



New Answers to Old Questions: What Happened to Classic Maya Civilization?

The Collapse of the Classic Maya: A Case for the Role of Water Control

ABSTRACT This article focuses on the role of water control in the emergence and demise of Classic Maya political power (c. C.E. 250–950), one that scholars have long underestimated. The scale of water control correlates with the degree of political power, reflected in three levels of Maya civic-ceremonial centers—regional, secondary, and minor. Such power derives from a complex relationship among center location, seasonal water supply, amount of agricultural land, and settlement density. Maya kings monopolized artificial reservoirs and other water sources during annual drought, providing the means to exact tribute from subjects. Climate change undermined the institution of rulership when existing ceremonies and technology failed to provide sufficient water. The collapse of rulers' power at regional centers in the Terminal Classic (c. C.E. 850–950) had differing impacts on smaller centers. Secondary and minor centers not heavily dependent on water control survived the drought and the collapse of regional centers. [Keywords: political power, water control, Classic Maya collapse]

SCHOLARS HAVE LONG speculated about the causes of both the rise and the dramatic collapse of the Classic Maya (c. C.E. 250–950) of Mesoamerica.¹ Their rise has been considered anomalous because Maya civilization seemed to deviate from the many examples documenting a close relationship between the control of water and political power (e.g., Fagan 1999:248–252; Weber 1964:31; Wittfogel 1957; Wortman 1985). In Mesopotamia, Egypt, China, the Indus Valley, Andean South America, and central Mexico, for example, ancient civilizations emerged in areas with natural water sources and agricultural land that supported a densely settled subject populace; elite control of water for agricultural production allowed leaders to exact tribute from the local population. In contrast, southern Maya kings in lowland jungles often ruled from civic-ceremonial centers in areas with fertile land, *but without natural water sources*, suggesting that power was unrelated to water control in these cases.

I argue that scholars have overlooked the importance of the control of *artificial* reservoirs by Maya rulers and suggest that control of this type of water resource played a critical role in the florescence of Maya civilization and in its later collapse. Further, I suggest that a focus on the con-

trol of artificial reservoirs helps explain differences in the historical trajectories of large and small Maya settlements. In large regional civic-ceremonial centers, Maya rulers lost the means to control water in the Terminal Classic (c. C.E. 850–950) because of climatic changes, resulting in the collapse of power. Minor and secondary centers in areas less dependent on water control, by contrast, survived the drought and avoided collapse.

The power of Maya rulers—particularly their ability to exact tribute, or surplus labor and goods, from others—derived from a complex relationship among a number of factors, particularly the location of the center from where they ruled, its seasonal water supply, the amount of agricultural land, and settlement density. I outline the specific relationship among these factors below.

A problem with any model is that it cannot account for every situation, as is the case when attempting to explain the Maya collapse. The model I present does not account for the political histories of every Maya center but provides a general organizational framework by which to evaluate how water control and political power figured in the rise and fall of political leadership among the Maya. I focus on the processes of collapse that occur once they are

set in motion rather than presenting a *new* cause. This approach, thus, does not discount earlier perspectives but views them as local events rather than pan-Maya explanations.

THE POLITICS OF WATER CONTROL

Generally, densely settled areas where people are tied to the land because of subsistence technology (e.g., plowed fields, canals, dams, agricultural terraces, fish ponds, transportation, storage facilities) facilitate the rise of consolidated political power (Gilman 1981) because leaders can more easily control access to critical resources, people, and their surplus (Earle 1997:7). Conversely, scattered resources are harder to monopolize and result in dispersed populations that are more difficult to integrate. Maya rulers faced particular difficulties in drawing farmers close to the ceremonial-civic centers over which they ruled. The majority of farmers lived dispersed in farmsteads throughout noncenter or hinterland areas, mirroring the patchlike distribution of fertile land (Dunning 1998; Fedick and Ford 1990; Rice 1993; Sanders 1977). Maya farmers used a combination of agricultural techniques including house gardens; short-fallow infields; long-fallow outfields to grow maize, beans, and squash (Flannery 1982; Harrison and Turner 1978; Killion 1990); and various types of intensive agricultural techniques such as raised fields, dams, canals, and terraces (Dunning 1997). However, few or none of these techniques appear to have been under elite control (Demarest 1992; Tourtellot 1993; cf. Marcus 1982). Other farmers lived near or in centers, where they may not have stayed during the labor-intensive rainy seasons, especially if their fields were at some distance, requiring the use of field houses (e.g., Ford 1992; Lucero 1999a; Webster 1992). In addition, some farmers may have had to find new land in the face of growing population and increasing competition over land, especially during the Classic period (Ford 1991b; Tourtellot 1993). Hinterland Maya farming communities also may have been relatively economically self-sufficient (Lucero 2001). Consequently, the ruling elite needed to integrate not only a relatively dispersed and self-sufficient populace but also one that may have been somewhat mobile (Drennan 1988; Ford 1990; Santley 1990).

That these rulers were able to do so is primarily because of the nature of seasonal rainfall and water availability in the area. Particularly significant is the four-month annual drought, from January to May. This had particular consequences in regions lacking rivers and lakes such as those where the regional centers Tikal, Caracol, and Calakmul emerged (Figure 1). The lack of surface water for four months every year required the Maya to devise ways to store water. Rather than concentrate people through a dependence on agricultural technologies, rulers concentrated an even more vital resource, drinking water. The earliest rulers of Tikal, Caracol, Calakmul, and other centers organized the construction and maintenance of large artificial reservoirs in center cores next to temples and other monumental architecture.² Rulers' control of reservoirs

during seasonal drought combined with their performance of associated rituals, facilitated dry-season nucleation at these centers, and lessened the need for hinterland communities to build their own reservoirs (Lucero 1999c).

A challenge the Maya faced, however, concerned standing water during the dry season. Standing water can become stagnant, can provide prime conditions for insects and parasites, and, more significantly, can result in the build-up of noxious chemicals, especially nitrogen (Burton 1979). The natural wetland biosphere acts to sustain water purity if correctly maintained (Hammer and Kadlec 1980; Nelson 1980). Maya rulers became responsible not only for providing enough potable water to last through the dry season by organizing the continual maintenance required to keep the reservoirs clean (Ford 1996), but also for performing rites necessary to propitiate deities such as Chac, the rain god.

A visible sign of clean water is the water lily. Water lilies, *Nymphaea ampla*, are sensitive hydrophytic plants that can only grow in shallow (1–3 meter), clean, still water that is not too acidic and does not have too much algae or too much calcium (Conrad 1905:116; Lundell 1937:18, 26). Thus, the presence of water lilies on the surface of *aguadas*, or rain-fed natural basins, and reservoirs is a visible indicator of clean water. The water lily was a symbol of royalty in Classic Maya society, as clearly expressed in the distribution of water lily motifs on stelae, monumental architecture, murals, and mobile wealth goods such as polychrome ceramic vessels (e.g., Rands 1953). Water imagery, and possible evidence for associated rituals, abounds at regional and secondary centers (Fash in press; Fash and Davis-Salazar 2001; Puleston 1977; Scarborough 1998), suggesting the important link between maintaining clean water and royal power in these areas.

The continued supply of clean water must have meant to the local populations that rulers were successful in supplicating gods and ancestors and that rulers had special ties to the supernatural world, which they used to benefit all—for a price, of course. Worldwide, rulers often are associated with fertility, purification, and associated rites (Helms 1993:78–79). Subjects often believe that holders of exclusive knowledge and skill are in closer proximity to the gods or are gods themselves (Friedman and Rowlands 1978; e.g., Weber 1964; Wortman 1985). The inscriptions and iconography found throughout civic-ceremonial centers amply illustrate that Classic Maya rulers had closer ties to important Maya deities, to ancestors, and to the supernatural world than the rest of Maya society (e.g., Houston and Stuart 1996; Marcus 1978; McNany 1995; Schele and Freidel 1990; Schele and Miller 1986).

Hinterland communities in areas without lakes or rivers did not build their own large-scale water catchment systems and did not develop equally complex political systems for several reasons. For one, artificial reservoirs initially required a substantial output of labor to construct, as well as continual maintenance that was not available in sparsely populated regions. In addition, hinterland *aguadas*

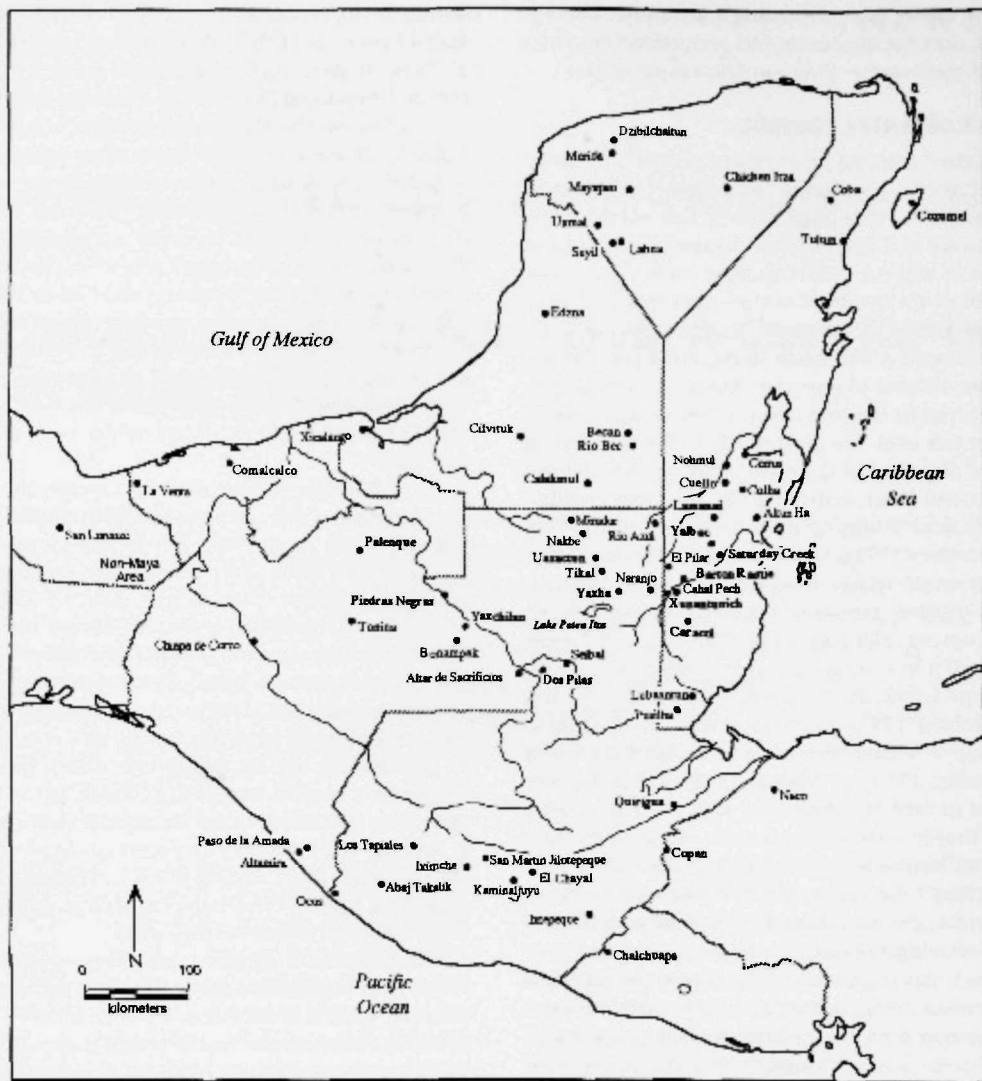


FIGURE 1. The Maya area with sites discussed in bold.

are small and would not have supported large, nucleated populations throughout the dry seasons, especially because water in smaller aguadas would likely evaporate more quickly than that in larger, maintained reservoirs (Scarborough 1996). Such communities may not have built water catchment systems or expanded and maintained aguadas because of the nature of standing water, which, as discussed above, requires significant effort to keep clean.

I do not claim that Maya farmers did not know about the properties of water; rather, as Scarborough (1998) argues, Maya rulers appropriated traditional water rituals to suit a political agenda. Nor do I posit that all hinterland Maya converged at centers every dry season. Instead, I suggest that prehistoric Maya farmers, especially in the southern

Maya lowlands, were more mobile than previously believed and that some of this mobility involved gravitating to stable water sources.

The ultimate result of the distribution of resources and subsistence practices was a somewhat fluid residential pattern whereby farmers may have had the option to participate in ceremonies sponsored by different rulers or perhaps even not at all. Consequently, this system was susceptible to fluctuations in the water supply that had reverberations throughout the lowlands, affecting all royal courts. In the Terminal Classic (c. C.E. 850-950), a series of events resulted in a situation in which rulers could not prevent their subjects from migrating out of the interior or dispersing permanently into hinterland areas. Consequently,

these centers were abruptly abandoned. Other centers have different, but related, histories, as I discuss below.

LATE CLASSIC MAYA CIVIC-CEREMONIAL CENTERS AND POLITICAL POWER (C. C.E. 550–850)

The varied types of political systems that existed during the Late Classic period at regional, secondary, and minor civic-ceremonial centers relate to how seasonal water supply and the amount of agricultural land affected settlement pat-

terns and available surplus (Table 1). At one end of the political spectrum were large regional centers; at the other, minor centers; secondary centers occupied a middle ground, smaller in size than regional centers but larger than minor ones.

Regional Centers

Regional centers such as Tikal, Calakmul, and Caracol were located in upland areas with large pockets of dispersed fertile

TABLE 1. Late Classic Maya Centers (c. C.E. 550–850).

Scale	Minor center	Secondary center ^a	River regional center	Non-river regional center
Distribution of resources	River, extensive alluvium	River, uplands with dispersed pockets of agricultural soils	River, concentrated alluvium	Non-river, uplands with reservoirs and large tracts of dispersed agricultural land
Water systems	None	Small-scale	Large-scale	Large-scale
Water imagery	None	Present	Present	Present
Settlement patterns and density	Relatively dispersed and low density; 100–150 ^b str/sq km	Slightly higher center density than hinterlands 275 ^c str/sq km v. up to 145 str/sq km	High center density 1449 ^d str/sq km v. 28–99 str/sq km in hinterlands	High center and hinterland density 235–557 ^e str/sq km v. 39–313 str/sq km
Territorial extent	Local	Center and immediate hinterlands	Center and immediate hinterlands, secondary centers	Center and immediate hinterlands, secondary centers
External relations	May or may not be subsumed under regional system	Hierarchical relations with larger polities	Equal and unequal inter-polity relations	Equal and unequal inter-polity relations
Political economy	No tribute	Some tribute	Tribute	Tribute
Interaction	Elite interaction; prestige-goods exchange	Elite and royal interaction (secondary): ball courts, palaces, writing, emblem glyphs, some funerary temples	Elite and royal interaction (primary): ball courts, writing, administrative palaces, emblem glyphs, funerary temples	Elite and royal interaction (primary): ball courts, writing, administrative palaces, emblem glyphs, funerary temples
Integrative strategies	Community events, ceremonies, public works	Community events, ceremonies, public works, royal rites	Community events, large-scale royal political/ceremonial events	Community events, large-scale royal political/ceremonial events
Duration	Stable, long-lasting	Political system tied to external conditions; subsistence system relatively stable	Political and subsistence systems stable as long as resources are	Required continual maintenance (feasts, ceremonies, display); affected by fluctuations; subsistence system relatively stable
Terminal Classic events	Not abandoned	Varies—relates to political and/or local resources; center abandoned, hinterlands not, or neither center nor hinterlands abandoned, or center briefly prospered	Centers abruptly abandoned, gradual abandonment of hinterlands as resources diminish	Centers abruptly abandoned, gradual abandonment of hinterlands as resources diminish
Examples	Saturday Creek, Barton Ramie	Lamanai, Piedras Negras, Quiriguá, Yalbac, Seibal, Yaxchilan, Dos Pilas, Xunantunich	Copán, Palenque	Tikal, Calakmul, Caracol

^a Some secondary centers may very likely turn out to be regional centers, particularly Piedras Negras and Yaxchilan. There are numerous other centers that fit this category including, for example, Altar de Sacrificios, Rio Azul, Motul de San José, El Peru, etc. The table only lists sites discussed in the text.

^b Lucero 1999b; Rice and Culbert 1990: table 1.1.

^c Ashmore 1990; Loten 1985; Rice and Culbert 1990: table 1.1; Tourtellot 1990.

^d Rice and Culbert 1990: table 1.1; Webster and Freter 1990.

^e Culbert et al. 1990; Folan et al. 1995. *Bajo* (seasonal swamps) settlement accounts for the lower densities.

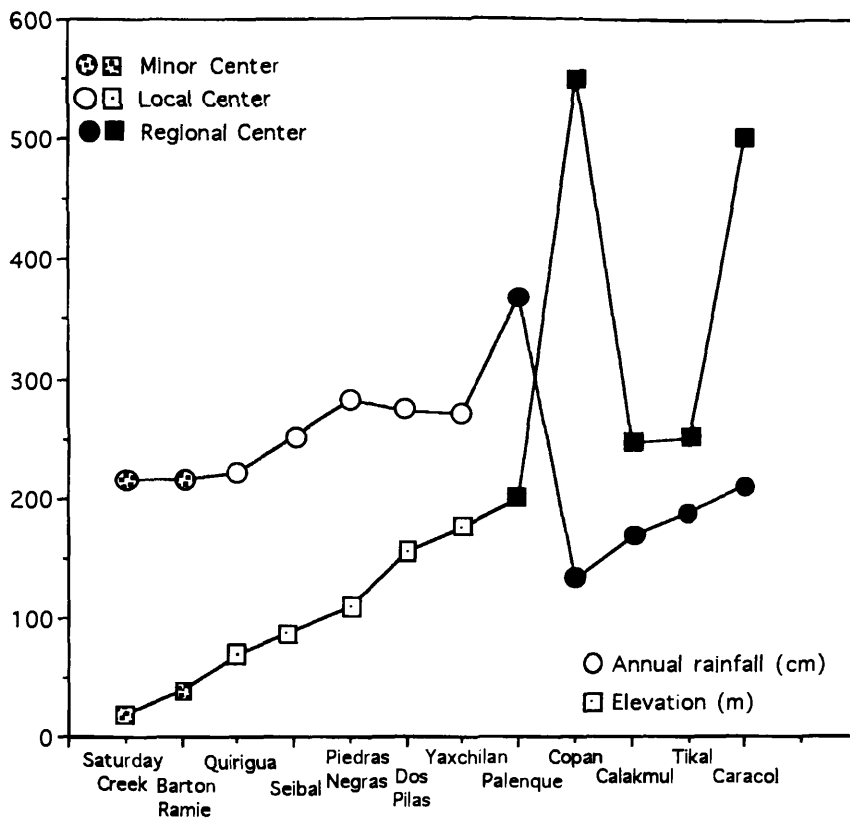


FIGURE 2. Elevation and annual rainfall in the southern Maya lowlands.

land difficult to monopolize and without permanent water sources. The need for an adequate water supply in the area of these regional centers is related to annual rainfall; it was typically less than that at secondary and regional river centers (Figure 2).³ For example, annual rainfall at secondary centers ranges from 220 to over 280 centimeters. At Tikal, it was just under 190 centimeters; at Calakmul, just under 170; and at Caracol, 210 (Neiman 1997). Tikal, Calakmul, and Caracol each had artificial reservoirs constructed next to monumental temples and palaces. At Tikal, for example, there are at least six major reservoirs, all located in the center core next to palaces and temples (Scarborough and Gallopín 1991). Ceramics excavated from the Palace Reservoir at Tikal date to the Early Classic period (c. C.E. 250–550), which Harrison (1993) correlates with the accelerated construction of monumental architecture in Tikal's core. Quarrying of reservoirs provided building materials, including limestone fill, wall facing, and plaster, for monumental construction projects (Scarborough 1993). At Calakmul, which is surrounded by *baños*, or low-lying seasonal swamps, there are extensive canal systems as well as 13 reservoirs and aguadas (Folan 1995). Caracol has at least two major reservoirs next to temples and is literally surrounded by terraced hillsides for

agriculture as well as water control (Chase and Chase 1996, 2001; Healy 1983).

Settlement was dense around these regional centers as well as throughout fertile hinterland areas. Powerful kings ruled over these domains of concentrated resources—reservoirs—and densely settled farmers. Rulers collected tribute because of their combined ability to control water, a restricted resource (e.g., Folan 1995; Ford 1996; Scarborough 1991, 1993), and associated knowledge and rituals (Fash in press; Scarborough 1998). Consequently, rulers funded large-scale rituals in central plazas and temples to attract, incorporate, and integrate farmers from the immediate area and beyond, especially during annual drought (Lucero 1999c). Rulers performed rituals and organized the maintenance of reservoirs and in return received tribute in the form of surplus labor, goods, and food.

As long as the water supply was adequate, rulership lasted. Tikal, for example, has one of the longest political histories in the entire southern Maya lowlands (C.E. 292–869). Clearly, rulers were successful in expanding and maintaining their political base through water control and integrative events. Their source of power, however, was susceptible to fluctuations, especially in the water supply, a fact that accounts for the Maya abandoning royal centers

by the ninth or tenth century. As long as subsistence resources were available, however, farmers did not necessarily abandon hinterland areas, for events taking place at royal centers did not always affect them. They continued to practice subsistence activities in small communities and to participate in local events; they also maintained small-scale water systems (e.g., *aguadas*).

Not all regional centers were located in areas without lakes or rivers; Palenque and Copán are prime examples. More typical of most other ancient civilizations, these sites are found along rivers with concentrated alluvium that supported regional hierarchical polities. Settlement was typically dense around these centers and noticeably less dense in areas beyond the alluvium. Rulers collected tribute because of their ability to monopolize concentrated alluvium and acquire tribute from nucleated settlements. Rulers sponsored large-scale rituals in central plazas and temples to incorporate and integrate larger numbers of farmers from the immediate area as well as to legitimate their rule. For example, alluvial soils around Copán are found within a 24 square kilometer area (Webster 1999). Rulers also built artificial reservoirs, which Barbara Fash (in press) argues were managed and controlled by the political elite, based on their distribution and analysis of iconography. Additionally, although the presence of rural *aguadas* signifies some degree of self-reliance, at least for access to water, relatively low annual rainfall (132 centimeters) and undrinkable river water during the height of the dry season meant that local farmers relied on water-management systems part of the year. Rulers also controlled trade with highland areas for jade and obsidian (Fash 1991). Similarly, Palenque is situated at the foothills of the Chiapas mountains above a fertile valley (de la Garza 1992:51–52). Inhabitants of Palenque, located in a hilly area with several streams and springs, built water systems consisting of aqueducts and canals to drain water away from the center—a not-too-surprising fact given that annual rainfall is over 360 centimeters. It is interesting to note that although water lilies cannot grow in Palenque's springs and flowing streams, their ubiquity in the iconographic record at Palenque is undeniable and indicates the importance of water symbolism in political ideology and rituals throughout the Maya region.

Rulers at regional river centers lasted as long as resources did. Demand for surplus production instituted by rulers could have contributed to the overexploitation of resources. Any decrease in surplus undermined the political system, whether it was resource degradation or decreasing water supply. Regional powers abandoned the trappings of what formerly defined Classic Maya political life—palaces, temples, inscribed sculpture, and so on. Consequently, Copán and Palenque, but not necessarily their hinterlands, were largely abandoned by the ninth or tenth century. Because of close ties, the decline of regional rulers also contributed to the disruption of secondary centers, as we will see below.

Secondary Centers

The histories of secondary centers show great variability, which is not surprising given their status as secondary polities. They do, however, have several factors in common. For example, Lamanai, Yalbac, Seibal, Piedras Negras, Dos Pilas,⁴ and Xunantunich are typically found along rivers largely in upland areas with dispersed pockets of agricultural land that supported local polities. Settlement was typically dense near centers and not as dense in hinterland areas. Rulers acquired some tribute because of their ability to monopolize nearby agricultural land and prestige goods exchange. These centers arose as secondary polities because of their rulers' participation in a royal interaction sphere established by regional rulers: rulers from secondary centers interacted with those in regional centers in such activities as intercenter alliances, marriages, warfare, prestige goods exchange, and royal rites. This pattern is borne out in the inscriptions in which regional royal histories begin earlier (C.E. 292–435) than secondary royal histories (C.E. 480 and later) (see Martin and Grube 2000).

At most secondary centers, residents lived above rivers on ridges and hills, which meant that saturated hillsides during the rainy season likely posed problems and influenced building plans and agricultural practices (Turner 1974). Because of the dispersed agricultural soils, Maya farmers used scattered small-scale water systems including *aguadas*, dams, canals, and drainage ditches (e.g., Dunning 1997; Fedick 1994). Their inconsistent distribution suggests that water systems had less of a political role in these areas.

The impact of climatic change in the tenth century on these centers varied and was related to the level of involvement of the local rulers with those in larger, regional centers. Secondary rulers were linked to regional rulers because nonlocal royal ties played a major role in maintaining political power. Any change in external relations, such as regional centers' loss of power, trade disruption, or diminishing surplus, reverberated throughout the royal interaction sphere. Local subsistence practices and wealth differentiation were not necessarily affected as long as resources were available. Consequently, there were varied responses to the collapse of power at regional centers. Many secondary centers where rulers had close ties with regional rulers were largely abandoned by the ninth or tenth century, though not necessarily their hinterland areas (e.g., Quiriguá and Yaxchilan). Weakening power at regional centers at the end of the Late Classic resulted in several secondary rulers claiming independence. For example, Quiriguá became independent from Copán, and Yaxchilan broke with Palenque and Tikal (Ashmore 1984; Mathews and Willey 1991). In such cases, rulers did not immediately lose power, so neither their centers nor the surrounding hinterlands were abandoned. Clearly, means other than water control existed to underwrite political systems, such as the monopolization of agricultural land, trade in nonexotics, and the use of alternative trade routes

and partners. Rulers at some secondary centers even prospered. For example, leaders at Seibal and Xunantunich witnessed a brief florescence (Leventhal and Ashmore 1997; Mathews and Willey 1991). Other secondary centers continued, but without royal trappings.

Minor Centers

Minor centers such as Barton Ramie and Saturday Creek were located along the Belize River with extensive alluvium. These centers were located in lower elevations and had higher annual rainfall than the majority of regional centers (see Figure 2). These communities were made up of relatively low densities of dispersed farmsteads, a condition not conducive for aspiring leaders to monopolize resources and acquire surplus. Wealth differences accounted for various-sized residences and differential access to prestige items. Elites or wealthy families sponsored local small-scale public rituals and feasts at small temples and plazas (Arie 2001) and organized the construction of public works to promote solidarity in the face of economic inequality. Residents of these areas did not rely on large-scale water systems because they tailored their agricultural schedules and building practices to the annual flooding and subsiding of the river (e.g., flood-recession agriculture). Annual inundation of the poorly drained soils of the lower terrace deterred the Maya from building or planting too close to the river. There is no obvious iconographic evidence at such centers for water imagery, which, by contrast, is pervasive on monumental architecture, sculpture, and mobile goods at secondary and regional centers (e.g., Cuauc or Witz Monster, Water Lily Monster, fish, crocodiles, water lilies, turtles, etc.). Communities around minor centers were stable and lasted as long as there were enough resources to sustain people. For example, Saturday Creek and Barton Ramie were occupied long after secondary and regional centers were abandoned (c. 900 B.C.E. up to c. C.E. 1500; Conlon and Ehret 2002; Willey 1965).

In sum, rulers at regional centers acquired political power through their ability to access concentrated alluvium and reservoirs and to acquire tribute from densely settled farmers. Similarly, secondary rulers attained some degree of power through controlling prestige goods exchange, but not to the extent found in regional polities because they were not able to completely control access to a critical resource. Elites at minor centers did not have political power but relied on their wealth, as landowners in particular, to procure prestige goods and conduct local ceremonies. A major factor preventing elites at minor centers from acquiring political power was their inability to monopolize extensive agricultural land and politically integrate dispersed people.

THE POLITICAL COLLAPSE

Events occurring during the Terminal Classic period at regional centers affected lower-order centers in various ways or not at all: some were abandoned, some became inde-

pendent, some experienced brief spurts of power, and some continued as they had (Marcus 1976:186–190, 1994). After the Terminal Classic, traditional ceremonies continued; rituals vital in defining Classic Maya rulership, however, disappeared, along with the power that had allowed kings to maintain such rich ritual and political lifestyles.

What set in motion the erosion of Classic Maya rulership in the Terminal Classic (c. C.E. 850–950)? Numerous explanations have been proffered; factors suggested to have affected Maya rulership include climate changes (Curtis 1996; Dahlin 1983; Folan 1983; Gill 2000; Gunn 1995; Hodell 1995; Hodell 2001; Lowe 1985); increased monocropping (Atran 1993); environmental and ecological degradation in the face of increasing population (Abrams and Rue 1988; Culbert 1977; Hosler 1977; Sabloff and Willey 1967; Santley 1986); foreign intrusion (Cowgill 1964); internal warfare (Demarest 1997); increasing competition (Bove 1981; Cowgill 1979); peasant revolt (Hamblin and Pitcher 1980; Thompson 1966); failures in management (Willey and Shimkin 1973), trade (Rathje 1973; Webb 1973), and subsistence (Culbert 1988; Turner 1974); yellow fever (Wilkinson 1995); and diminishing subsistence returns (Tainter 1988).

Increasingly, studies show that climate change occurred at the end of the Classic period, beginning in the late C.E. 700s (e.g., Curtis 1996; Curtis and Hodell 1993; Dahlin 1983; Folan 1983; Gill 2000; Gunn 1995; Hodell 1995; Leyden 1996; Messenger 1990). I argue that this may have set in motion several of the “causes” mentioned above or have exacerbated existing local problems.

While local climate patterns varied, evidence indicates that long-term climate change affected the entire Maya lowlands. For example, Gunn, Folan, and Robichaux (1995) propose a model, based on current global climate patterns, in which periods of florescence in lowland Maya history are related to periods when there was an optimal balance between wet and dry seasons. According to them, the Maya collapse was related to a period when an *imbalance* existed between wet and dry seasons that affected agricultural schedules. Pollen data from the lakes region in the Petén suggest that deforestation was already in place by the Early Classic, which may have further added to the burden of unstable seasonal patterns, not to mention a steadily increasing population (Deevey 1979; Rice 1993, 1996). Hodell, Curtis, and Brenner (1995; see also Curtis 1996), using lake core date from Lake Chichancanab and Punta Laguna in the Yucatán to assess temporal changes in oxygen isotopes and sediment composition, argue for an arid period beginning c. C.E. 750, lasting through c. C.E. 1000, perhaps because of periodic episodes of increased solar activity that occurred every 200 years or so (Hodell 2001).

I suggest that decreasing rainfall resulted in water-management systems failing, which shook the foundation of regional rulers. Drier conditions particularly affected those areas in higher elevations with relatively low annual rainfall (see Figure 2). Artificial reservoirs no longer could

adequately fulfill daily water needs. Consequently, Tikal's core was largely abandoned in the 900s,⁵ as was Calakmul's (Marcus 1998), the latter dealing not only with drought but possibly with the Putun Maya from the Gulf Coast of Tabasco, Mexico, taking advantage of a weakened rulership. Caracol's epicenter was abruptly abandoned by c. C.E. 890 and burned, though a remnant population remained for another 200 years or so (Chase and Chase 1996, 2001; Chase and Chase 2000).

For rulers of Copán and Palenque, the disruption in the royal interaction sphere resulted in the disappearance of royal hallmarks, including monumental architecture, inscriptions, and water symbolism. There are also indications that decreasing subsistence resources contributed to the disintegration of power, as indicated at Copán, where leaders were not only faced with depleting resources (Fash 1991:170–183; Paine and Freter 1996; Webster 1999; Wingard 1996) but also with in-fighting among elite lineages (Fash and Stuart 1991; Freter 1994). These factors would also explain why their last inscribed date (C.E. 822) is earlier than Tikal's (C.E. 869) and Caracol's (C.E. 859). Another factor affecting Copán more so than other river centers may have been similar to those influencing nonriver regional centers: changing rainfall patterns. Copán's annual rainfall is significantly less than at most other river centers, just over 130 centimeters. Although annual rainfall at Palenque is over 360 centimeters, royal power nonetheless would have disintegrated when changing conditions exacerbated internal political instability resulting from Palenque's defeat twice in the 700s at the hands of rulers from Tonina, a secondary center 65 kilometers to the south (Martin and Grube 2000:172–174, 182). These losses also explain why Palenque has one of the earliest, last-known inscribed dates in the southern lowlands, C.E. 799, much earlier than Tonina, which has the latest last-known inscribed date, C.E. 909.

Decreasing rainfall and its possible effects, such as increased disease and decreasing resources and health, set in motion the erosion of political power at regional centers. Diminishing subsistence returns would have been blamed on those in power who had in the past claimed close intimacy with supernatural powers associated with rain and subsistence. As a result, the foundation of political power dissipated, with the final outcome consisting of a combination of farmers emigrating from the interior or permanently living in hinterland areas and some population loss because of decreasing health and fertility (Culbert 1977, 1988; Lowe 1985:62; Santley 1986; Willey and Shimkin 1973).

Even though at first glance it may seem that there was massive population loss during and after the collapse, increasing evidence from hinterland studies suggests that what might have happened, instead, was both migration out of these areas *and* a reversion to nonplatform houses constructed of thatch or wattle and daub, resulting in "invisible" mounds in the archaeological record (cf. Rice 1996). The collapse of Classic Maya polities resulted in people or-

ganizing at the community level in some areas. For example, the Petén Itza lakes region was inhabited in the Postclassic period until the conquest (Rice 1996). Ford (1986) has recorded a notable presence of Terminal Classic occupation in the intercenter area between Tikal and Yaxha, 29 kilometers apart, after the Maya had abandoned the centers. For those Maya who migrated, some went north, perhaps attracted by a new religion revolving around Kukulcan and trade centered at Chichén Itzá; others may have headed to Belize and to the highlands of Chiapas.

At secondary centers in areas with higher annual rainfall and small-scale water systems, the disruption felt elsewhere did not automatically result in dramatic change; instead, restructuring may have taken place and, in some cases as mentioned above, a florescence. Lamanai's location at a lagoon on fertile land, for example, coupled with trade with the Yucatán Maya, provided its inhabitants with the means to survive the political disintegration through the 17th century (Loten 1985; Pendergast 1986). The Maya continued to live for a time at Quiriguá, perhaps because of "its apparent isolation, its self sufficiency within the rich lower Motagua Valley, and a continued control over the lucrative highland–Caribbean trade route" (Sharer 1978:69). Leaders at Seibal and Xunantunich witnessed a brief florescence, with Seibal's leaders likely taking advantage of the upheavals happening throughout the Pasión region, perhaps with a little help from the Putun Maya; and Xunantunich's leaders benefiting from the waning power at Naranjo (Leventhal and Ashmore 1997; Mathews and Willey 1991). Even though Dos Pilas is in a resource-rich zone, historic circumstances, specifically its location in a region with several competing center rulers, resulted in its eventual abandonment after Ruler Four was defeated in C.E. 761 by a neighboring king from Tamarandito (Demarest 1997). However, recent paleoecological research on landscape changes conducted by Johnston, Breckenridge, and Hansen (2001) indicates that Laguna Las Pozas in the Pasión drainage of Guatemala was occupied in the Early Postclassic (c. C.E. 900–1200) after nearby centers including Dos Pilas and Aguateca were abandoned (see also Palka 1997). Classic political life eventually ceased at most secondary river centers because of the disruption in the royal interaction sphere and decreasing resources.

Finally, the Maya who lived at minor centers were the least affected by dramatic events taking place at larger, more politically integrated centers. For example, the Maya who occupied Saturday Creek until at least C.E. 1500 (Conlon and Ehret 2002) did not have to face failing water systems. Their location along a major river with plentiful alluvium provided them the means to weather changing climate and to continue with community life. Local elites had less access to exotic goods, but they soon obtained long-distance wares from different routes, particularly sea trade from the north. Political shifts occurring elsewhere in the southern Maya lowlands had little impact on a

community that was not much involved in Classic Maya political machinations from the start.

SUMMARY

Creating and controlling critical resources in the form of water-management systems in conjunction with the use of integrative strategies such as ceremonies provided a powerful, centripetal political tool for Maya rulers of regional centers. Centers lacking permanent or adequate water sources in higher elevations with relatively low rainfall, and in which water systems and ritual were vital to political life, were greatly affected by climatic changes. As drier conditions became more common, water-management systems and crops failed, as did ceremonies that previously had resulted in bountiful rain and food. Decreased rainfall combined with increasing soil depletion, deforestation, and susceptibility to disease, resulted in the migration and dispersal of Maya farmers who once nucleated around centers. In the end, rulers were probably blamed for all the mishaps occurring as a result of climate change, as well as for decreasing resources.

Repercussions were felt throughout the southern Maya lowlands. At secondary centers where rulers controlled some resources, such as nearby agricultural land and prestige goods exchange, the collapse of a strong royal interaction sphere may account for their political disintegration. The Maya at minor centers, however, continued performing daily subsistence and social activities, largely unaffected by what was happening elsewhere.

The majority of Maya did not disappear or die off after political disintegration; they only permanently left the fold of political leadership, which could no longer provide them with a strong inducement to remain. Postcollapse reorganization in the interior is, thus, best understood as a process unfolding at the community and local levels. In the southern Maya lowlands after the Terminal Classic, former subjects no longer had to supply tribute to a ruling class; they only had to work for their families and the community to which they belonged, although this may have included local elites.

The Classic Maya were similar to other ancient civilizations where water control underwrote political power. As in these other societies, subjects perceived rulers as protectors and providers of water. When conditions changed and rainfall decreased, rulers were the first ones blamed. This resulted in them losing the surplus of others, their primary means of support, and ultimately in their loss of power.

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NOTES

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1. Some Mayanists contest the term *collapse*. Sabloff (1992) describes Terminal Classic events as a population shift to the northern Yucatán lowlands, perhaps because of economic opportunities such as salt trade. Marcus (1993, 1998), using ethnohistoric accounts of Postclassic and colonial Maya political institutions, proposes that there were neither "golden ages" nor "collapses" but, rather, a series of cyclic "peaks" and "troughs" across the region. Peaks are periods when centers incorporated a number of secondary centers/provinces under their control. Troughs are periods when provinces "broke away" from primary centers because secondary royals were able to attract supporters from regional centers.

2. Although sites such as Uaxactun, Nakbe, El Mirador, and others are located in similar settings, historical and environmental circumstances prevented them from becoming regional powers. In the former case, nascent rulers at the less powerful centers were subsumed into political systems of their more powerful neighbors early on (e.g., Uaxactun/Tikal, Nakbe/El Mirador/Calakmul, etc.). In the latter case, not enough agricultural land prevented large groups of people from settling some areas (Fedick and Ford 1990; Ford 1991a). El Mirador, with one of the earliest massive temples (El Tigre) in the Preclassic, might have lost most of its inhabitants at the end of the Late Preclassic (c. C.E. 250) (Matheny 1987), perhaps because of problems with reservoirs silting up (Scarborough 1993) as well as drought (Dahlin 1983).

The ancient Maya began to build water systems before they constructed monumental architecture (Scarborough 1993). The earliest known water systems in the southern Maya lowlands (c. 1000 B.C.E.) are found in northern Belize and consist of "shallow ditches draining the margin of swamps" (Evans and Webster 2001:354). The construction of water systems accelerated after 1000 B.C.E. and included wetland reclamation (e.g., Cerros, Belize, and Edzná, Campeche) and "passive" or concave microwatershed systems that took advantage of the natural landscape, particularly depressions (e.g., El Mirador, Petén) (Scarborough 1993). Water symbolism also appears in the Preclassic in association with early public monumental architecture (Scarborough 1998). Water storage—particularly reservoirs—became important in the Early Classic (c. C.E. 250–550) when more Maya moved into upland areas with fertile land but without permanent water sources (e.g., Tikal). Even areas with water sources such as Copán and Rio Azul began to build reservoirs (Fash and Davis-Salazar 2001; Harrison 1993). Water management reached its height in complexity and scale in the Late Classic period (c. C.E. 550–850), epitomized in convex microwatershed systems where reservoirs, dams, and channels were designed to capture and store water (e.g., Tikal, Caracol) (Scarborough 1993; Scarborough and Gallopini 1991).

3. Although pre-Hispanic annual rainfall may have been different than that at present, the relative differences of rainfall between different areas should be similar.

4. Although Dos Pilas is not located along a river, it is an atypical secondary center for several reasons. It is located in an upland area with a perennial spring close to the main plaza, and inhabitants had access to underground water (caves) near El Duende, the major temple (Brady 1997; Demarest 1997). It is classified as a secondary, rather than regional, center for the following reasons: (1) it has concentrated water resources, (2) it is located in the politically circumscribed Petexbatún area, and (3) it has specific historical circumstances—rulers arose to power when a branch from the Tikal royal family moved to Dos Pilas and later allied with a major rival of Tikal, Calakmul. Consequently, this center participated in long-distance interactions with regional centers when its rulers broke away from Tikal and became an autonomous power.

5. The last known inscriptions from several nonriver regional centers date from C.E. 810 to 869, regional centers along rivers date from C.E. 799 to 822, and secondary centers date from c. C.E. 761 to 810 (not including Seibal—C.E. 889). Archaeological evidence, however, indicates that the majority of centers were abandoned by the 900s.

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