbe (Hansen 1998), Finca Acapulco, El Vergel, and San Mateo in the Grijalva River Valley, and La Libertad in southern Chiapas (Agrinier 1991), as well as Paso de la Amada in the Soconusco region (Lesure 1997). At Yaxnohcah, ballcourts seem to appear at ca. 400 B.C. (Vázquez López et al. 2022) and constitute one of the earliest examples in both the Central and Southern Lowlands to date. However, at this time, lowland ballcourts appear to have been densely concentrated in northwestern Yucatan. Archaeologists have documented 24 ballcourts (Anderson 2014; Anderson et al. 2004; Medina Castillo 2003, 2005; Peniche May 2010; Robles Castellanos and Andrews 2000, 2001, 2003; Robles Castellanos and Ligorred Perramon 2008), most in second-tier centers and dated, based on the presence of Dzudzuquil, Juventud, and Chunhinta pottery fragments, to the late Middle Preclassic (ca. 700–400 B.C.). These ballcourts seem to have played a significant role in the construction of community identities (Anderson et al. 2018:214; see also Fox 1996).

Later in the Middle Preclassic, other forms of monumental architecture appear, as modifications of horizontal platforms begin to rise vertically, foreshadowing the heights reached in the Late Preclassic. This evolution is clearly seen at Blackman Eddy in Belize (Figure 1; Brown and Garber 1998, Brown et al. 1998). Structure B1-5th, dating to 795–400 B.C., is the first unequivocally public construction in this sequence. It consisted of an inline triad rising 1.48 m above the surrounding plaza. While B1-4th modification, dating to 800–415 B.C., does not add much in height, 1.58 m, it does expand the horizontal footprint of the structure and includes a highly fragmented stucco mask armature flanking the central staircase, the earliest known in the Maya Lowlands (Brown and Garber 1998; Brown et al. 1998). Height gain is mainly realized with the construction of B1-3rd, which includes six subphases. The earliest four subphases, B1-3rd-g-d, date to the late Middle Preclassic and indicate a

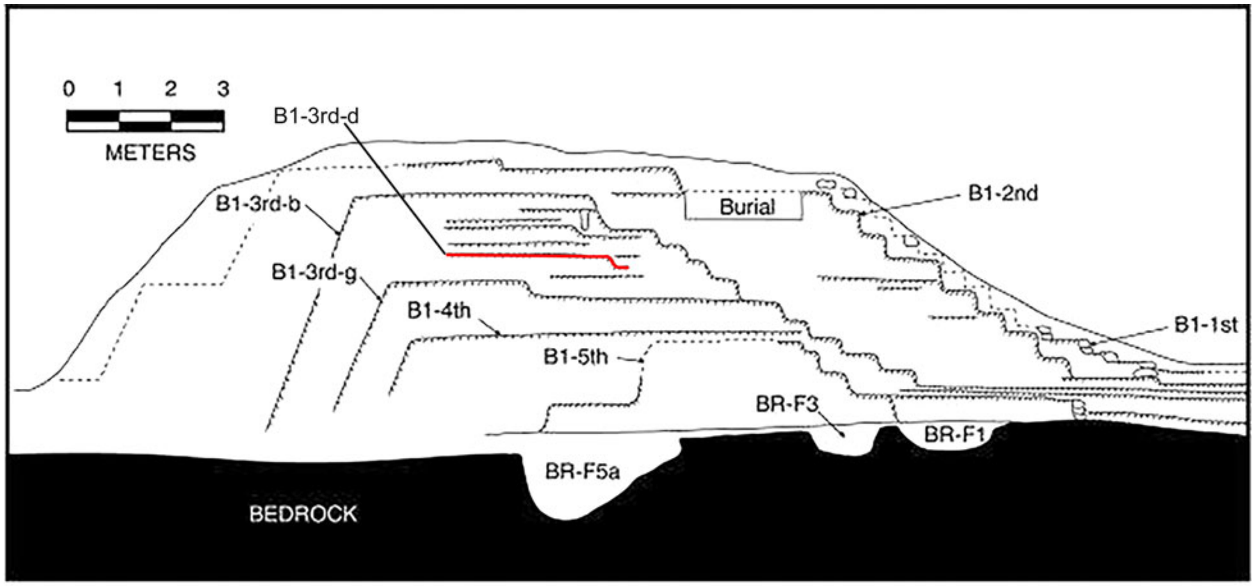

Figure 1. Profile of Structure B1 construction sequence (Brown and Garber 2005:Figure 2).

dramatic increase in rebuilding activities, including monolithic limestone block construction. Structures B1-3rd-g-e represent a slow rise in verticality, culminating in a pyramidal form in Structure B1-3rd-d. This building phase reached approximately 4 m above the original surface and dated to the late Middle Preclassic to early Late Preclassic transition, based on a Joventud vessel recovered from a dedication cache (Brown and Garber 2005; M. Kathryn Brown, personal communication 2021).

Structures at Nakbe, such as Structure 49, rose to even greater heights, as much as 8 m above the original surface (Forsyth 1993: 117, 121). Like Blackman Eddy, the exteriors of the structures were built using large monolithic blocks, an apparent characteristic of late Middle Preclassic construction techniques. Likewise, in the Northern Lowlands, the acropolises at Xocnaceh (Gallareta Negrón 2018) and Poxila (Robles Castellanos and Ceballos Gallareta 2018) exhibit megalithic block construction, emphasizing a vertical monumentality during the late Middle Preclassic. According to Gallareta Negrón (2018:285–286), the basal platform of Xocnaceh's acropolis was 64 m east–west by 24 m north–south (800/700–400/300 B.C.), although it rose to a height of just over 2 m. The next construction phase was a significant expansion, also dated to the late Middle Preclassic, with a basal platform of 140 × 140 m, a height of 6 m, and containing more than 100,000 m^3 of fill. The Middle Preclassic acropolises at Xcoch (Smyth et al. 2017) and Yaxhom (Ringle et al. 2021) may have been even larger, though their dimensions are masked in great part by later construction (Smyth et al. 2017). Therefore, we see that while monumentality emerged well before the transition to an agroeconomy was complete, the construction of public buildings accelerated and building types diversified and spread after 700 B.C.

EARLY INFRASTRUCTURE

In this section we will discuss the investment in agricultural and water management features that occurred during the Middle Preclassic. Agricultural features are difficult to identify in general and especially difficult to date, and those dated to the Middle Preclassic, through either ceramic identifications or radiocarbon dating, are particularly scarce. What we do know is primarily derived from excavations in the Southern Lowlands (Beach et al. 2008; Dunning and Beach 2010; Dunning et al. 2008; Hansen et al. 2002; Jacob 1995; Pohl et al. 1990, 1996).

Ditching in wetlands began at places such as Cob Swamp as early as 1000 cal B.C., consistent with evidence from San Antonio on Albion Island (Pohl et al. 1990) and Colha (Jacob 1992, 1995). Initially, ditching appears to have been an adaptation designed to mitigate rising water tables and extend the growing period during the dry season, as ditches allowed fields on wetland margins to drain at a faster rate at the end of the rainy season (Beach et al. 2009:1715; Pohl et al. 1990). Investigations in intermittent wetlands indicate that Maya agriculture was extensive during this period, and generally consisted of dry season farming along the margins of wetlands, and rainy season farming in uplands. Nevertheless, sediments, including clay, from slope erosion, likely linked to human activity in upland areas, aggraded over earlier paleosols during the latter part of this period (Beach et al. 2008:312, 2009: 1716; Dunning et al. 2019:136–140).

By the end of the Middle Preclassic (500–300 B.C.), farmers commenced the construction of terraces along *bajo* margins to adjust for erosion and sedimentation (Beach et al. 2008:312, 2009; Dunning and Beach 2010; Garrison and Dunning 2009). Near the site of San Bartolo, a terrace system was constructed on the margins of the Bajo Donato to retard the severe soil erosion initiated by slope clearance prior to this time (Dunning et al. 2008, 2019; Garrison and Dunning 2009:539). In addition, upland terraces, while uncommon during the Middle Preclassic, were not absent. At Chan, Belize, terrace construction north of the site core near a natural spring began in the Middle Preclassic and continued through the Late Classic (Wyatt 2008). Together, the initiation of terracing and perhaps other forms of erosion mitigation clearly indicated that the Maya had become aware of the hazards associated with removing forest cover from sloping terrain and the amount of soil cover that was being lost. Maya farmers also likely became aware that terracing further had the benefit of adding to soil moisture levels that would have increased crop yields (Dunning and Beach 2010; Hansen et al. 2002).

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Landesque capital involves the building of productive and sustainable landscapes, ensuring not only the viability of agriculture in a region, but also long-term occupation (Hoaen and Loney 2013). In the Maya Lowlands, reliable access to potable water, especially during the dry season, was crucial to the success of sedentary communities. Consequently, after 800 B.C., in addition to investing in agricultural features, Middle Preclassic people also collaborated to build reservoirs for water storage on a grand scale. There is no direct evidence that water storage systems were used explicitly for agricultural purposes. However, even if they did not contribute to increasing crop yields, the water stored would have been critical for sustaining sedentary populations during the dry season.

Example of early reservoirs are notable in the Southern Lowlands, especially in the Central Karstic Uplands. First detected by LiDAR in 2014, Brisa Reservoir is both the oldest and largest known reservoir at Yaxnohcah. Excavations in Brisa Reservoir at Yaxnohcah have revealed that it originated around 800–600 B.C. (Dunning et al. 2017, 2022). The reservoir is enormous, with a surface area of almost 39,379 m^2, but is rudimentary compared with later constructions (Figure 2). It was created by walling off a section of the Bajo Tomatal adjacent to an angled quarried limestone scarp. The berm that surrounded this early reservoir lies below the Brisa E-Group, which, based on ceramic identifications, was built earlier, between 1000 and 800 B.C.

The lower depth of the early Middle Preclassic *bajo* soil surface within the tank of Brisa Reservoir relative to its position under the berm indicates that the reservoir was constructed utilizing a preexisting low spot along the edge of Bajo Tomatal that may have naturally accumulated water in the wet season. No floors were recovered in excavations, suggesting that the builders used the natural clay layers encountered 1 m below the current surface to prevent water seepage. The berm that defined the reservoir's southern and eastern sides appears to have been constructed initially between 800 and 650 B.C. but modified episodically to provide even greater elevation and width throughout the Middle and Late Preclassic periods. The berm height ranges from 238.3 m to 242.3 m.a.s.l. It has sloped walls, an average width of 40 m, and an overall perimeter length of approximately 390 m along the southern and eastern sides of the reservoir, which equates to a surface area of 15,605 m^2.

The base of the berm was formed by a relatively thin layer of lighter-colored clay, overlain with a thick deposit of *bajo* topsoil likely dredged from the adjacent *bajo* surface. Subsequently, a deposit of soil, sascab, and gravel was used to further heighten the berm. Ceramics recovered in both the deposit of bajo soil and the overlying fill were identified as belonging to the late facet Macal complex (800–650 B.C.). Late Preclassic ceramics assigned to the Chay complex (400–200 B.C.) were recovered near the upper soil surface, likely deposited during a later dredging episode or during continued use of the reservoir.

We used the volume tool in ArcGIS Pro to estimate the capacity of the Brisa Reservoir. Based on the average height of the berm and the current topography of the sloping walls and reservoir floor, we calculated a capacity of approximately 89,379 m^3. However, during its use, it was likely much larger, as excavations of the clay layers forming the floor were 1 m deeper than the current surface.

Brisa Reservoir takes its name from the Brisa E-Group complex situated atop the escarpment on the north side of the reservoir. Runoff from this group was channeled into Brisa Reservoir, indicating the close association of ritual activity conducted in the E-Group and emergent water management practices during the Middle Preclassic. The catchment zone for Brisa Reservoir also included a large area of unpaved surface, modified from the surrounding terrain, that formed a basin directing runoff into the reservoir at the base of the escarpment. The edges of the irregular basin likely followed a natural contour in the landscape and sloped steeply toward the interior of the basin. The base of the catchment basin was slightly sloped toward a single spillway, used to funnel water

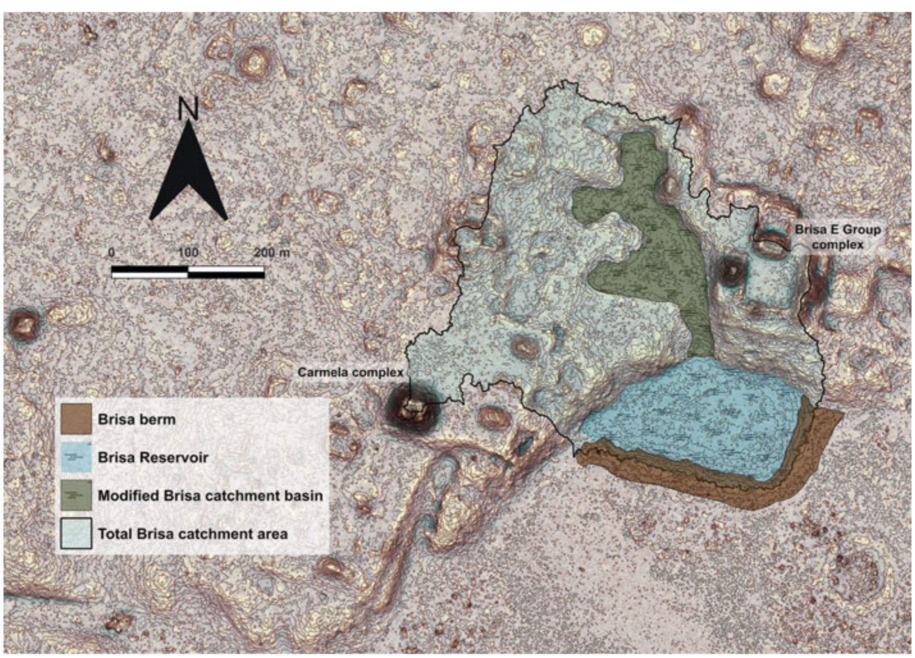

Figure 2. Brisa Reservoir, berm, and catchment area, the oldest and largest known reservoir in Yaxnohcah, Campeche, Mexico. Map by Reese-Taylor and Montgomery.

into the reservoir. The surface area of catchment basin and the spillway encompassed approximately 22,000 m^2. Excavations in the center of the basin revealed a buried paleosol at a depth of around 80–120 cm below the surface, overlaying the sascab bedrock. Levels above the paleosol consisted of aggraded sediments eroded from the surrounding elevated areas. Ceramics recovered from the paleosol consist exclusively of early Middle Preclassic types (Macal complex). This suggests that the catchment basin, the spillway, and the Brisa Reservoir were constructed simultaneously during the early Middle Preclassic, just after the construction of the early Brisa E-Group complex. Together these features, including the Brisa E-Group complex, constituted a landscape modification for managing water that encompassed a minimum of 189,500 m^2 (Figure 2).

In addition to the Brisa Reservoir, additional reservoirs located in the Central Karstic Uplands appear to be constructed using the same techniques (Morales-Aguilar and Hansen 2019). Several reservoirs share common elements, such as a location at the edge of a large *bajo* adjacent to a steep slope, a berm surrounding the inner tank, and a rectangular shape. These reservoirs include the El Mirador Reservoir, adjacent to the El Tigre triadic complex at El Mirador; the La Jarrilla Reservoir, located in an arm of the La Jarrilla *bajo* between El Mirador to the north and La Muerta to the south; the Nakbe Reservoir, situated south of the eastern complex at Nakbe; the Isla de Ramón Reservoir, and the Tintal Reservoir, located east of the Henequén complex. Like Brisa, each of these reservoirs has a large area on the adjacent elevated terrain that would have served as a catchment surface for runoff channeled into the storage feature. The La Jarrilla Reservoir also possessed several unique features. Although located immediately beneath a steep slope, the reservoir is elongated with a roughly north–south orientation with the El Mirador-Tintal causeway lying adjacent and parallel to the western berm.

According to Morales-Aguilar and Hansen (2019), the Nakbe and the La Jarrilla reservoirs date to the Middle Preclassic. Ceramics recovered during excavations of the La Jarrilla berm suggest that it was constructed between 650 and 550 B.C., and a carbon sample obtained in a deep level within the berm yielded a date of 580 B.C., confirming the date of the ceramics. Like the Brisa Reservoir at Yaxnohcah, the La Jarrilla Reservoir was likely dredged and the berm elevated during the Late Preclassic (Morales-Aguilar and Hansen 2019).

Excavations in San Bartolo Aguada revealed that it began as a limestone quarry, which was converted to a central reservoir by lining the floor with a thick coat of plaster (Dunning et al. 2008; Garrison and Dunning 2009). This reflects a major investment in infrastructure that is not apparent in other Central Karstic Uplands reservoirs, though the San Bartolo Reservoir is notably smaller than those discussed above. Charcoal embedded in the plaster floor produced a radiocarbon date of 780–410 cal B.C. The Aguada Tintal, a smaller reservoir located 7 km north of the main precinct at San Bartolo, also dates from 780–410 B.C.

In the Northern Lowlands, infrastructure is not as apparent, but the agroeconomy seemed to be thriving, based on the number of large Middle Preclassic sites now known from the region. On the northern fringe of the Puuc Region, the large site of Xocnaceh is located along the foot of the Sierrita de Ticul, which provided access to productive cumulic soils eroded from the north face of the Puuc escarpment and permanent water from rock-hewn wells (Gallareta Negrón 2018:289). In the Puuc region proper, Preclassic sites were distributed adjacent to larger basins of higher quality soil and settlements were anchored by large reservoirs (Ringle et al. 2021; Smyth et al. 2020). At Xcoch, the earliest known floor in the largest reservoir, Aguada La Gondola, lies at a depth of 310 cm below the surface and consists of compact clay and sascab (Smyth et al. 2017). An AMS date of 89 B.C.–A.D. 1 was obtained from a carbon sample from the floor; however, it is possible that early Middle Preclassic floors lie beneath this level, as excavations were discontinued before reaching the natural surface underlying the reservoir. In addition, Aguada La Gondola is located at a terminus to a Middle Preclassic sacbe, which would have provided easy access to this important water source and connected it to a ritual complex at the mouth of the deep cave underlying the site center (Smyth et al. 2017). Aktun Xcoch cave contained a permanent water source that was regularly accessed during the early Middle Preclassic, based on the presence of Yotolin Patterned Burnished vessels found near the edge of the deep pool (Smyth et al. 2017).

DISCUSSION: THE ENTANGLEMENT OF LANDESQUE CAPITAL AND SOCIOPOLITICAL COMPLEXITY IN THE MIDDLE PRECLASSIC

From our assessment, patterns pertaining to the emergence of landesque capital during the Middle Preclassic reflect both the shift to an agricultural economy and the availability and organization of communal labor during the Middle Preclassic. Subsistence transitioned from broad-spectrum horticulture to an increased reliance on maize agriculture at about 1000 B.C. throughout the Lowlands. Interestingly, the inclusion of maize as a staple in diets preceded the emergence of farming by as much as 1,000 years. Isotopic evidence on human remains from southern Belize show that at least some individuals had a diet that consisted of 50 percent C4 plants or animals who ate C4 plants by 2000 B.C. (Kennett et al. 2020). The increase in maize as a dietary element coincided with evidence for burning throughout the Lowlands (1400–900 B.C.) and the appearance of the constricted adze (3000–1000 B.C.) as a general-purpose tool, all of which suggest that extensive gardening was practiced by small mobile groups.

Yet by all accounts, populations in the Maya Lowlands did not fully embrace sedentism for another 100–200 years, as evidence is amassing that mobile lifeways continued, at least in part, until 800 B.C. From 1000 to 800 B.C., during this interregnum between the emergence of maize agriculture and the complete shift to a sedentary lifeway, the lowland Maya constructed enormous platforms and leveled massive hilltops to create spaces for communal activities, including sweat baths (Estrada-Belli 2011; Hammond and Bauer 2001; Inomata et al. 2013, 2019, 2020, 2021; Źralka et al. 2022), and E-Groups were built in the western lowlands, the Central Karstic Uplands, and into central Peten (Aimers and Rice 2006; Doyle 2012; Estrada-Belli 2006, 2011; Hansen 1998; Inomata 2013; Inomata et al. 2020; Pugh et al. 2022; Reese-Taylor 2017; Rice and Pugh 2017; Rice et al. 2019).

Collective labor prior to 800 B.C. seems to have been directed toward projects promoting communal cohesion and community building. These projects created public places for ritual practices centered around the life-cycle of maize (Estrada-Belli 2006, 2011; Taube 2005), which the early Maya deemed crucial for the success of growing communities and their incipient agricultural systems. This is most evident in the jade celt caches dating to 1000–800 B.C., recovered from early E-Groups at Ceibal and Aguada Fénix (Inomata 2017; Inomata and Triadan 2016; Inomata et al. 2020).

In addition, innovations in cultivation and building practices led to changes in manufacturing skills, specifically in lithic production. Most notably, the constricted adze, the Preceramic gardening tool of choice, was replaced during the early Middle Preclassic by the oval biface. This general utility tool not only supplanted the constricted adze for wood cutting, chopping, and other horticultural activities, but was also useful for moving soil and preparing bedrock, a necessary prelude to creating fields for agriculture and building structures, quarrying limestone for construction materials, and shaping limestone blocks.

While the timing of the first permanent settlements varied from region to region, by 800 B.C., sedentism appeared to be an established lifeway throughout the Maya Lowlands. Evidence for permanent communities has been recovered in the Belize River Valley (Awe 1992; Ebert et al. 2017; Powis et al. 2009), northern Belize (Hammond 1991; Hester et al. 1982; McAnany and López Varela 1999; Potter et al. 1984; Valdez 1987), the Pasion River area (Adams 1971; Triadan et al. 2017), the Peten Lakes region (Pugh et al. 2022; Rice and Pugh 2017; Rice et al. 2019), the Central Karstic Uplands (Hansen 1998; Reese-Taylor et al. 2018), the Gulf coast of Campeche (Ek 2022), as well as in the Puuc Hills (Gallareta Negrón 2018; Parker et al. 2022; Smyth et al. 2020).

After 800 B.C., not only did sedentary settlements become dominant in the landscape of the Maya Lowlands, but the construction of civic architecture accelerated. E-Groups continued in importance in the Central and Southern Lowlands and, after 700 B.C., spread to the Northern Lowlands, northern Belize, and the Belize River Valley. Between 800 and 700 B.C., water jars were included, along with jade, in E-Group caches at Ceibal and Cival (Estrada-Belli 2006, 2011; Inomata 2017; Inomata and Triadan 2016), suggesting a re-focus of ceremonial practices on water rites to ensure the timely commencement of the rainy season, crucial for the viability of humans and plants alike. Ballcourts were also present in the Northern Lowlands during the Middle Preclassic, perhaps as early as 700 B.C. (Robles Castellanos and Ceballos Gallareta 2018) and appear in the Southern and Central Lowlands by ca. 400–300 B.C. (Vázquez López et al. 2022).

The transition to agriculture, while allowing greater productivity, also resulted in new problems, such as soil erosion and the depletion of nutrients in soils. In addition, the effects of rising water tables on perennial wetland fields in coastal and riparian areas also diminished soil productivity, and strategies for addressing such changes were critical for the nascent agroeconomy (Beach et al. 2019). Increased investment in infrastructure as a form of landesque capital followed the shift to more sedentary lifeways. This implies that in the Lowlands, long-term improvements were made as inhabitants became more capable of holding or controlling the investment (Blaikie and Brookfield 1987; Brookfield 1984). Ditching along the margins of perennial wetlands began as early as 1000 B.C. and is best documented in the Eastern Maya Lowlands at Cob Swamp, Albion Island, and similar locations. Creating ditches to speed up the draining of fields on wetland margins was a simple but effective solution to slowly rising water tables that augmented the number of days available for dry-season farming in wetland environments. Terraces, which retard soil erosion in upland areas for more productive farming during the rainy season, are uncommon in the archaeological record of this period. However, evidence from Chan, in western Belize, suggests that terraces were an important innovation in the late Middle Preclassic adjacent to this riverine floodplain area, and one which may be overlooked in many regions.

However, the most dramatic form of landesque capital seen in the Maya Lowlands during the Middle Preclassic is the reservoirs and catchment basins constructed by the inhabitants of the Central Karstic Uplands and other parts of the Elevated Interior Region, such as the Puuc, where perennial water sources were extremely scarce (Dunning et al. 2012, 2022). The reservoirs and catchment areas would have provided secure sources of water in the dry season, as well as mitigated runoff away from vulnerable *bajo* margin fields during the rainy season. Many central reservoirs are massive in size, with capacity estimates conservatively ranging in size from 69,300 m^3 in some instances to 6,653 m^3. Based on excavations in the Brisa Reservoir at Yaxnohcah, we understand that the construction was simple (Dunning et al. 2022). Berms were built by drawing and piling *bajo* sediments in perimeters around previously existing low-lying areas. Known reservoirs had no formal floor during the Middle Preclassic, but instead depended on the natural, compacted clayey sediments of the *bajos* to hold water. Located adjacent to natural escarpments, each reservoir was positioned to take advantage of areas where natural runoff occurred. Catchment areas were amplified by skillful modifications. Builders enhanced the sloped natural (and, later, the constructed) landscape above the reservoirs by creating basins, which received the water and redirected it into the reservoir.

The Brisa berm was a massive earthwork, comprising over 66,4000 m^3 of sediment and clay fill. In addition, this volume of fill does not include the amount of fill excavated from the basin of the reservoir to create a flattened and impermeable surface. At present, the interior of the reservoir is approximately 2 m below the exterior surface of the Bajo Tomatal. Assuming that sedimentation rates are the same for the interior and exterior of the reservoir, we can use this difference to calculate that a total of 80,266 m^3 of sediment may have been removed from the interior and used to construct the berm. This one construction, then, represented a huge investment for Middle Preclassic Yaxnohcah. And of the six contemporaneous reservoirs of this type identified in the Central Karstic Uplands, only the La Jarrilla Reservoir at El Mirador was smaller.

Our understanding of landesque capital during the Middle Preclassic lags behind our knowledge of architectural constructions. However, from this brief overview, it is clear that landesque capital played a crucial role in the development of complexity in the Maya Lowlands. It is likely not coincidental that the most impressive examples of landesque capital in the Lowlands, the massive reservoirs of the Central Karstic Uplands, are found in a region that is known for its huge populations and large cities during the Late Preclassic. At Yaxnohcah, there appears to be a direct spatial relationship between the Brisa Reservoir and the most prominent Middle Preclassic architectural complex in the civic precinct, suggesting a degree of control by an emerging elite. This may also be the case at Nakbe, El Mirador, and El Tintal. Certainly, a large labor force, and possibly new lithic tool forms, were needed to construct and maintain the reservoir, which would have demanded collective action and cooperation among semi-autonomous communities in the Yaxnohcah area (Reese-Taylor 2017; Vázquez López et al. 2022).

Indeed, the creation of many early reservoirs was interwoven with the expansion of communal architecture to a point that they cannot be considered independently. The Prehispanic Maya considered ideological practices to be crucial to the ongoing viability of human populations and agricultural systems alike and, at times, purposefully linked the places in which these rituals took place with large-scale infrastructure projects that also sustained life, enhancing the functionality of these features. In such cases, we argue that the boundaries between civic-ceremonial architecture and infrastructure were blurred, so much so that ceremonial precincts that directly affected the outcomes of sustainable practices and features should also be considered as landesque capital.

In the Central Karstic Uplands especially, the construction of reservoirs and enlargement of plazas and platforms appear to have been symbiotic endeavors, each influencing the final form of the other to such an extent that they must have been conceived and planned as a unit. In many cases, it is possible that the enlargement of early plazas may have had less to do with the need to accommodate more people than the need to direct and capture more water. Moreover, the ability of nascent elites to effectively envision and carry out ideologically complex construction projects with direct environmental and religious impacts ensured the lasting success and cohesion of the community and, no doubt, advanced the development of sociopolitical complexity during the Middle Preclassic.

The reservoirs and agricultural investments would also have contributed to the expansion of wetland agriculture in this region, which likely provided an advantage to the local inhabitants. Agricultural surpluses would have supported economic development, specifically the establishment of trade networks and craft specializations. Although trade networks and household specialization can be seen in all regions during the Middle Preclassic (Parker et al. 2022), the large-scale landesque capital in the Central Karstic Uplands may have been crucial for its economic success in the Late Preclassic.

Significantly, however, various forms of landesque capital were not limited to one region during the Middle Preclassic, but appeared throughout the Maya Lowlands and included not only infrastructure projects, such as reservoirs, but also civic complexes supporting ideological practices, which were viewed by the Maya as equally indispensable to the well-being of the community. While features of landesque capital appeared among the Maya as early as 1000 B.C., if not earlier, forms diversified and became entangled throughout the Middle Preclassic. As a result, an ontology of landesque capital arose, based on the synergistic fusing of daily and ritual practices with physical features, which established a foundation for resilience, sustainability, and well-being in subsequent generations.

RESUMEN

En las tierras bajas mayas, el preclásico medio (1000–300/400 a.C.) se caracteriza por cambios a gran escala vinculados con el establecimiento de las primeras comunidades sedentarias y la vida cívica. Hacia finales de este período se observa el surgimiento de los primeros estados y la centralización de la autoridad expresada mediante la figura del gobernante. En este trabajo nos centramos en la relación entre el capital paisajístico y la complejidad sociopolítica en las tierras bajas mayas, con el fin de obtener un mejor entendimiento de la naturaleza de las transformaciones ocurridas durante el preclásico medio. Capital paisajístico (*landesque capital*) se refiere a la inversión permanente en la modificación de la tierra que resulta en mayores rendimientos agrícolas y el abastecimiento confiable de agua —reservorios, áreas de captación de agua, sistemas de irrigación y suelos antropogénicos, entre otros. Este tipo de capital consiste en la construcción de paisajes productivos y sustentables que aseguran la viabilidad de la agricultura y la ocupación a largo plazo en un entorno (Hoaen y Loney 2013), por lo que implica la interacción entre humanos y ecosistemas. Consideramos que esta infraestructura económica también incluyó a los complejos cívico-ceremoniales porque estos no sólo dirigieron el flujo de agua a los reservorios, sino que también constituyeron el escenario de prácticas rituales que aseguraba la buena voluntad de los dioses en las prácticas agrícolas. De esta manera, estas inversiones permanentes en el paisaje aumentaron la resiliencia, la sustentabilidad y el bienestar entre los mayas tempranos.

En el presente trabajo argumentamos que estos desarrollos fueron la consecuencia de la modificación continua y acumulada del suelo que tomó lugar en el período precerámico/preclásico temprano, y la inversión de mano de obra en rasgos agrícolas, grandes obras públicas y determinados complejos cívicos durante el preclásico medio. Llama la atención que el momento y la ubicación de las inversiones de este período estén fuertemente correlacionados con procesos fundamentales como la transición al sedentarismo, el control de los recursos, cambios en la producción lítica y una élite emergente. Observamos que durante el preclásico medio, algunas de las mayores inversiones de este tipo de ambiente construido ocurrieron en la meseta kárstica central, culminando en el surgimiento de grandes ciudades en el preclásico tardío.

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