

## **Water Management in Lowland Mesoamerica**

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### Abstract

Common among prehispanic lowland Mesoamerican cultures was their reliance for agriculture and basic drinking needs on rainfall rather than massive irrigation systems. This reliance was made more precarious by the dramatic seasonal changes that come with the dry and rainy seasons, and how it affected water quality, transportation, and agricultural schedules. Through a discussion of water management and concomitant factors in Mesoamerica, I assess what the past can teach us regarding today's problems—not enough water, too much water, water quality, and water management. I largely focus on the Classic Maya of the southern lowlands. I do, however, present a brief description on other lowland Mesoamerican water management systems. After addressing the Maya collapse, I focus on seasonal water issues, geography, and subsistence practices. I then discuss the relationship between water management and political histories and the impacts of a long-term drought. I end with a discussion of the lessons left to us by the ancient Maya. The fact that history repeats itself is not necessarily a good thing and many people, particularly politicians, public policy makers, and industry leaders appear to be unwilling to act upon lessons from the past.

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*What's behind today's water scarcity? A lack of finance. A lack of human capacity. A lack of adaptive institutions. And a lack of good governance—*2006 International Water Management Institute

In his classic treatise, *Oriental Despotism* (1957), Karl Wittfogel maintains that ancient states are underwritten by agriculture sustained by irrigation systems. Wittfogel defined societies lacking such extensive large-scale irrigations systems as marginal (p. 3). For example, because the Classic Maya (c. A.D. 250-950) did not build large-scale irrigation systems due to the supposed unsuitability of the lowland Maya karstic topography (p. 184), he labeled the Maya a “marginal agrarian” (p. 182) despotic society. However, polities indeed were underwritten by water control systems, just not massive irrigation ones. Betty Meggers (1954) also saw limitations in the Maya area, and by extension lowland Mesoamerica, in her classic article on environmental determinism. Based on her work in the Amazonian jungle where many areas are poorly suited for intensive agriculture because of their soils (though recent scholarship demonstrates otherwise; see Erickson 2003, 2006), she assumed that other tropical settings were the same, and, thus, could not support complex societies. Consequently, Maya civilization emerged due to external influences and “did not last” but witnessed “700 years of decline” (Meggers 1954:819). More recently, Meggers was still “struck by the seeming contradiction between the complexity of Maya culture and the relatively low agricultural potential of their environment” (1998:xii). Nevertheless, lowland Mesoamerican areas have some of the best agricultural soils. Together, water control and agricultural success provided the basis for the emergence of the earliest (Olmec) and some of the most complex (e.g., Maya) societies in the New World (e.g., Scarborough 2003; Lucero and Fash, eds, 2006).

Through a discussion of water management and concomitant factors in lowland Mesoamerica, I assess what the past can teach us regarding today's problems—not enough water, too much water, water quality, and water management. After all, history repeats itself. This fact is not necessarily a good thing and many people, particularly politicians, public policy makers, and industry leaders appear to be unwilling to act upon lessons from the past. These constituencies miss the key point that the past is not only vital to understanding the present, but also for preserving our future.

To make the case that the past can inform on the present, I largely focus on the Classic Maya of the southern lowlands. I do, however, present a brief description on other lowland Mesoamerican water management systems. After addressing the Maya collapse, I focus on seasonal water issues, geography, and subsistence practices. I then discuss the relationship between water management and political histories and the impacts of a long-term drought. I end with a discussion of the lessons left to us by the ancient Maya.

### **Prehispanic Water Management in Lowland Mesoamerica**

Vernon Scarborough (2003:39) defines water management as “society’s interruption and redirection of the natural movement or collection of water.” An expanded definition

includes strategies both for times when there is too little water and times when there is too much water. Water management covers topics like the draining of excess water, the diversion of rain runoff, the control of floodwater, the control of salinization, and water storage. It also can refer to soil erosion management when intensive rains threaten to remove soil (Marcus and Stanish 2006:2; e.g., Matheny 1978).

Common among lowland Mesoamerican cultures was their reliance for agriculture and basic drinking needs on rainfall rather than massive irrigation systems (Figure 19.1). This reliance was made more precarious by the dramatic seasonal changes that come with the dry and rainy seasons, and how it affected water quality, transportation, and agricultural schedules. These factors, in turn, impacted social, political, economic, and religious life in Mesoamerica.

#### ***Gulf Coast***

The Gulf Coast has abundant rainfall with little variation from year to year; it also has a relatively short dry season (Coe and Diehl 1980). And combined with the rich alluvium replenished each year by flooding,

farmers can grow crops year-round.

The earliest civilization in the Americas developed in the Gulf Coast region of Mexico. The Olmec were the first to expend labor on water management features and symbolism, a not too surprising fact given that Olmec sites are surrounded by rivers and streams (González Lauck 1996). San Lorenzo, an early Olmec site (1200-800 B.C.) in the lower Coatzacoalcos drainage, reveals evidence for sophisticated water systems (Cyphers et al. 2006). Excavations in Group E in the site core revealed a 171 m long stone aqueduct. It is in a plaza replete with royal (e.g., stone throne) and water (e.g., duck monument) iconography and draws from a well surrounded by red-colored floors. Thirty tons of basalt, a non-local material, was used to build the aqueduct.

Aqueducts are also found at the Olmec site of La Venta (800-400 B.C.). Archaeologists uncovered four aqueducts on the summit of the Stirling Acropolis, which overlooks Complex B (Diehl 2004:66). Diehl (2004:106) aptly notes their significance; "...they are always associated with palaces and stone sculptures displaying water symbolism....In all likelihood, these lavish water works symbolized both the link between rulers and water deities and the real and metaphorical control the elite exerted over [water]."

The Olmec also built other water features, particularly *islotas*, "low, artificial earthen bases [that] were built near river courses to take advantage of the slightly higher levee elevation" (Cyphers and Zurita-Noguera 2006:36-37). They served to protect structures from rising waters and provided a base from which to exploit the rich wetland resources (fish and turtles) and to practice recession agriculture. Not unexpectedly, their distribution concentrates near communication routes and regional centers (e.g., San Lorenzo).

The pattern continued further north in the San Juan Basin, the home of the Totonac, where there is evidence for wetland maize agriculture by c. A.D. 500 (Seimens et al. 1988). At the Postclassic (c. A.D. 1000-conquest) site of Zempoala along the Río Actopan, which in Nahuatl means "twenty" or "abundant waters," the Totonac built a system of aqueducts to bring fresh water to the city, and drains to remove wastewater (Brüggemann 2001). Interestingly, and likely due to more annual rainfall, noticeable water supplying features are lacking at another major Totonac site, El Tajín, which reached its peak between the 9<sup>th</sup> and 11<sup>th</sup> centuries (Brüggemann 2001). One channel has been found behind the Temple of the Niches.

Water is more prevalent, however, in the iconography, especially that found on North and South ballcourt panels.

Clearly, water features and symbolism played a major role in Gulf Coast religion, politics, and subsistence. This pattern is similar to that found in other parts of lowland Mesoamerica.

### ***Northern Lowlands***

In the northern lowlands, which include most of the Yucatán peninsula of Mexico (Figure 19.2), surface water is limited: “There are only a handful of lakes, small springs, *aguadas*, and open karsts and caverns where water may be obtained” (Matheny 1982:158), as well as a few rivers in the south. Major water sources are *cenotes*—“karstic solution features” (Brown 2006:174) or sinkholes fed by the water table found in the northern lowlands where it is relatively high (see Vesilind 2003).

In the upper northeast reaches of the Yucatán, Scott Fedick has mapped and explored the wetlands in the Yalahau region (Fedick 1998). Rock alignments on the margins of perennial and seasonal wetlands suggest several uses by the Maya in the Early Classic and Postclassic periods; water-recession agriculture and/or “fertilizer factory.” In the latter instance, muck and soil may have been used to fertilize gardens and fields. Furthermore, the Maya may have used other resources associated with wetlands, including edible cattails and blue-green algae.

At Chichén Itzá (c. A.D. 800-1100), one of the most well-known of the northern lowland sites, its inhabitants relied on two major *cenotes*, one within the ceremonial core, and the other located at the end of a causeway north of the core (Sharer 2006:562-565). The Maya made offerings into the Sacred Well, as the latter is known—gold, jade, ceramic, lithics, and even human sacrifice. Clearly, the *cenotes* had both sacred and profane qualities and uses.

In the arid northwest corner of the Yucatán peninsula is the Postclassic center of Mayapan (c. A.D. 1200-1450), a site famous for its nine km defensive wall. While lakes are found in the area, which differ from *cenotes* because of their distinctive “geologic history, morphology, hydrology, distribution, and social function” (Brown 2006:174), it is the *cenotes* around which the Maya built residential and ceremonial

buildings (Brown 2006). In addition to providing passageways to the underworld, cenotes provided fish, clay for pottery, and stalactites to build altars. Three of the most important cenotes are surrounded by ceremonial architecture. For example, the temple of Kukulcan next to a cenote, with its nine terraces representing the nine levels of the underworld, clearly signifies a supernatural role for the subterranean water access. At Uxmal, a Late Classic/Terminal Classic center, Matheny (1978) argues for the presence of a sophisticated hydraulic engineering system, including reservoirs (six), diversion canals, and a 'fortress' surrounded by a moat. However, more recent work has shown that while the reservoirs do indeed exist, as well as a few dams, the canals, fortress, and moat apparently do not (Dunning, personal communication, 2007).

At Edzná, located along the Río Candelaria, Campeche, Matheny and his colleagues argue that the Maya built complex water management systems consisting of extensive canals, reservoirs, and a moat (Matheny et al. 1983). While built sometime in the Late Preclassic, the Maya used them through the Terminal Classic period (p. 6). Of the 29 known canals, the most impressive is the Great Canal; it is over 12 km in length, 50 m wide at places, and c. 1.5 m in depth (pp. 68, 73, Table 30). Benavidos Castillo (1997:35) argues that these features not only served a utilitarian purpose, but also expressed political power via the labor expended to build and maintain them. However, Doolittle (2006:6), argues that most of these supposed water systems, other than the Great Canal, are natural geological formations, specifically, grikes, "solution-enlarged structural joints found in karstic landscapes."

In southwest Yucatán, archaeologists have recorded ridged field systems (c. 1.5-2 km<sup>2</sup>) and canals (100s 1-2 km in length) along the upper Candelaria (Seimens and Puleston 1972). The challenge is dating them since they could be associated with 15<sup>th</sup>-16<sup>th</sup> century Acalan or from earlier time periods based on ceramics that date to c. A.D. 800-1200. Some of the linear features may also have served as fisheries, which also occurred in northern Belize and northern Veracruz (Seimens 1996).

To survive in an area with limited annual rainfall and water resources, the Maya of the northern lowlands adapted in varied ways by building several kinds of water features—most of which were likely politically organized and controlled to varying degrees.

## The Classic Maya of the Southern Maya Lowlands

The Classic Maya in the southern lowlands (c. A.D. 250-950) adopted a still-water system (e.g., reservoirs, raised fields, use of seasonally inundated wetlands) (Scarborough 2003:67-68, 99-102, 159; 2006). Scarborough argues that the “longevity of the Maya can be attributable to their successful, uninterrupted, accretive landscape engineering, an adaptation in part conditioned by a seasonally-limited water supply and the fragility of the wet-dry tropical forest” (1993:19-20). To illustrate how Maya political leaders were involved in water management, I focus on the Late Classic period (c. A.D. 550-850) during which rulership, population size, and the reliance on artificial water systems were at their peak. I first, however, present a brief summary of the history of water facilities in the southern lowlands.

The Maya started migrating into inland areas (e.g., the Petén) from riverine or coastal areas in the Middle Preclassic period by c. 1200 (Ford 1986:59, 80-82). Tikal and its environs had plentiful agricultural land, but limited water sources. It, like Calakmul and several other centers without permanent water sources such as lakes or rivers, was surrounded by *bajos*, or seasonally inundated swamps. “Bajos and other wetlands are a common feature...variably covering between 40 and 60 percent of land area” (Dunning et al. 2006:82). “[W]ater systems were likely dependent on shallow lakes and swamp-margin settings, or *civales*” (Scarborough 2006:236). Even if some bajos turn out to have been perennial wetlands or lakes that silted up as a result of erosion by the beginning of the Classic period as some have argued (e.g., Pope and Dahlin 1989; Culbert 1997; Culbert et al. 1996; Dunning et al. 1998; Hansen et al. 2002; Dunning et al. 2003, 2006; Kunen 2006), as populations grew water would have remained a concern. Furthermore, the proximity of seasonal swamps to centers provided even more water and agricultural surplus for rulers to exploit. To offset seasonally limited water supplies in such areas, Maya built water systems—even before they constructed monumental architecture (Scarborough 1993; see Scarborough 2001:354). These systems include wetland reclamation (e.g., Cerros) and “passive” or concave micro-watershed systems where the Maya took advantage of the natural landscape, particularly depressions (e.g., El Mirador, Petén) (Scarborough 1993,

2000) (Figure 19.3). The Maya began incorporating water symbolism on to public monumental architecture (Scarborough 1998). Evidence suggests that some water management systems failed as a result of silting-up (Scarborough 1993; Hansen et al. 2002), drought (Gill 2000), or subjugation by more powerful polities (Marcus 2003). This scenario has been suggested for El Mirador and Nakbe, centers the Maya abandoned in the late Preclassic, by c. A.D. 250 (e.g., Hansen et al. 2002).

The Maya continued migrating inland during the Early Classic (c. A.D. 250-550) and started relying on increasingly larger and more sophisticated artificial reservoirs (e.g., Tikal). Even centers found along rivers, such as Copán and Río Azul, began building reservoirs and other water control features (Harrison 1993; Fash and Davis-Salazar 2006). “The high incidence of berms and terraces along the margins of several bajos suggests the important role of flood-recession agricultural during the Classic period...” (Scarborough 2006:229; e.g., Kunen 2006). Iconographic representations of water proliferates. For example, kings at Tikal, Copán and other centers incorporated the central Mexican rain god, Tlaloc, to enhance their claims of supernatural connections (Schele and Miller 1986:213; Fash 1998).

Water systems further increased in size and scope in the Late Classic (c. A.D. 550-850), which is not surprising given its associated increases in population size. Maya built sophisticatedly engineered reservoir systems, epitomized by elevated convex macro-watershed systems whereby reservoirs, dams and channels were designed to capture and store water (e.g., Tikal, Caracol) (Scarborough and Gallopín 1991; Scarborough 1993, 2003:50-51, 2007). “Controlled release from these elevated reservoirs to the downslope flanks and adjacent bajo margins supplied household and agricultural water...” (Scarborough 2003:110-111) (e.g., Tikal). Furthermore, in addition to the growing needs of an expanding population, the Maya also had to resolve disputes over water (Scarborough 2003:96-99).

At the end of the Classic period (c. A.D. 850-950), people abandoned rulers and centers because reservoirs were drying up (see Demarest et al. 2004b).<sup>1</sup> The Maya who did not leave the southern lowlands to wetter areas to the north, south, east and west, lived in small settlements near permanent water sources (e.g., the Belize River valley, wetland areas in northern Belize, nearby lakes and rivers in the Petén, etc.)

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<sup>1</sup> The northern lowlands, in contrast, experienced a florescence from c. A.D. 750 to 1000 (e.g., Demarest et al. 2004a).

(e.g., Willey et al. 1965:292; Johnston et al. 2001; Andres and Pyburn 2004; Ashmore et al. 2004; Fash et al. 2004; Laporte 2004; Lucero et al. 2004; Masson and Mock 2004; McAnany et al. 2004; Mock 2004; Rice and Rice 2004). Living near coasts (e.g., Belize) provided Maya access to marine resources; they also practiced wetland agriculture near shallow lakes. Some groups moved to Chichén Itzá (Cobos Palma 2004), attracted by opportunities in trade and other production activities, not to mention a new religion centered around Kukulcan, the feathered serpent from central Mexico. Maritime trade of subsistence (e.g., salt) and prestige goods became increasingly important in the north (McKillop 1995, 1996). Areas in the Yucatán peninsula, such as the southern areas of Quintana Roo, incorporated the use of irrigation canals to support the growing immigrant populations (Carmean et al. 2004).

In sum, in a trend that begins in the Preclassic and ends in the Postclassic, the Maya first lived near and relied on permanent water sources such as lakes, rivers, and bajos. Only later in the Classic period did they increasingly rely on artificial water systems. After the Maya abandoned southern lowland centers by the A.D. 900's, they went back to living near permanent water sources in smaller communities.

### **The Maya Collapse**

Property in water is older and more important than property in land—Robertson Smith (1956[1894]:104).

Collapse is a political phenomenon. Political histories are what change or disintegrate rather than traditional lifeways; the daily lives of the majority of people are typically unaffected since political systems and demands are superimposed onto existing social and economic institutions, which long outlast political dynasties (Lucero 2006c).

The most powerful kings in the southern lowlands emerged in areas with plentiful farmland associated with pronounced seasonal variability (Lucero 1999b, 2002, 2003, 2006c) (see Figure 19.2). Rulers provided access to potable water during the annual dry season, capital during the rainy season, and integrated farmers through sponsorship of large-scale ceremonies, feasts, and ballgames (Ford 1996; Scarborough 1998). In

their rise to power, kings, through ceremonies and material success, demonstrated that they were able to communicate with ancestors and gods to bring forth prosperity for all. Farmers looked to rulers to supplicate supernatural entities by providing enough rain (e.g., Marcus 2006). This was critical as agriculture was rainfall-dependent. The average Maya commoner in the Classic period from c. A.D. 250 to 850 typically had little choice but to acquiesce to tribute demands. This was especially true in areas where farmers relied on kings to supply water during the annual six-month dry season and where communities were tethered to large artificial reservoirs and concomitant rites. However, hundreds of civic-ceremonial centers served as royal courts with varying degrees of power. In many cases, commoners could choose which ruler to pay tribute, a fact suggested by the hinterland settlement pattern where people lived dispersed in farmsteads but in walking distance of several centers as well as the prevalent and public monumental architecture that served as a backdrop for monarchs to attract and entertain subjects—not to mention collect tribute.

Royal power lasted for a millennium in the southern Maya lowlands, from c. 100 B.C. to the A.D. 900's—an amazing feat; and it would take something drastic to bring it to an end between c. A.D. 850 and 950. The civic-ceremonial centers for which the Maya are so famous were abandoned. Many scholars have proposed various reasons for this collapse, from peasant revolt to increased warfare (see Sabloff 1992; Lucero 2002). I, along with others, argue that a long-term drought played a major role in the demise of Maya rulership.

Kings disappeared—people did not. Royal ceremonies that once highlighted their success now only emphasized their failures. Farmers adapted to increasing drought and concomitant problems by abandoning their rulers. These agriculturalists either dispersed into the hinterlands or migrated out of the southern lowlands in all directions. It was impossible to fill the political vacuum without enough water—ceremonies alone no longer proved adequate.

The Classic Maya flourished in a relatively unique setting—how? Responses to the natural conditions described above were diverse, a strategy that worked well for the Maya for millennia. Geography and seasonality affected settlement decisions, and other societal issues (social organization, religion, economic system, etc.), especially the role of water management systems and concomitant political histories (see

Lucero 2006c:Table 2.1, 70-73, 117-123, 154-162).

To appreciate settlement patterns and associated management and political histories, it is essential to acknowledge how seasonal and geographic conditions impacted daily life (Lucero 2006a; Scarborough 2007).

### ***Maya Seasonality***

The “tropics” often invoke visions of heavy rainfall, lush forest, sweltering heat, and exotic animals (Bacus and Lucero 1999). Tropical areas, indeed, have the most diverse and complex ecosystems in the world. Somewhat ironically, however, water quantity and quality can be a concern—a critical factor in a humid environment where people must imbibe more water than their counterparts in temperate areas (McAnany 1990). Water quality problems include endemic diseases (e.g., hepatic schistosomiasis) and pests, such as parasite-ridden flies and malaria-bearing mosquitoes that “flourish in environments disturbed by humans” (Miksic 1999:173). Standing, stagnant water provides prime breeding conditions for water-borne diseases (e.g., cholera and diarrhea), parasites and pests to proliferate, as well as the build-up of noxious chemicals (e.g., nitrogen) (Burton et al. 1979; e.g., Hansen et al. 2002). And temperature changes throughout the year are not noticeable enough to kill-off pests. A growing reliance on intensive agricultural practices worsens the situation since land clearing results in open areas where stagnant water collects.

Keeping water clean undoubtedly was part of the water management regimen, as was dealing with human waste disposal, especially with water supplies being so close at hand. The Maya recognized the significance of the wetland biosphere and applied its principles by maintaining a balance of hydrophytic and macrophytic plants and other organisms to keep the water clean (Hammer and Kadlec 1980; Nelson et al. 1980). The presence of water lilies (*Nymphaea ampla*), an important feature in Maya cosmology and royal ideology, on the surface of aguadas and reservoirs is a visible indicator of clean water. They are sensitive hydrophytic plants that can only flourish in shallow (1-3 meter), clean, and still water. Water cannot be too acidic nor have too much algae or calcium (Conrad 1905:116; Lundell 1937:18, 26).

Every aspect of Maya life, past and present, was rainfall-dependent. The annual dry season, from four to

six months in length, was a concern whether or not people lived near water sources. Many parts of the southern lowlands transform into a green desert where it does not rain at all for four months and temperatures and humidity noticeably climb (see Scarborough 1993; Graham 1999). The dry season, usually from January through May or June, was largely the time for non-agricultural activities. But people needed water for daily drinking needs, cooking, food preparation, the manufacture of plaster and ceramics, bathing, and other activities (e.g., Marcus 2006). In areas without permanent water sources, people relied on artificial reservoirs at centers (e.g., Ford 1996; Scarborough 1998; Lucero 1999b, 2006c).

The length and intensity of the rainy and dry seasons are also important variables. Depending on the area, average rainfall per year ranges from 1350 to 3700 mm (Scarborough 1993, 2003:108; see Neiman 1997). During the rainy season, the Maya dealt with flooding, hurricanes, turbid waters, debris-clogged and un-navigable rivers, erosion, mudslides, and crop damage (Lucero 2006b). However, the Maya did not generally settle in areas that flooded, such as vulnerable coasts or lower river terraces, though tropical storms occasionally caused heavy damage to crops and the built environment even in more elevated zones (as happens at present, e.g., Hurricane Mitch). The rainy season is also a labor-intensive time for agriculture (Atran 1993); thus, when the rains begin each season is critical for the timing of agricultural schedules. The beginning of the rainy season can vary up to five months in any given area, as well as the amount of rainfall per year (Gunn et al. 2002). Rainfall is unpredictable, which is witnessed at present (Harrison 1993). If the rainy season begins earlier than usual, planted seeds do not germinate and farmers cannot burn the wet vegetation in milpas; if the rainy season begins later than usual, seeds can rot. In the dry season, the agricultural downtime, the Maya faced decreasing water availability, worsening water quality, and low and disease-ridden rivers difficult to navigate.

### ***Maya Geography and Subsistence Strategies***

Unlike elsewhere in the world where intensive agriculturalists settled densely along rivers or lakes, the dispersed character of agricultural soils and the varied terrain (hills, escarpments, and other karstic features) resulted in a situation where farmers did not rely on river run-off and concomitant large-scale irrigation

systems such as canalization. “Most Maya cities of Tikal’s complexity, if not its size, are located on natural promontories away from permanent water sources” (Scarborough and Gallopín 1991:659), which mostly consist of cenotes, rivers, aguadas, and lakes.

Cenotes have been defined (natural or artificial wells). Aguadas are rain-fed natural depressions. Surface rivers feed into lakes. In the southern lowlands, however, the water table is too low to percolate to the surface. While yearly drought (and flooding) was an issue, fertile land was not (e.g., Lucero 2006a). Mollisols, which comprise only one percent of the world's tropical soils, predominate in the southern Maya lowlands and are “...considered by agronomists to be among the world’s most important, naturally productive soils, with yields unsurpassed by other unirrigated areas” (Fedick 1988:106; also, Dunning et al. 1999). However, these soils are dispersed in various-sized pockets throughout the Maya area; thus, the densest settlements, largest centers, and the most powerful polities are found in areas with large tracts of good agricultural land (Ford 1991). Yet, most of these powerhouses are not found near permanent water sources, including Tikal, Calakmul, Naranjo, Caracol, and others. This diverse settlement pattern influenced by the distribution of productive land also impacted how political leaders integrated and communicated with their subjects (see Roscoe 1993), a feat elites had to accomplish without extensive road systems (not to mention an absence of beasts of burden, wheeled carts, etc.).

Maya farmers lived in farmsteads (1-5 structures surrounding a patio) dispersed throughout the hinterlands and on the outskirts of centers near their fields and gardens (Drennan 1988), mirroring scattered pockets of fertile land (Sanders 1977; Ford 1986; Fedick and Ford 1990; Ford 1991; Puleston 1983; Rice 1993; Scarborough 1998; Dunning et al. 1996, 1998; Fedick 1996; Dunning et al. 1999; Lucero 1999a). Dispersed soils not only resulted in such an extensive settlement pattern, but also in small-scale subsistence or water systems adapted to grow the staples of maize, beans and squash in house gardens, short-fallow infields, long-fallow outfields, and combinations of these techniques (Harrison and Turner 1978; Flannery 1982; Killion 1990). Large-scale water systems (i.e., reservoirs) are found only in centers. Small-scale water systems include aguadas, raised fields in northern Belize, dams, canals, and terraces (Dunning et al. 1997; e.g., Harrison 1993; Fedick 1994; Harrison 1996; Pohl and Bloom 1996; Pohl et al. 1996; Pope et al.

1996; Kunen 2006). In a few areas, the Maya expanded fault springs, as they appear to have done at Itzán, Uaxactún, and Quiriguá (Johnston 2004; also, Ashmore 1984).

During the rainy season, farmers in hinterland areas without access to permanent water sources likely stored water in jars and other containers, which were replenished daily by the rains. They could only amass enough labor to expand small aguadas (e.g., Scarborough 2003:93); their small size could not support large numbers of people throughout the year, and water would eventually evaporate during the course of the dry season (Scarborough 1996; but see Weiss-Krejci and Sabbas 2002). Basically, during the dry season most farmers had little choice but to trek to centers to use royal reservoirs. As to which royal reservoirs they traveled, farmers at least had options.

### **Classic Maya Politics and Climate Change**

There is an old saying in the water business, There are two things you cannot take out of water...*salt and politics* (Horne, n.d.).

Maya farmers were basically economically and socially self-sufficient (e.g., Freter 1994; Gonlin 1994; Hayden 1994; Lucero 2001). What brought them to centers was central water stores. Seasonal water needs and associated ceremonies were the linchpin in the emergence and maintenance of Maya rulership (Scarborough and Gallopín 1991:659; Lucero 1999b, 2003, 2006c). D'Altroy and Earle (1985) have shown the critical importance of central storage in political centralization, which was the case for the Classic Maya. Maya rulers did not store massive quantities of agricultural produce, but water. Consequently, large-scale subsistence systems related to the collection and maintenance of water for daily needs were emphasized—that is, the construction of reservoirs and the modification of aguadas—rather than formal agricultural features that are generally small-scale.

The relationship between water management and power is amply illustrated in the iconography (Lucero 1999b). A major symbol of Classic Maya royalty is the water lily, an indicator of clean water, and associated

elements (e.g., water lily pads, water lily monster, etc.), which are depicted on stelae, monumental architecture, murals, and mobile wealth goods such as polychrome ceramic vessels (e.g., Rands 1953; Puleston 1977; Hellmuth 1987; Scarborough 1998; Fash 2005; Fash and Davis-Salazar 2006). *Nab Winik Makna*, or Water Lily Lords, refers to Classic Maya kings (Ford 1996:303). Water lilies often are included in royal headdresses (Fash and Davis-Salazar 2006), and king's names often include 'water' (e.g., Waterlily Lord of Tikal, and Lord Water of Caracol). Kings also impersonated sun, maize and other gods through the wearing of masks and costumes, including a deity that "...seems to be aquatic represented as a serpent with a water-lily bound to its head" ("water serpent;" Houston and Stuart 1996:299).

In the latter part of the Late Classic period in the late 700's, evidence indicates that a long-term drought struck (e.g., Dahlin 1983; Folan et al. 1983; Messenger 1990; Curtis and Hodell 1993; Gunn et al. 1995; Hodell et al. 1995; Curtis et al. 1996; Leyden et al. 1996; Gill 2000; Brenner et al. 2002; Haug et al. 2003) that may have lasted through c. A.D. 1000 (Hodell et al. 2001). Changing weather patterns set in motion a series of events that exacerbated existing problems (e.g., conflict over water). As a result, rulers eventually lost power beginning in the late 700's through the 900's (Demarest et al. 2004a). Further exacerbating long-term drought was deforestation, which was more apparent in certain areas (e.g., Copán) (Deevey et al. 1979; Rice 1993, 1996; Wingard 1996).

Decreasing rainfall undermined the institution of kingship; royal ceremonies and water systems that had once worked failed to provide sufficient water (Webster 2002:327-328). And since kings had claimed such close ties to supernatural forces, they were the first ones blamed by farmers. Farmers no longer felt obligated to pay tribute to rulers who failed to supply water. They abandoned their kings and seats of power and either lived in small communities in hinterland areas (e.g., Webster and Gonlin 1988; Freter 1994) near lakes or rivers (e.g., Rice 1996; Masson 1997; Johnston et al. 2001; Masson and Mock 2004; Rice and Rice 2004), or left the southern lowlands altogether (e.g., Laporte 2004; McAnany et al. 2004; Mock 2004). Population sizes also likely decreased due to worsening health conditions resulting from decreasing water supplies and quality (Willey and Shimkin 1973; Culbert 1977; Lowe 1985:62; Santley et al. 1986; Culbert 1988).

Drier conditions particularly impacted areas without rivers and lakes and zones with relatively low

annual rainfall in higher elevations (Figure 19.4). And since rainfall and elevation both influenced agricultural regimes (e.g., different temperatures) (see Akin 1991:47), adapting to shorter seasons with less rainfall became problematic.

It is important to keep in mind when attempting to understand Maya society the seasonal availability of water—its quantity, quality, and distribution. Together these factors influenced settlement practices, agricultural schedules, ceremonial life, and political histories (see Lucero 2006b).

### **Discussion and Concluding Remarks**

Could Maya rulers have done anything differently? In this particular case, the conditions were such that people responded in a manner that saved lives—they left the political fold and dealt with water needs at the community level; in addition, some people left the southern lowlands. At first when inadequate rainfall extended beyond a few seasons, Maya kings expended dwindling resources in increasingly ornate feasts and ceremonies in a last-ditch effort to supplicate ancestors and gods; by doing so they depleted stores of food and water without taking into account continuing famine and the need for seeds for planting and water for life. When attempts failed, farmers blamed royal supplicants. Kings, however, felt they had no choice but to sponsor such events because they had worked in the past. Resources that could have been spent on alternative options instead went to tried-and-true ceremonies that only further depleted decreasing resources. Such short-term responses had long-lasting political impacts. Even if kings had implemented a more practical course of action—if there were one—with potential long-term benefits, they might still have lost their subjects' support since people in general prefer familiar practices versus dramatic changes.

What lessons can we learn from past Maya and other Mesoamerican lowland societies? We can first assume, as elsewhere, that people make decisions to ensure the survival of their families. The political elite, however, will do what they can to keep their power—in this case, the right to exact tribute. When problems first begin to develop, rulers initially rely on traditional means; if this strategy fails, political systems fall apart. The long-term drought resulted in Maya rulers disappearing—not the general populace. Those who

remained in the southern lowlands re-organized at the community level and obtained water from lakes and rivers. People adapted, kings did not. People diversified subsistence strategies to feed families, but royal institutions did not change their course of action and paid the ultimate price.

Political leaders do not voluntarily abandon tried-and-true strategies—but what if Maya rulers had invested in innovative, perhaps even counter-intuitive, strategies? If they had, would it have been enough to save royal power? The Maya case differs from most failed political systems in that people physically abandoned centers and some hinterland areas, a situation that resulted in a political vacuum. So even if rulers were willing to try something new, it is likely not to have been enough. In most cases today, however, it is not too late. Governments open to new ideas and diversifying strategies have a chance. Short-term responses have short-term benefits, often with detrimental and unintended consequences (e.g., expending precious resources in a futile attempt to prevent the inevitable; see Fagan 1999). Long-term responses, however, are difficult to appreciate, especially by politicians who are always thinking about their political survival and legacy.

In the face of worsening problems, our responses increasingly are “trading up on the scale of vulnerability” (Fagan 2004:xv). There are the usual problems of over-exploitation and environmental degradation. Another critical factor, and one often overlooked, is the over-reliance on current modes of survival whether it be technology, religion, or agricultural systems. As Machiavelli stated centuries ago, “...since Fortune changes and men stand fixed in their old ways, they are prosperous so long as there is congruity between them, and the reverse when there is not” (1994[1514]:82). This over-reliance can and does lead to an inability to adapt in the face of change.

To guarantee long-term benefits, that is, implementing policies that will ensure enough clean water (e.g., appreciating the wetland biosphere to maintain clean water), political sacrifice is a necessity. Nearly all public policies that are necessary to prevent future catastrophes in the long term will be unpopular. But not many politicians, if any, are willing to sacrifice their immediate political careers and legacy (individual gains) for the greater good. Today, with increased individual rights and democracy, political leaders are more beholden than ever to the general public for their support. To take our minds off more pressing

matters, politicians typically revert or focusing on other matters, usually moral in nature (e.g., flag-burning, same sex marriage, immigration, abstinence, etc.). They use the tactic of accusing the messenger, who warns about the detrimental consequences of global climate change, of being a left-wing liberal alarmist who does not have the best interest of the common person—since they (we) make the dire warnings from ivory towers. The solution can, however, well up from the general populace; for example, the meeting of environmental and evangelical groups to save the environment, including maintaining clean water supplies, is a surprising start. As the Classic Maya showed us, it is the people, not politicians, who in the end resolve problems—after having given political leaders several opportunities to take control of the situation.

In conclusion, water is vital to life and politics. While we cannot truly control acts of nature (floods, drought), we can do something about improving water quality and allocation. It will require political will power, especially grass root action on a worldwide scale, to avert future misfortune.

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