

PRECOLUMBIAN
WATER
MANAGEMENT

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PRECOLUMBIAN WATER MANAGEMENT

Ideology, Ritual, and Power

EDITED BY

Lisa J. Lucero and Barbara W. Fash

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Precolumbian Water Management An Introduction

LISA J. LUCERO AND BARBARA W. FASH

When we think of ancient Mesoamerica and the Southwest, images of temples, monuments, maize, tropical forests, and arid landscapes come to mind; the image of water does not. Yet water was every bit as essential as maize for sustenance and was a driving force in the development of complex society throughout the region, whether in a desert or in the jungle. No settlement could be without it, and every geographic zone adapted procurement and storage systems to suit local conditions. But because of its basic nature water is often overlooked in importance if not forgotten altogether in Precolumbian studies. This is not to say that water has not captured the attention of many archaeologists and historians. This has been especially true since the publication of works such as *Oriental Despotism* (1957), in which Karl A. Wittfogel argues that complex societies or civilizations are underwritten by an agricultural base supported by irrigation. Since then, anthropologists have realized that it is much more complicated than a simple formula wherein irrigation equals civilization. Thanks to archaeological research throughout the globe, we know not only that water systems have a long history but that they come in diverse forms with varied purposes (e.g., Scarborough 2003). In addition to traditional religious uses, water sources and systems had numerous practical functions, from irrigation to water storage. Not surprisingly, water symbolism and ritual are prevalent throughout Mesoamerica and the Southwest. In this volume our goal is to present the varied aspects of water and a unified perspective of how water was conceived, used, and represented in ancient Mesoamerica and the Southwest as well as what mechanisms were used to build upon its sacredness to enhance political authority. The diverse chapters in this volume underscore the importance of water-management research and its need to be included in archaeological research.

Given current and critical issues regarding the growing scarcity of freshwater, it is surprising that we as anthropologists do not study water

more. In the recent United Nations World Water Development Report, World Water Assessment Programme the secretary general of the UN, Kofi Annan, states, "The centrality of freshwater in our lives cannot be overestimated. Water has been a major factor in the rise and fall of civilizations." Adequate water supplies are essential for food production and health. Keeping water clean and free from waterborne and vector-borne diseases is also of vital importance, especially since humans need 20–50 liters of water per day for various uses. Food and agricultural production require even more water. Further, "the circulation of water powers most of the other natural cycles and conditions the weather and climate," and the effects of floods and drought can have devastating impacts (United Nations 2003:xix, 6, 103–8, 123, 192, 65, 272–75). While the situation may be worse at present than in ancient times, issues revolving around water management continue to be of vital importance for social, political, and religious life.

The Present Work

The primary focus of the present book is water management in Precolumbian Mesoamerica and the Southwest (fig. 1.1). We thought it important to provide contrasting environments, from desert to highland and lowland Mesoamerica, using Vernon Scarborough's definition: water management "is society's interruption and redirection of the natural movement or collection of water" (2003:39). The control of water, a material and spiritual resource, shaped the political, economic, and religious landscape of the ancient Americas. Expressed through ritual, iconography, and site planning, water and subsistence management legitimized claims to power and integrated people around a vital element of the natural and social worlds. Focusing on prehistoric water-management facilities, settlement patterns, shrines and water-related imagery, and associated civic-ceremonial and residential architecture clearly can contribute much to the ways that archaeologists study ancient societies. Evidence suggests that ritual activities and iconography associated with water management, the built environment, and sacred places were critical elements in the manifestation of political ideologies throughout Mesoamerica and neighboring areas, particularly the Southwest.

The themes of ideology, ritual, and power reflect the fact that water systems pervade all aspects of society and are thus key not only in providing water for people, fields, livestock, and so on but as a means to support a political system, whether it be hierarchical (e.g., large Maya centers), communal (parts of the Southwest), or heterarchical (e.g., smaller Maya

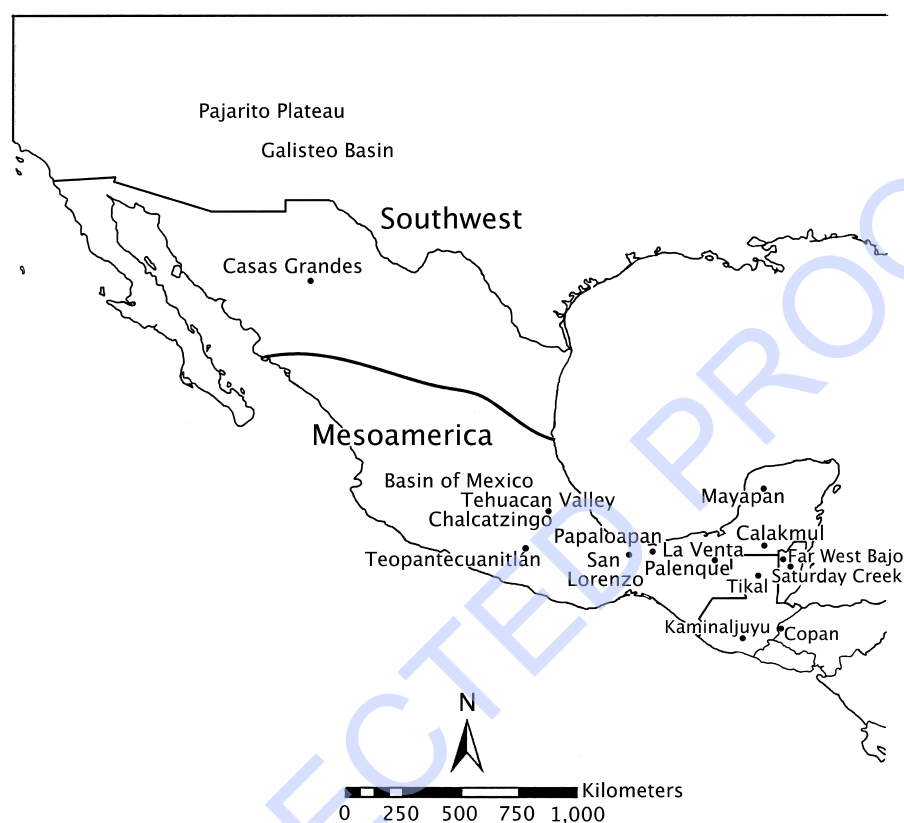


Fig. I.1 Greater Mesoamerica with areas covered in text.

centers and communities). Although this may seem obvious, it should not be taken for granted, or we risk missing data reflecting the manipulation and consequences of this major resource in the political economy of ancient peoples. We intend to draw attention to the need to incorporate water management in investigations and surveys and the varied types of information that can be gleaned from such an approach.

The scale and location of water systems in relation to settlement reflect their role in society, including the emergence and maintenance of political leadership. Since water-management systems typically are built in a relatively short period of time, they are actually a “better measure of an elite’s power and control than lofty pyramids that may reflect many generations of labor” (Scarborough 2003:84). Seasonal issues are also of importance—too much or not enough seasonal rain typically results in

situations in which capital and organization are needed to repair water systems as well as allocate water supplies (e.g., Scarborough 2003:96–99). For example, in Egypt famine caused by drought or flood damage was always a concern, since all Egyptians depended on the annual rising and subsiding of the Nile for survival (Hassan 1994). In the Americas this scenario is more obvious in drier highland areas compared to wetter lowland areas. However, this dichotomy cannot be taken too far. For example, the Maya, who lived in the humid tropics, also relied on water systems during the annual dry season (or drought) (Lucero 1999b; Scarborough 1998). Seasonal fluctuations are clearly critical factors in both humid and arid regions. Noticeable wet and dry seasons combined with intensive agriculture and a reliance on water systems can provide the means for political leaders to emerge. People beholden to these leaders, however, materially benefit in what they get in return for supplying tribute, including capital to repair subsistence systems damaged by flooding or heavy rainfall, water during drought, and food during famine. Further, since seasonal vagaries are beyond human control, supplicating rain and water deities was just as critical for survival. It was perceived that the rains would not arrive if the necessary ceremonies were not performed or if they were performed incorrectly. The political elite demonstrated their success as intermediaries with the supernatural world; cross-culturally, rulers are associated with fertility and purification, including clean water (e.g., Friedman 1975, 1998; Helms 1993, 1998; McAnany 1995). This relationship is reflected in the iconography in which water and fertility symbols and deities typically predominate, often depicted with rulers. People repaid rulers for their accomplishments with tribute, labor, and offerings. In societies without rulers, water systems and symbolism are still critical, as the cases in the Southwest illustrate.

Although important and insightful works on water symbolism and hydraulic engineering have predated our effort in diverse areas (Angulo Villaseñor 1987b, 1993; Coe and Diehl 1980; Puleston 1976, 1977; Rands 1953, 1955; Stark 1999a; Thompson 1952, 1974; Woodbury and Neely 1972), such studies have never been brought together in one cohesive volume. This book originated with a symposium organized by the editors at the annual meeting of the Society for American Archaeology in April 2001. We recognized that our research had a similar and overlapping focus that could be brought together with a growing body of research on water management. Chapters by Dunning, Beach, and Luzzadder-Beach, Carballal Staedtler and Flores Hernández, Brown, and Snead were contributed after the conference to broaden the areas covered. Unfortunately, the untimely passing of our esteemed colleague, Jürgen K. Brüggemann, resulted in our

not being able to include his SAA contribution on comparing Tajín and Zempoala. Our goal in bringing together such a cross section of scholars is to discuss various dimensions of water management in Mesoamerica and the Southwest and its key role in revealing ancient political, subsistence, and ideological systems. While we would have liked to have included a broader representation of ancient water systems (e.g., those of South America: see Erickson 1988; Gelles 2000), space constraints prevented it.

The top-down approach taken by most contributors assumes that water is critical not only for daily survival but for political power. Even if leaders do not act as water managers, they are heavily involved in propitiating supernatural entities for everyone. It is this latter role that largely gives them power over others and the resulting ability to exact tribute. Leaders are responsible not only for performing key water rites but also for providing capital to repair water systems damaged by flooding or heavy rainfall. If these responsibilities are not met, political leaders often lose the basis of their power: the labor of others.

Organization and Overview

We have organized the chapters in chronological order because in this collection the development of technologies and strategies over time was more compelling than specific issues. In part 1, "Early Development and Engineered Systems," the chapters largely focus on Preclassic water systems, which highlight the skill and planning of hydraulics in formative times, and their subsequent impact and development into the Classic period. Part 2 covers Classic systems and the growing evidence for water symbolism and ritual that accompanied a wide range of regional adaptations. Part 3, "Water Systems in Postclassic Mesoamerica," accentuates the relationships of these later developments to earlier systems while being more closely related to modern water issues. The final part deals with the frontier or neighboring areas of Mesoamerica, the Southwest (northern Mexico and the southwestern United States). Chapter authors address their particular artificial systems or manipulations of natural features found in the archaeological record, combine that with discussions of water symbolism and ideology based on the ritual and ethnographic evidence, and then enlighten the significance of the political power changes that were a result of these combined forces. And, as several chapters illustrate, the degree of political authority was largely conditioned by the scale of water systems at the rulers' disposal; thus when water systems failed, so did a basis for political power.

To begin, Cyphers, Hernández-Portilla, Varela-Gómez, and Grégor-López describe and discuss the cosmological and social significance of some of the earliest (1000–800 BC) artificial water systems, such as aqueducts, in Mesoamerica, located in the Olmec heartland in Veracruz, Mexico. They argue that the location, size, and construction materials of aqueducts and other water systems relate to differences in wealth and power and propose that proximity and association with more substantial architecture and better quality aqueducts may indicate elite control of freshwater. They bring evidence to bear upon how sunken plazas, perhaps viewed as portals to the otherworld, and water symbolism at Olmec sites are related to rulership. In addition, artifact deposits near monuments with water symbols may indicate rain-related ceremonies.

In the following chapter Cyphers and Zurita-Noguera discuss Olmec water and land systems, particularly *islotes* (artificial raised areas), which first appeared c. 1200 BC on floodplains to support recession agriculture. They discuss the significance of the settlement and presumably political hierarchy in the San Lorenzo area with regard to transportation and control of trade. Islotes also relate to differential power in that their size and location reflect access and control over transportation and trade routes, not to mention agricultural fields (and surplus). The authors also assess the distribution and significance of stone monuments, particularly thrones and their iconography, as reflecting political networks and hierarchical relations.

Nichols, Frederick, Morett Alatorre, and Sánchez Martínez detail the role of water management in political economy through their discussion of Preclassic water systems in Central Mexico, particularly canals in the Yauhtepec Valley. They suggest that rulers likely were associated with water management throughout Central Mexico (e.g., Teotihuacan). Although numerous scholars previously have dealt with this topic (Angulo Villaseñor 1987b; Charlton and Nichols 1997; Manzanilla 2000; Sanders 1957; Sanders and Price 1968), Nichols and her colleagues present new data to support an innovative model that assesses both agricultural intensification and landscape modification. It appears that, whatever their strategies, the ruling elites of Central Mexico were involved in water management and agricultural production and likely as intermediaries between the cosmic forces involving water and more earthly concerns.

In the following chapter on Kaminaljuyu, Guatemala, Valdés details the Middle (c. 600 BC) and Late (c. 300–200 BC) Preclassic canals, which he suggests indicate an earlier development of political complexity than previously thought in the Guatemalan highlands. Valdés notes that, based on offerings archaeologists have recovered from Lake Miraflores, includ-

ing items with aquatic elements, rulers of Kaminaljuyu may also have conducted water-related rituals. Water systems appear to provide the basis for political power at Kaminaljuyu, as Valdés argues in his discussion of irrigation canals that diverted water from Lake Miraflores. Irrigated fields provided the surplus necessary to support a political hierarchy as well as the control of jade and obsidian for exchange. The site's subsequent decline came about when Lake Miraflores began drying up c. AD 100–200.

In chapter 5 Dunning, Beach, and Luzzadder-Beach focus on the “*bajo* conundrum,” that is, how it is not possible to generalize about *bajos* (seasonal swamps or wetlands), which make up 40–60 percent of the Maya Lowlands. They provide an excellent summary of recent research on the bajo question: Were they or were they not at one time in the past shallow lakes or perennial wetlands? The authors' perusal of the literature as well as their own research in northwestern Belize demonstrate that the degree of heterogeneity is such that it is not possible to generalize about bajos in close proximity. There is little doubt that the distribution of bajos as well as the wet and dry seasons and karst topography had a major impact on settlement and agricultural strategies. Their role in politics became more significant during the Early Classic, when there is clear evidence that either anthropogenic or climate changes resulted in sedimentation and/or desiccation of bajos as well as lakes and perennial wetlands. It was at this time that the Maya relied more on artificial reservoirs, or enhanced *aguadas*. Increasing water scarcity, especially seasonally, set the stage for the increasing reliance on water-management systems controlled by elites and rulers.

In the following chapter Kunen argues that the Balinese *subak* (independent farming communities) can serve as a model to evaluate bajo communities in northern Belize as well as elsewhere in the southern Maya Lowlands. The varied water and land-management features were locally maintained, likely at the community level, and have a long history (definitely in the Early Classic, and there is some evidence for Late Preclassic features). Agriculture was thus not centralized, which is similar to the Balinese case and in contrast to water features near, for example, Caracol. Kunen describes three relatively prosperous Maya bajo communities in northwestern Belize and argues for the presence of founders' compounds, which served as the community center for ceremonies. If anyone made community decisions, it was descendants of founders. This, like agricultural production, was also conducted at the community level and was not centralized. This case has interesting implications for how the Maya political elite could access the agricultural surplus of community labor.

In her chapter Lucero attempts to demonstrate how seasonal water

issues and the scale of water systems relate to degree of political power. Along with Dunning and his colleagues, she emphasizes the importance of taking into account seasonal water shortages and the impact of seasonal weather on settlement decisions and political histories. Areas with seasonal water shortages and rulers who were closely tied to water management show the most complexity, while areas with plentiful water with little or no water systems show the least evidence for political power.

Using the abundant iconographic record and recent archaeological research in and around Copan, Fash and Davis-Salazar argue that the largest ruling groups were the chief water managers and administrators. Even though Copan is located along a river, during the dry season inhabitants likely relied on large reservoirs and aguadas, a fact that appears to have benefited rulers. Fash and Davis-Salazar's chapter builds upon Fash's (2005) iconographic research of the water iconography at Copan, which suggests that a complex of symbols represented the water-management system, with archaeological evidence from Davis-Salazar's excavations of reservoirs. Water symbolism at elite compounds throughout the Copan Valley points to the importance of water in subsistence and communal organization. It also supports the authors' claim that the position of the ruling family of Copan as the largest corporate group and major water managers may have afforded them the means to acquire surplus from surrounding farmers. The authors' model draws upon various ethnographic evidence such as the nearby Chorti and Evon Vogt's work in Zinacantan.

In a similar approach, French, Stuart, and Morales use iconographic and archaeological information to explore the significance of water systems at Palenque. New data from several projects have revealed that, in contrast to most other Maya centers, Palenque water systems, including aqueducts and drains, were built primarily (though not exclusively) to control water flow from the fifty-six springs and nine streams, which were plentiful throughout the year. The authors detail water symbolism, in this instance where water systems were built to drain water, not to store it per se. As at Copan, however, the iconography demonstrates the significance of water in religious and political life, as indicated by the combination of water motifs and rulership (e.g., crocodiles, water lilies, etc.). Aqueducts, bridges, dams, drains, walled channels, and pools are found associated with monumental architecture, suggesting their connection to rulership and political power, similar to elsewhere in the Maya area. A distinctive factor, though, is that aqueducts were covered to expand available surface area.

Part 3 begins with a chapter by Carballal Staedtler and Flores Hernández on the diverse water systems revolving around the myriad lakes

in the Basin of Mexico, including irrigation channels, dams for irrigation and flood control, dikes, and *chinampas* (raised fields). Islands were occupied by the fourteenth century (e.g., Tenochtitlan), and causeways (*calzadas*) were built to connect them, the network of which relates to water rights, communication, and alliances. Although much has been written about chinampas and Aztec period water systems, the authors demonstrate that many features appear to be earlier innovations that were later intensified with the arrival of the Mexica in the region. Once realizing the potential of this hydraulic system already in place, the Mexica were able to build an empire.

In the following chapter Brown describes natural water sources in and near the Postclassic Maya capital of Mayapán, particularly *cenotes* (sink-holes) within the walls of the city. The karstic geology and topography had a major impact on the nature of water sources. At Mayapán cenotes are found in association with ceremonial architecture (e.g., at the Temple of Kukulcan), indicating the role of water in ritual and cosmology, not to mention city planning. Cenotes also served more practical purposes, for example, to harvest turtles and fish. This was particularly significant in the northern Maya Lowlands, where the climate was much drier than in the southern lowlands and where water supply was a year-round concern rather than just a seasonal one. These issues had major implications regarding settlement decisions and political strategies.

Moving to the Southwest, Walker and McGahee make a critical point that since water systems often serve as the center of ritual life, it is to be expected that this fact would be reflected in technology. Much time and effort were spent on water systems and concomitant ritual paraphernalia. The authors demonstrate these points through a discussion of water systems in Casas Grandes, Chihuahua, Mexico, including irrigation, flood control, sewage disposal, and drinking water. Water was critical in the dry environment, a fact reflected in the wells and reservoirs. The authors illustrate a pattern of ritualized technology through discussing wells and detailing the artifacts used to seal one of the major wells, which they argue was ritually abandoned rather than closed as the result of a destructive battle. They suggest that elites — not necessarily political but perhaps religious — managed and controlled the springs, wells, and reservoirs, water systems that were key to meeting agriculture and daily water needs.

Continuing in the Southwest, Snead argues along similar lines in his discussion of residential reservoirs in the Rio Grande region in northern New Mexico. He discusses the diverse water systems used to survive in a desert environment — canals, check dams, gravel-mulch fields, and reservoirs. These features were significant for agriculture and drinking water.

Using ethnographic case studies, he argues that residential reservoirs in northern New Mexico not only provided drinking water but also were part of the sacred landscape, along with kivas and shrines at springs, suggesting that reservoirs may have mirrored sacred lakes and thus were important ceremonial loci.

Scarborough provides a conclusion and synthesis chapter and discusses the history and advances in water system research. He distinguishes between moving-water and still-water systems in terms of their chronology, functions, and symbolism. His extensive experience and dedication to the topic allow him to present considerations of each chapter within an historical perspective. His well-known work on water systems in Belize and comparative research in Bali and Greece provide him with a global foundation from which to synthesize the volume's contributions. His synthesis provides insightful comments on the multiple adaptations through time and their significance in understanding how ancient Mesoamerican and southwestern cultures worked within their environmental settings. He raises thought-provoking questions and, by doing so, advances one of the main purposes of this volume: the need for archaeologists to include a detailed site survey of water technology coupled with ideological, ritual, and ethnographic evidence.

Concluding Remarks

This volume is geographically and temporally comprehensive and thus provides a rare perspective on prehistoric water control and management. It includes a wide spectrum of sociopolitical systems, from village societies to empires, and represents a range of theoretical approaches for investigating ideological, political, social, and economic dimensions of water systems. We hope this book thus contributes to a comparative understanding of ancient water systems, focusing on common patterns of water management within Mesoamerica and the Southwest without diminishing the unique historical qualities of each of the societies discussed. Water management is an area of research we have been drawn to because it explains many aspects of past civilizations' attempts to organize social and political structures through control of this basic resource. We also find that one of the great pleasures of working on this topic is that, unlike past rulers concerned with power or control, our colleagues openly share data and ideas in the interest of spreading knowledge and searching for both geographical and ritual explanations for how water was conceived of and manipulated in the past. With today's water shortages so threaten-

ing, through these studies we become more keenly aware of our common link with past cultures and better able to understand water's limitations.

Acknowledgments

We wish to thank all the participants in the symposium that led to this volume and to the authors who joined the effort afterward. It has been a pleasure to work with a group so enthusiastic and dedicated to reaching a wider audience and sharing the varied ideas we all have about the importance of water in the archaeological record and its impact today. We are also grateful to the three anonymous reviewers, whose insightful comments and suggestions for improvements helped shape the volume into a more accurate and thoughtful consideration of the topic. Valuable suggestions, advice, and encouragement from William Fash were appreciated throughout the process. Finally, our thanks to the editors at the University of Arizona Press for their support of this project.

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EARLY DEVELOPMENT AND ENGINEERED SYSTEMS

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Cosmological and Sociopolitical Synergy in Preclassic Architectural Complexes

ANN CYPHERS, ALEJANDRO HERNÁNDEZ-PORTILLA,
MARISOL VARELA-GÓMEZ, AND LILIA GRÉGOR-LÓPEZ

Planned architectural complexes were the locus of specific behaviors in the Mesoamerican past, and their analysis can lead to a better understanding of practices and beliefs relating to ceremonies, political and religious administration, and social identity and differentiation. In particular, Preclassic architectural settings are imbued with symbolism related to origin myths, water, fertility, and the underworld. Rulers and sunken patios could have functioned as the symbolic threshold between the natural and supernatural worlds, that is, the portal to the underworld (Grove 1973, 1997; Reilly 1994a).

Recent work at San Lorenzo, Veracruz, by the San Lorenzo Tenochtitlan Archaeological Project (SLTAP) revealed a well-preserved Early Preclassic architectural complex that is deeply buried in the area referred to as Group E. In this chapter we first provide a background summary of the Olmec and then review the composition of the architectural complex in order to examine aspects of rulership, ritual, ancestor worship, and cosmology. This setting and five others at various coastal and inland sites (fig. 1.1) are compared in order to trace conceptual continuities and changing social interaction strategies through the Early and Middle Preclassic periods.

The Olmec

A millennium and a half before the Christian era and long before documented Mesoamerican history, Mexico's Gulf Coast Lowlands witnessed the first stirrings of Olmec culture. During the Early Preclassic (1200–800 BC), in the first regional center, San Lorenzo, the Olmec designed and created monumental constructions and stone monuments while extending their influence across the coast and trading with diverse regions, both near and far, until it declined around 800 BC. Like its predecessor, the

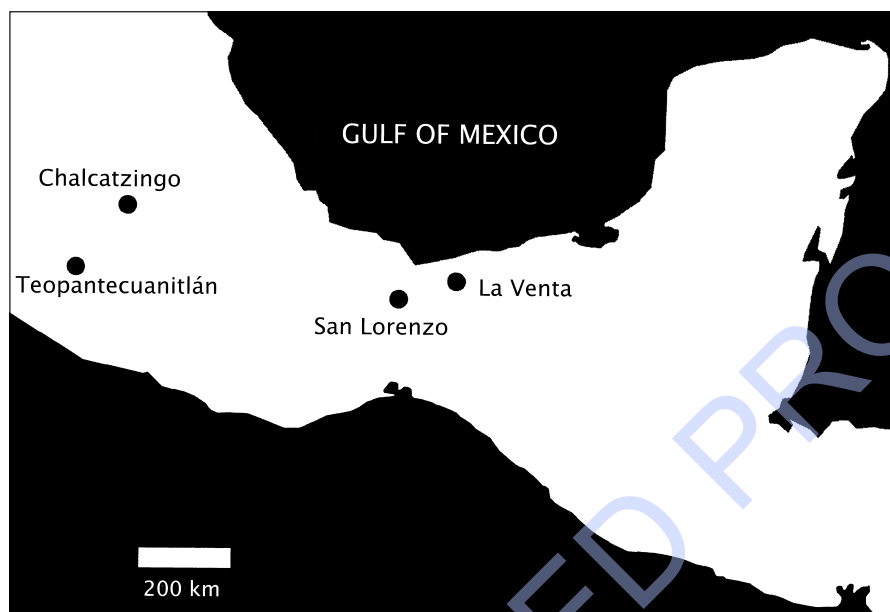


Fig. 1.1 The archaeological sites mentioned in the text.

Middle Preclassic (800–400 BC) regional center of La Venta was governed by rulers whose colossal stone portraits and other massive sculptures have made this culture widely known today. Their public constructions and long-distance transport of weighty stone monuments bear witness to their political power, which was instrumental in extending their participation in broad economic spheres. The Early Preclassic development of the Olmec civilization coincides with the widespread distribution of ideologically imbued items such as “Olmec-style” engraved pottery and figurines and, in the Middle Preclassic, monumental stone art and greenstone objects (Coe 1965b; Demarest 1989; Grove 1989b; Marcus 1989).

The San Lorenzo site is set on a low ridge amidst broad floodplains and meandering rivers in the lower Coatzacoalcas drainage and has human occupation dating to 1500 BC (Coe and Diehl 1980), with its florescence occurring between 1200 and 800 BC. Matthew Stirling’s (1955) pioneering work there in the 1940s sought monumental evidence that would help resolve the then-current debate on the antiquity of the Olmec.

In the 1960s Michael Coe and Richard Diehl’s (1980) work provided the first firm stratigraphic sequence for the Olmec region and addressed the next major debate, the question of the temporal precedence of the

Olmec. In addition, Coe and Diehl offered the first population estimate for the site, one thousand inhabitants, which disproved the current idea of “vacant Olmec ceremonial centers.” From their work a large number of monuments were revealed, and many were excavated in situ, including a stone aqueduct. Their efforts confirmed San Lorenzo’s temporal placement and importance. Later work concentrated on the exposure of stone monuments (Beverido 1970; Brüggemann and Hers 1970). The discovery of two colossal heads resulted from the pioneering application of magnetometry (Coe and Diehl 1980).

In 1990 SLTAP initiated work that includes systematic regional survey and excavations in habitation, productive, and ceremonial areas of San Lorenzo and other hinterland sites (Cyphers and Borstein n.d.; Cyphers 1997a, 1997b, 1997c, n.d.a, n.d.b, n.d.c; Symonds, Cyphers, and Lunagómez 2002). From this research we now know that during its florescence the site’s more than five thousand inhabitants occupied some 500 hectares, including the artificially terraced plateau. Extensive excavations in plateau, terraces, and periphery show that important social differences existed among the inhabitants based on construction technique and size of dwellings, productive activities, and imported resources. One particular SLTAP concern has been the investigation of the context of stone monuments in order to understand their function and meaning, such as the Group E work discussed below.

The combined work of all research projects at San Lorenzo provides a mental picture of a very large, complex regional center located in an area of resource concentration that developed a regional system of communication and transport consistent with the riverine landscape. The seemingly sudden appearance of monumental stone sculpture during its florescence was the materialization of a preexisting social and political capability to organize productive specialization and the extensive labor force required for long-distance transport of the stone from the source. Genealogy, the basis for social differentiation, ultimately was formalized into a system of hereditary rule and political administration (see Cyphers and Zurita-Noguera, this volume). Supernatural beliefs, particularly those related to water and the underworld, constituted the ideological certification of royal descent groups.

Olmec studies encompass archaeological and art historical perspectives, each providing key components to the understanding of this culture and its development. The insights from iconographic studies of Olmec and “Olmec-style” art emphasize the ideological themes of water and agricultural fertility, shamanism, the underworld, rulership, and divine descent (Bernal 1969; Coe 1965b, 1972; Coe and Diehl 1980; Covarrubias

1957; de la Fuente 1981; Drucker 1952; Furst 1968; Grove 1970, 1972, 1973, 1981, 1987; Joralemon 1971; Taube 1996; among others). The history of Olmec studies, like many others, is characterized by periodic shifts in perspective, such as in the theories regarding its antiquity (Preclassic vs. Classic period), origins (highland vs. lowland), and impact on distant areas (local development vs. outside influence). The “mother culture vs. sister cultures” polemic (Hammond 1988) is the most recent stab at sorting out the developmental mechanisms and trajectories of social complexity in the Gulf Coast and other regions.

The present chapter bears directly on this last issue. Our examination of the dating, architecture, ideology, and sociopolitical organization related to a specific area of the site, Group E, provides an opportunity to explore the temporality and occurrence of the interrelated concepts of sovereignty, genealogy, and the watery surface of the underworld.

Group E

Group E, characterized by gently rolling terrain punctuated by several lagoons and the presence of several well-known large stone monuments, stands out as a locus of elite activity in the central portion of the site, even though no Olmec construction features are visible on the surface. The size, shape, and iconography of the following four monuments help us understand its associated cosmological meanings:

- A large, intact, monolithic throne, Monument 14, discovered by Matthew Stirling (1955:15–16) in 1945 near the northeastern edge of Laguna 8, later was moved to the Xalapa Museum of Anthropology (fig. 1.2a). In it, the principle of divine descent is embodied in a sacred ancestor emerging from the cave-niche entrance to the underworld, often considered the source of rain and mist (Grove 1970, 1973:134). Its lateral bas-relief may represent bound captives (Coe and Diehl 1980, 1:392) or successors to the office of ruler (Cyphers n.d.d), who may have been kinsmen, as demonstrated by the rope tying them to the divine ancestor (Grove 1973:134–35, 1981:66).
- Colossal head 8, Monument 61, excavated by Jürgen Brüggemann and Marie-Areti Hers in 1970, was removed from the site in 1986 (fig. 1.2b). Formally similar to other colossal heads, it is a portrait representation of a ruler, perhaps a sacred ancestor (Stirling 1955:20; Wicke 1971:144).
- A basalt aqueduct, Monument 73, measuring 171 meters in length (Coe and Diehl 1980, 1:118–26; Krotser 1973), is located southwest of the colossal head and south of the throne.
- Monument 52, a hollowed-out seated human-feline figure (fig. 1.2c),

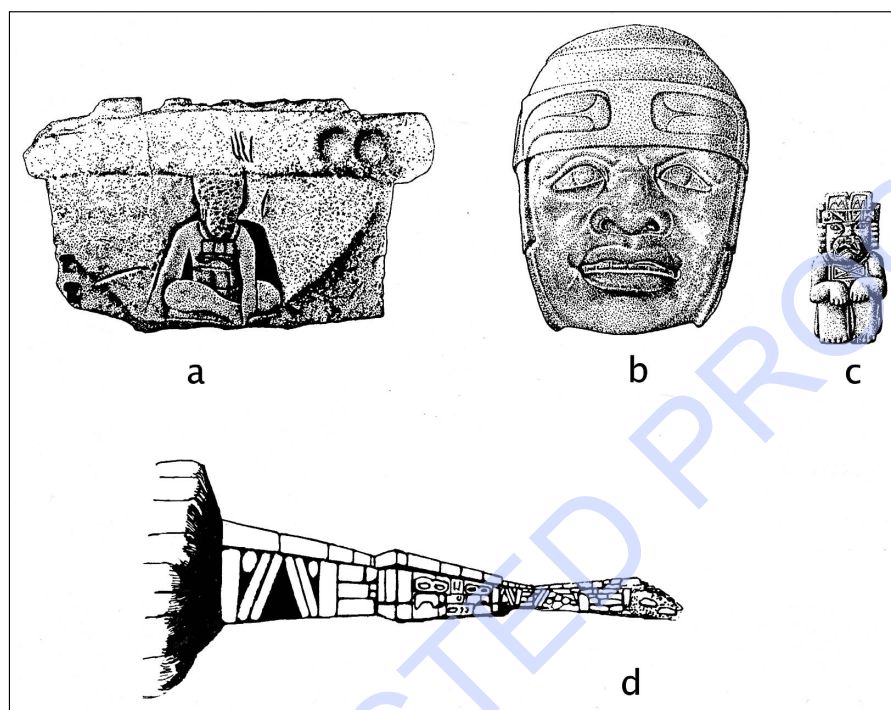


Fig. 1.2 Monuments and architecture described in the text: (a) Monument 14 from San Lorenzo (1.83 meters high, 3.48 meters long, and 1.52 meters deep); (b) Monument 61 from San Lorenzo (2.2 meters high, 1.65 meters wide, and 1.6 meters deep); (c) Monument 52 from San Lorenzo (90 centimeters high, 46 centimeters wide, and 35 centimeters deep); (d) sketch of Chalcatzingo's Monument 22 and its surrounding sunken patio (based on a drawing published in Fash 1987:fig. 7.4). (Drawings courtesy of Fernando Botas)

was excavated near but stratigraphically higher than the basalt aqueduct (Coe and Diehl 1980, 1:361–63), having been displaced from its original location in the complex by later earth-moving activity during the creation of Laguna 8 (Cyphers n.d.a). Notwithstanding its interpretation as a rain deity (Coe and Diehl 1980, 1:363), it may have functioned as a standard-bearer (Cyphers 2004), an emblem heralding the identity of a ruler or elite group.

The studies cited above convincingly demonstrate the presence of rulership, ancestry, and water symbolism in Group E monuments. These themes and the likelihood of an undisturbed sovereign context for Monu-

ment 14 motivated the SLTAP to examine this locus. Monuments 14, 61, and 73, all thematically related pieces entailing high social costs due to their size and the distance to the source of basalt (Williams and Heizer 1965), are of crucial importance because of their Early Preclassic (1200–800 BC) context in the architectural complex under consideration. We will show that this complex provides additional support for the interpretations of sunken patios offered by Grove and Reilly, symbolically considered the watery access to the underworld in the Olmec belief system as well as in other Mesoamerican cultures (Bassie-Sweet 1996:69; Grove 1973, 1981; Reilly 1994a, 1994b).

Two SLTAP excavation operations were designed to explore and date the archaeological context of the throne and find the origin point of the aqueduct, respectively. The goals were met through extensive excavations conducted over four field seasons (1992–95). At the present time it is possible to draw together the information from this work plus that from two other projects (Brüggemann and Hers 1970; Coe and Diehl 1980) to synthesize and interpret excavated features. The editorial limitations of the present chapter do not permit a full exposition of the excavation data; consequently, a general description of the features is the basis for discussion.

In comparison to other Early Preclassic constructions at San Lorenzo, this architectural complex stands out as a specialized elite area due to its size, construction style, intrasite location, and artifact associations. It is composed of low earthen platforms surrounding an interior sunken patio. It was about 75 meters long on each side and rose about 4 meters above the ancient ground surface (excluding the height of superstructures) in its final building phase. We divide the complex into four parts for discussion purposes: the north, east, and south platforms and the central sunken patio (see the reconstruction in fig. 1.3). SLTAP excavations were conducted in the north and south platforms and sunken patio, whereas information about the east platform is based on unpublished excavation data and images kindly provided by Marie-Areti Hers. If structures once existed on the western side of the patio, they may have been destroyed during the post-Preclassic construction of Laguna 8 (Cyphers 1997a:112); we may never know the full design and layout of the architecture. Despite this drawback of the lagoon, its humidity was beneficial insofar as it aided in the excellent preservation of the sunken patio and the north platform. The excavation of the Group E complex is far from complete. Nonetheless, through the joint efforts of three projects nearly 300 square meters of the architecture have been excavated to depths as great as 5 meters below ground surface.

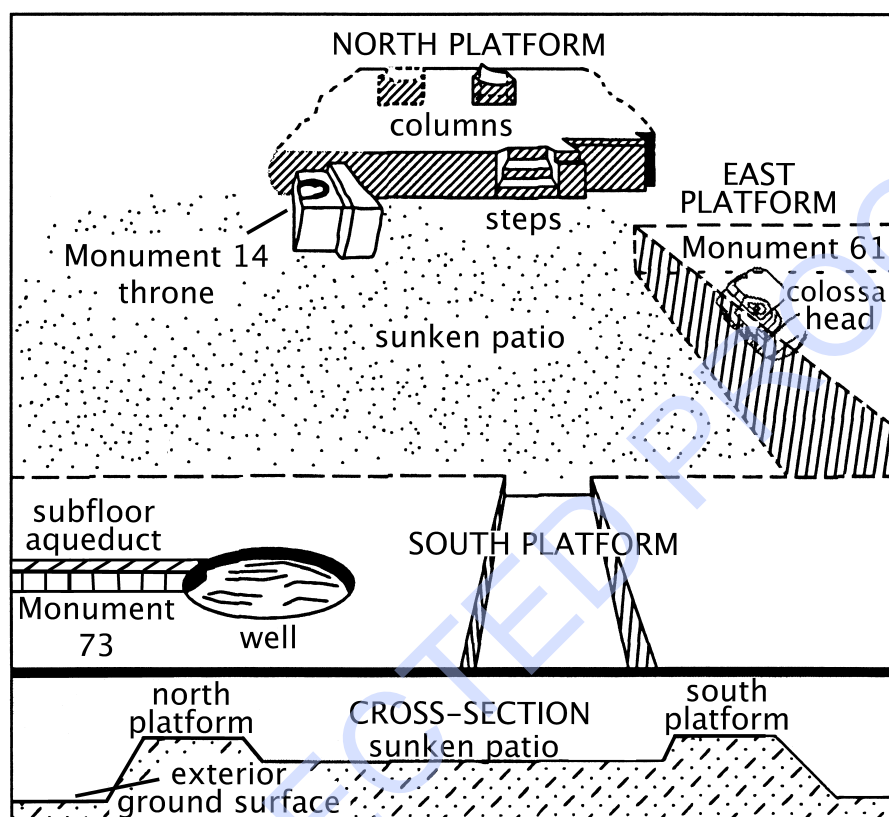


Fig. 1.3 Hypothetical schematic reconstruction of the Group E complex (top) and north-south cross section (below) based on excavations conducted in the sunken patio and the north, south, and east platforms. (Drawing courtesy of Rubén Jaimes)

The North Platform. Excavations at the location of the throne exposed a portion of a two-stage platform and the contiguous northern portion of the sunken patio (Cyphers 1997b, n.d.a; Varela-Gómez 2003). The earliest, red sand-plastered stage was expanded upon in the second and final yellow stage. The two building episodes show the continued use of the platform between 1200 and 1000 BC, with its abandonment around 900 BC.

In its first episode the red platform appears to be rectangular with one known inset corner. Oriented due east-west, it measures about 7 meters wide, but, due to the limits of the excavation area and the disturbance created during the removal of the throne, its precise length is undetermined,

but it surpassed 15 meters. Its south side is 1.25 meters high, measured from the level of the patio. The southern red *talud* with a 15-degree inclination was interrupted by three steps. The excavations on the upper surface of the longer and more sloping northern talud revealed the base of a large red sand-plastered earthen column (2 by 2 meters), which perhaps helped sustain a palm thatch roof. Before the next construction episode the superstructure was razed to the base of the column, and offerings were deposited on the floor of the adjacent sunken patio to the south.

The second building episode, with its yellow sandy clay-plastered surface, increased the platform size by about 30 percent, to about 9 meters wide and more than 1.4 meters above the level of the patio (height after razing). The east-west orientation was maintained along its more than 15-meter length. A cache of sixty-eight whole and partial vessels was placed under the floor along with a rare bifacial chert projectile point.

The Sunken Patio. The design of this enclosed area was ideal for private ritual. Sunken in relation to the surrounding platforms, the base level of the patio was about 4 meters higher than the ancient ground surface outside the complex (see profile in fig. 1.3), which, in a sense, could be considered a kind of acropolis with the patio sunken in its center. Its configuration seems to foreshadow later complexes, such as platforms bearing sunken plazas and temple groups.

Its south-central and westernmost portions were destroyed by the lagoon construction, modern dredging, and throne-removal operation. Just as the north platform shows a red and a yellow building stage, so does this patio, which may have been roofed, since both sand-plastered floors are quite well preserved and no evidence for drains was found.

The north-south length of the patio is estimated at about 50 meters. A radiocarbon sample from the red and yellow floor interface dates to 981 ± 60 BC (1220–1020 BC, calibrated with OxCal 3.5), which supports the relative ceramic dating; the red stage dates to 1200–1000 BC; and the yellow construction episode dates to 1000–900 BC.

Offerings of figurines, bones, obsidian artifacts, and vessels deposited on both floors aid in dating and activity reconstruction. Unusual offerings were found on the yellow floor, such as a human mandible, scattered infant and bird bones (Carlos Serrano, Liliana Torres, and Enrique Villamar, personal communication, 1995, 2002), and a vessel containing human rib segments.

Easily detected from the disturbance created by its removal, the throne's position in the patio was near the southern base of the north platform. It lay upon its back, with the upper portion, or actual ruler's seat,

facing east (Stirling 1955:15). Its association with the yellow floor does not preclude its earlier use during the red stage. We believe that it was turned onto its back as part of termination rites related to the cessation of the sovereign function of the area.

The East Platform. In 1970, during the excavation of a large magnetic anomaly (Breiner and Coe 1972), Brüggemann and Hers (1970) discovered colossal head 8. They interpreted the mixed soils encasing the head as a large pit intruded into the site's sedimentary geologic formation, even though they did not detect the outline of the feature (Marie-Areti Hers, personal communication, 2001). The ceramics date to the San Lorenzo phase, 1150–900 BC (Coe in Coe and Diehl 1991:33).

Based on the stratigraphic reanalysis of their units from the original wall drawings and color slides, the “mixed soils” appear to be identical to the fill of the north platform discussed above. In addition, a red sand floor capping the head is seen in all wall cuts, further attesting that the monument was intentionally interred within the fill of a platform structure and sealed by its floor (Cyphers n.d.a). Future excavation may be able to define more of the platform.

The South Platform. This low structure, bordering the sunken patio on the south, contained the eastern end of the basalt aqueduct, whose length is the most impressive of all trough lines known at San Lorenzo. The following discussion draws on excavation information about this portion of Group E from SLTAP research (Cyphers and Hernández n.d.; Hernández-Portilla 2000) and previously published work (Coe and Diehl 1980, 1:118–26, fig. 83; Krotser 1973).

Due to the magnitude and depth of the architecture, we are still far from defining the shape and size of this platform, which supported at least two structures. One red-floored superstructure, more than 22.5 meters long (east–west), is associated with the insertion point of the aqueduct into the well; to the east of the well a dip gives way to another small rise bearing a contemporaneous bentonite floor (measuring 7 meters, north–south).

Our excavations indicate that the initial section of the aqueduct was a subfloor line fed from a freshwater well. The Olmec plastered the associated red sand floor more than twenty-five times, which gradually increased the height of the well's mouth, a strategy perhaps designed to contain rising water levels and control structural damage.

Costly in imported material and labor, the stone aqueduct, built using an estimated 30 tons of basalt, has three inclined branch lines or feeders

perpendicular to the main line on its south side at distances between 48 and 58 meters west of the red-floored structure mentioned above. Once presumed to be unfinished lines, instead they may be overflow drains created to protect structures covering the main line. Water flowing from the well into the line required monitoring and control via sluice gates and checkpoints. The duck fount (Monument 9) decorated with water symbolism, found in a location slightly removed from the previous pieces, probably was destined to receive water from the aqueduct (Coe and Diehl 1980, 1:314–15; Stirling 1955:14).

The overall 2 percent grade of the main trunk is an average of the incline of various sections, and the distinct grades and styles of ducts and covers have been interpreted as the consequence of lax engineering control and logistical building problems (Krotser 1973:45, 47). However, the stylistic and technical changes along the main line may signal several construction stages. The shifts in grade, the position and style of covers, and the duct sizes match finite sections, perhaps pointing to a section-by-section increase in length.

Around 900 BC the stone aqueduct ceased to function, and the easternmost troughs were removed from their ditch, which was then plugged with orange clay. This event occurred simultaneously with other termination rites and the cessation of activity in the complex.

Observations on the Group E Complex

The Group E complex, with its intricately interwoven notions of sovereignty, ancestry, water, and the underworld, functioned as an elite space, as is clear from its special construction style, stone monument associations, and lack of a typical domestic assemblage (Varela-Gómez 2003). Although it is enveloped by interlocking cosmological themes, specific function varies within it. For example, the north platform and adjacent portion of the sunken patio appear to be most closely linked to rulership, as evidenced by the great throne. Due to its size, this monument is specific to maximum regional leadership (see Cyphers and Zurita-Noguera, this volume), and the ruler who used it manifests the legitimating code asserting his direct kin link to the divine ancestor (Grove 1970, 1973). Particularly intriguing in this platform is the inset corner located near the eastern edge of the SLTAP excavation area; however, only complete plan maps obtained from future extensive exploration will reveal if there is any formal relationship to the quatrefoil motif proposed by Fash and Davis-Salazar (this volume) as being related not only to caves but also to the water sources associated with them.

Through the offerings we perceive a difference in the character of the formal ritual behavior conducted during the second use episode, specifically in the emphasis on death. The human mandible, the dish of human rib segments, and the unusual chert biface are accompanied by the remains of babies and birds, possible remnants of propitiatory and divination rites.

On the other hand, the east platform encasing the colossal head may have served as a shrine honoring an ancestral ruler. Its eastern position coincides with sunrise and attendant concepts of origin and birth, a common theme in Mesoamerica (Angulo Villaseñor 1987a:155–56). The type of social participation required for the head's interment necessarily dictated a public event due to the labor requirements of its transport and maneuver. Following burial, although the image became invisible to the living, it must have given a special meaning to the area, possibly one related to the social identity of a specific corporate group. Its planned ritual placement might be a tribute to an ancestor who symbolized the group collectivity of the complex.

Finally, water associations may be inferred from some of the sunken patio's offerings, but it is the southern structure that has the strongest apparent affinity, because it contains the well and aqueduct housed within a prestigious edifice. We regard this as strongly reinforcing the reading of sunken patios as the symbolic access to the watery surface of the underworld (Grove 1973, 1981; Reilly 1994a, 1994b).

To summarize, the major themes of the Group E complex refer to rulership, ancestry, water, and the underworld, and its layout may reflect an early cosmological model legitimating the sovereign's place in the universe. As the official locus of at least one sovereign, this exclusive complex is characterized by an internal segregation of symbolic, political, economic, and commemorative functions that may indicate its use by the utmost politico-religious elite.

Other Architectural Complexes

Architectural settings at three later sites illustrate temporal continuity in supernatural beliefs and ritual activities. At the same time, important differences among them signal variations in the strategies of interregional communication through time, including political and genealogical ties (see Grove 1981), which we will discuss following a brief description of each case.

The first example is La Venta's ceremonial court (A-1), located to the north of the great mound (C-1) and dated to c. 600 BC. It has water and

underworld associations in the basalt tomb, sandstone sarcophagus, serpentine offerings, and sunken patio, which measures about 40 by 57 meters and is 1.5 meters deep (González Lauck 1990, 1996; Grove 1999). Thrones are absent, but three aligned colossal heads, set less than 100 meters north of Mound A-2, may represent sacred ancestors.

In Teopantecuanitlan, Guerrero, a site limited to the south by the imposing Cerro Tecuan-tepec, Guadalupe Martínez Donjuán (1986, 1994) and Christine Niederberger (1996) have reported a sunken patio in the ceremonial complex. The first yellow clay construction phase contains underworld symbols next to the access steps. In the second phase the 19-by-14-meter patio contains four inverted T-shaped stone monoliths showing underworld beings and a subfloor drain. The active symbol of rulership, the throne, is noticeably absent; however, a small “colossal” head was incorporated into the north wall of the adjacent construction during the third phase, about 600 BC.

The site of Chalcatzingo, Morelos, is bounded on the south by the impressive Cerro de la Cantera, considered a “sacred mountain” by Grove (1987, 1997). Of its two architectural settings with specific underworld associations, the earlier one is largest and has a longer period of use than the second one.

The first setting is composed of Structures 4 and 5 in the Plaza Central (Grove and Cyphers Guillén 1987:29–31, fig. 4.4; Prindiville and Grove 1987:63–64, fig. 6.2). The Barranca phase building stage (1000–700 BC) of the north platform, Structure 4, is over 15 meters long (east–west) and 4.2 meters high. During the Late Cantera subphase (600–500 BC) it housed Monument 9, which represents the earth monster’s open mouth (Grove and Angulo 1987:124); in addition, it contained the site’s two most prestigious crypt burials (Merry de Morales 1987:100). Structure 5, located about 17 meters to the south of Structure 4, also was built during the Barranca phase. More than 13 meters long and 2.7 meters high, this building is separated from the parallel Structure 4 by a stone pavement. It is unknown if the space between them is closed off on the east and west by other buildings; accordingly, a ball court function is unconfirmed (Prindiville and Grove 1987:64). Nevertheless, clear underworld associations in the Late Cantera subphase burials and stone monument hint that this setting could be an architectural complex conceptually similar to San Lorenzo’s Group E.

The second setting at Chalcatzingo is the sunken patio with the “altar-throne,” Monument 22, dating to 700–500 BC. William Fash (1987) analyzes this 11.6-by-7-plus-meter patio and masonry “altar,” whose throne

and rulership attributions are complemented by its tomb function for human burials resting in its hollow interior. Associated infant burials suggest propitiatory rain ceremonials or accession/termination rites. Although lacking an aqueduct, the patio is located only a short distance from a diversion dam placed across a stream cutting through the site (Grove and Cyphers Guillén 1987:41–42). Notably, no sacred ancestor imagery is present.

At these sites each complex's unique combination of features contains important sociopolitical messages. For example, the absence of a throne in Teopantecuanitlan's complex may indicate that the seat of power was elsewhere at the site, or perhaps the same principles of rulership and ancestry as the contemporary coastal capital were not adhered to. Indeed, the diminutive, crude "colossal" head, little like the Olmec ones, imperfectly emulates coastal manifestations of ancestor worship (see Grove 1987:436 on frontier art).

In contrast, Chalcatzingo has the maximum expression of rulership, the throne. The sacred frontal image demonstrates the ruler's legitimation via the use of a key Olmec underworld symbol (Grove 1970), but the auspicious absence of the ancestor and frontal niche likely indicates that this local ruler was not a blood relative to the most divine Olmec descent group. Accordingly, the use of the underworld symbol may have been acquired through appointment and/or intermarriage. In the absence of DNA studies we can only wonder if the two individuals buried in the hollow interior of the masonry throne were related to Gulf Coast people or if they were native elites immortalized as sacred ancestors in a symbolic act to found Chalcatzingo's own line of divine descent.

Conversely, Teopantecuanitlan and Chalcatzingo share a rare architectural feature—the masonry design of patio walls built with niches shaped in the form of a half-diamond and bordered on each side by a stone knob. Even though these elements have never been found at Gulf Coast capitals, their replication at two important highland sites suggests that these places were equivalent in some aspect, perhaps sociopolitical, which warranted a similar sacred backing. Interestingly, politically designed replication in rulership contexts is present since the Early Preclassic on the Gulf Coast, where twin monolithic stone thrones from two secondary centers in the San Lorenzo region, Loma del Zapote and Estero Rabón (Monuments 2 and 8, respectively), have identical underworld symbolism on their upper ledge (Cyphers 1997c:figs. 9.6, 9.7; Cyphers and Zurita-Noguera, this volume; Symonds, Cyphers, and Lunagómez 2002).

Ceremonial Complexes, Cosmology, and Interregional Alliances

The initial information from San Lorenzo's Group E suggests the conceptual unity of sovereignty, genealogy, and the watery surface of the underworld. Perhaps eventually it will be shown to be another symbolic model of the Olmec universe, in which the enclosed court is conceived as an otherworld and ancestral location (Reilly 1999).

It is useful to contrast Reilly's reconstruction of La Venta and San Lorenzo's Group E because there are important differences. First, unlike Group E, La Venta Complex A lacks the ruler icon, the throne; in addition, the ancestral images in colossal head form are located outside the precinct. In contrast, Group E lacks anything comparable to La Venta's stone sarcophagus, basalt column tomb, jade offerings, and serpentine mosaics. It appears to have been an active sovereign space, whereas Reilly suggests the La Venta construction to be the symbolic representation of a mythic place used as a mortuary complex.

Nonetheless, general shared correspondences in north-south symbolism may be part of an early template, as Grove (1997) has suggested with regard to general site layouts. For example, the San Lorenzo throne is located in the northern sector, as is the basalt-column tomb of Complex A, analogically interpreted by Reilly as coincident with the Maya concept of the "celestial location of the First Father" (1999:37). To the south is La Venta's great mound, suggested by Reilly as the Mountain of Creation. The association of water with the southern sector of Complex A follows from the two mosaic pavements, interpreted by Reilly as symbols of water and agricultural fertility. Likewise, the strong reference to water in San Lorenzo's Group E corresponds to the southern portion.

In contrast, the symbolic north-south associations currently do not appear to hold for the architectural complexes in distant sites. These complexes do, however, illustrate the enduring importance of fundamental architectural styles and perhaps general beliefs regarding water and the underworld. Their differences and similarities seem to reflect certain qualitative changes in interregional interaction.

Basic Early Preclassic cosmological concepts, modified according to the particular landscape features of each site, persisted at Middle Preclassic sites located on the already established pathways of social and economic communication. The basic design of early Olmec architectural complexes was assimilated into the ostentatious buildings of later chiefdoms far from the Gulf lowlands in what seems like an energetic attempt

to institutionalize status and office. The increasingly formalized interaction fomented not just trade but also sociopolitical alliances.

There is still much to learn about the variety of mechanisms promoting such concepts, yet there is reason to believe that some were mandated by marriage (see Clark and Pye 2000; Cyphers 1984; Drucker 1981; Grove 1987). The combinations of features in the complexes may indicate that highland Middle Preclassic marriage alliances did not occur with an ancient and powerful Olmec family descended from the divine ancestor but perhaps were connected with lesser Gulf Coast corporate groups, or, as Grove has suggested (1989a:144–47), they were celebrated between interacting highland sites, a situation that would promote yet other kinds of alliances and kin relationships.

As inferred from the trappings of legitimization and rulership, Olmec genealogical management would have allowed them to maintain absolute control of divine ancestry, foment sociopolitical inequality in a wide interregional network, and monopolize for their own ends the wealth accruing from this socially restricted field of interaction. In this way they could open the door to unbalanced reciprocal elite exchange in an increasingly complex political economy pushed beyond the geographical limits of the Gulf Coast.

Early Preclassic exchange networks opened the way for a Middle Preclassic alliance system (Grove 1989a:122, 146). In light of the fact that the basic design of architectural complexes was established early on the Gulf Coast, its apparent absence in the highlands during the same period could be a reflection of relatively unencumbered social and economic interactions. In contrast, its later formal adoption bespeaks ritually celebrated sociopolitical alliances designed to insure strict elite control of such interactions.

Further Implications of Architectural Complexes

Given the absence of monumental art outside the Gulf lowlands during the Early Preclassic, the wide distribution of cosmologically charged, portable objects has been used to show that water and underworld concepts were disseminated from the beginning of Olmec times or even earlier and could have arisen from a pan-Mesoamerican ideological substratum (Grove 1989b; Marcus 1989). In this view, Olmec contact did not influence the development of increasingly complex social systems (see also Demarest 1989; Flannery and Marcus 2000).

In our opinion, this view now requires reconsideration in light of two

new lines of evidence. First, Sergio Herrera's neutron activation sourcing studies pinpoint the source of widely traded decorated pottery with "X complex" motifs (Grove 1989a) in the San Lorenzo region (Herrera et al. 1998, 1999; Blomster, Neff, and Glascock 2005), which perhaps hints at the ideological origins of these motifs. Second, the early sunken patio at San Lorenzo, emulated in later architecture in both the highlands and lowlands, indicates that something more complex than the sharing of pottery motifs and a restricted trade in portable objects was happening in the highlands during the Early Preclassic period. Exactly how and why cosmological and perhaps sociopolitical concepts were transmitted and assimilated into architecture remain to be clarified by future research. However, these data suggest that the dismissal of a profound early coastal influence on highland development must be evaluated once again.

Acknowledgments

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2

A Land That Tastes of Water

ANN CYPHERS AND JUDITH ZURITA-NOGUERA

Water set the basic rhythms of Olmec life. Beyond its role as a vital resource, water conditioned and helped shape human settlement, and its use and management reflect social differences. The importance of water in the heartland (fig. 2.1) is well illustrated by the titles of publications by eminent Olmec scholars, such as “Finding Jewels of Jade in a Mexican Swamp” (Stirling and Stirling 1942) and *The People of the River* (Coe and Diehl 1980). Alfonso Caso (1965:12) once called the region the “Mesopotamia of the Americas.” Indeed, Enrique Cárdenas wrote poetically of the essence of the vast riverine plains, home of the Olmec capitals: “Centro y movimiento de la región, el río Coatzacoalcos lo llena todo. Arborescente, radicular, serpiente misma, corre como vértebra estructural por un país donde el ámbito natural sabe a agua” [Center and movement of the region, the Coatzacoalcos river fills all. Forested, radicular, itself a serpent, it runs as a spinal column through a land that tastes of water] (1986:14, our translation).

Environmental descriptions recognizing the overwhelming presence of water in the Gulf lowlands of the Mexican states of southern Veracruz and western Tabasco sometimes create an impression of a uniform environment. For example, Bernal states, “The Olmec rivers run through flat jungle land, and their flooding, except in small areas, is more harmful than profitable in a society which cannot control these avalanches of water. Thus not only the swamps but the savannas . . . are useless to a rather primitive agriculture” (1969:20). However, the great diversity in this humid, tropical region, previously thought insufficient to sustain the development of civilization, was a superlative asset to the Olmec. Their adaptation, shaped in many ways by water, enabled them to achieve and sustain social complexity in a unique manner.

We will attempt to discern aspects of their early regional adaptation

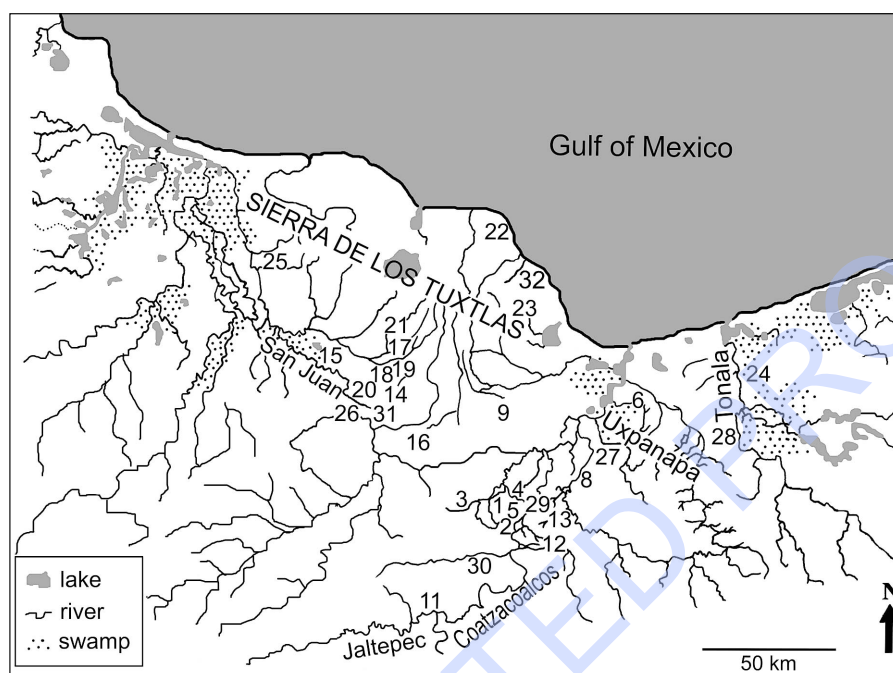


Fig. 2.1 The location of Olmec sites in relation to rivers and other geographical features. The numbers refer to the following sites:

- | | |
|-------------------------|-----------------------------------------|
| 1 San Lorenzo | 17 La Isla |
| 2 Loma del Zapote | 18 El Cardonal |
| 3 Estero Rabón | 19 Loma de la Piedra |
| 4 El Remolino | 20 Llano del Júcaro |
| 5 Tenochtitlan | 21 Los Mangos |
| 6 Ixthuatlan | 22 Zapotitlan |
| 7 Arroyo Sonso | 23 Pajapan |
| 8 Emilio Carranza | 24 La Venta |
| 9 Chiquipixta | 25 Tres Zapotes |
| 10 La Oaxaqueña | 26 El Marquesillo |
| 11 Las Limas | 27 Santa María Uxpanapa (Antonio Plaza) |
| 12 El Manatí | 28 Los Soldados |
| 13 La Merced | 29 Ahuatepec |
| 14 Laguna de los Cerros | 30 Ojo de Agua |
| 15 Cuatotolapan | 31 El Nuevo Órgano |
| 16 Cruz del Milagro | 32 Piedra Labrada |

and integration by examining environmental and settlement information in conjunction with the distribution of specific kinds of stone monuments. Given the spottiness of regional archaeological coverage, our review can only point out preliminary indicators of diachronic processes and mechanisms. The starting points for our analysis are settlement studies conducted by the San Lorenzo Tenochtitlan Archaeological Project (Borstein 2001; Cyphers and Borstein n.d.; Symonds, Cyphers, and Lunagómez 2002) in combination with geomorphological studies (Ortiz Pérez and Cyphers 1997) that show the relationship of site location to extinct waterways and other natural features. The Early Preclassic (1500–800 BC) settlement patterns around San Lorenzo first are examined in relation to environment and subsistence, followed by the settlement hierarchy framed in terms of transportation and communication lines and the occurrence of stone monuments. These sections illustrate essential patterns and principles that subsequently will be traced over a wider area. Next, monolithic stone thrones provide the basis for further considerations of hierarchy around San Lorenzo. Then, by pinpointing isolated occurrences of stone sculpture, the locational principles operative around San Lorenzo are suggested to be applicable to a larger area, and alternative explanations for this widespread distribution are considered.

Although criticized as an inadequate marker of sociopolitical importance (Grove et al. 1993), stone monuments often are the yardstick by which the relative importance of Olmec sites is measured. In accord with Symonds, Cyphers, and Lunagómez (2002), the number and type of monuments constitute essential knowledge for understanding the Olmec, often characterized as America's first civilization (Coe 1968). There is little doubt in our minds that stone monument frequency indicates relative site importance in the settlement hierarchy (e.g., 129 at San Lorenzo, 15 at Loma del Zapote, 8 at Estero Rabón, 5 at Tenochtitlan, and 2 at El Remolino). By gathering together the information on settlement location in some explored and other relatively unexplored portions of the Gulf Coast, we relate the spatial distribution of certain types of stone sculpture to the scale and levels of sociopolitical integration.

Using their profound understanding of the natural landscape, the Olmec structured settlement distribution for subsistence purposes, transportation, and communication. Their particular framework for managing the natural and human environment appears particularly conducive for encouraging social cohesion and economic and political integration.

Water, Land, and Subsistence

Systematic and intensive survey coverage in the Olmec world (fig. 2.1) is uneven, yet extant studies (e.g., Borstein 2001; Cyphers and Alonso 1999; Cyphers and Borstein n.d.; Lunagómez 1999; Rust and Sharer 1988; Sisson 1976; Symonds, Cyphers, and Lunagómez 2002; von Nagy 1997) show that the dynamic behavior of the great deltaic plains is key to understanding how this particular environment conditioned ancient behaviors (see Jiménez 1990; von Nagy 1997; Ortiz Pérez and Cyphers 1997; West, Psuty, and Thom 1969). The following summary, based on Symonds, Cyphers, and Lunagómez (2002), shows how settlement development and subsistence were influenced by these characteristics in the San Lorenzo region.

By 1200 BC San Lorenzo had become a 20-hectare village located on an island vantage point circumscribed by river courses and vast alluvial plains (Ortiz Pérez and Cyphers 1997).¹ The other twenty-nine permanent sites in the 400-square-kilometer survey area show a preference for elevated ground emerging from the seasonally flooded bottomlands, especially the large promontories and slightly elevated spots near fluvial courses. Clearly, there was an interest in strategic places near river confluences and crossings. Of the 105 sites, 76 may have been seasonal occupations. At this time the low population level, estimated at 426–1,017 people, and the relative abundance of cultivable lands and aquatic resources precluded severe competition, a situation that would change after 1000 BC.

Despite poor botanical macroremain preservation in these early phases (prior to 1200 BC), preliminary phytolith analyses identify maize and/or other wild edible grasses (Zurita-Noguera 1997). The settlement pattern suggests the use of two terrains, the high ground above the flood line for swidden cultivation and the low floodplains for recession agriculture. Maize cultivation also was possible on point-bar formations and ancient levees rising above normal flood line and adjacent to scars of ancient river channels (Ortiz Pérez and Cyphers 1997).

Six campsites in the floodplains likely are related to seasonal subsistence collecting, and the location of another sixteen campsites on all other types of terrain above flood level is a pattern typical of regions characterized by the swidden fallow-cultivation cycle. The low campsite frequency indicates that swidden agricultural input in the subsistence regime was considerably less than that of floodplain strategies.

Prior to 1200 BC alluvial plain exploitation for subsistence activities was accomplished from the vantage points of fifty-four *islotes*. These low, artificial earthen bases were built near river courses to take advantage of

the slightly higher levee elevation. They protected the structures on their upper surface from increasing water levels and provided shelter for the people exploiting the natural resources of the floodplains. Symonds, Cyphers, and Lunagómez (2002) conservatively propose islotes as seasonal occupations. The creation of forty-seven islotes just north of San Lorenzo established rights to special spots in the island's floodplains as part of what appears to be a planned subsistence strategy designed to intensively exploit a specialized econiche for fishing, hunting, collecting, and recession agriculture.

The islotes, the hydrologic cycle of the plains, and the material assemblage provide important clues to the complexity of early lowland riverine subsistence strategies. The northern alluvial plain is today drier and less fertile than in the past, in part due to a modern road built upon a dike-like construction that dates to the late 1980s. As little as twenty-five years ago, during flooding it would convert to a veritable sea, and the renewing force of the floods brought in sediments and large quantities of fauna to the plain. Upon recession of the water the soil fertility was renovated, and fish and turtles trapped in depressed portions could be easily harvested. The seasonal variation in water levels affects the availability, types, and quantities of fish, turtles, shellfish, and waterfowl, which could have been effectively exploited from the islotes. The subsistence importance of several aquatic protein resources lies in their potential as food reserves. For example, turtles can be held in captivity for months. Also, even though the preservation of animal protein by salting and drying is not feasible in the humid tropics, smoking is effective.

The location of islotes also was optimal for agriculture in the low floodplains. With the onset of the hot dry months of the year (starting in March), the gradual drying of portions of the floodplain left highly fertile, humid soils where recession agricultural techniques could be practiced. Today in Tabasco this type of agriculture, called the *marceño* cycle, continues to be practiced (Mariaca Méndez 1996). Regarding ancient crop scheduling, it is important to note that the timing of the maize harvest in the floodplains is coincident with the preparations for maize cultivation on high ground during the rainy season, which begins in June.

The settlement study shows that in the next phase, between 1200 and 800 BC, the regional center of San Lorenzo dominated six other types of permanent sites, complemented by two kinds of seasonal sites. Mean population development accelerated at San Lorenzo, eventually reaching its maximum of fifty-five hundred people. The remaining population within the survey area, more than eight thousand people, was distributed among the other ninety-eight permanent communities. The largest popu-

lation concentration was on the San Lorenzo island, with nearly eleven thousand residents (including San Lorenzo).

Throughout the study region swidden campsites more than doubled in frequency, from twenty-two in the previous phase to forty-six, with clear clustering around permanent villages. An accompanying increase in large hamlets may reflect fissioning and the growth of daughter communities. At the same time, islotos increased in number to eighty-one, but their frequency decreased with regard to permanent sites. These simultaneous trends may indicate that upland swidden agriculture gained in importance even as wetland cultivation and aquatic resource exploitation continued.²

Settlement in the wetlands appears to have focused on recession maize agriculture and wild resource collecting, especially aquatic fauna. In contrast to the higher areas (which were progressively deforested), the alluvial plains generally were not as susceptible to overexploitation due to the renovating hydrologic cycle. In times of persistent drought the varied products of the swampy plains could provide important subsistence relief.

The perennial floral and faunal products of the plains constituted important food reserves for agriculturalists planting high-risk crops with low productivity, such as maize. With regard to aquatic protein resources, we know that fish in Olmec times were much larger than those caught today (B. Zuñiga, personal communication, 2003), so that modern productivity is not useful for comparison due to the effects of overexploitation and river contamination. Faunal identifications show a heavy reliance on aquatic protein sources (Wing 1980; Zuñiga n.d.). Uniquely designed hearths found on the islotos (Symonds, Cyphers, and Lunagómez 2002:43; Vega 1999) seem appropriate for smoking fish, which will preserve for about thirty days. Further data are required to determine if the scale of their procurement could have exceeded local needs such that their exportation, particularly to the neighboring uplands, could have constituted a potential base for economic development.

Root crops have been proposed as possible early Olmec mainstays (Coe and Diehl 1980, 2:84–85, 144). If a manioc diet is not supplemented by animal protein, however, certain dietary deficiencies will develop (Lathrap 1970:49). Throughout most of the area the abundance of animal protein would have precluded such problems. Interestingly, early microbotanical evidence for manioc recently has been identified near La Venta (Pope et al. 2001). One root crop, known as *malanga* (*Xanthosoma violaceum*), grows well in humid, permeable terrain such as depressions, slopes, and ravines near permanent water sources but not in water-logged areas. Re-

quiring drier ground for its cultivation is manioc (*Manihot* sp.); its staggered planting can insure year-round availability and in-ground storage. These requirements indicate the Olmec of San Lorenzo would not have produced root crops in the adjacent floodplains but may have done so in the higher areas.

As population rapidly grew from 1200 to 800 BC, the progressive reduction of cultivable high ground on the island probably diminished the availability of local foodstuffs. Maize production necessarily would have been concentrated mostly on the floodplains and levees. We would expect an increasing tendency for infield garden plots, particularly appropriate for root crops, which generally are appreciated for their high yield, perennial availability, and in-ground storage potential. Recent phytolith identifications of manioc in habitation areas of San Lorenzo (Judith Zurita and Irwin Rovner, personal communication, 2000) may support this idea.

Water, Transportation, and Hierarchy

Land travel in the immediate San Lorenzo area is mandated in large part by geography. The high ground bisecting the island location of the capital and the low linked promontories to the northeast afford the only water-free sections in the ample floodplains in the immediate area. The natural characteristics of the broad plains of the lower Coatzacoalcas drainage, crossed by numerous navigable river courses and dotted by strands of higher ground, lent itself to the development of a transportation system that helped structure the relationship between the capital and its hinterland. Necessary for the efficient movement of goods and people was the management of transportation and communication routes, particularly locations at fluvial confluences, fording points, passes, and the intersection of land and water routes (fig. 2.2). Notably, at the most important locations secondary centers and stone monuments echo the settlement hierarchy.

The San Lorenzo island was geographically favored by its central position in a semiradial system of converging river tributaries. Located on the island's highest ground, San Lorenzo boasts 129 stone monuments whose size varies from colossal to small. Large sites, also with stone monuments, sit on high ground at the northern tip of the island: El Remolino is characterized by two large stone columns, and Tenochtitlan has five medium-size stone sculptures (Coe and Diehl 1980; Stirling 1955).

At the southern tip of the island Loma del Zapote, a secondary center guarding the north bank of the pass cutting through the high grounds, is

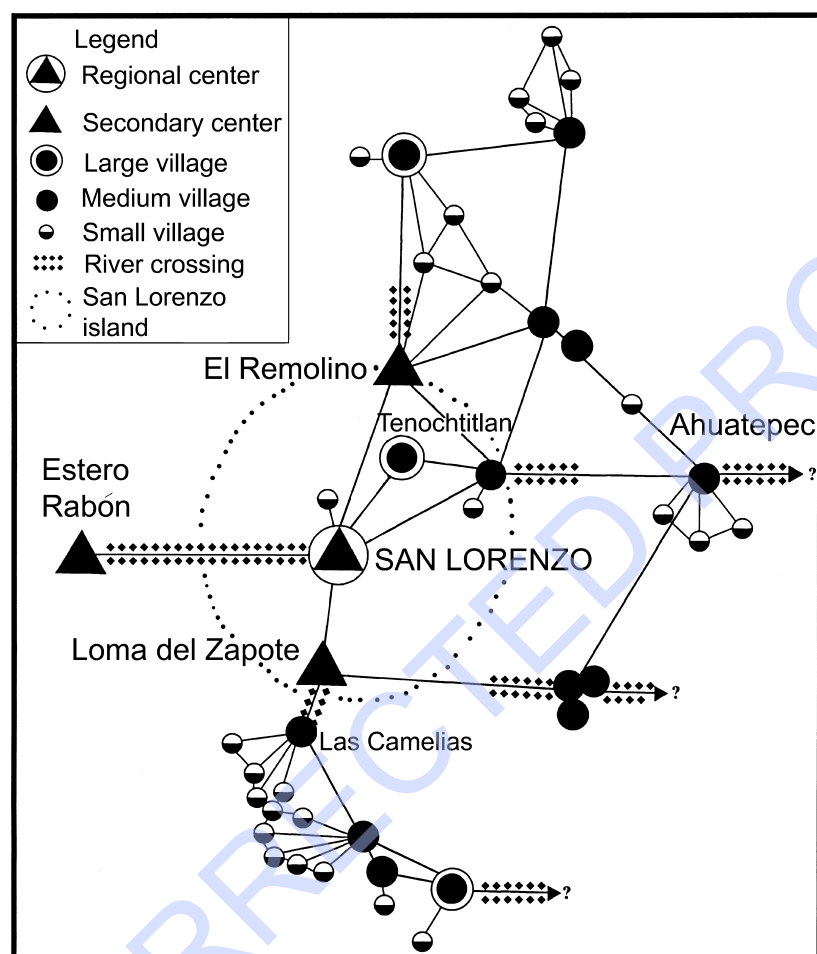


Fig. 2.2 Schematic representation of settlement hierarchy in the San Lorenzo region. (Adapted from Symonds, Cyphers, and Lunagómez 2002:fig. 4.11)

where the ancient river course bifurcated around the southern tip of the San Lorenzo island (see fig. 2.2). This site possesses fifteen stone monuments, including one throne, and transportation architecture. Its large, sheltered, **U**-shaped artificial cove served as a docking spot adjacent to the pass, and its two causeways next to the eastern river branch (Ortiz Pérez and Cyphers 1997) served as docks and short roads, allowing people and products to move from the river edge onto the high portion of the island. Located on opposing riverbanks overlooking the narrow pass, Loma del

Zapote and Las Camelias were in the perfect position to control water and land passage (see fig. 2.2).

Off the island and to the southwest of San Lorenzo, another secondary center, Estero Rabón, grew at another key upriver confluence (Borstein 2001; Cyphers and Borstein n.d.; Symonds, Cyphers, and Lunagómez 2002), that of the ancient Rabón with the Juile River, which in turn joined the Tatagapa drainage that circumvented the San Lorenzo island on the west (see fig. 2.2). Among its eight stone monuments a small throne, nearly identical in some ways to the one at Loma del Zapote, almost seems to be a metaphor for secondary political position.

The role of these sites in transportation routes is indicated by their key geographical and locational features. The absence of land-based transportation works should not eliminate their consideration as loci for societal integration. With regard to road works, it has been shown that a constant relationship does not necessarily exist between political complexity and increased technological elaboration of roads, yet, importantly, the characteristics of a road system do provide minimum standards for political organization (Hassig 1991:24; cf. Earle 1991:15). By the same token, we believe that naturally endowed circuits also may have the same effect on regional transportation organization.

Transportation networks designed according to natural fluvial and terrestrial pathways may be one basis for political and economic development (see Hassig 1985:211–19), as appears to be the case in the deltaic plain of the lower Coatzacoalcos River, where the nature of the topography and of the hydrology conditions settlement by leaving little alternative for the location of communication routes. The selective layout of planned routes is suggested by the patterning of key site locations at fluvial intersections and the causeways.

Stone Icons and Hierarchy

Following the interpretations of numerous authors (e.g., Bernal 1969; Clark and Pérez 1994; Coe 1965b, 1968, 1972; Coe and Diehl 1980; de la Fuente 1981; Drucker 1952; Furst 1968; Grove 1970, 1973; Joralemon 1971; Taube 1996), the meaning of Olmec stone sculptures clearly is not monolithic but rather is diverse. Likewise, its functions vary, with some placed as political emblems in strategic sites in the settlement system. The Olmec frequently incorporated water ideology into political messages (see Grove 1970, 1973).

Thrones are an icon of rulership, as demonstrated by Grove (1970, 1973), and their distribution in the San Lorenzo hinterland is noticeably

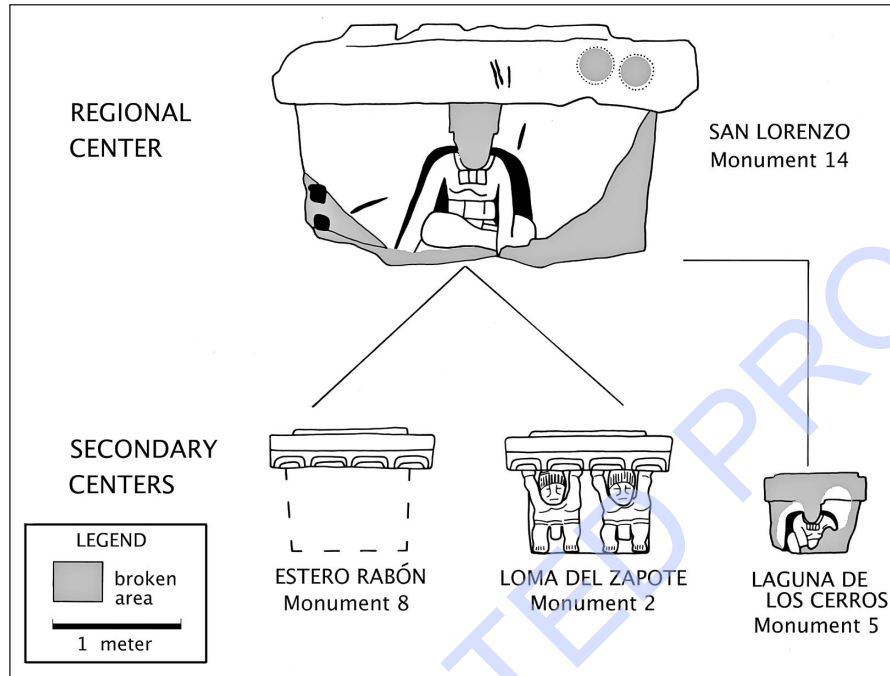


Fig. 2.3 Thrones from San Lorenzo and nearby secondary centers, Loma del Zapote and Estero Rabón, as well as outlying Laguna de los Cerros, showing size differences and general iconographic features.

restricted. On the basis of the sculptural style of the two small thrones, LZ-2 and ER-8, and the chronological study of the two secondary centers where they were found, Loma del Zapote and Estero Rabón, we consider these monuments to be largely contemporary in San Lorenzo's apogee phase (1200–800 BC). Their spatial occurrence, mirroring the settlement hierarchy (fig. 2.3), suggests they may have functioned as important politico-administrative emblems (Cyphers 2004; see Cyphers et al., this volume).

Thrones in general share a basic form, although size varies considerably, with large thrones found only at regional centers. The emblematic nature of throne size is further highlighted by other legitimizing symbols. According to Grove (1970, 1973), the right to rule is verified by two elements: (1) the “jaguar monster” (or earth monster), represented on the upper ledge; and (2) the divine ancestor, emerging from the mythical ori-

gin cave on the front of the throne. However, since these elements do not coexist on all thrones, their meanings must differ slightly. The correlation between these stone monuments and settlement hierarchy in the San Lorenzo hinterland provides insight into the differential significance of the elements defined by Grove.

The throne from the secondary center of Loma del Zapote, LZ-2, in the San Lorenzo settlement system, is worthy of note insofar as it lacks the representation of the divine ancestor in the cave. In its stead two dwarfs are shown in high relief on the flat frontal face of the piece. It does, however, show abstract earth monster motifs on the ledge. We believe that the lack of co-occurrence of the two elements in this piece indicates that earth monster motifs were used as a symbol of office (along with the size and shape of the throne). The absence of the divine descent elements may indicate that the Loma del Zapote ruler could not presume sacred ancestry, as did the maximum rulers of the capital, and may have been designated by the capital and/or occupied the throne by right of marriage.

The throne from Estero Rabón, ER-8 (unfortunately missing the lower portion), may have been a twin to LZ-2, since its ledge dimensions vary only by a few centimeters and it shows identical jaguar monster symbolism. The similarity in size, coupled with the shared symbolism, of LZ-2 and ER-8 points to certain status equivalence between the rulers of two secondary sites, each located at a key river junction.

Based on the pattern around San Lorenzo, the heads of lesser Early Preclassic centers possessed appropriate icons of rulership, the small to medium-size thrones that symbolize their hierarchical position in the region. When such thrones lack the iconography that refers to the principle of divine descent (sacred ancestor), we suggest that corresponding secondary rulers pertain to subordinate lineages. In other thrones representations of the divine ancestor allude to the ruler's royal heritage and membership in the maximal lineage. A particularly clear example is the tiny throne, Monument 5, from Laguna de los Cerros (see fig. 2.3), in which the sacred ancestor is nearly identical to the one on San Lorenzo's Monument 14 (Cyphers n.d.d).

Therefore, it seems that thrones not only epitomize the formalization of genealogical relationships into political office but also show that genealogical distance determined the degree of access to the supernatural. On the basis of the above throne-site correlations, we propose that political ideology in the San Lorenzo region served to confirm, control, and expand the capital's jurisdiction across a vast and difficult water-laden terrain by institutionalizing the office of ruler at key secondary sites. Such

positions, formalized in sacred stone, reinforced the settlement hierarchy in a possible attempt to reduce the lesser centers' self-sufficiency, increase their dependency, and hence buttress the political administration.

Stone Monument Distribution

When we examine monument distribution across the Olmec region, our knowledge is, without a doubt, uneven due to the lack of systematic coverage of vast areas, site overburden, and looting. Even as we are conscious that post-Olmec factors may have affected the ancient spatial pattern of small and medium-size monuments such that the actual distribution may be skewed, we believe that such effects are less likely with regard to larger pieces. The utilization of monument distribution as an initial point of departure should not be deterred, because these objects were not casual cultural manifestations but rather constitute indicators of ancient behaviors and deliberately placed social symbols.

Here we specifically examine Early Preclassic sites located outside the core hinterland of major capitals that have one or two stone monuments (but lack thrones) that could possibly date as early as 1000–800 BC, based on their style and/or relevant settlement data. Because of the lack of archaeological work at most of these places, their temporal placement and other characteristics inhibit their firm inclusion in specific sociopolitical systems.

Turning our attention to these finds, we observe that the location of each site (see fig. 2.1) seems to obey principles similar to those observed around San Lorenzo. Contrasting with the nucleation of secondary and tertiary sites at river confluences around San Lorenzo is a seemingly dispersed distribution of nodal communities, each with at least one monument. Nevertheless, when this distribution is examined closely, the judicious location of each site at a favorable position for land and/or water transport points to the integration of a fluvial and terrestrial communication web that varied in shape and extent through time.³

This statement is supported by the following sites, which lack thrones but contain other stone sculpture. These were important communities placed at island locations, river confluences, and curves in terrestrial and fluvial transportation networks in the southern Gulf Coast region:

- Santa María Uxpanapa, origin of the Wrestler sculpture (Corona 1962), is located on Capoacan Island close to the west bank of the Uxpanapa River. Early-twentieth-century maps show that even in later times it served as a principal river stop and portage point.

- Monument 60 in the La Venta catalog, a small feline sculpture, was discovered on the outskirts of Ixthuatlan (de la Fuente 1973:108), a town strategically located near the confluence of the Coatzacoalcos, Uxpánapa, and San Antonio rivers. It is similar to Monuments 7 and 10 from Loma del Zapote (Cyphers 1994, 2004).
- From Ahuatepec, in the immediate San Lorenzo area (Cyphers 1992), comes a small feline that is similar to San Lorenzo Monument 120 (Cyphers n.d.a).
- The site of Arroyo Sonso, located 15 kilometers due west from Las Choapas, was first reported by Nomland (1932:591), who states that its stone figure was recovered close to the bifurcated head of the stream of the same name (which unites with the Uxpánapa River west of the town called La Concepción). It is stylistically similar to Monument 37 from San Lorenzo (González Lauck 1991).
- Near Emilio Carranza (formerly called Salinas), a small feline statue was found by local people (Cyphers 2004). This site is located at the southern head of an ancient island once surrounded by the Coahuila, Otapan, and Coatzacoalcos rivers. It is stylistically comparable to Monument 120 from San Lorenzo (Cyphers n.d.a).
- From the area of Jáltipan de Morelos, a seated male figure was reported from the Arroyo Chiquipixta (Cyphers and López 1996), a stream whose hydrology has been altered by extensive modern sulfur mining.
- Upriver from San Lorenzo and about 9 kilometers north of La Oaxaqueña there is a massive basalt disk with grooves and cup-shaped depressions at Ojo de Agua, a site located on a plateau near a stream that empties into the Coatzacoalcos River (Cobean n.d.).
- From Los Soldados, adjacent to Las Choapas, there is a seated transformation figure (de la Fuente 1973:161–62). Although exact details of its original location are unknown, this bitumen-rich area, upriver from La Venta, is adjacent to the Tancoachapa River on a bridge of elevated ground between the Tonalá system and the Uxpánapa River.
- Cuautotolapan Viejo, located on a major curve of the San Juan River, was an important site between 1000 and 800 BC (Cyphers and Borstein n.d.). Its large seated male figure was retrieved from the river (Medellín Zenil 1971; de la Fuente 1973:129).
- Cruz del Milagro, located on the divide between the San Juan and Coatzacoalcos drainages and overlooking the former, with its unbroken, medium-size seated male figure, also was an important early village (Borstein 2001; Cyphers and Borstein n.d.).
- Loma de la Piedra, overlooking the Cuitlazoyo River, has a large decapitated human torso (Grove et al. 1993).

- Zapotitlan, located next to the river of the same name where it drains into the Gulf of Mexico, rendered a decapitated human figure (Medellín Zenil 1971).⁴
- Piedra Labrada is located next to the Tecuanapan River close to its outlet in the Gulf of Mexico that was reported by Alfonso Medellín Zenil (1960) and later investigated by Marco Antonio Reyes López. It has several Olmec monuments whose style appears to be early (Roberto Lunagómez, personal communication, 2003).
- La Isla, located at the junction of the Amayo and Hueyapan rivers, has a nearly complete transformation figure (Grove 1994:223).
- El Nuevo Órgano, located south of Laguna de los Cerros, has a hollow stone anthropomorphic sculpture (Delgado 1997).
- Tres Zapotes has at least one anthropomorphic monument that may be considered Early Preclassic, Monument M (Stirling 1943:23). The site is located beside the Arroyo Hueyapan a few kilometers upriver from its junction with the San Juan River.

Our review of these sites shows that most are located at key positions in the fluvial and terrestrial communication web. The majority are naturalistic human figures, followed by supernatural felines and transformation figures. Their thematic variability suggests the operation of several mechanisms, as illustrated by previous interpretations of transformation figures as “kings in transformation” (Clark 1997:223) and as evidence of state shamanism (Reilly 1989), as well as the reading of isolated human figures as “lesser kings” and “princes” of dependent centers (Clark and Pérez 1994:266).

We believe the spatial distribution of large transformation figures, at least 1.3 meters tall, points to a selective rural participation in Reilly’s shamanic cult. Unfortunately, the distribution of isolated supernatural feline sculptures is probably skewed due to their small size, which regrettably facilitates removal and sale.

Given the previous analysis of thrones, it is clear that we differ somewhat from Clark and Pérez on the interpretation of “lesser kings” and “princes” from human figures. Because the information on site type is scant, correlation between the size of these pieces and site magnitude is an interesting hypothesis remaining to be tested (see fig. 2.1 and table 2.1). We suspect that their degree of adornment and size will be shown to relate to the position of their respective sites in the settlement system, as illustrated by the pieces from villages of Cuautotolapan and Cruz del Milagro (Borstein 2001; Cyphers and Borstein n.d.). Greater size (taller than

Table 2.1 Descriptive Information on the Stone Monuments Mentioned in the Text

Site	Monument number	Sculpture height	General description	Monument condition
Santa María				
Uxpanapa	1	0.66	seated human	complete
Cruz del Milagro	1	1.30	seated human	complete
Cuatotolapan	1	1.51	seated human	complete
Loma de la Piedra	1	1.58*	seated human	decapitation
Chiquipixta	1	0.54	seated human	complete
El Cardonal	1	1.65*	seated human on pedestal	upper torso removed
Zapotitlán	1	1.30*	standing human	decapitation
Ixthuatlan	La Venta Monument 60	0.60	supernatural feline	complete
Emilio Carranza	1	0.37	supernatural feline	complete
Ahuatepec	1	0.23	supernatural feline	complete
Arroyo Sonso	1	1.30*	transformation figure	partial decapitation
Los Soldados	1	1.35*	transformation figure	partial decapitation
La Isla	A	1.50*	transformation figure	decapitation
La Isla	B	1.50*	transformation figure	decapitation
Tres Zapotes	M	1.20	seated human	complete
El Nuevo Órgano	1	0.37	hollow anthropomorphic lid	complete
Ojo de Agua	1	1.70 (diameter)	disk	grooves

*The height of incomplete pieces was estimated using the same 2:3 head-to-body ratio observed in whole sculptures.

1.3 meters), sometimes associated with more body adornments, may indicate that their respective sites played more prestigious regional roles. Consequently, we would consider other alternative interpretations of such monuments, including their use as icons of rural authorities or local lineage heads and in certain types of cults.

Settlement and Sculpture

Through the analysis of Early Preclassic settlement patterns and sculpture we infer a preliminary regional panorama in which social, religious, and political activities and alliances included varied kinds and levels of aristocratic participation. Royal lineages at primary centers dominated lesser aristocratic lineages in secondary centers, and distant rural nobility was tied into the hierarchy via diverse mechanisms adapted to their particular social spheres. As such, regional organization appears to have involved the transformation and institutionalization of social and genealogical distance as political hierarchy. Our reconstruction suggests a political administration that formalized a conical clanlike structure in which official aristocratic genealogy is ritually celebrated (Friedman and Rowlands 1977; Kirchhoff 1955) within a spatially restricted prestige system intimately related to hierarchical social forms.

Given that it has been proposed that monumental sculpture was used to create versatile commemorative scenes in the San Lorenzo region during the Early Preclassic (Cyphers 1993, 1994), we suggest that low-level rural sites during that time may have participated in periodical and centralized ritual activities by including their monuments, which perhaps represented legendary and revered figures, in the ceremonies. Such ritual participation could create and maintain certain identities and increase social and religious integration by promoting the lateral unification of a poorly developed distant hinterland into the belief system. Also, along with the development of transportation systems, organized activities of this nature could forge pathways for dependency relationships, trade, and social interaction. In this way, difficulties in sociopolitical integration and in the movement of people and goods, affected at all times by the hydrologic cycle, could have been offset in the vast deltaic plains and more rugged uplands.

Whereas Early Preclassic settlement and sculpture can be conceived as social, political, and religious manifestations of territorial integration on the Gulf Coast, during the subsequent Middle Preclassic period (800–400 BC) isolated stone figures diminish and are replaced by stelae in different strategic locations on the Gulf Coast and in more distant places (Clark and Pye 2000; Grove 1987:436). This stylistic and distributional change seems to mark a concern with formalizing distant elite exchange relationships.

Final Comments

We have seen that the river systems in the great deltaic plains around San Lorenzo contained specific traits that influenced and shaped the growth of settlement hierarchies, specifically in the networked fluvial courses. Island locations, circumscribed by natural barriers such as rivers and vast floodplains, tended to attract population in areas of high resource concentration. River flow imposed directionality on the movement of people and goods. Secondary and tertiary settlements were strategically established at narrow straits and river confluences to manage and control downriver traffic, link to terrestrial routes, and capture upriver goods. These communities often were purposefully marked by stone monuments that called attention to the importance of the site and its leader. In the lower Coatzacoalcos drainage the administrative hierarchy established at key transportation points involved a political hierarchy of local rulers backed by principles of divine legitimization similar to those enjoyed by the maximum authorities of the regional center at San Lorenzo. The dendritic and semiradial shape of the fluvial network acted as a broad funnel that channeled water, people, and goods to the downriver apex of the system. By taking advantage of the natural landscape, the Olmec designed spatial patterns of settlement along these lines in order to propitiate interrelationships and interactions in social, economic, and political frameworks.

The same natural conditions that helped shape complex development at San Lorenzo may have been related to its decline (beginning around 900 BC) insofar as the component parts of this top-heavy system were highly dispersed across the watery landscape with centrifugal tendencies that challenged social cohesion and integration. Other vulnerable aspects of the system included an underdeveloped outer hinterland, localized high population densities, subsistence problems on the San Lorenzo island, and the distance from the capital to nodal control points. Although the design of the socioreligious system created political, spiritual, and social ties with elites in the satellites, these mechanisms may have deteriorated at some point, since representations of weapons in monumental art, dated between 1000 and 800 BC, provide possible evidence for increasing conflict (Cyphers n.d.a) that could have been a consequence of multiple factors, including environmental and social problems, regional abandonment, and competition from other sites.⁵

In the Olmec world regional mobility, which is related to all types of social and economic activity, was particularly restricted by the friction of distance. Transportation networks composed of linkages, flows, nodes, activity spheres, and hierarchical relationships were influenced by dis-

tance and the nature of the geography and, as such, became key components of the functional organization of the region. The systematic organization of the hinterland with regard to settlement location, distances, directionality, transportation efficiency, social relations, services, and population densities resulted in a complex horizontal and vertical nesting of various types of regional social and activity spheres.

Acknowledgments

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3

Water Management and Political Economy in Formative Period Central Mexico

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FERNANDO SÁNCHEZ MARTÍNEZ

Water was a life-sustaining force invested with symbolic and material significance by pre-Hispanic peoples of Central Mexico. They managed water to sustain themselves, their social relations, and the cosmic forces who they believed created the universe. Water management was a collective undertaking that involved building an array of facilities of varying scales, such as canals, dikes, check dams, aqueducts, drains, and cisterns. The construction of such facilities over the centuries was part of a broader socially (and ecologically) recursive transformation of the landscape that began c. 1500–1200 BC with the earliest villages and continued until (and even after) the conquest of Tenochtitlan in 1519–21. In this chapter we focus on Formative period irrigation, which includes some of the oldest archaeological remains of water management in Central Mexico, and its relation to the political economy (fig. 3.1, table 3.1).

In this chapter we look at irrigation from a broad perspective of the political economy (Hirth 1996) to discuss ideas about social production and how stratification would have encouraged agricultural change, including innovations and landscape modifications for irrigation. We examine these relationships in light of recent investigations of pre-Hispanic irrigation features in the Yauhtepec Valley of Morelos and discuss the relationship of irrigation to strategies of political economy. We consider parallels between the changing landscape of cultivated and irrigated fields and stratification and the development of a sacred and symbolic landscape where ritual water management was important and agricultural metaphors were invoked to express concepts of rulership in the early Teotihuacan state.

Social Production, Agricultural Intensification, and Landscape Modification

Following the completion of regional settlement pattern surveys in the Basin of Mexico, Sanders, Parsons, and Santley (1979) presented a major

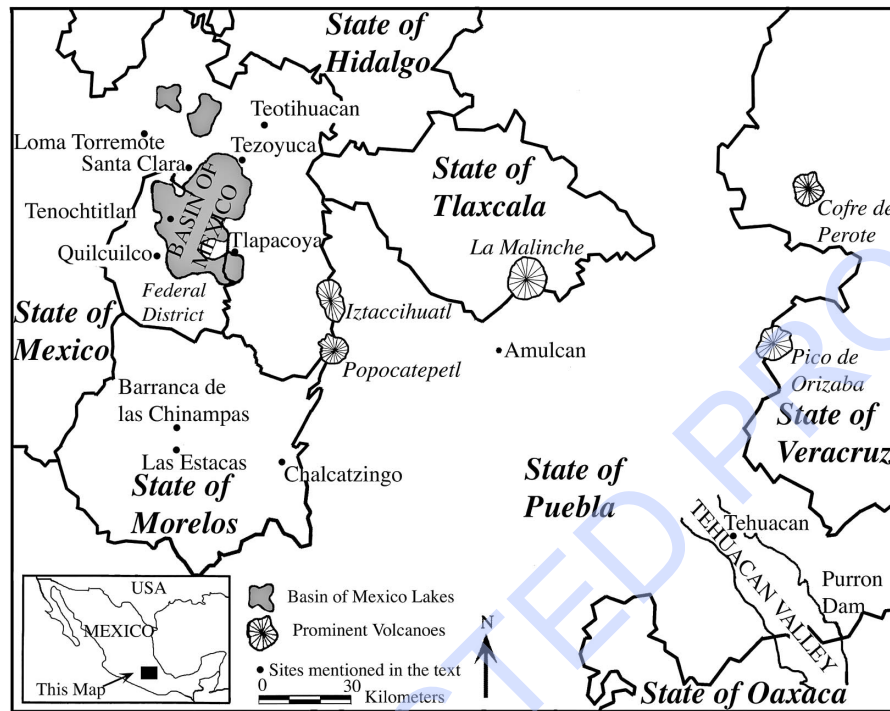


Fig. 3.1 Central Mexico, showing locations of places mentioned in the text.

archaeological synthesis of the history of pre-Hispanic agriculture in the Basin of Mexico in which they offered a model of agricultural change that drew significant inspiration from cultural ecology, the work of Esther Boserup (1965), and Karl Wittfogel's (1957) ideas about hydraulic management and state development. Boserup had challenged the notion that people were held captive to a particular land-use regime because of environmental constraints, their level of technology, or their "cultural backwardness." She argued that subsistence farmers' decisions about preindustrial land-use practices are "rational" and take into consideration labor costs, yields, and land availability as a function of population pressure. It quickly became apparent that Boserup's model required modification because it did not consider effects of risks in semiarid environments such as Central Mexico (Nichols 1987, 1989; Sanders 1976; Sanders and Webster 1978). Boserup was subject to other criticisms for treating population growth as an independent phenomenon (e.g., Cowgill 1975; Netting 1990).

Table 3.1 Basin of Mexico Chronology

Period	Approximate dates
Late Postclassic	AD 1350/1400–1521
Middle Postclassic	AD 1000/1150–1350/1400
Early Postclassic	AD 800/950–1000/1150
Epiclassic	AD 650–800/950
Classic	
Metepéc	AD 550–650
Xolalapan	AD 400–650
Tlamimilopa	AD 200–400
Miccaoltli	AD 150–200
Formative	
Terminal	150 BC–AD 150
Tzacualli	1 BC–AD 150
Patlachique	150 BC–AD 1
Late Formative	650/500–150 BC
Middle Formative	1150/1050–650/500 BC
Early Formative	1500/1400–1150/1050 BC

Sources: Cowgill 1996; Sanders, Parsons, and Santley 1979.

Hydraulic management models for the Basin of Mexico have been much debated (Sanders, Parsons, and Santley 1979). They are criticized for taking too narrow a view of the political economy and the complexities of water management (Hirth 1996; see Scarborough 2003:17–38 for a thoughtful recent review). At the same time, nearly all societies have some kind of constituted authority for making decisions about water (Hunt 1988; Hunt and Hunt 1976; Scarborough 2003). Strongly centralized regional control of water resources by early states, however, probably was relatively rare. Such states depended on the agrarian economy, and decisions about water allocation, canal maintenance, and so on are usually most effectively made at the local level. Direct state intervention in the Basin of Mexico likely was limited to situations that required long-term economic investments. Such situations, Scarborough (2003:123) suggests, may have been precipitated by water crises with regional impacts caused by a rise in consumers and/or droughts. He cites the example of large-scale Aztec *chinampa* (raised field) construction in the southern basin during the fifteenth century (Nichols 1987; Nichols and Frederick 1993; Parsons 1991). The rapid growth of Teotihuacan would have been another critical juncture.

In contrast to top-down models, political economy approaches emphasize how intensification is prompted by emerging elites to obtain predictable surpluses for financing activities (e.g., gift exchanges and feasting, craft specialization, acquisition of exotic prestige goods and ritual paraphernalia, etc.) in pursuit of authority and power (Fisher, Pollard, and Frederick 1999:643). Socioeconomic differentiation can be an important impetus to the development of agricultural water management: “When agriculture expanded into the higher risk areas of the Basin of Mexico, *particularly when the process was accompanied by increasing stratification[,] then the stimulus to develop technology to increase and regularize yields would have been considerable*” (Sanders, Parsons, and Santley 1979:391, emphasis added). Although there has been little recent research on the initial development of complex societies in the basin, archaeological evidence of “ranking” is evident in Central Mexico as early as the Early Formative—the first time when pottery-using villages are manifest in the known archaeological record of the region. Network strategies seem to have been especially important in the Early and Middle Formative (Blanton et al. 1996).

Systems of social differentiation depend on the creation and mobilization of agricultural surpluses and are themselves a stimulus to surplus production (Sahlins 1972). Aspiring leaders, “aggrandizers,” chiefs, kings, queens, emperors, and empresses require surpluses to attract and retain followers and subjects, to finance their activities, and to validate their status (e.g., Earle 2001:31–32; Hirth 1996). Thus social position—status, rank, class, and so on—influences both perceptions and responses to risk and uncertainty (Cancian 1980:165).

H. C. Brookfield (1972:37–38), in his analysis of land use in the island Pacific, argued that it is important to distinguish between production for use by the domestic or household unit and social production of surpluses. Brookfield’s analyses of data from the island Pacific led him to conclude that with regard to social production “there is no necessary close relationship between population numbers and density” (1972:38). He makes an additional distinction between “innovation” and “intensification” and suggests that, unlike intensification (decreasing fallow cycles), agrotechnical innovations are not correlated with population pressure but with the creation of surpluses related to systems of social differentiation because “innovation . . . offers the hope of advantage” (1984:35; see also Nell 1979). Brookfield’s inclusive approach to agricultural change builds on Boserup’s theory of intensification but includes non-Boserupian social production.

Patrick Kirch (1994:18–19), drawing on Boserup (1965) and Sahlins (1972), incorporated Brookfield’s ideas in a model of agricultural change

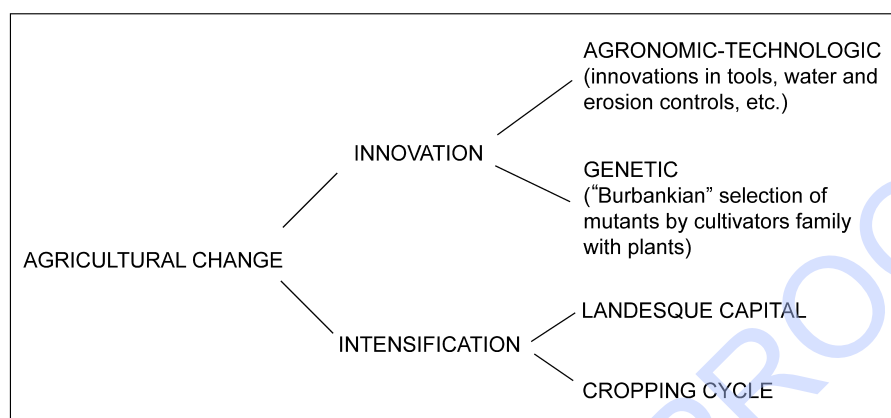


Fig. 3.2 Kirch's model of agricultural change (1994:18–19).

in which increased demands for surplus/social production are expected to promote innovations and “*landesque* intensification” (fig. 3.2). Innovations are inventions that increase output or yield per unit area and that may or may not significantly increase labor costs. Landesque intensification, as defined by Kirch, involves the permanent modification of an agricultural landscape (as opposed to reductions in the fallow cycle). The principal labor input often is incurred in the initial creation of the agricultural landscape; the maintenance labor may or may not be significantly more than it is with less intensive land-use practices (see also Logan and Sanders 1976:42).

Agency, Strategies of Political Economy, and Irrigation

Brookfield's proposition that increasing social differentiation favors the adoption of agricultural innovations, including landscape modifications, was developed from research in the humid tropics of the Pacific and Micronesia. Recent agency models of political economy proposed by archaeologists working in Mesoamerica also emphasize the importance of social or surplus production, its mobilization, and the adoption of innovations. In their model of chiefdom development for the Pacific Coast, Clark and Blake (1994) observe that because systems of status rivalry depend on regular social/surplus production, they encourage the adoption of innovations (although Clark and Blake do not specifically address agricultural developments). Along with Hayden (1995), Clark and Blake emphasize that the development of institutionalized, hereditary inequality

from status competition in reciprocal exchange networks requires access to abundant and regular resources. Competition, according to Clark and Blake, can only escalate where resources are “accessible, productive, and relatively regular. One or two bad seasons can undo years of public posturing, faction building, and prestations, with loss of face and depletion of stored resources and social credits” (1994:19). For prestige seekers, food production is important not only for feasting but to obtain physical and social resources and knowledge from outside their communities through ties to other status seekers. Innovations that increase production to attract and maintain followers will be quickly adopted.

Political economy models posit that increasing social differentiation during the Formative in the semiarid Central Mexican highlands should be correlated not only with evidence of agricultural intensification but with innovations in agrotechnology and landscape modifications for irrigation. Irrigation increases the productivity and regularity of both subsistence or household production and social production. Clark and Blake’s (1994) model of chiefdom formation emphasizes the regional scale of prestige competition and the ability of some status seekers to convert temporary positions of prestige into permanent heritable positions, if they can pass on heritable wealth to the next generation either through patronized craft production and/or through monopolizing foreign (outside) resources. In Hayden’s (1995:25) view, the development of stratification depends on the ability of aggrandizers and their corporate groups to control a spatially restricted resource. Because of the restricted distribution of irrigable land and water sources in Central Mexico, irrigation created new opportunities for manipulation of such “spatially restricted” productive resources and perhaps contributed to the development of patron-client relations (Earle 1987:294; Nichols 1987, 1989; Sanders and Webster 1978).

Prestige goods exchange was important in the development of the Chalcatzingo chiefdom in Early and Middle Formative Morelos, as was the alignment of leaders with cosmic forces (Grove 1994). A major theme of Olmec public art and ceremony that involved ritual water management at Chalcatzingo “was the conspicuous display of social surplus and wealth” (Taube 2000b:304). In the Basin of Mexico archaeologists have recovered prestige goods from Early and Middle Formative sites such as Tlatilco and Tlapacoya (Joyce 1999; Niederberger 2000:187; Tolstoy 1989; Vaillant 1930, 1931, 1935). At the Late Formative town of Loma Torremote in the northern basin Santley (1993) found that polychrome pottery and exotic goods of shell and jadeite occurred exclusively in the largest house compound along with obsidian tool production and evidence of certain ritual activities, including a shrine not found in other compounds. The stor-

age area for foodstuffs is several orders of magnitude larger in this compound, which also has multiple sets of serving vessels. Similarly, Sanders (1965:97) reports that more than half the sherds from the Tezoyuca hill-top site are either small individual serving bowls or decorated drinking goblets that Sanders suggests were used in public ceremonial feasts and food distributions. Feasting and sumptuary gift exchanges continued to be important for status negotiations through the Late Postclassic and were a prerequisite of Aztec noble status (Brumfiel 1994).

By the Early Formative, with the establishment of a village lifeway in Central Mexico, prestige-goods exchanges already were part of the political economy, and this seems to have intensified during the Middle Formative, as suggested by the growth of Chalcatzingo. However, the increasingly complex regional polities of the Late Formative lack evidence for the elaborate ritual veneration of apical ancestors, leadership positions legitimized in the idiom of ancestors, and complex systems of ranked lineages (see the summary in Charlton and Nichols 1997:182–83). Blanton et al. (1996) suggest that by the start of the Late Formative leaders increasingly focused on corporate politico-economic strategies. (Network and corporate strategies are not mutually exclusive, and wealth continued to be important in the competition for prestige and power and in their validation.)

In Mesoamerica Blanton et al. (1996:7) point out that the largest-scale corporate political economies developed in areas of irrigated alluvium. Farmers in the northern Basin of Mexico began to irrigate their fields as early as the Middle Formative (Nichols 1982). Evidence of substantial soil deposition on the alluvial plain in the area of the Middle Formative Santa Clara irrigation system suggests interesting parallels with the situation Earle describes for Hawaii, where cultivation of uplands resulted in their degradation and the alluviation of valley floors and “chiefs promoted a rapid shift to irrigated agriculture on the new alluvial soils as a means to maximize their competitive position” (1987:295; Nichols and Frederick 1993:126–27).

In the Valley of Puebla agricultural water management of the valley floor at Amalucan began perhaps as early as 700 BC with the construction of drainage canals to which large irrigation canals and impoundment facilities were added in the Late Formative (Fowler 1987). The adjoining Middle and Late Formative settlement is substantial and includes civic-ceremonial platform mounds, with residential areas on the valley floor and on terraces on the slopes of Cerro Amalucan (Fowler 1969:209, 1987:52). Initial construction of the Purrón Dam complex in the Tehuacan Valley—the largest documented Formative period agricultural water-management system in highland Mesoamerica—also began

c. 750–600 BC (Spencer 2000:149–59; Woodbury and Neely 1972:92–93). In addition to increasing the productivity and security of staple food production, irrigation in the Tehuacan Valley permitted cultivation of tropical plants, including cotton, along with avocado and black and white sapotes and coyol palm nuts—exotic, prestige food items that were used as trade goods (Spencer 2000:156). The subsequent expansion of the Purron Dam complex to monumental proportions paralleled a rapid growth in regional population and “a growth in commerce and in the concentration of political power” (Woodbury and Neely 1972:125).

Recent investigations by Charles Frederick and his colleagues in the Yautepec Valley of Morelos document a long history of irrigation in the region beginning in the Middle Formative. The Yautepec irrigation features incorporated innovations and became more complex over time. As predicted by Brookfield and our discussions of political economy, not only did farmers implement a new technology with irrigation, but they continued to innovate and at times undertake substantial landscape modifications (see also Doolittle 1990).

Canal Irrigation in the Yautepec River Valley

Recently, the origins of canal irrigation in the Yautepec Valley were investigated by the Ticuman Archaeobotanical Project under the direction of Luis Morett, Fernando Sanchez, and Charles Frederick. This work was designed to elucidate the sequence of irrigation canals preserved in the alluvial deposits of the Yautepec River in the vicinity of Ticuman. Fieldwork was centered on two localities: near the Balneario Las Estacas situated southeast of Ticuman and north of Ticuman at the Barranca de las Chinampas, which is near the settlement of Barranca Honda. Mechanical excavation, in addition to close examination of natural exposures (cutbanks and barranca walls), permitted a detailed reconstruction of canal irrigation through time.

Las Estacas

The earliest evidence of irrigation encountered was in the vicinity of Las Estacas. Las Estacas today is a series of coalescing springs that together form an oasis-like environment dominated by a perennial river known as the Río Azul. Today the entire discharge of the Río Azul is captured for irrigation in a large, deep, and swiftly flowing canal. Mechanical excavations downstream of the Balneario found evidence of Colonial period spring irrigation but no pre-Hispanic canals. However, in a cutbank of

the Yautepec River nearby we found what appears to be a lined irrigation canal that contained abundant Middle Formative sherds. This canal was about 5 meters wide and 1 meter deep, and the base was formed by a layer of small tabular to rounded stones and sherds in addition to some charcoal. Although it is possible that this canal represents diversion of the Yautepec River, we believe its source was the ancestral Río Azul; this hypothesis is being tested by means of diatom analysis.

Barranca de las Chinampas

The most complete record of irrigation was obtained from Barranca de las Chinampas, where the first evidence of irrigation was found in the form of large irrigation canals beginning in the Late Formative and that persisted with roughly the same morphology through the Terminal Formative (fig. 3.3). These canals were very broad (9–11 meters) and shallow (c. 50 centimeters) and appear to represent large-scale diversion of flood-water. The size of these canals clearly underscores the social investment in irrigation, which appears to have made a dramatic entrance. This system was probably cumbersome in comparison to modern irrigation and may not have been used to irrigate large areas, but we can trace these features about 200 meters.

We noted a substantial change in landscape organization during the Classic period, with the local construction of low-gradient terraces with canals at the rear and the establishment of symmetrical yet smaller (than the Formative) canals, the capacity of which was maintained or increased by means of banks. It is clear that in this period there was a substantial increase in agricultural capital and the creation of a much more organized agrarian landscape.

Toward the end of the Classic and into the Epiclassic flooding by the Yautepec River repeatedly buried the valley floor and in one case preserved an entire field, furrows and all. It was around this time (precisely when is ill defined at the moment) that the canals shift from silt-filled earthen features to travertine-encrusted ones. We initially thought this represented a shift of irrigation water from a river to a spring source, but, following the discovery of substantial travertine in the recent yet prehistoric Yautepec River channel, we now think that this shift represents either a change to more perennial irrigation, with travertine encrustation occurring during periods when the base flow was primarily sustained by spring discharge and not diluted by meteoric water (i.e., rainwater), or an alteration in the chemistry of the base flow of the Yautepec River.

The travertine-encrusted canals persisted into the Colonial period. We

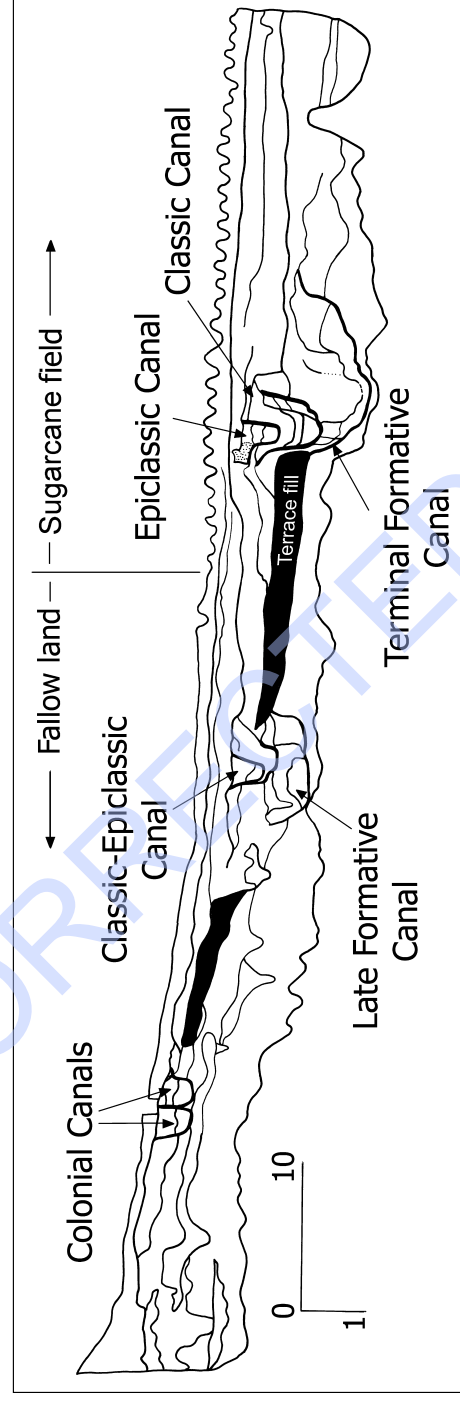


Fig. 3.3 Simplified line drawing of Trench 1 at Barranca de las Chinampas showing the stratigraphic relationships between irrigation canals of various ages.

found a younger, stratigraphically higher travertine-encrusted canal from which we recovered a *piloncillo* (raw sugar) mold and a horse toe bone. Examination of the waterworks associated with the former hacienda Xochimanca revealed extensive travertine encrustation as well.

In summary, the work from Barranca de las Chinampas indicates that irrigation began not with small canals but with extremely large ones that became progressively smaller through time. Although the capital investment associated with this innovation was clearly substantial, a much more systematic and sophisticated restructuring of the landscape was noted during the Classic period. Much of this was removed from view during the Late Classic, Epiclassic, or Postclassic flooding, which buried the valley floor and preserved stratified evidence of the changes in irrigation canals. Cultivation and irrigation have continued to this day, and the trend has been for a progressive decrease in canal size, but this is undoubtedly complemented by an increase in system complexity, which is not reflected well in our study.

Fostering Fields and Society

The development of an agricultural political economy transformed the physical, social, and symbolic landscapes of Central Mexico, where, as elsewhere in Mesoamerica, the four-sided maize field became a metaphor for order (Taube 2000b:303). In Central Mexico this transformation was accompanied by an emphasis on ritual water management that entailed the construction of facilities with counterparts in irrigation such as dams, canals, dikes, and reservoirs, as at Chalcatzingo (Angulo Villaseñor 1988; Doolittle 1990:48; Manzanilla 2000:90–91). The decline of Chalcatzingo and the growth of regional centers in the Basin of Mexico marked major changes in the political economy that Grove (1984:165) suggests were related to the widespread implementation of irrigation. The greater productivity and relatively large expanses of irrigable land were capable of supporting much larger populations than farming on the Gulf Coast. Grove argues that by c. 500 BC leaders of larger highland polities were able to disrupt “exchange networks in their favor, leaving little if anything to sustain the material needs of the few Olmec centers, who were ill-equipped to compete for the control of distant resources. As the Gulf Coast centers declined in economic [and political] importance, and as new centers arose in the highlands, the frontier alliances likewise fell apart. A gateway-city function for Chalcatzingo was no longer possible and its regional importance was usurped by other centers” (1984:165).

Specialized obsidian production may have shifted from Chalcatzingo

to Cuicuilco by the start of the Late Formative (Charlton cited in Hirth 1984:131). Chiefs in western Morelos perhaps exchanged agricultural products, such as cotton, for obsidian from Cuicuilco (Hirth 1984:143). Irrigation canals found at Cuicuilco distributed water from spring-fed perennial rivers (Cordova, Martin del Pozzo, and López Camacho 1994: 591; Doolittle 1990:48; Palerm 1961; Pastrana and Fournier 1997).

Blanton et al. (1996:9) suggest that beginning in the Late Formative corporate strategies of political economy were increasingly emphasized in Central Mexico, although such strategies may not have become dominant until after 250 BC (Cowgill 1996:53). Sanders and Webster (1978) point out that the close juxtaposition of irrigable and nonirrigable land in Central Mexico would have favored the development of patron-client relations. Earle (2001:31) argues that resource circumscription is critical for the development of staple finance systems and corporate strategies.

Around 100 BC the landscape of Central Mexico underwent dramatic changes as Teotihuacan grew explosively and became the dominant city and state in Central Mexico. By this time floodwater irrigation was widely used in the Teotihuacan Valley and consisted of a series of independent systems, most likely under the control of local corporate groups (Nichols, Spence, and Borland 1991; Sanders 1965, 1976:117–19; Sanders, Parsons, and Santley 1979). Although we lack direct data on permanent irrigation, given the pattern of development of floodwater irrigation it seems likely that farmers would have also made use of the larger and more secure sources of permanent irrigation water by this time. Based on pollen data, Sanders (1976:117–18) suggests that chinampa cultivation began during the Late or Terminal Formative in the area immediately south of Teotihuacan. Recent salvage excavations at the Puxtla barrio church found remains of agricultural drainage canals consistent with chinampas dating to the Early Classic and Late Tlamimilopa/Early Xolalapan (Gamboa Cabezas 2000).

Following the rapid growth of Teotihuacan after 100 BC that concentrated 80 percent of the basin's population in the city, the leaders of Teotihuacan initiated a massive urban reorganization and construction program. To accommodate the city's grid plan, the San Juan River and other streams were rerouted, which would have impacted both permanent and floodwater irrigation systems. The relocation of most of the basin's population into Teotihuacan must have required some kind of coordinated land allocation, since many of these people were farmers. As part of their ambitious building program Teotihuacan's rulers might have initiated major agricultural landscape modifications for irrigation and chinampa

farming (Parsons 1991:36; Scarborough 2003:124). An expanded permanent irrigation system and the creation of chinampas would have given Teotihuacan's rulers valuable agricultural land to offer to farming households displaced by urban growth and to immigrant elites and commoners from other parts of the basin; in return, the rulers would have received tribute revenues from such lands. Although irrigation and chinampas were probably organized and managed by corporate groups of farmers within the city, the large-scale reorganization of the city suggests that some control shifted to the state, at least for the short term. Parsons (1991: 36) views this as part of a deliberate political strategy by Teotihuacan's rulers to directly manage agricultural land and labor; others suggest the political economy as more decentralized (Cowgill 1997).

The political advantages of Teotihuacan's primate settlement pattern apparently outweighed, at least for the short term, its economic inefficiencies. The urban expansion of Teotihuacan caused the abandonment of some floodwater systems and a substantial reduction in some others on the edge of the city. We do not know what kinds of land-tenure systems were present at Teotihuacan. Nichols, Spence, and Borland (1991) suggest that it is difficult to imagine that people who had traditionally cultivated lands would have willingly or happily given up their irrigated fields to have them used for residential construction, in some cases by foreign immigrants.

In the Yautepec Valley we see the sudden onset of large irrigation features (the best record being from Barranca de las Chinampas) during the Formative, followed by a prominent restructuring of the landscape during the Classic period. Formative period settlement patterns in the Yautepec Valley are not well understood because of the serious problem of buried sites (Charles Frederick, Luis Morett, and Fernando Sánchez, unpublished data; Smith, personal communication, 2001). During the Classic period Teotihuacan extended its control to the Yautepec Valley (Smith and Montiel 2001). The valley could supply Teotihuacan with tropical cultigens such as cotton (which cannot be grown in the Basin of Mexico) that became increasingly important in the political economy. Based on the available information, it is hard to compare the Formative and Classic agricultural capital investments in the valley, since the early irrigation systems involved excavation of large features of yet unknown length. The Classic systems consisted of smaller canals but involved a significant phase of landscape organization and earth moving. The greatest investment may have occurred during the Classic period, although this is a subjective assessment.

Ideology

Essential to the development of a political economy are “ideologies about rank, status, and their validation within the society’s broader cosmology” (Hirth 1996:225). Successful irrigation depended on rituals to propitiate the cosmic forces that made clouds rain and water flow up from the earth as springs and rivers. Water, fertility, and political authority and power formed a core concept in Central Mexican cosmology and religious practice (Manzanilla 2000). During the Formative the relationship of people to the cosmic forces of water and creation became more hierarchical and political. Beginning in the Late Formative pyramids were constructed on top of springs and caves. These monumental “sacred mountains” built by human hands conspicuously expressed rulers’ connections to sacred places “where celestial gods, the terrestrial fertility and sustenance deities, and the underworld beings met” (Angulo Villaseñor, cited in Manzanilla 2000:91; Blanton et al. 1996:9; Hirth 1984:135). Such “material metaphors convey to a constituency that those in power have not only the authority to construct such works (implied by their monumental structures) but also the privilege of lavishly consuming this precious resource” (Scarborough 2003:84).

Blanton and colleagues (1996:9) suggest that the Central Mexican emphasis on sacred places, as opposed to sacred persons, and corporate rulership had begun by the Late Formative. Subsequently, Teotihuacan’s rulers promoted an ideology of Teotihuacan as the place where time itself began (Millon 1992:382). This sacred place also “represented security through an abundance of water” (Heyden 2000:179). The emphasis on sacred places in those regions of Mesoamerica where people irrigated large expanses of alluvium and elaborated corporate strategies perhaps also expressed underlying concepts about rights to land. Among *ranchería* people who irrigated the low desert of the North American Southwest, place, physical proximity, and ongoing participation in constructing and maintaining irrigation facilities rather than relations with ancestors in unilineal kin groups largely determined access to agricultural land (Fish 1996:114).

The Teotihuacan concept of rulership was linked with cultivation and water management, including irrigation. “Rain apparently constitutes a Teotihuacan metaphor for governance, with the polity watering and thereby sustaining smaller subsidiary districts or commoners” (Taube 2000a:26). Tlaloc expressed political administration “as a cultivating, irrigating god,” and the tilled earth glyph represented farmed, irrigated

fields (Taube 2000a:45, 47; see also Millon 1973:301–2, 1988; Pasztory 1997:104–6). Heyden interprets Teotihuacan mural images of streams of red and blue water flowing from caves as a metaphor for the security and abundance of a watery environment and “power and stability in the government” (2000:180). The Feathered Serpent, which became a pan-Mesoamerican symbol of rulership, waters plant toponyms in murals at Techinantla. As mediators between people and cosmic forces, it was the responsibility of Teotihuacan’s rulers to water the fields through rain and irrigation, to make people productive through agriculture, and to supply the surplus on which their authority and power depended.

Conclusions

In 1939 Alfred Kroeber (1939:218) concluded that irrigation was insignificant in Mexico in pre-Hispanic times. Archaeological research since then has documented a long history for irrigation in Central Mexico. However, important details of that history and the organization of irrigation during the Formative remain sketchy. Nonetheless, agricultural change was not always gradualist. The onset of new forms and new scales of both agricultural and ritual water management was sometimes sudden. Landscape modifications and innovations involving irrigation were correlated with increasing stratification and also with demographic and ideological changes. If agricultural innovations and landscape modifications offer the “hope for advantage,” as Brookfield (1984:35) proposes and the archaeological evidence seems to support, then we must ask what advantages were sought by people who had differing interests: to feed a family through the dry season and have seeds to plant in the spring, to make gruel for a toddling daughter’s growing appetite, to feast relatives and other supporters, to exchange seeds for medicinal herbs, obsidian knives, incense, or tropical feathers, to give seeds to a patron to cultivate one’s fields, or to make tribute payments to a ruler?

To populate the pre-Hispanic Mesoamerican landscape of the Formative with the activities, interactions, and beliefs of human agents whom we distantly glimpse through the archaeological record means that archaeologists must break through the confines of compartmentalizing culture. Water management was but one element in the complex changes of Central Mexico’s landscape during the Formative, but it was one that cross-cut technology, economics, politics, and ideology. The decisions by farmers during the Formative period to dig ditches that would bring water from springs, streams, and runoff in order to irrigate crops and perform

life-sustaining rituals connected human authority and power with cosmic forces of creation and productivity in new ways that had far-reaching consequences for the Mesoamerican landscape.

Acknowledgments

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4

Water Management at Kaminaljuyu The Beginnings of Power and Ideology in the Guatemalan Highlands

JUAN ANTONIO VALDÉS

The site of Kaminaljuyu is located in the central highlands of Guatemala and was one of the larger and more important centers during the Preclassic (fig. 4.1). The site, which displays clear Preclassic iconographic evidence of connections with the greatest entities in the southern Mesoamerica area, functioned as a regionally powerful center during the Late Preclassic (400 BC–AD 200) and perhaps even earlier, during the Middle Preclassic (1000–400 BC), when sophisticated hierarchical patterns were emerging and upon which at least some aspects of the Classic Maya political landscape may have been modeled.

Recent research at Kaminaljuyu has been dominated by two Guatemalan investigations, the San Jorge Project (Hatch 1993, 1997) and the Miraflores Project (Valdés 1997, 1998; Valdés and Kaplan 2001; Valdés and Wright 2004), which explored the periphery zone demarcating the southern limit of this ancient city. Both projects revealed an unknown facet of the site—the ample use of irrigation systems managed through three enormous channels (fig. 4.2). Surprisingly, perhaps, the first of these three (the Miraflores Canal) was built and used during the Middle Preclassic, and the other two (the San Jorge and Mirador Canals) were built and used during the Late Preclassic. The Miraflores Canal is especially significant, since it is the earliest canal in the Maya region and one of the largest reported in Mesoamerica in general. These discoveries led to a reevaluation of the political and administrative system of the city, suggesting that its sociopolitical complexity was much more ancient than was previously believed. This fact is demonstrated by the large-scale construction projects (which began as early as the Middle Preclassic) that led the city toward an era of progress and political or economic expansion under the leadership of local nobles and sovereigns.

In this chapter I will attempt to demonstrate that the rulers of Kaminaljuyu successfully converted their city into a primary center as early as

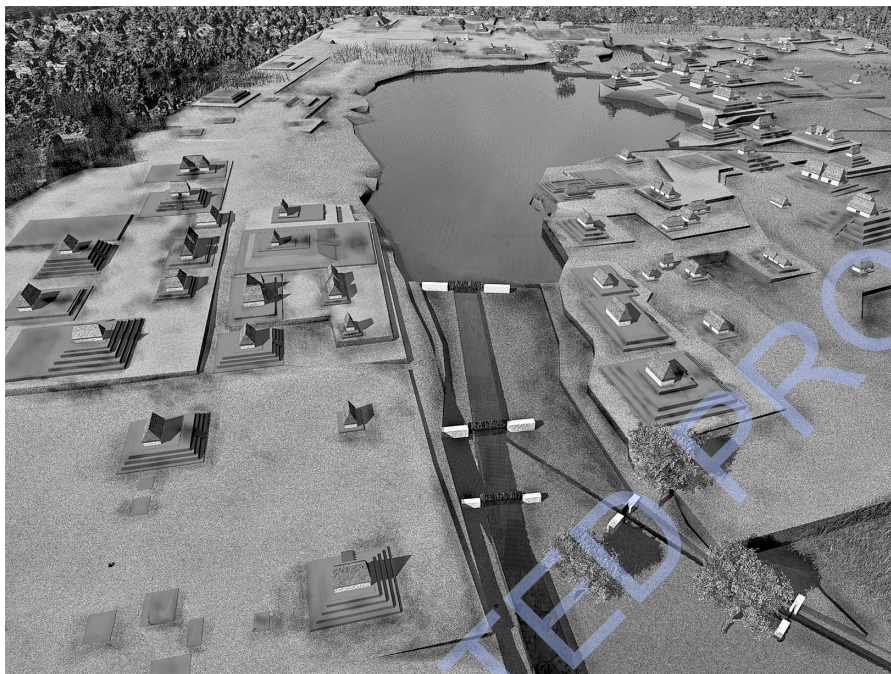


Fig. 4.1 Kaminaljuyu, showing the areas investigated by the Miraflores II and San Jorge Projects, highlighting the canals in the southern section of the city. At the center is Lake Miraflores.

c. 700–600 BC, during the Middle Preclassic, using new and spectacular water-management technology to intensify agricultural production. This included the construction of irrigation canals for cultivated fields.

Economy, Power, and Ritual during the Middle and Late Preclassic

Evidence demonstrates that, beginning in the Las Charcas and Providencia phases of the Middle Preclassic, urban construction was initiated in the central altiplano of Guatemala, including Kaminaljuyu, where inhabitants built a plaza with ritual architecture and plain stelae placed in front of major structures, signifying their importance (Shook 1952b; Shook and Hatch 1999). A large number of figurines and three-pronged *incensarios* indicate that rituals were an integral part of this emergent society. Its first sculpted monument, Stela 9 (dated c. 700 BC), shows a human dancer

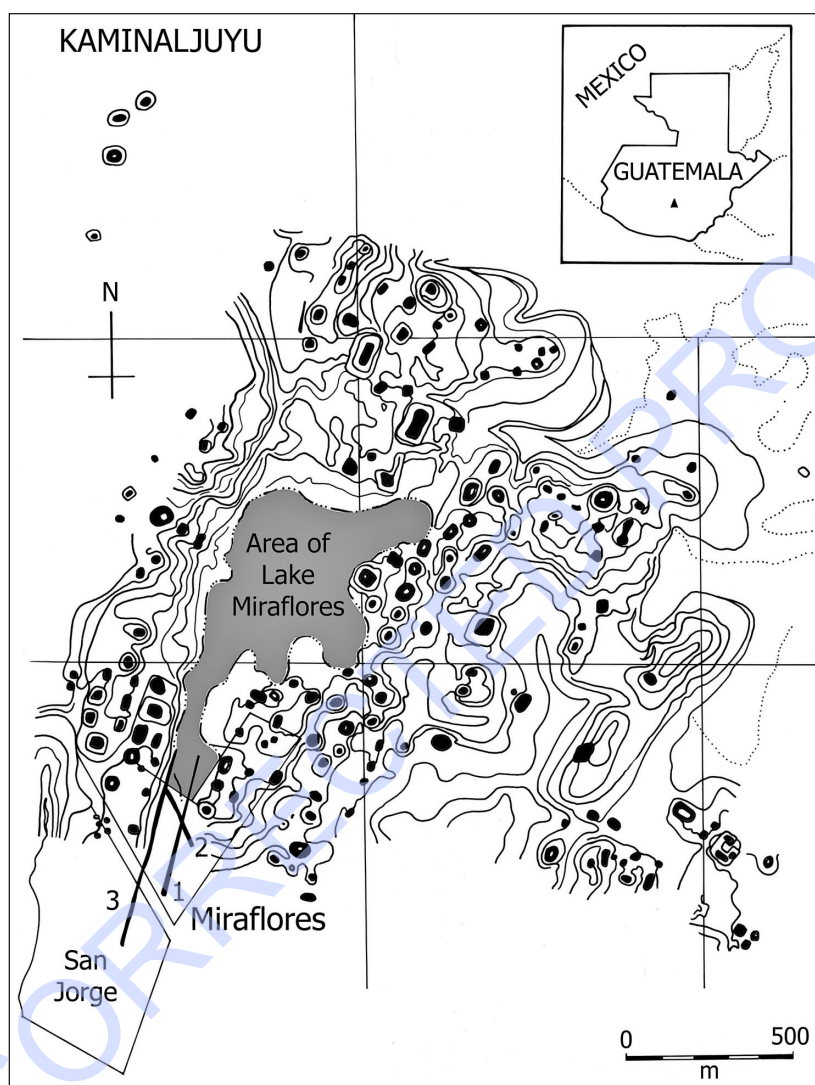


Fig. 4.2 Location of excavations and the three major canals at Kaminaljuyu: Miraflores (1), and Mirador (2), and San Jorge (3).

looking to the sky, with volutes coming from his mouth representing speech or singing to the gods. He is positioned over a water animal or a monster of the underworld.

It was during the Providencia phase (600–400 BC) that the leaders of Kaminaljuyu decided to spearhead communal efforts for territorial do-

minion, which had obvious benefits for the local economy and politics. For local leaders and their support groups the fusion of ideology and technology had positive results for achieving power, although we cannot know the degree to which the government maintained control over local lineages at this time.

Within the entire city these efforts resulted in an enormous construction program of civil and religious architecture, the erection of sculptured monuments associated with aspects of religion and politics, the diversification of ceramic styles, the expansion of obsidian workshops, an increase in communal kitchens, and the use of new hydraulic engineering programs to increase agricultural production (Braswell 1996; Hatch 1993, 1997; Parsons 1986; Shook 1952b; Shook and Hatch 1999; Valdés 1995; Valdés and Wright 2004).

There is no doubt that the presence of water in the form of Lake Miraflores with its irrigation canals was an important “seductive” factor in the attraction of new inhabitants to the valley, resulting in considerable growth in the population around 600–400 BC. The creation of a water system in the southern periphery of the city also increased harvests, culminating in an epoch of abundance and splendor. Evidence of maize, beans, avocados, squash, vegetables, and herbs has been found in Preclassic domestic areas, cultivated fields, terraces, and middens (Gutiérrez Mendoza 1990) as well as deer bones, demonstrating meat consumption (Emery n.d.). We are certain that this florescence of Kaminaljuyu from the beginning of the Late Preclassic led to the consolidation of administrative and political power in the hands of a supreme ruler who had himself represented in a triumphant manner in the sculpted monuments, such as Stelae 10 and 11 and Monument 65, and who surrounded himself with his court of relations and city leaders. This elite had the necessary authority to order the construction of great works of architecture and hydraulic engineering, as witnessed in the amount of materials and labor for the construction of large pyramidal structures 20 meters in height and the excavation of enormous trenches into the *talpetate* (natural soil and a mixture of orange clay and white volcanic sand) to form canals. They also sponsored religious ceremonies in temples and in formal plazas and made dedicatory offerings in the lake. The elite also dominated interregional commerce and agricultural surplus, and they devised bellicose campaigns to expand their territory.

The two richest tombs in Kaminaljuyu stand as clear evidence of the centralization of political power during the Late Preclassic. These were discovered in Structure E-III-3 (Shook and Kidder 1952), where two rulers were interred with lavish grave goods and extensive foreign trade items,

indicating economic and political stratification. The tombs were placed one above the other, and, due to their temporal proximity and similar patterning in construction, body position, and grave goods, archaeologists (Hatch 1993; Shook and Hatch 1999) have inferred that these royal persons were father and son and that perhaps succession was hereditary. As this funerary edifice was the largest at the site and the most noteworthy for containing two funerary chambers of two great dignitaries, it is certain that this complex was also a central feature for the entire city during the Late Preclassic.

Images of the warrior-rulers richly attired and in triumphant posture were sculpted on monuments, sometimes accompanied by representations of kneeling captives in positions of humiliation (Kaplan 2000; Parsons 1986; Valdés 1995). For example, Monument 65 depicts the figure of the sovereign seated on his throne in the center of the scene, surrounded by bound and naked prisoners. The frequency of this type of sculpted stone monuments at Kaminaljuyu demonstrates that it was not all peaceful in the region but that there was competition and a struggle for prestige, power, and territorial expansion.

Ritual activities were always tied to the most important resource of the city, which without a doubt was Lake Miraflores. Various offerings and special deposits of innumerable vessels have been discovered in the ancient bed of the lake, while the representations of animals such as toads, frogs, fish, and aquatic birds were integrated in all the artistic and cultural themes of its inhabitants. The lake also had an impact on the architectural development of the city. Urban planning integrated the lakeshore at the heart of the city as part of its livelihood and the center from where the life and strength of its occupants emerged. Some principal groups were constructed as noble residences near the lakeshore.

Irrigation Systems in Kaminaljuyu during the Middle Preclassic

My investigations with the Miraflores Project succeeded in demonstrating that the beginning of the site's sociopolitical complexity took place as early as the Middle Preclassic (Valdés 1998) and not during the Late Preclassic, as was previously reconstructed by the University of Pennsylvania Kaminaljuyu Project (Michels 1979b) or by the San Jorge Project (Hatch 1997). Our excavations in the Miraflores area indicate that Kaminaljuyu underwent a significant population growth and a spectacular architectural development, accompanied by sophisticated systems of hydraulic engineering beginning in the Providencia phase. These developments oc-

curred on a large scale due in large part to the soil fertility and Lake Miraflores, which was the main water source for the city.

Lake Miraflores was approximately 1 kilometer long by 550 meters wide and provided aquatic food sources that complemented the agricultural diet of the inhabitants, including algae, fish, and aquatic animals such as turtles and herons. Coatimundi, rabbits, and white-tailed deer also proliferated in the areas surrounding the lake. Bone fragments of all these animal species were recovered in household contexts during our excavations, suggesting they were a ready food source (Emery n.d.). The use of canals and the presence of abundant water allowed the implementation of a system of intensive agriculture, increasing the yield of annual harvests of maize, legumes, squash, chilis, avocados, and other crops for which botanical evidence has been found archaeologically (Hatch 1993, 1997).

As expected, the agricultural surplus benefited the local economy and increased the status of the site's leaders. The construction of these works must have involved a large labor force, and for this reason we can conclude that the sovereigns must have enjoyed sufficient charisma and power to be able to order the excavation of thousands of cubic meters of natural soil for the opening of the first of a series of irrigation canals.

The Miraflores Canal

The first hydraulic construction appeared in the southern part of Kaminaljuyu. This was the Miraflores Canal, which was excavated completely from talpetate. This canal was 1 kilometer long and was oriented 9 degrees east of north; water flowed south naturally due to the inclination of the terrain. The beginning of the canal, located in the extreme south of Lake Miraflores (fig. 4.3), was **V**-shaped, 3.3 meters wide and 5.8 meters deep. Farther south the canal was expanded in width and decreased in depth and became more **U**-shaped because the water did not need to be moved with as much velocity. The southern end of the canal was almost 8 meters wide and only 1 meter deep. Based on its trajectory, the canal likely functioned to provide a system of controlled flooding, as its banks had different heights, imitating a natural system of inundation.

The expected increase in agricultural surplus was so effective that the channel continued to be utilized for three to four centuries until the beginning of the Late Preclassic, when for reasons still unknown the Miraflores Canal was abandoned at the beginning of the Verbena phase (400–200 BC), becoming an enormous trench that was then used as a trash pit.

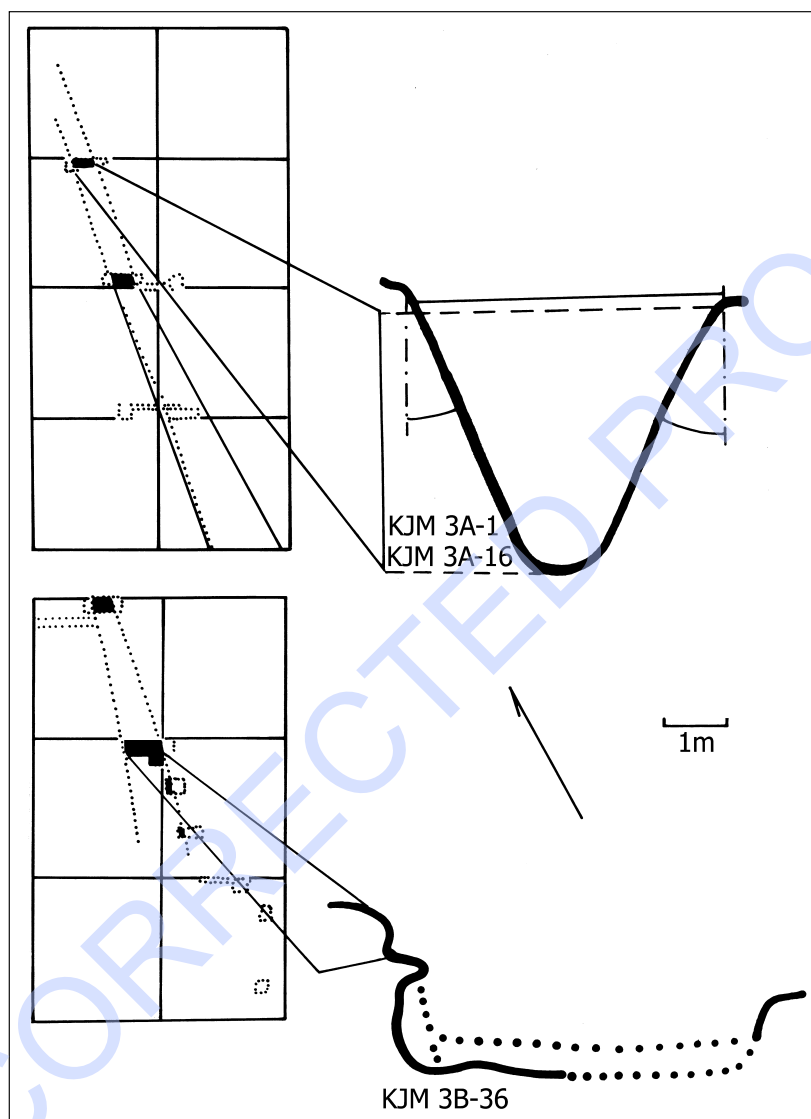


Fig. 4.3 Plan and cross sections of the Miraflores canal at its starting point near the lake.

A new network of canals was planned or built at this time, and of these the San Jorge Canal was the largest.

Effects of the Irrigation Canals during the Late Preclassic

During the Late Preclassic the system of canals was amplified and improved with the application of new technologies. Hundreds of farmers must have worked in these 5 kilometers of irrigated fields, which could produce continuously year-round. Communal kitchens were also discovered in association with irrigated fields in the southern section of Kaminaljuyu by the San Jorge and Miraflores projects, which were used for the continual preparation of food to satisfy the dietary needs of the field workers (Hatch 1997; Shook and Hatch 1999).

It is probable that there was tremendous pressure to create even more maize surplus (and other products) to satisfy the growing needs of an increasing population in the city. Surplus was also used for exchange with other regions during the Miraflores sphere (200 BC–AD 200), a period of major interaction in the Guatemalan highlands. Without a doubt, the use of a new and more complex hydraulic technology enhanced the audacity, power, and prestige of the local sovereign who was able to order such irrigation works. This fact is expressed in sculpted monuments, where the use of complex iconography depicts the king in mythological scenes (e.g., Stela 25), royal scenes (e.g., Altars 1 and 2, Stela 21), and powerful scenes of rulers and bound captives (e.g., Stelae 10 and 11 and Monument 65).

It is clear that the economic stability achieved by Kaminaljuyu is reflected in the commercialization of its products (jade, obsidian, and pottery); its agricultural surplus also attracted neighboring populations. At the beginning of the Late Preclassic people abandoned their settlements to move to the ancient city, which was being rapidly transformed into the primary center of the central highlands of Guatemala. For example, the village site of Piedra Parada, located to the east of the valley of Guatemala 14 kilometers distant, was occupied between 1000 and 400 BC but was abandoned c. 400 BC (de León and Valdés 2002).

Piedra Parada exhibits the same cultural traits as the other Middle Preclassic sites in the vicinity of Kaminaljuyu (e.g., Canchón, Santa Isabel, Cuyá, Virginia, Rosario-Naranjo, and others), including the placement of structures around plazas, avenues or streets lined by buildings, and the presence of plain stelae or altars demarcating the central axis in front of the main structure (Shook 1952b). The presence of the same pattern in many sites in the central valley indicates that they shared the same culture

whether large or small, reflecting a system of egalitarian or heterarchical social and economic interaction. However, Kaminaljuyu began to surpass the other centers with the emergence of kingship.

The San Jorge Canal

The San Jorge Canal was built c. 300–200 BC, and it was the largest of all the known canals of Kaminaljuyu (see figs. 4.1a and 4.3). It runs more or less parallel to the Miraflores Canal, exiting as usual from the southern tip of the lake. It reached 18 meters in width, 8 meters in depth, and 1,750 meters in length. It had several branches that irrigated the fields in a manner similar to a river delta.

Excavations conducted by the San Jorge Project in the periphery south of Kaminaljuyu detected secondary canals and the use of raised fields for intensive cultivation (Hatch 1997). It was also determined that the canal had an enlarged basin in its middle part that served as a water tank associated with a “hydraulic jump,” which functioned to regulate the flow and velocity of the water so that it could then be directed toward smaller irrigation channels, carrying the water to the east and to the west of the principal canal. This canal was practically a river, and it could have aided in draining excess water from the lake during the rainy season and providing water to the fields during the dry season.

Near this canal the excavators discovered various areas that served as communal kitchens, where fresh drinks, *atol*, tortillas, and other food for the field workers were prepared. Excavations by the Miraflores San Jorge Projects revealed three to four sunken hearths together in the interior of these houses, demonstrating that fires were kept burning continuously for the preparation of large quantities of food. A number of *comales* were sunk into the floor near the hearths; they certainly served to hold the corn dough balls for making tortillas or the water used during tortilla preparation to keep the hands from sticking to the corn dough.

The Mirador Canal

The Mirador Canal is the smallest of the three canals (see fig. 4.2). Its width is 2.6 meters, and its depth reaches 3 meters. Excavations uncovered the distal extreme of the canal at the southeast, which is smaller toward its end (1.6 meters wide and 0.35 meter deep). Thus, the channel ends by sending water slowly across the fields. Due to the orientation of the canal from west to east, it seems that this was a secondary channel of the San

Jorge Canal, but its origins could not be identified because of the presence of modern houses in this zone. In any case, its length was calculated to be c. 230 meters.

The importance of this canal lies in its use of a new technology previously unknown. There are sections in this canal that have 90-degree projecting angles, which clearly indicates the use of sluices, likely made of wood. Sluices allowed people to better control the quantity of water used, possibly because the lake was already drying at the end of the Late Preclassic. Aside from this, the bottom of the canal had several depressions where sediment, soil, and sand collected, suggesting that these were cleaned and maintained as needed.

Other Canals and Water Systems of the Late Preclassic

Investigations undertaken in the northeastern part of Kaminaljuyu by Japanese archaeologists of the Museum of Tobacco and Salt also discovered a Y-shaped canal adjacent to Mound B-I-1 that measured 1 meter in width and 0.65 meter in depth. The canal was associated with a Late Preclassic monumental construction, consisting of a pyramid 16 meters high, located at the west side of the Acropolis complex of Kaminaljuyu (Ohi and Ito 1993).

Another canal, built of thin stone slabs, was uncovered in 1991 in the upper part of the enormous mound called La Culebra (the snake). This is also a Late Preclassic construction and represents an amazing earthwork (an aqueduct of 4.5 kilometers long by 15 meters high) made to conduct water from the mountains of the southeast of the Guatemala Valley to the vicinity of Kaminaljuyu (Jacinto Cifuentes, personal communication, 1991; Navarrete and Lujan 1986; Ortega and Ito 2000).

Another system of water capture discovered in the southern section of Kaminaljuyu consisted of “water reservoirs” formed by holes or depressions of medium and large size (c. 6 meters in diameter) that captured rainwater, taking advantage of the slope of the terrain, including the group of mounds that includes Mound B-V-9 (Velásquez 1994). Large-scale pits for capturing water were also found adjacent to structures excavated by the Miraflores Project (Structure B-V-5), although these were probably used during the Classic period, between AD 200 and 900. The bottoms of these pits were lined with clay to prevent water filtration.

The Crisis at the End of the Preclassic and the Arrival of the Early Classic

The splendor achieved during the Preclassic began to decline when Lake Miraflores started to dry up c. AD 100–200. Although it is still difficult to explain the cause of the drying of the lake, it is possible that it could have been due to the uncontrolled exploitation of this aquatic resource or the presence of seismic faults. Whatever the reasons, it had fatal consequences for agricultural production, the economy, and political power, the latter witnessing its territorial dominion weakening and the Miraflores sphere fracturing.

The use of the canals seems to have been interrupted at the end of the Preclassic, and the inhabitants of Kaminaljuyu returned to earlier subsistence practices. Human bone analysis indicates that the use of maize decreased at this time (Valdés and Wright 2004; Wright et al. 1998), but the people continued to consume other agricultural products. The popular discontent against the ancient rulers was made clear when various monuments were broken and the sculpted features desacralized. This weakened political situation was taken advantage of by an intrusive group that, according to Hatch (2000), arrived from Chiapas or the western highlands of Guatemala, abruptly replacing the ceramic tradition and interrupting the erection of sculpted monuments at Kaminaljuyu.

Chaos must have taken hold of the population with the arrival of these intrusive peoples, who with almost complete certainty were K'ichean Mayan speakers. These people displaced the ancient population of Cholan speakers, who during previous centuries had fought to maintain the prestige and greatness of Kaminaljuyu. With the arrival of new people and a reduction in the aquatic environment, the agricultural system employed became more extensive than intensive. Although this change in cultivation strategy appears to have been fatal to Kaminaljuyu's history as a center, it seems it did not drastically affect the recent arrivals, who were already accustomed to this kind of system.

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CLASSIC WATER SYSTEMS

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5

Environmental Variability among Bajos in the Southern Maya Lowlands and Its Implications for Ancient Maya Civilization and Archaeology

NICHOLAS P. DUNNING, TIMOTHY BEACH, AND
SHERYL LUZZADDER-BEACH

The exploration of [these] uninviting yet interesting swamps [*bajos*]
will repay in discoveries all effort devoted to them.

—C. L. Lundell, *The Vegetation of the Petén*

Many of the largest and earliest centers in the southern Maya Lowlands were situated adjacent to large karst depressions known as bajos. This spatial relationship has long puzzled scholars, because many “upland” bajos today are characterized by seasonal swamps, an environment generally perceived to be resource-poor. While the term *bajo* is variously used in the Maya Lowlands to describe any low-lying terrain, particularly poorly drained or generally swampy terrain, this chapter is largely concerned with the environmental history of “upland” or “interior” bajos, which are situated roughly 80 meters or more above mean sea level.

Over the years, diverse scholars have suggested a number of solutions to the “bajo conundrum,” proposing variously that upland or interior bajos had once been lakes, had once been perennial wetlands, are more environmentally diverse and potentially productive than commonly realized, or were heavily modified by human engineering to make them agriculturally productive. The common thrust of these various studies is that there was something about the bajos that made them considerably more attractive as resources and settlement locations than is immediately obvious today. However, one problem with many of these studies has been a tendency to generalize findings from one bajo or set of bajos to the great majority of bajos, thus painting a broad picture of their role as important locations in the course of Maya civilization.

This chapter briefly reviews geoarchaeological data that have been recovered from a number of upland or interior bajos across the southern Maya Lowlands. We suggest that, just as scientists working in the Maya Lowlands have been remiss in appreciating the present-day environmen-

tal heterogeneity of bajos, we have similarly only now begun to understand the diversity of past environments that existed within these depressions. This environmental diversity within bajos across both space and time likely had dramatic implications for the Maya occupation of the southern lowlands.

Water is an especially precious resource across much of the Maya Lowlands interior because of three basic facts. First, the region has a tropical wet-dry climate, with more than 90 percent of rainfall arriving during a late May–December wet season, leaving the landscape parched for four months. Second, the region is largely karst, with most water quickly entering the complex groundwater system and accessible only in a limited number of places. Third, water in bajos, *aguadas*, or karst aquifers has the potential for contamination from large ancient populations and naturally from salinity (Luzzadder-Beach 2000). As ancient Maya civilization developed, adaptation to this hydrology was critical for the success or failure of individual regions, cities, and dynasties. The idea that significant hydrologic changes may have occurred within bajos during the Maya occupation of the region potentially adds a significant dimension to understanding the adaptive systems associated with Maya civilization. We will touch further on the implications of the variable nature of interior wetlands in the concluding section of the chapter. Similarly, this diversity within the bajos has important implications for the conduct of archaeological investigations in the region.

Bajos and Wetlands in the Maya Lowlands

Bajos and other wetlands are a common feature across the southern and central Maya Lowlands, variably covering between 40 and 60 percent of land area across the region (fig. 5.1). Around the low-lying exterior margins of the southern lowlands wetlands are often riparian and typically of a perennial nature, maintaining saturated or near-saturated soil moisture conditions throughout the year. For example, such perennial wetlands are found along Booth's River, the New River, and the coast of the Caribbean in Belize (fig. 5.2). In contrast, interior areas of the lowlands are generally elevated between 80 and 250 meters above sea level, and perennial surface water of any sort is generally rare, with the notable exception of the lakes within the Petén Itzá fault system. The large karst depressions known as bajos, however, are variably common throughout this elevated region, with their greatest abundance occurring within the sprawling Mirador Basin, although the largest bajos (e.g., the Bajo de Santa Fe east of Tikal) occur farther southeast and southwest on the Petén Karst

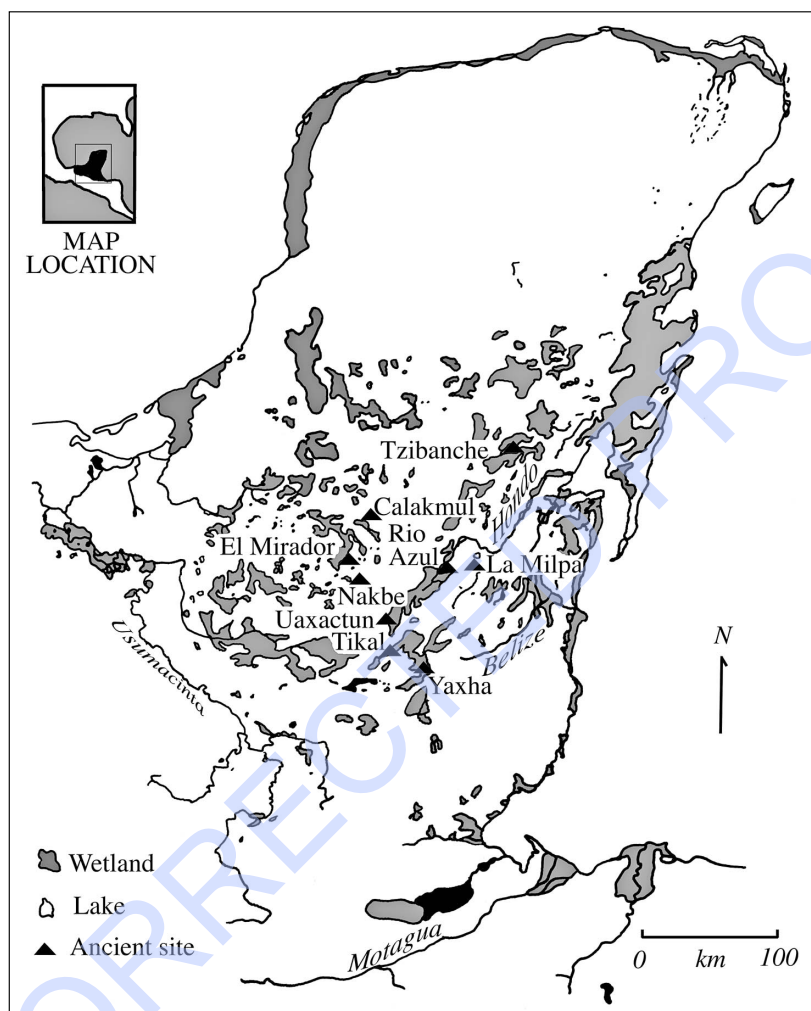


Fig. 5.1 The Maya Lowlands, showing the general distribution of wetlands (after Dunning, Luzzadder-Beach, et al. 2002:fig. 1; modified from Pope and Dahlin 1989:fig. 1) and sites mentioned in the text.

Plateau (Dunning et al. 1998). The seasonal wetlands found in most of the interior bajos today are typically flooded for several months and mostly edaphically dry for the remainder of the year. The interior bajos contain a variety of vegetation complexes depending on the relative degree of inundation and desiccation characteristic of any given area and on variation in soil parent material (Brokaw and Mallory 1993; Culbert et al. 1996; Lun-



Fig. 5.2 General elevational profile of the eastern side of the southern Maya Lowlands; vertical exaggeration is fifty times. (After Dunning, Luzzadder-Beach, et al. 2002:fig. 2)

dell 1937; Pope and Dahlin 1989; Siemens 1978). Some interior bajos even include pockets of perennial wetlands with generally herbaceous vegetation known locally as *civales* (Castañeda 1995; Jacob 1995; Lundell 1937). Soils in the interior bajos range from organic peats (Histosols) found in *civales* to heavy clay Vertisols, a soil type that seems to characterize the most extensive areas. These Vertisols pose significant difficulties for agriculture and have large seasonal water deficits.

Pope and Dahlin (1989) used satellite imagery to map the distribution of wetlands in the Maya Lowlands (see fig. 5.1). These authors heuristically divided wetlands into two basic categories, perennial and seasonal, noting the general correlation between perennial wetlands with lower elevation locations and seasonal wetlands with relatively higher elevations. They also noted that, to date, most conclusive evidence for ancient Maya intensive wetland agriculture was from relatively low elevation, perennially moist wetlands and not their higher, drier counterparts. While island field systems have been intensively investigated in several low-lying perennial wetlands of northern Belize, there is, nevertheless, still considerable controversy concerning the degree to which these island field systems are the result of natural processes or human modification and the temporal periods during which they were used for agricultural production (Adams 1980, 1993; Adams et al. 1990; Culbert, Levi, and Cruz 1990; Harrison 1990, 1996; Jacob 1995; Pope and Dahlin 1989, 1993; Pope, Pohl, and Jacob 1996; Turner 1978, 1993; Turner and Harrison 1983). One thing that is clear about these wetlands is that while their present-day hydrologies are relatively stable in comparison to their upland counterparts, these low-lying wetlands have been subject to considerable hydrologic variation over time — variation to which the Maya apparently adapted with variable success (Beach et al. n.d.; Beach et al. 2003; Rejmankova et al. 1995).

The degree to which the bajos of the elevated interior portions of the Maya Lowlands were a valuable resource for agriculture or other uses has been even more controversial. Following the detection using aerial photography of wetland fields in the Bajo Morcoy in southern Quintana Roo, many scholars believed that similar field systems would likely be found throughout the interior bajos of the central and southern Maya Lowlands (Harrison 1978, 1990; Turner 1978). Moreover, it appeared for a period of time that airborne synthetic aperture radar (SAR) had successfully detected patterning consistent with canals and wetland field systems across wide areas of the lowlands (Adams 1980; Adams, Brown, and Culbert 1981; Adams et al. 1990). However, any remote sensing technique has potential errors, and field checking was not possible in many areas at the time of the survey. In this case, system noise in the SAR data or bedrock fracturing produced large amounts of false patterning, including in areas that were not wetlands (Adams 1993; Dunning and Beach 2004; Dunning, Beach, and Rue 1997; Pope and Dahlin 1989, 1993). Since then, debate has centered on the degree to which effective agriculture was possible within the upland bajos and the amount of variability that might exist within and between bajos. It is becoming increasingly apparent that the seasonal swamps found today in interior bajos are far from environmentally homogeneous, with some areas having greater agricultural potential than others (Culbert et al. 1996; Kunen et al. 2000). Whether or not they were agriculturally limited, bajos cover large areas of the southern and central Maya Lowlands, and it would be surprising if these basins did not play a significant land-use role throughout the course of Maya civilization. However, the degree to which environmental conditions within bajos may have changed over time has been far from clear, a problem that has spurred geoarchaeological interest.

A Litany of Bajo Investigations

The geoarchaeological investigation of bajos began with the excavation of a single stratigraphic pit in 1932 (Ricketson 1937:11) but progressed slowly until the late 1980s and 1990s, when several projects began independently investigating bajos in separate locations in the southern Maya Lowlands. A thorough summary of bajo research would require a monograph-length work. Here, based on data compiled to date, we offer a series of chronologically sequenced descriptions of what various bajos in the southern lowlands might have looked like as they evolved. It should be noted that we do not have data for all investigated bajos for all time periods. These discrepancies reflect not only variation in the problem orientation and

methods involved in different investigations but also the nature of paleo-environmental data. Typically, two different types of environmental situations are represented in bajo sediments: (1) periods of environmental stability when gradual, cumulative processes (e.g., pedogenesis, or soil formation) are represented; and (2) periods of instability when rapid change (abrupt aggradation or sedimentation) is evident. Since neither type of evidence may be represented in or have been recovered in all bajos, the descriptions that we are able to offer below are somewhat uneven.

13,000–11,000 BP: The Late Pleistocene

Data from this early date are extremely limited. In 2003 two 5-meter-deep backhoe trenches excavated in the Dumbbell Bajo north of La Milpa in northwestern Belize penetrated a massive horizon of red orange iron and aluminum-dominated clay (Dunning 2004, n.d.). Traces of charcoal in the upper portion of this stratum were dateable to $12,470 \pm 40$ BP (calibrated). The morphology and composition of this horizon suggest that it represents a Pleistocene Oxisol formed during a period of considerably greater aridity in association with an ecosystem dominated by grasses and scattered woody vegetation. This interpretation is consistent with data from two lake sediment cores from the central Petén that portray a late Pleistocene landscape of relatively cool, dry, grassy savannas studded with junipers and other scrubby woody vegetation (Brenner 1994; Leyden 1984). These lake cores also suggest that the transition from Pleistocene savanna to Holocene forests began in the region around 11,000 BP.

Intriguingly, Cowgill and Hutchinson (1963:12) encountered a dark layer of “carbonaceous material of unknown nature and origin” at a depth of about 5 meters in a soil pit excavated in an arm of the large Bajo de Santa Fe some 3.5 kilometers east of Tikal. This layer yielded a radiocarbon date of $11,560 \pm 360$ BP, although no mention is made concerning pretreatment of the sample, and it is possible that this date may be erroneously old due to hard-water contamination. Unfortunately, no further analyses were conducted on this material. However, based on Cowgill and Hutchinson’s brief description, this carbonaceous layer would seem to closely resemble a similar layer found in a 1999 excavation in the Bajo La Justa north of Yaxha (Dunning 1999; Dunning, Luzzadder-Beach, et al. 2002). This material proved to have been of lacustrine origin (see below), raising the possibility that a shallow lake may have existed in a portion of the Bajo de Santa Fe during late Pleistocene times, although this scenario must be treated with great caution. The dry savanna environment indi-

cated for the Dumbbell Bajo is likely more representative of the majority of bajos at this time.

3500–2500 BP: The Maya Landnam

Between 11,500 and 3500 BP the Maya Lowlands were colonized by a variety of forest types, ranging from dry scrub in the relatively arid north-west Yucatán to tropical cloud forest on the mountainous flanks at the southern terminus of the peninsula (Dunning et al. 1998). Across much of the southern lowlands palynological evidence suggests the development of a tropical wet-dry deciduous forest similar to that found in the region today. This period is a cultural black hole: we simply have little information about the possible human use, if any, of bajos during these eight millennia.

Between 3500 and 2500 BP much of the Maya Lowlands was colonized by Maya people. During this period radical environmental changes took place across the region in conjunction with the widespread introduction of agriculture. In a host of lacustrine sediment cores forest species indicators rapidly decline, and weedy disturbance indicators and cultigens come into the picture. Hammond (2004) aptly describes this period as the “Maya landnam,” an era of sweeping forest clearance and widespread establishment of permanent settlements. In numerous topographic low points throughout the region this period is also marked by the start of deposition of “Maya clay,” largely inorganic sediments indicative of accelerating soil erosion rates on adjacent sloping terrain (Beach et al. n.d.).

Paleoenvironmental data from the bajos of the southern lowlands suggest that a range of wetland environments faced the early Maya settlers. Much of our information about conditions within the bajos at this time comes from the isotopic carbon in the organic matter found in buried former surface horizons because variations in composition allow us to distinguish the relative quantities of arboreal and herbaceous vegetation from that contributed to the soil organic matter (Jacob 1995; Dunning, Luzzadder-Beach, et al. 2002). While this is a highly inexact method for reconstructing vegetation complexes, it has provided some promising results.

Several bajos show evidence for considerably moister conditions than are found in these depressions today. In the small Guijarral Bajo northeast of La Milpa and a section of the large Bajo La Justa north of Yaxha, carbon isotopes clearly indicate a predominance of herbaceous vegetation, most likely associated with a perennial wetland with abundant cattail and

aquatic grasses, tied to radiocarbon dates of 3030 ± 40 BP and 2980 ± 40 BP, respectively (Dunning 2004, n.d.; Dunning, Beach, and Luzzadder-Beach 2005). Jacob (1995) and Hansen and colleagues (2002) interpret a buried organic horizon in a large bajo adjacent to Nakbe as having formed in a perennial wetland, probably dating to around 3000 BP, although this dating is mainly inferential. They believe that the mucky organic soil (Histosol) from this wetland was used to fertilize riparian agricultural terraces at Nakbe dating to the Middle Preclassic period around 2700 BP.

Other bajo carbon isotopes in buried organic horizons from this time period are less strongly indicative of the dominance of herbaceous vegetation and wetter conditions. In the "El Pinal" section of the Bajo de Santa Fe some 16 kilometers northeast of central Tikal and in an arm of the large Bajo Zocotzal southwest of Tikal buried surface horizons with radiocarbon dates of 2550 ± 40 BP and 2660 ± 40 BP produced isotopic signatures that suggest a mixture of herbaceous and woody vegetation, probably indicative of conditions wetter than the present day but not as perennially moist as in the bajos just described (Dunning, Beach, and Luzzadder-Beach 2005).

In the huge Bajo Laberinto near Calakmul a strikingly different situation apparently existed. Gunn and others (2002) report indications of the existence of a shallow saline gypsic lake and wetland tied to a radiocarbon date of 2530 ± 40 BP. This may have resembled the present-day Lake Salpeten in Guatemala. Such a saline lake would not have provided a valuable hydrologic or agricultural resource to earlier Maya colonists. On the other hand, the perennial or near-perennial wetlands indicated for the other bajos described above would have held attractive resources for the Maya, including a water supply, organic soils valuable as fertilizer or for seasonal cropping, and numerous types of wildlife.

There are also indications that toward the end of this time period environmental conditions within some bajos were changing. In the Bajo Zocotzal a large alluvial fan rapidly buried the former wetland sometime after 2660 ± 40 BP (Dunning, Beach, and Luzzadder-Beach 2005). By 2250 ± 40 BP large quantities of sediments were infilling wide areas of the Bajo Laberinto (Gunn et al. 2002). Hansen and others (2002) argue that by about 2200 BP hydrologic conditions within the Nakbe Bajo had altered dramatically as the result of massive sedimentation that essentially destroyed the perennial wetland ecosystem, perhaps triggering the abandonment of the Nakbe community.

2100–1900 BP: The Late Preclassic

By the height of the Late Preclassic period large population centers had arisen on the flanks of many bajos. The largest of these, El Mirador, was set amidst several large bajos. Systematic ground surveys, mapping, and excavations were carried out in the bajos, including in causeways that cross the bajo (Dahlin 1989; Dahlin and Dahlin 1994; Dahlin, Foss, and Chambers 1980). It is noteworthy that the stratigraphy in a few pits included one or more buried topsoil horizons; however, these were mainly found in the borrow pit “canals” flanking causeways and beneath apparent house platforms found on slightly elevated terrain in sections of the bajo. There were no indications that the causeways had been intended to function as dams, since these features remain low and follow the elevation of the bajo downward, allowing little water impoundment (Dahlin 1989). Rather, the causeways appear to be relatively low walkways that would have made passage across the bajo considerably easier, particularly during the rainy season.

Vertisols were found to be the prevalent soil within the surveyed portion of the bajo (Dahlin, Foss, and Chambers 1980). The investigators argue that these Vertisols would have made significant agriculture difficult because these soils are often deficient in phosphorus, potassium, and zinc, low in organic matter, poorly aerated, overly acidic, subject to seasonal shrinking and swelling capable of tearing crop roots, extremely hard when dry, and plastic and sticky when wet (Pope and Dahlin 1989, 1993). No indications were found of buried lacustrine or peaty deposits, and it was concluded that similar soils existed in the bajo during the time of Maya occupation as exist there today (Dahlin and Dahlin 1994; Pope and Dahlin 1989, 1993). Dahlin and Dahlin (1994) also argue that the presence of Late Preclassic habitation platforms indicates that conditions within the bajo were likely even drier during El Mirador's heyday. Hansen and colleagues (2002) nonetheless argue that the Mirador bajos may have once held perennial wetlands like those near Nakbe. We do know that the residents of El Mirador built reservoirs along the slope margins, thereby adapting to this environment. Despite such adaptations, this huge center was largely abandoned by around AD 100.

Very different conditions are indicated for two other bajos. In the small Far West Bajo on the western flank of La Milpa a buried peaty layer dating to 1950 ± 50 BP contained preserved pollen, clearly indicating a perennial wetland with abundant cattail and aquatic grasses, none of which exist in the bajo today (Dunning, Luzzadder-Beach, et al. 2002; Dunning et al. 2003). In a portion of the Bajo La Justa near Yaxha excavations also en-

countered a buried peaty layer dating to 1930 ± 40 BP. Here preserved pollen demonstrated the former presence of a shallow lake containing a large quantity of water lilies (Dunning, Luzzadder-Beach, et al. 2002). Clearly, these places held a considerable attraction for the communities on their flanks.

As a whole we still do not know whether seasonal wetland bajos with their annual scarcity of water and problematic Vertisols were wetter and had richer, organic soils across the majority of the southern lowlands at this time. However, it is clear that conditions were changing in some bajos near the end of the Late Preclassic. In the Bajo La Justa sedimentation was occurring in the shallow lake north of Yaxha. At one point the Maya ditched through the accumulating sediment, possibly to bring this area into cultivation, but further sedimentation buried their efforts (Dunning, Luzzadder-Beach, et al. 2002). Similarly, in the Far West Bajo near La Milpa episodic sedimentation was altering the hydrology of the bajo around the start of the Early Classic period.

1500 BP: The Middle Classic

By the middle of the Classic period there is no evidence for the continued existence of either significant perennial wetlands or lakes within any of the upland bajos of the southern Maya Lowlands. Data from the Guijarral, Far West, and Dumbbell bajos near La Milpa all indicate the presence of seasonal wetlands with chiefly arboreal vegetation and Vertisols developing in aggraded clayey sediments. However, another type of anthropogenic transformation was under way along the margins of these bajos. In many locations the erosion and deposition of earlier years had created broad aprons of deep colluvial and alluvial soils. By AD 700 the Maya were apparently setting about developing intensified agricultural production on these soils, as evidenced by fieldwall and terrace systems (Beach et al. 2002; Dunning, Luzzadder-Beach, et al. 2002; see Kunen, this volume). At Calakmul similar exploitation of anthropogenic colluvial soils was widespread (Gunn et al. 2002).

In other bajos different types of agriculture are evident. In the Bajo Morocoy near Tzibanche aerial survey and limited ground investigations have identified an extensive system of island fields, at least some of which were, at least partly, in production during the Classic (Gliessman et al. 1983; Harrison 1977, 1978; Harrison and Turner 1978). However, there has been considerable disagreement about the greater significance of these fields. Some have argued that the Bajo Morocoy is representative of many interior bajos, and, therefore, they suggest that intensive wetland agri-

culture may have been practiced in many or most upland bajos (Adams 1980, 1993; Harrison 1990). However, others have challenged this view, arguing that the hydrology of the Bajo Morocoy is more like that of a low-lying perennial wetland than that of an elevated bajo, and, therefore, the island field systems found there should not be taken as evidence for the widespread existence of such cultivation in interior bajos (Pope and Dahlin 1989, 1993). To date, no other extensive island field systems have been identified in other upland bajos. However, more recently, high-resolution satellite imagery has revealed a number of linear features within several bajos in the Petén, but these features have not yet been identified on the ground. Near the center of the Bajo La Justa a large rectangular reservoir (Aguada Maya) has been observed, but its date and exact functions are unknown (Culbert et al. 1996).

Given that large numbers of Maya people continued to live on elevated terrain within and immediately adjacent to bajos throughout the Classic period, it is likely that agriculture of some sort was being practiced within these depressions (Kunen et al. 2000). It is likely that the Maya of this time were highly attuned to the numerous microenvironments and soils with the bajos and fully exploited their cultivable potential.

1000 BP: Abandonment

Just as it is unclear exactly what roles bajos played in Classic Maya civilization, it is not known what role, if any, they may have played in its collapse. Paleoenvironmental data from the bajos at this time are almost nonexistent. A short sediment core from the small Aguada Pulgada in the Bajo de Santa Fe indicates drying conditions and eutrophication occurring probably after AD 800 (Dunning, Culbert, et al. 2002). A similar core taken from the Aguada Zacatal west of Nakbe clearly shows forest clearance and then regrowth associated with the nearby small Late Classic site of the same name (Hansen et al. 2002). Clearly, by 1000 BP Maya occupation of the upland bajos of the southern lowlands had effectively ceased.

Discussion

From the review above it should be clear that the karst depressions of the southern Maya Lowlands have been characterized by a range of environmental conditions over the past twelve thousand years. As the Maya began to colonize this region some thirty-five hundred years ago, the bajos apparently presented them with both opportunities and constraints to occupation that varied from bajo to bajo. In all likelihood, environmental con-

ditions varied internally, particularly within the larger bajos. Gunn and colleagues (2002) suggest that the bajos flanking Calakmul were “contaminated with gypsum,” making large population concentrations in the vicinity difficult. On the other hand, at least some bajos appear to have contained shallow lakes or perennial wetlands, both of which would have been attractive resources for early settlers. Such lakes/wetlands are best documented for La Milpa’s Far West Bajo and at least a part of Bajo La Justa near Yaxha (Dunning, Luzzadder-Beach, et al. 2002) as well as a bajo near Nakbe (Jacob 1995; Hansen et al. 2002). Evidence suggests that the Guijarral Bajo near La Milpa also contained a perennial wetland. On the other hand, data from the nearby Dumbbell Bajo are ambiguous, but it appears most likely that no lake or perennial wetland was present there, despite this bajo being lower in elevation than the superadjacent Far West Bajo and Guijarral Bajo. It is distinctly possible that the subsurface drainage of the Dumbbell Bajo has at least at times been significantly more rapid than that of the two smaller bajos (fig. 5.3). Given the karstic nature of this area and the presence of significant faulting, such variation in subsurface hydrology is not surprising.

The margins of bajos may have presented the Maya of the Preclassic period with another opportunity, namely reservoirs, as a focus for urbanization, utilizing the topographic advantages presented by bajo topography (Scarborough 1993). While evidence for natural lakes at El Mirador is lacking, the Maya did construct bajo-margin reservoirs there (Dahlin, Foss, and Chambers 1980). However, Gunn and colleagues (2002) suggest that conditions within the Bajo Laberinto were too saline for impounding potable water until Late Preclassic sedimentation created more favorable reservoir conditions along the bajo margin.

The impacts that ancient Maya occupation had on the bajos of the southern Maya Lowlands also appear to have varied from bajo to bajo. In the Far West Bajo at La Milpa ancient Maya land clearance produced significant erosion beginning in the Late Preclassic, resulting in huge amounts of both alluvial and colluvial deposition (Dunning, Luzzadder-Beach, et al. 2002; Dunning et al. 2003). This deposition appears to have factored significantly in the transformation of this bajo from a perennial wetland to a seasonal swamp, compromising its usefulness as a water source by the beginning of the Early Classic. Hansen and colleagues (2002) describe a similar transformation of the Nakbe Bajo and attribute the early abandonment of Nakbe and nearby centers at least in part to this environmental change. Parallel transformations of bajos from perennially to seasonally wet conditions also seem to have occurred during the Late Preclassic near Guijarral and Yaxha. On the other hand, Preclassic–Early

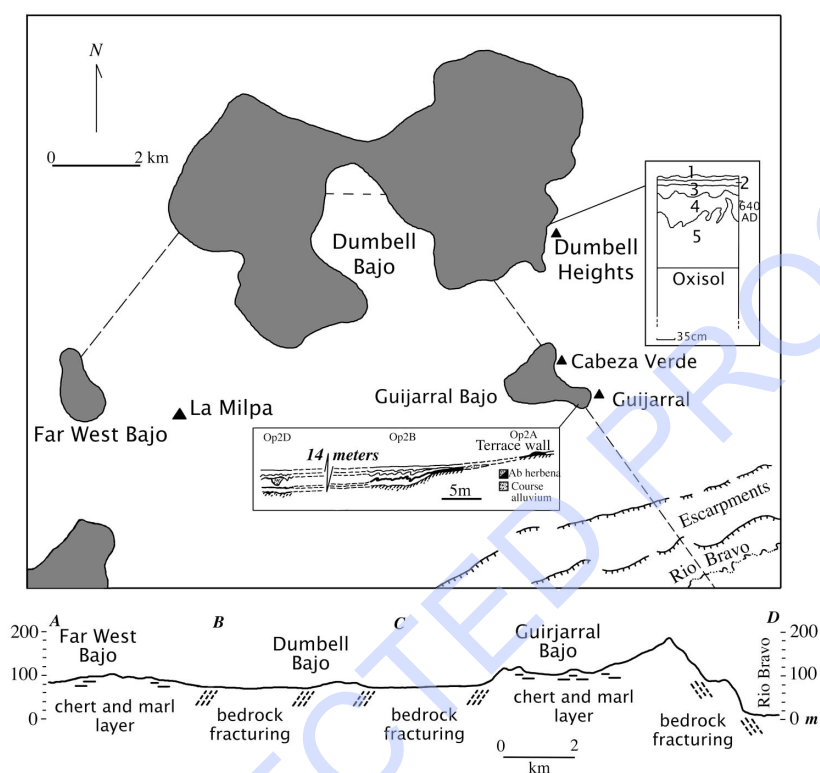


Fig. 5.3 Map and cross section of the bajos lying north of La Milpa, Belize, including details on several excavation units.

Classic erosion deposited calcium-rich sediments into the bajos flanking Calakmul, perhaps making those places considerably more habitable in terms of both reservoir water quality and the creation of rich farmland. Similarly, the colluvial aprons around the Far West Bajo at La Milpa (and apparently also at Guijarral) became the focus of intensive Classic period agriculture.

These findings strongly suggest that many bajos continued to be an important resource in the Classic period, although we have little direct evidence on the nature of land use in the bajos themselves. We believe that organic mucks were likely mined from the bajos near La Milpa and used to enhance production on the hundreds of terraces that flank these bajos. In this manner the bajos may have been used indirectly for intensive agricultural production, as has also been suggested at Nakbe (Hansen et al. 2002). However, with the transformation of some bajos from peren-

nial to seasonal wetlands, their importance as a source of fertile mucks would have diminished. At least in some bajos or portions of bajos, surface soils and hydrology would have been as unfavorable for agriculture during ancient Maya times as they are today, as exemplified by studies in the El Mirador Bajo and the “Pinal” areas of the Bajo de Santa Fe (Dahlin and Dahlin 1994; Dunning, Culbert, et al. 2002; Pope and Dahlin 1989). However, within many bajos significant areas of soils with few such limitations can be found today and presumably were also available to the ancient Maya (Beach et al. 2002; Culbert, Levi, and Cruz 1990). The continued presence of sizeable populations living in close proximity to bajos through the Classic period certainly suggests that these depressions continued to have a significant productive use (Kunen et al. 2000). While the preferential settlement of some bajo margins during the Preclassic could quite simply be explained by their importance as a water source, it is unlikely that inertia alone can explain their continued settlement.

Though there is considerable evidence for environmental change within upland interior bajos during the course of Maya civilization, the degree to which changes may have been influenced by climate change is still not clear. Various proxy studies have indicated that a general pattern of increasing aridity may have set in some three thousand years ago and gradually intensified until about one thousand years ago (Brenner et al. 2002). However, some data indicate that particularly severe pulses of aridity may have occurred within this trend, most notably coinciding with the ends of the Late Preclassic and Classic periods (Gunn, Folan, and Robichaux 1995; Hodell et al. 2001). Thus, it is distinctly possible that changes occurring with bajos were to some degree independent of Maya involvement. However, given the great amount of Maya activities in and around bajos, it may be impossible to ever fully resolve the relative importance of natural and anthropogenic changes within these basins, a problem that also afflicts sedimentary records in regional lakes with heavy human disturbance in their watersheds (Brenner et al. 2002; Rosenmeier et al. 2002). Regardless of whether the causality was principally natural, anthropogenic, or equal parts of both, it is reasonably clear that water became increasingly and perhaps episodically scarce in significant parts of the Maya Lowlands, and the drying of many bajos would have posed significant challenges for the Maya.

Ideological Transformations

For traditional Yucatec Maya farmers, the earth, or *luum*, is believed to impart *itz*, “sap” or “the holy substance of life,” to growing plants and

other things. This is part of the cyclical system in which *yiitz ka'an*, “the holy substance of the sky,” is believed to bring fertility to the earth in the form of rainfall (Dunning 2003). A more sacred and life-sustaining view of soil and water is hard to imagine. In contemporary rituals Maya shamans call forth the *itz* from the ground and from the sky at critical times in the agricultural cycle. Beliefs concerning the importance of *itz* in Maya cosmology can be traced back well into the Preclassic period (Freidel, Schele, and Parker 1993:116–40). These beliefs thus appear to have evolved hand in hand with Maya agriculture and culture, adapting to and reflecting changes in the environment and society (Dunning and Beach 2004). These changes and reflections included the loss of wetlands as the Preclassic period waned and the construction of reservoir and terrace systems as the Classic period progressed—the institutionalization of a sacred bond between the Maya and their environment. These ideas apparently originated early on in the development of ancient Maya cosmology and were born in part out of the observations of water in the natural world (Fash and Davis-Salazar, this volume; Freidel, Schele, and Parker 1993:132–60; Harrison 1977; Lucero, this volume; Puleston 1977; Scarborough 1998). However, these ideas became increasingly important and codified as the result of environmental transformations in the Maya world that took place in the Late Preclassic through Early Classic periods (400 BC–AD 600).

Some of the basic Maya and Mesoamerican ideas concerning the role of water in the structure of the world and its consequent ritual use appear to have their earliest expressions among the Olmec during the Middle Preclassic (Angulo Villaseñor 1993; Freidel, Schele, and Parker 1993; Scarborough 1998). These central ideas included the concept of the earth's land surface floating on a sea or watery surface of the underworld that not only surrounded the land but breached its surface in many places in lakes, swamps, sinkholes, and caves. Another critical concept was that of sacred mountains and caves as centering points on the landscape. These cave mountains were also points of access to and locations of the emergence of the earth's waters as well as places of ancestral origin. Both among the Olmec and Preclassic Maya these ideas became manifest in architecture as pyramidal “temple mountains” and plazas and reservoirs that reproduced this basic cosmological structure as the venue for human ritual (Dunning et al. 1999). The art and iconography that were used to adorn these architectural stages and the costumes of the rulers and other important persons who presided in the rituals were steeped in both pictorial and symbolic expressions of water and a watery world, including waterbirds, crocodiles, fish, turtles, frogs, and water lilies (Harrison 1977; Lucero 1999b; Puleston 1977; Rands 1953). Water lilies in particular came

to be used as a badge and title of political authority during the Classic period (Ford 1996; Lucero 1999b, this volume). Similarly, the Classic glyph for itz was a flower and was used in badges connoting shamanistic power (Freidel, Schele, and Parker 1993:412).

Assuming that our model of bajo transformation is representative of conditions affecting basins within much of the interior portions of the central and southern Maya Lowlands, it has important implications for understanding changes that occurred in Maya civilization toward the end of the Preclassic. One of the most notable changes occurring at that time was the abandonment of El Mirador, Nakbe, and nearby urban centers (Hansen 1992; Hansen et al. 2002). Notably, these were the largest known Preclassic urban centers in the Maya Lowlands. It is possible that their great size made them particularly vulnerable to environmental disturbance, or, perhaps because of their large size, environmental degradation was more severe or rapid than in neighboring areas, triggering abandonment. While the environmental disturbance generated by Preclassic people was certainly significant elsewhere, it may not have been as rapid or as acute as around El Mirador and Nakbe. This difference may help explain why, in neighboring localities like Tikal, Calakmul, Río Azul, and La Milpa, population continued to grow and urban development persisted.

Nevertheless, in many places like La Milpa the loss of perennial water sources in the bajos necessitated developing new water sources and more water-conservative agriculture. Thus it is not surprising that during the transition from the Preclassic to the Classic reservoirs became an integral part of the urban landscape at many southern lowland centers (Scarborough 1993). The localized control of water resource by urban elites, the intensification of local agricultural production, and the centralization and stratification of land wealth were also fundamental components of the Preclassic to Classic transition (Dunning 1995). These processes were seemingly brought about in part by the adaptations necessitated by the transformation of the bajos and probably also facilitated by the disruption of the urban hierarchy accompanying the fall of El Mirador and nearby Preclassic centers.

Where legible, the glyphic texts on stelae and other monuments tie the founding of Classic royal dynasties to the first years of the Early Classic period (AD 250–600), marking a shift to political states based on institutionalized royal succession (Grube 1995). The art and iconography of Classic period royalty contain many water/wetland associations, most notably the water lily, which was a symbol of both purity and abundance (Fash 2005; Fash and Davis-Salazar, this volume; Ford 1996; Lucero 1999b, this volume; Puleston 1977; Rands 1953; Thompson 1970). Some glyphic

texts go so far as to refer to Maya nobility as “water lily people” (Lucero 1999b). The Maya rulers of the Classic period, as the water lily people, were the keepers of water and reservoirs (Fash 2005; Fash and Davis-Salazar, this volume). In fact, the presence of water lilies within reservoirs may have both ecologically and symbolically indicated the purity of the water (Lucero 1999b, this volume). As alluded to earlier, in Maya cosmology wetlands are strongly identified with the origins and order of the world. In Maya iconography wetland symbolism is linked to cosmic and ancestral progenitors. While these symbolic associations had their origins in the Preclassic, when the southern lowlands were a much wetter environment, these associations intensified during the Classic period and became more strongly identified with royal authority, reflecting the increased scarcity of water in the environment and its symbolic and actual control in urban settings. As the urban dwellers of the Classic period came to be dependent on reservoirs to survive the dry season, so too they became dependent on rainfall to replenish the reservoirs. At the Classic centers of Copan and Palenque, on the flanks of the Maya Lowlands where flowing surface water is abundant, the symbols of rulership and cosmic order and the physical management of water flow are closely interlinked (Fash and Davis-Salazar, this volume; French, Stuart, and Morales, this volume).

Maya rulers of the Classic period are also often identified by their costumes and by glyphic texts as shamans, or *itzam*, that is, “*itz*-ers,” or those who can summon *itz* (Freidel, Schele, and Parker 1993:411). In this sense these rulers became the ritual keepers of the gateways in the “*itz* cycle” and symbolic facilitators of the hydrologic cycle. In this manner they manipulated potent symbols in an effort to aid the desired flow of *itz*, to insure the movement of water from the earth into the sky and back again, fertilizing the soil, restoring the watery essence of the world, and renewing life. However, this association of royal power with both real and symbolic manipulation of water would also have made the authority of rulers highly vulnerable to dispute should the forces of nature and the ingenuity of adaptive strategies fail to provide the water necessary for the maintenance of Maya civilization and human life (Lucero, this volume).

Epilogue

Over the years a number of scholars have pointed out that there is a great deal of variability in the ecology of present-day bajos (e.g., Brokaw and Mallory 1993; Culbert, Levi, and Cruz 1990; Culbert et al. 1996; Kunen et al. 2000; Lundell 1937; Pope and Dahlin 1989). It is becoming increasingly clear that considerable variability existed in bajo ecology in the past

—a finding that should not really come as a great surprise. From our review of the data currently available it would seem that the present-day conditions in any given bajo do not appear to allow us to retrodict conditions in that bajo in the past. In short, we are likely faced with the daunting task of geoarchaeologically investigating bajos on an individual basis if we wish to gain an environmental understanding of the history of adjacent settlements. To date, most intensive geoarchaeological investigations of bajos have taken place in close proximity to ancient urban centers (e.g., La Milpa, Yaxha, El Mirador, Nakbe, and Calakmul). Not surprisingly, the evidence for dramatic human impacts has been considerable in these locations, whereas studies in bajo locations farther removed from urban places have produced a more varied picture both of environmental conditions and human impacts. If we are to gain a fuller understanding of the nature and history of human interactions with bajos, our investigations must carry us farther into these complex depressions. However, if our work is to take on meaning, we must also seek out the archaeological correlates of environmental change reflected in both mundane adaptive technologies and ideological patterning.

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6

Water Management, Ritual, and Community in Tropical Complex Societies

JULIE L. KUNEN

Water management has long been viewed as a critical impetus in the formation of archaic states, especially those located along extensive river floodplains or large lakes. Marx's Asiatic mode of production and Wittfogel's model of hydraulic societies emphasized centralized state control over agricultural lands and irrigation, respectively, as the principal sources of power in these polities (Marx in Avineri 1969; Wittfogel 1957). In the last thirty years, however, scholars have turned away from models of archaic states as rigidly hierarchical despotisms reliant upon state administration of a hydraulic bureaucracy. The popularity of various theater state or galactic polity models—models that emphasize the notion of the state as a replica of the cosmos, with a divine ruler invested with ritual power at its sacred center, the capital city—has influenced interpretations of statecraft not only in Southeast Asia, where such models originated, but also in Mesoamerica (Demarest and Conrad 1992; Freidel 1992; Geertz 1980; Heine-Geldern 1956; Inomata and Houston 2001). Proponents of these models maintain that power rests on an ideology linking a society's rulers to the forces of natural and supernatural elements through elaborate royal ritual and state ceremony.

Ongoing debate concerning the basis for and degree of centralization of political power in archaic states has yielded an important insight: throughout the premodern world, civilizations arose through multiple trajectories of state formation. Differences in these trajectories are particularly evident in tropical complex polities, where certain ecological parameters not found in more arid locales pose a challenge for political organization (Scarborough, Schoenfelder, and Lansing 1999; Wisseman Christie 1986). Of primary consideration is the dispersed nature of critical natural resources and, often as a result, population. A second environmental factor of supreme importance is the marked seasonality of rainfall in the tropics. The unique circumstances of tropical civilizations thus re-

quire a set of models that makes careful consideration of how and to what degree states control, manage, and manipulate their resource base.

Recent scholarship among the archaic states of Southeast Asia, where Marx originally claimed to identify an Asiatic mode of production, has identified two very different developmental histories (Kulke 1986; Lansing 1991; Scarborough, Schoenfelder, and Lansing 1999; Stargardt 1986; Vickery 1986; Wisseman Christie 1986). In certain parts of the region, such as Java and possibly Cambodia, imperial states developed that were closely tied to the centralized expansion of irrigated rice agriculture through state-sponsored programs of large-scale canal and storage tank construction. These polities are associated with dense urban populations, construction of state capitals modeled on Hindu-Buddhist cosmology, monumental temple architecture reflective of the sacred mountain at the center of this cosmology, and annexation of large amounts of territory. In contrast, in other regions, such as Bali, centralized states did not evolve, or they flourished briefly and then devolved into small kingdoms or principalities. In these areas the expansion of irrigation agriculture was a more local affair, reliant upon intervillage coordination and cooperation. No large-scale waterworks were constructed, nor did large cities develop. Construction of monumental architecture was short-lived, and kingdoms remained territorially compact, although quite numerous (Lansing 1991, n.d.).

A comparison between Bali and the pre-Hispanic Maya Lowlands allows us to investigate questions regarding the organization of different types of agricultural systems, to examine the important role of ritual in agricultural production and state making, and, in a more general manner, to talk about the possibilities for understanding water management in prehistoric societies where neither informants nor texts exist (in the case of the Maya no writings of an economic nature have been discovered). Finally, the comparison allows us to speculate on the possibility that the extremely ritualized, elaborately regulated irrigation management system of Bali may have had parallels in the equally ritual-driven, highly regulated Classic Maya society.

I begin this chapter by revisiting the roles of water management and ritual in the formation and organization of ancient states and in theories of state formation. I focus upon two civilizations, the Balinese and the Lowland Maya, that illustrate a trajectory of development in which critical natural resources were not tightly controlled by a centralized political power. Rather, well-developed local or community-level institutions that managed resources seem to have precluded such centralized economic control, leading to smaller and/or more dispersed polities. In

both instances these local institutions have a strong ritual component. In Bali water temples serve as ritual regulators of both irrigation schedules and social relations among cooperating groups of farmers. Similarly, in the Maya Lowlands I hypothesize that household shrines may represent a similar institution for the management of village agricultural resources. I explore this hypothesis below using data from a recent study of ancient Maya farming communities and agricultural features conducted in the Far West Bajo, a small wetland in northwestern Belize. I conclude by proposing further research to consider the possibility that Maya shrines are cadastral, not only serving as focal points for ancestor rites but also, and importantly because of their links to powerful ancestors, demarcating territorial divisions and bolstering land claims by resident social groups.

Bali and the Lowland Maya

Recently, several anthropologists have argued for commonalities in the origins and development of sociopolitical complexity in Bali and the Maya Lowlands (Kunen 1996; Scarborough, Schoenfelder, and Lansing 1999). The two regions share a number of similarities. Bali, of course, was the original model for the theater state (Geertz 1980). Its capitals were founded upon the idea that earthly success depended on replicating, in all human endeavors and as closely as possible, the cosmic order of the larger universe. Thus the prevailing organizational principle was parallelism between the macrocosm of the universe and the microcosm of the human world (Heine-Geldern 1956). The state should not only mirror this order but also embody the unity of the cosmos through its organization. The staging of cosmologically significant ritual performances required the mobilization of enormous resources and manpower. The more elaborate the ritual, the more divine the king and the more exemplary the state.

Similarly, ample iconographic, epigraphic, and artifactual evidence testifies to the extraordinarily ritualized nature of Maya life during the Classic period. Ideology and ceremonial display played an important role in the evolution of Maya civilization. Maya capitals, like Balinese ones, served as stages for the enactment of rituals that reproduced the cosmic order on earth, with the divine ruler at the symbolic center of the universe (Inomata and Houston 2001). Symbolism displayed by Maya rulers to illustrate their ties to the supernatural world evinces a similar concern with the four cardinal directions and with a religion structured by architectural and ritual links between the several planes of the cosmos, including the underworld, the earth, and the celestial heavens (Freidel and Schele 1988).

On a less ethereal plane, Scarborough, Schoenfelder, and Lansing (1999) have argued for ecological similarities between the two regions. On the surface this may seem far-fetched, as most of Bali is mountainous, volcanic, and fertile, while much of the Maya Lowlands is relatively flat, karstic, and thinly covered with soil. However, neither region is dominated by large rivers with extensive floodplains, as in many other areas of archaic state formation, such as Mesopotamia, Egypt, and the Indus Valley. Rather, irrigation agriculture in both locations relies upon the capture of many small, dispersed water sources (Lansing n.d.). In Bali agriculture relied upon the close coordination of small networks of spring- and stream-fed irrigation canals and tunnels to water-terraced rice paddies. In the Maya area such a strategy involved storage and management of rainfall through construction of reservoirs, manipulation of streams, and creation of carefully engineered terraced and walled agricultural fields (Kunen 2004; Lucero 1999b; Scarborough 1998).

In his research Scarborough (1998) emphasizes the centralized, “top-down” control and management of water resources by Maya elites residing in ridgetop political centers. He envisions the construction of artificial “convex” watersheds (which included carefully engineered plazas designed to channel rainfall), centralized storage reservoirs, and a series of check dams regulating the release of water to dependent populations on the slopes below. I suggest that a further commonality between the Balinese and the Maya examples is the existence of local level, “bottom-up” strategies for management of irrigation agricultural systems.

In the Balinese case these involve the *subaks*, or village-based irrigation societies. A subak as a technical unit consists of all the rice terraces irrigated from a single canal. As a social unit it is an autonomous corporation consisting of the owners of all the terraces irrigated from a single irrigation canal. It is an organization that parallels but is separate from the hamlet corporation, which governs civic affairs and which may be considered the principal body of local village government (Geertz 1980). Stargardt (1986) has argued that the existence of such local mechanisms for the organization of irrigation agriculture hindered the development of centralized states in places such as Bali and that these social structures are noticeably absent in areas where centralized polities and oversight of large-scale construction of waterworks occurred.

Bali's failure to develop a more centralized political and economic organization can in part be attributed to its steeply dissected topography, which precluded the construction of canals and tanks on a scale large enough to have benefited from state administration (Lansing 1991). Instead, irrigation agriculture was intensified at the local level through the

incremental expansion of networks of small irrigation canals and groups of rice terraces. Irrigation networks were constructed, maintained, and regulated by subaks, which fostered cooperation among villages of dispersed farmers reliant upon shared water sources. A critical component of the subak system are networks of water temples whose ritual roles extended to regulation of irrigation schedules and management of the flow of information throughout the network (Geertz 1980; Lansing 1991). The subak system thus produced a set of economic and ritual ties linking farmers, water, and land to temple networks (Geertz 1980). These networks existed *outside* the state power structure, forming in essence a parallel ritual hierarchy at whose pinnacle was not the king but the highest water temple priest (Lansing n.d.). Unlike lowland areas such as Java and Cambodia, where the intensification of agriculture created a positive feedback loop that contributed to centralization and the growth of the state, in Bali intensification of agriculture coincided with the decline of royal power and the concomitant expansion of networks of village-based water temples (Lansing n.d.).

Much of what is known about Balinese water temples comes from inscriptions, ethnohistoric documents, and ethnographic observations. Unfortunately, the Maya area suffers from a lack of inscriptions pertaining to economic matters and a relative dearth of evidence regarding nonelite ritual activities. If such institutions are to be identified, it is to the archaeological record we must turn. I focus on one class of structures that may represent community ritual institutions that served to coordinate the use of critical agricultural resources. These are the small shrines or pyramidal structures commonly found in even the smallest Maya settlements.

Ancient Maya Communities

In recent research in northwestern Belize I investigated the organization of ancient settlements with respect to the use and management of resources critical to agricultural production, including land, water, and raw materials for tool production (Kunen 2001, 2004). I sought to understand the relationship between access to these resources and the social and spatial organization of three ancient Maya farming communities associated with a small seasonal wetland, or *bajo*. My research linked aspects of residential variability, most notably length of occupation, size and complexity of house compounds, and extent of architectural elaboration, to access to resources by demonstrating that the residences of community founders — those with evidence for the longest occupation — were also the largest, most complex, and most elaborate in each community. I argued that the

high socioeconomic status of community founders, expressed most visibly in the architecture of the residence, was based on access to the greatest number and/or highest quality of productive resources. Founding families at each community established themselves first, building residential compounds and gaining access to prime agricultural lands. These compounds grew in size and complexity as family size and economic prosperity increased. As population rose, new residential groups were established. These families made use of fewer or lower quality resources and thus had fewer resources to invest in domestic architecture. As production intensified, risk management favored diversification. Those families with access to multiple ecological zones were better positioned to develop multiple production strategies. Perhaps because early success increased their size, or perhaps because their original claims include terrain in various zones, founding families were most able to craft a diverse domestic economy. Their continued success over generations allowed them to invest agricultural surplus in architecture. The result was the larger, more complex, and more elaborate residential compounds that mark their homes. The presence of shrines or temples in these groups suggests that community leadership by founding families had a ritual component.

The Far West Bajo

My data are derived from a portion of the sustaining area around the important Maya site of La Milpa in northwestern Belize (fig. 6.1). The study area lies within the Bravo Hills region, which is characterized by faulted limestone broken into a series of undulating plains and karstic hills. The Far West Bajo is one of many small enclosed depressions (bajos) lying between these ridges and hills throughout the area. The region lies within the neotropics and is therefore subject to highly seasonal rainfall. An annual dry season from December until May poses substantial challenges to human inhabitants of the region, as perennial sources of water are rare (Dunning et al. 2003:19; see Dunning, Beach, and Luzzadder-Beach, this volume).

The environment of the Far West Bajo is thus ecotonal, consisting of upland hills and ridges, gentle slopes, and the seasonally wet bajo. This heterogeneity provided ample possibilities for landscape modifications, facilitating human activity. Residents of bajo communities divided the landscape into discrete zones, each with a distinct use pattern (fig. 6.2). Settlements were located on isolated hills or on ridgetops surrounding the bajo. Here groups of masonry structures and stone-faced rubble platforms clustered together on high, flat terrain. In residential zones there is

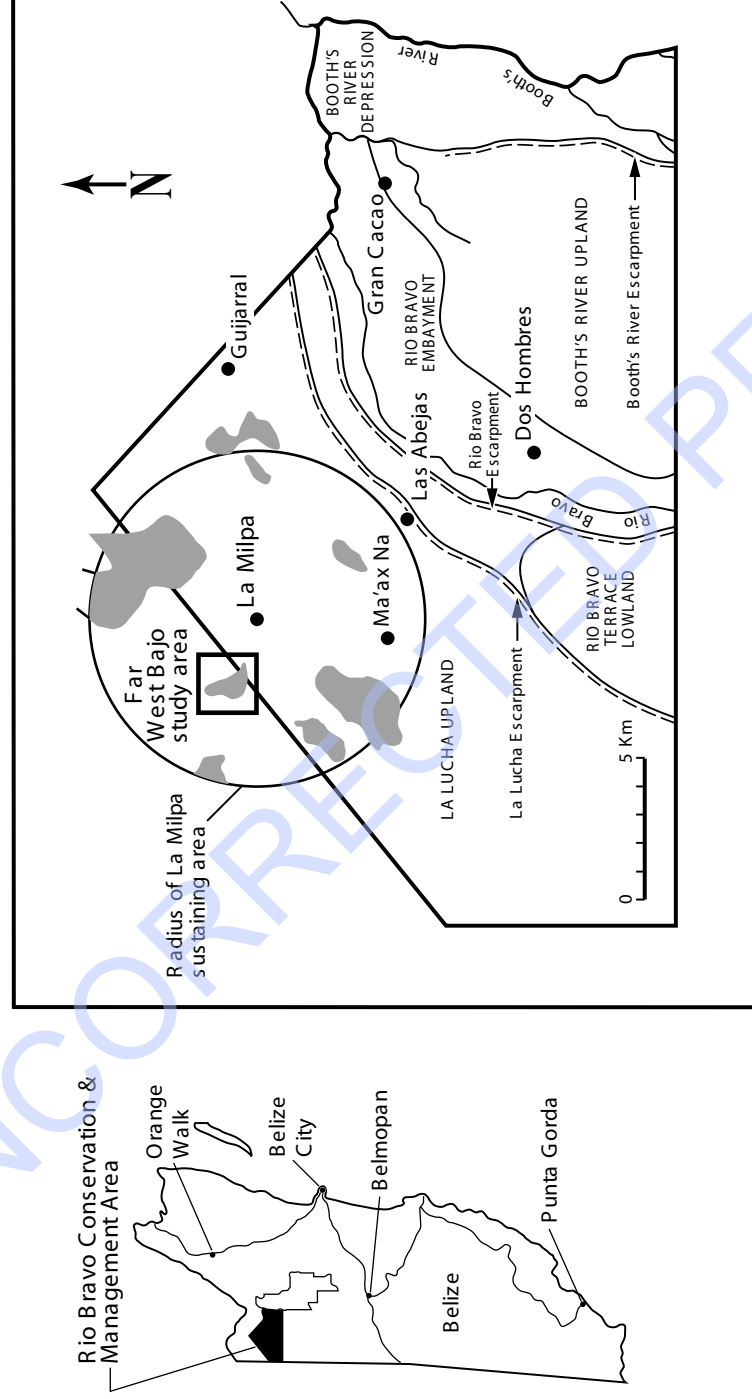


Fig. 6.1 Northwestern Belize, indicating the study area, major sites of the region, and physiography. (After Houk 1996:84; reproduced courtesy of Brett A. Houk and the Programme for Belize Archaeological Project)

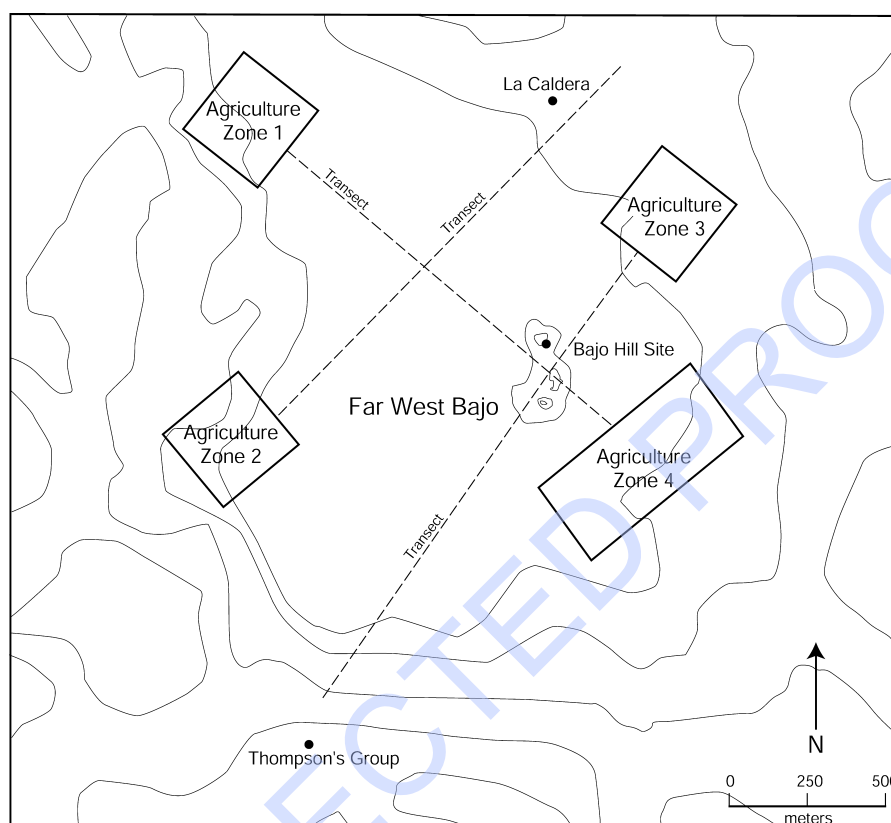


Fig. 6.2 Location of residential sites and agricultural zones in the Far West Bajo. (Reproduced from the *Journal of Field Archaeology* with the permission of the Trustees of Boston University. All rights reserved)

no evidence for significant landscape modification. Instead, distinct agricultural zones were found in the gentle slopes at the edge of the bajo. These areas were marked by dense concentrations of water- and land-management features, including terraces, fieldwalls, and circular rock-piles. Finally, the bajo itself served as a reservoir for basic resources and raw materials, including water, chert, clay, and organic soil. In summary, the bajo and its surroundings were divided into three distinct zones of human activity that correspond to the three principal divisions of the natural landscape: residential zones in uplands and hilly areas, agricultural zones on the sloping bajo margins, and a resource-extractive zone in the bajo interior.

The Agricultural Landscape of the Far West Bajo

I identified three residential communities of substantial size in the Far West Bajo. The Bajo Hill site consists of thirty-eight structures grouped atop the isolated karstic hill within the bajo. Here I tested sixteen structures, eight plazas or extramural spaces, and two patio walls in ten architectural groups. La Caldera is a more imposing site, consisting of seventy-five structures arranged in thirty-two groups above a moderate slope on the north side of the bajo. At La Caldera seven structures, six plaza areas or extramural spaces, and one residential terrace in six groups were tested. Finally, Thompson's Group is a large, formally arranged site of fifty-three structures located atop a steep ridge to the south of the bajo. Here my colleague Hubert Robichaux (1995) placed six test pits in plaza areas.

Excavations throughout these three sites revealed a moderate Late Preclassic presence, indicated by Late Preclassic construction phases in 6.9 percent of structures tested. Population increased during the Early Classic, as indicated by ceramics of this period dating construction in 13.8 percent of structures tested. Population in the area also grew during the early part of the Late Classic. Of structures tested, 17 percent contained ceramic material dating construction to this period. As in most areas of the Maya Lowlands, the Late/Terminal Classic period features the densest population, although the population of this period is not as high as that found in other regions of the lowlands (where, often, over 90 percent of structures feature Late/Terminal Classic construction episodes). Over 65 percent of structures in the study area contained sealed Late/Terminal Classic construction. No Postclassic material was encountered, indicating a total abandonment of the area by this time.

Examination of various measures of architectural complexity demonstrates that occupants of bajo communities, although nonurban agriculturalists, were not low status, as some scholars have argued elsewhere in the Maya Lowlands (e.g., Webster and Gonlin 1988). The houses of community residents were not simple platforms made of unfaced rubble. Rather, the architecture of the three communities demonstrates that residents were prosperous. Investment in masonry, vaulting, benches, plastering, burial chambers, and caches is evidence of residents' ability to marshal economic resources and display them in a conspicuous manner. At the Bajo Hill site most structures feature partial masonry walls and plaster floors. At La Caldera, with one exception all structures tested had partial or full masonry walls and plaster floors. At least one had a vaulted roof. Finally, at Thompson's Group Robichaux reports the presence of masonry and vaulting.

Rebuilding episodes also yield evidence of longevity, prosperity, and family growth over time. At the Bajo Hill site the most common pattern of rebuilding involved conversion from a masonry-edged platform to a partially walled roomed structure. At La Caldera all tested structures were multiphase, and renovation involved the inclusion of benches, floor replasterings, and the conversion of roomed buildings into imposing tall platforms. No comparative data are available from Thompson's Group, since Robichaux did not excavate in structures, although he documents a long history of occupation at this settlement (1995:134–42, 390–402).

These three measures—occupation history, architectural attributes, and rebuilding episodes—demonstrate that each of the three bajo communities prospered and expanded over time. Yet prosperity was not evenly distributed throughout each community. Each bajo community features a principal residential group three to six times larger than the other groups (fig. 6.3). Each of the principal groups has the most complex layout, including between five and eight structures. Most important, each of the principal groups contains a pyramidal structure on the eastern side of the plaza. This pattern suggests that economic prosperity and elevated social status, both of which I link to access to critical natural resources, are also connected to ritual behaviors associated with shrines or temples.

A diverse array of water- and land-management features was found throughout the Far West Bajo. These included dry slope terraces, foot-slope terraces, box terraces, fieldwalls, walkways, *pozas* (small water tanks), and barrier walls that appear to have diverted water out of small streams for agricultural purposes. These features were found primarily at the base of long slopes around the margins of the bajo but were also occasionally located higher up on gentle slopes and small hills and in flat terrain close to the bajo edge. In only two cases were agricultural features directly associated with a formal residential compound, and only in the first case was the association one of spatial integration. In all other instances associated platforms were small, isolated structures of cobble construction that were probably fieldhouses.

I classified 384 of the 679 features recorded in the Far West Bajo as water- or land-management features of three different kinds: terraces, fieldwalls (berms), and rockpiles. I focus here on the first two categories, both linear features. More than sixty terraces were mapped, most running roughly parallel to the slope contour. They range in length from 2 to 50 meters. A typical terrace featured a front wall made of unshaped, dry-laid limestone boulders atop bedrock behind which soil had built up, forming a level surface. The majority of terraces are dry slope terraces, found on gentle slopes of less than 10 degrees. Some of the terraces lie near the

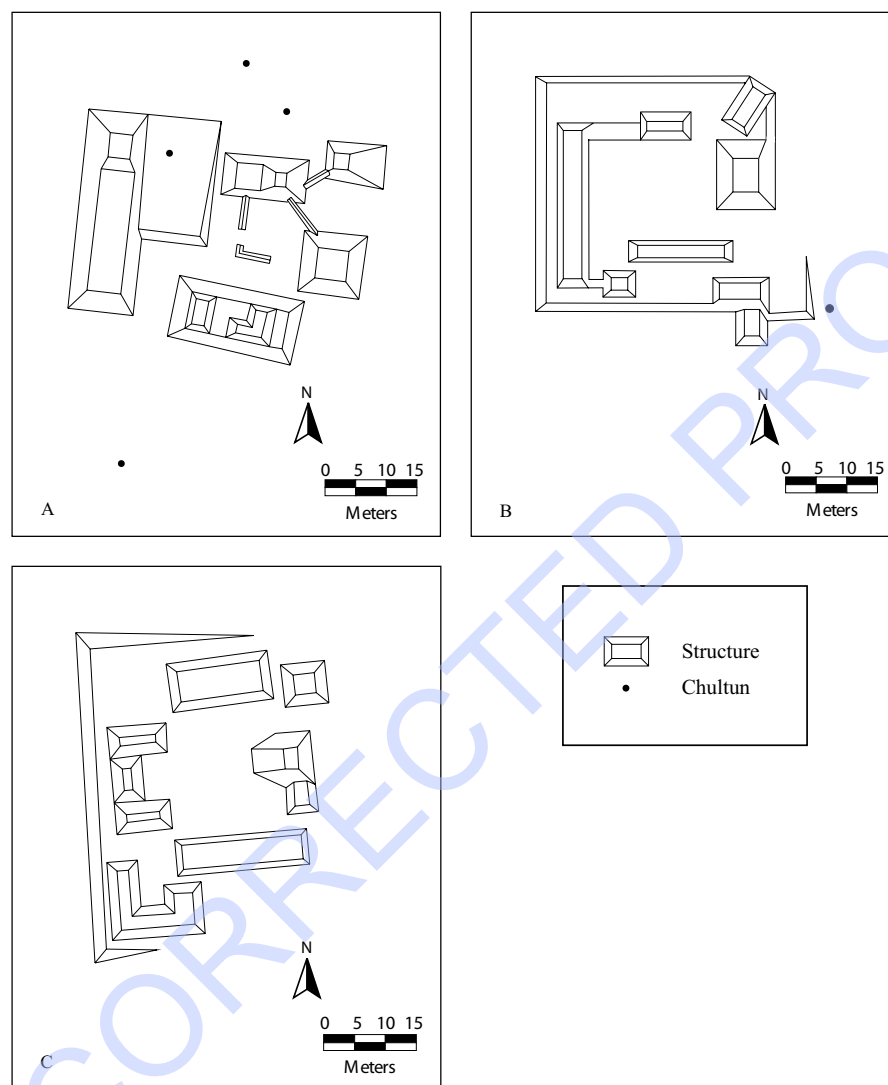


Fig. 6.3 Principal architectural groups: (A) Bajo Hill site; (B) La Caldera; (C) Thompson's Group. (Drafted by Ron Redsteer and Nicole Kilburn; Thompson's Group reproduced with permission of Hubert R. Robichaux)

foot of long slopes, where retention of slopewash could be maximized. These terraces can be considered footslope terraces, although the slopes at whose base they are located are not very steep. One or two of the mapped terraces are box terraces, which form enclosed rectangular plots.

Based on surface indications alone, terraces are not always easily distinguishable from rubble fieldwalls. Like terraces, fieldwalls are linear rubble features, but, unlike terraces, they usually do not contain an interior wall or footing stones. Instead, most are unstratified masses of chert and limestone cobbles in a clayey soil matrix. In the study area 101 features were classified as fieldwalls, ranging in length from 3 to 50 meters. Unlike terraces, these features do not always run parallel to the slope contour. Some do, while most run at an angle to the contour, and still others run perpendicular to the slope. Often they intersect or abut terraces, forming V-shaped or rectilinear patterns. Both terraces and fieldwalls were concentrated in four distinct agricultural zones located around the margins of the Far West Bajo and are spatially distinct from ridgetop residential zones.

Agricultural features are notoriously hard to date because they usually contain very few ceramics and those that are present are often too eroded to be diagnostic. The lack of floors to provide sealed contexts exacerbates the problem (Turner 1983:96). Yet the dating of agricultural features is critical to discussions about the pace and mode of resource management in the Maya Lowlands. If all agricultural features in an area date to the same time period, they may be interpreted as indicating the very rapid inception of intensive methods of resource control. This is especially true in the Late Classic, when population densities in most parts of the lowlands were at their maximum and many scholars infer that agricultural intensification reached its widest extent. In contrast, if the features date to several time periods, they may indicate the more gradual adoption of resource management strategies.

In many instances the lack of diagnostic ceramics from agricultural contexts prompts scholars to date features by reference to the nearest datable residential structures on the grounds that there is likely to be an association between the local settlers and nearby fields (Turner 1983:96). In the Far West Bajo, however, the spatial segregation of terraced fields from nodes of residential architecture precludes this option. To facilitate the discussion of chronology, all datable ceramics from all lots excavated in a single feature have been aggregated. Since most of the agricultural features are single component, lumping the ceramics together does not unduly distort their construction history. Nevertheless, in most cases only a handful of datable ceramics was excavated in any one agricultural feature.

The agricultural features tested throughout the Far West Bajo are surprisingly early, with most ceramic material dating to periods prior to the Late/Terminal Classic. Of the six features excavated in Agricultural Zone 1, five yielded very small numbers of datable ceramics. These date to the Late Preclassic (four sherds), the Early Classic (six sherds), the early Late Classic (ten sherds), and the Late/Terminal Classic (four sherds). Eight features in Agricultural Zone 2 were excavated, but only four of these are datable. All are early, as a total of only four Late/Terminal Classic sherds were recovered from the tested features. Early Classic and early Late Classic dates for the Agricultural Zone 2 features seem likely. In Agricultural Zone 3 a pair of features (one terrace and one rockpile) yielded only Late Preclassic material, although admittedly in small amounts. A terrace yielded a single early Late Classic sherd. Again, early dates seem possible. In Agricultural Zone 4 only two fieldwalls yielded ceramics. One contained Late Preclassic and Late/Terminal Classic material. The other contained Early Classic and early Late Classic ceramics.

Another way to examine the ceramic data is to calculate the latest period represented in each excavation. For example, one terrace, one field-wall, and one rockpile contain sherds dating no later than the Late Preclassic, and another three features contain ceramics no later than the early Late Classic. Looked at in this manner, the ceramic data suggest early use of many of the features. The admittedly sparse ceramic data from the agricultural zones suggests that, while some features were utilized during each time period, many of them are earlier than expected, given that more than two thirds (69 percent) of datable sherds from the three bajo communities date to the Late/Terminal Classic.

Implications for Control of Critical Natural Resources

The spatial patterning of water- and land-management features in the Far West Bajo suggests that agricultural production, at least in this part of the Maya Lowlands, was not centrally planned and implemented by an overarching state-level administration. The features are not very large or formal in their construction method. They are neither uniformly spaced nor regular in shape or size. They were built incrementally, not in coordinated episodes of investment in landscape engineering. This is in marked contrast to the large scale, spatial extent, regularity of size, and uniformity of construction methods of waterworks and land-management features attributed to landscape projects with centralized oversight, as at Caracol in the Maya area or Angkor in Cambodia (Chase and Chase 1998; Stargardt 1986; Vickery 1986). Neither do the features suggest household levels

of production, however. Terraces and fieldwalls are not carefully interspersed among residential groups to form coherent units. They do not delimit small farmsteads or house lots, as is documented in the Belize River Valley and the Río Bec region (Fedick 1984; Fedick and Ford 1990; Turner 1983). Box terraces, usually interpreted as seed beds or house gardens and associated with individual residential units, are not prevalent in the area. Rather, the agricultural features of the Far West Bajo are spatially discrete from residential areas and constitute concentrated zones of resource management.

The connection between domestic groups and particular resources encourages both residential stability and proprietary use rights. Continued residence in a particular location cements claims to critical resources and solidifies the right of inheritance through the generations. This is especially important in systems of intensive agriculture, where improvements to land require investment of time, labor, and materials. Such systems are likely to develop only in situations where claims to the improved land—what Dunning and his colleagues refer to as “intensifying investment in localized space” (1999:657)—can be sustained.

The unplanned, incremental development of the Far West Bajo agricultural landscape is paralleled by the accretionary trajectory of Balinese irrigation systems, which grew organically through construction of canal sections, aqueducts, and tunnels to expand irrigation to new areas, producing “a tethered chain of terraced hillocks” (Lansing n.d.). Given what we know about local regulation of irrigation in Bali through subaks and water temples, investigation of how ritual served to regulate resource management by agricultural villages in the Maya area offers a potentially profitable avenue of research. In many ancient Maya villages ritual practices were focused on shrines situated within principal residential compounds, like those described for the three Far West Bajo communities.

Ancestors, Shrines, and Resource Control

Several Mayanists, most notably Marshall Becker (1971, 1988, 1999), William Haviland (1981, 1988), and Patricia McNany (1955, 1998), have identified small, square buildings, often located on the eastern sides of courtyard-focused residential compounds, as household or lineage shrines. These structures are thought to replicate on a smaller scale the monumental pyramids housing royal burials in large Maya centers. The interment of bodies in the small shrines suggests to these scholars that such buildings were the focus of household or lineage-based ritual practices, often including ancestor veneration.

McAnany (1995) interprets the creation of ancestors as a claim to land and rights in resources made by associated lineages. For instance, at K'axob in northern Belize she demonstrates a close connection between land tenure and the organization of settlements based on the concept of lineages as the residents of architectural groups. Lineages, as McAnany sees them, are primarily resource-holding groups linked to particular tracts of land and patches of resources. At K'axob McAnany finds that the largest and most elaborate platforms are those with Preclassic cores. Moreover, the more complex clusters of structures, which McAnany refers to as alpha residences, feature shrines that are associated with ancestor veneration. These complexes are often surrounded by smaller residences, sometimes lacking shrines. The practice of ancestor veneration in the older, more complex residential groups suggests that their residents recognized and respected the role of the lineage in creating resource-based prosperity.

Tourtellot (1988) makes a slightly different argument at Seibal, focusing not on the largest residential groups but on the largest structures within residential groups as the potential homes of founders. He attributes the architectural prominence of these structures to either the founding family's early start in the area or its greater access to resources. It is likely that the two reinforced each other. Tourtellot cites ceramic data, among other evidence denoting the residences of family heads, that suggest that the largest structures were also the earliest structures in each residential group.

Fry (1969) notes that at Tikal family heads or those with higher social status are identified with large, complex residential groups, which often contain special function structures indicative of clan leadership. Similarly, Haviland (1988) attributes to the family head the architecturally more complex structure in a residential group at Tikal whose history he examined in depth. He cites several architectural measures of social status at Tikal, including vaulting, masonry construction, presence of eastern shrines, elaborate burials within those shrines, and outbuildings as part of the residential complex (Haviland 1981). These measures are very similar to the ones I used to suggest the presence of community founders in the Far West Bajo communities.

Other researchers working in the Río Bravo region have also argued for archaeological evidence of corporate landholding groups. Hageman and Lohse (2003) have argued for "First Tier Groups" of high-status residences that are akin to residences of first founders documented by McAnany and myself. These groups are all east-focused patio groups similar in plan to the Plaza Plan 2 groups identified at Tikal by Becker (1971, 1999).

Hageman and Lohse interpret each of these compounds as an “expression of local politico-religious power” and suggest that they are physical evidence for the presence of corporate groups in the region (2003:119).

A growing body of research on ancient Maya corporate groups thus stipulates a connection between architectural evidence for founding families and their potential roles as leaders of social groups whose primary identity is as resource-holding entities. A common thread throughout this research is the presence in high-status residential compounds of shrines serving what are variously interpreted as ritual, public, or administrative needs, but what is still lacking is evidence linking shrines to the control and management of resources. An explicit focus on these structures in light of these interpretations of ancient Maya social organization will strengthen our understanding of the use, access, and control of critical natural resources.

Conclusion

Based on spatial patterns in residential features of the Far West Bajo I documented the presence of economically prosperous founding families, pioneers of agricultural villages whose economic and social success I attribute to privileged access to critical natural resources. Architectural patterns in the residential compounds associated with these founding families include the presence of shrines, suggesting a ritual role in these families’ community leadership. Furthermore, research summarized above by other scholars on household shrines interprets them as foci of ancestor veneration by corporate resource-holding groups. In this view community leaders are seen as those with successful claims to rights in land and resources. A connection is thus hypothesized between shrines as loci of ritual practices that help to define social groups and social groups as attached to or laying claim to specified resources. Only further research on the roles of shrines will allow us to evaluate such a hypothesis linking shrines to social groups’ rights in resources. With additional data we will be better able to assess whether such structures represent a social institution parallel to Balinese water temples, in which ritual regulates both resources and the social relationships that partition and control them.

7

The Political and Sacred Power of Water in Classic Maya Society

LISA J. LUCERO

Weather has a major impact on the varied natural and social landscapes found throughout the southern Maya Lowlands; it affects settlement decisions, ritual practices, agricultural schedules, and political histories. Factors such as annual flooding, hurricanes, and other aspects of water (e.g., waterborne diseases and water quality) play a role in varied political histories, since how people subsist and live on the landscape affects surplus production and, more significantly, how leaders tap into the surplus. In this chapter I explore the role of water in Maya political and ritual life during the Late Classic period (c. AD 550–850), when Maya rulers reached heights of power never attained before (see Lucero 1999a). I attempt to show that seasonal availability and amount of water and the distribution of agricultural land influence (but do not determine) center, settlement, and political complexity.

For millennia the ancient Maya successfully adapted in a tropical setting, one that presents several challenges. For example, seasonal drought is a problem. Fluctuating seasonal rainfall patterns also add to the uncertainty of tropical life—if farmers plant too soon before the rains begin, the seeds will rot; if they plant too late, the seeds will not germinate. The Maya also had to contend with waterborne diseases. Flowing water typically is safer and cleaner than standing water but can pose dangers during the height of the rainy season (especially for travel) as well as become stagnant during the height of the dry season.

These and other issues relating to water clearly had an impact on ancient tropical societies, and we need to think about them when attempting to explain Late Classic Maya political systems. In the following section I detail how Maya centers vary with regard to seasonal water supply and amount of agricultural land. I do not claim that there is a formula whereby water issues plus agricultural land equal political history; how-

ever, political systems require sustenance, and it is this topic upon which I largely focus.

Water and Politics

In an earlier model I argue that at nonriver major centers like Tikal, Calakmul, and Caracol rulers' maintenance of artificial reservoirs combined with their knowledge and performance of associated rituals facilitated dry-season nucleation at centers and lessened the need for hinterland farmers to build their own reservoirs (Lucero 1999b, 2003). Water is critical during the dry season, especially from January through April or May, when for all intents and purposes many areas transform into a green desert. Insects and parasites proliferate in standing water, which also promotes the buildup of harmful chemicals and organics. The reservoirs thus had to be kept clean, which would have been possible through the maintenance of the right mix of subsurface and surface plants and aquatic life to create a balanced wetland biosphere (see Burton et al. 1979). An indicator of clean water at *aguadas* (rain-fed natural basins) and artificial reservoirs is the presence of water lilies (*Nymphaea ampla*). Water lilies are sensitive hydrophytic plants that can grow only in 1–3-meter-deep clean still water (Conrad 1905:116). The water lily is also a symbol of royalty in Classic Maya society (e.g., Rands 1953). In addition, water imagery and evidence for associated rituals are found at major centers (Fash 2005; Fash and Davis-Salazar, this volume; Scarborough 1998), suggesting that rulers conducted water-cleansing rites.

While this scenario attempts to explain events witnessed at Tikal and similarly situated major centers like Caracol and Calakmul, I became interested in the role of water and politics at other center types, specifically minor, secondary, and river regional centers (e.g., Lucero 2002, 2006) described below (table 7.1). While there is much variability among centers whereby each center has its own center, each center type has key factors that distinguish it from others. Each type can be viewed as part of a continuum. The typology used here is only an attempt to separate the constituent parts of a complex and dynamic system. Even though each center has its own specific history, all Maya, elite or not, lived in a tropical setting that had an impact on their social, economic, political, and religious lives.

Minor centers such as Barton Ramie and Saturday Creek are found along the Belize River on a relatively broad alluvium (1–2 kilometers wide or more) (fig. 7.1). Settlement is typically dispersed, with structure densities ranging from about 100 to 150 structures per square kilometer (e.g.,

Table 7.1 Late Classic Maya centers, c. AD 550–850

Scale	Minor center	Secondary center	River regional center	Nonriver regional center
Distribution of resources	river, extensive alluvium	river, uplands with dispersed or limited agricultural soils	concentrated alluvium	uplands with large tracts of dispersed agricultural land and reservoirs
Settlement density	relatively low settlement density	similar settlement density in centers and hinterlands	high settlement density near center	high settlement density near center and in hinterlands
Political economy	no tribute	some tribute	tribute	tribute
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 interpolity relations with equals (polities)	equal and unequal interpolity relations	equal and unequal interpolity relations
Interaction	acquired prestige goods	elite and royal interaction (secondary): prestige-goods exchange, intercenter alliances, marriages and warfare, royal dynasties and rites, writing, and emblem glyphs	elite and royal interaction (primary): prestige-goods exchange, intercenter alliances, marriages and warfare, royal dynasties and rites, writing, and emblem glyphs	elite and royal interaction (primary): prestige-goods exchange, intercenter alliances, marriages and warfare, royal dynasties and rites, writing, and emblem glyphs

Type and scale of monumental architecture	small temples and ball courts	large ball courts, palaces, temples, some funerary temples	large ball courts, private and administrative palaces, funerary temples	large ball courts, private and administrative palaces, 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
Annual rainfall (millimeters)*	Saturday Creek — 2,160	Piedras Negras — 2,838 Yaxchilan — 2,711 Quirigua — 2,220 Dos Pilas — 2,735 Seibal — 2,663	Copan — 1,316 Palenque — 3,681	Tikal — 1,882 Calakmul — 1,671 Caracol — 2,100
Scale of water systems	none	small-scale	large-scale	large-scale
Water imagery	none	present	present	present

* See Neiman 1997:table 15.1.



Fig. 7.1 The Maya area.

Lucero et al. 2004; Rice and Culbert 1990:table 1.1). Minor centers include commoner and elite residences, temples typically not exceeding 10 meters in height, and small plazas or public areas (Arie 2001; Lucero et al. 2004). They may or may not have been subsumed under a regional polity, depending on factors such as distance from major centers and accessibility. Whether or not they were beholden to rulers at larger centers, the Maya interacted with other Maya through exchange and performed daily tasks, including farming, manufacturing (e.g., of ceramic vessels and stone tools), and rituals. The degree to which people were involved in different kinds of economic activities depended on local raw materials (e.g., clay, quarries, etc.).

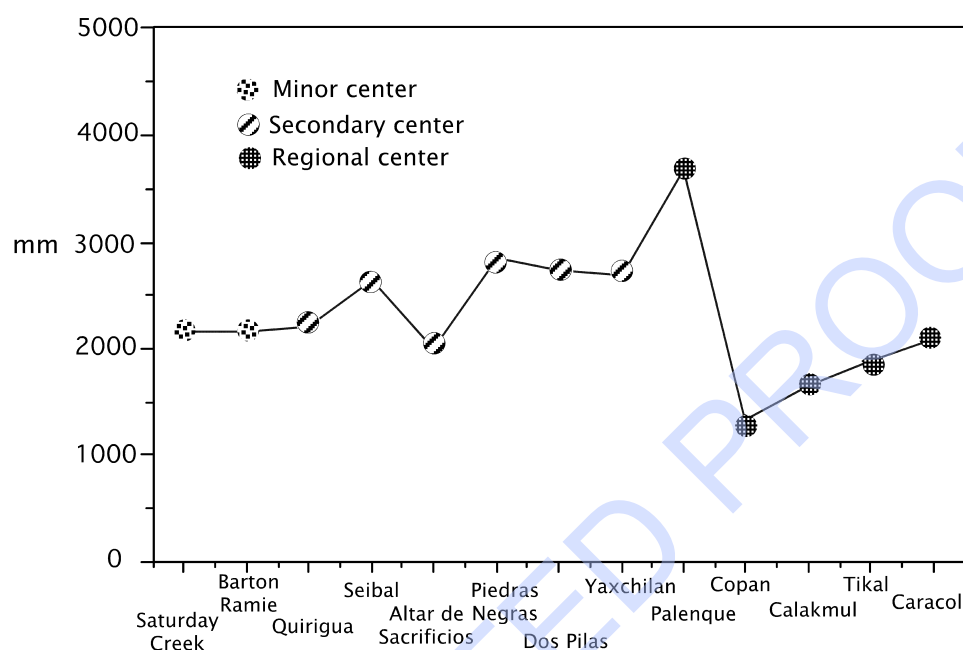


Fig. 7.2 Annual rainfall at Maya centers.

Local elites—wealthy families—sponsored local small-scale public events such as feasts and ceremonies and organized the construction of public works to promote solidarity in the face of economic inequality. It would have been difficult for political aspirants to integrate dispersed farmers and exact tribute. The relatively small temples and lack of palaces, public iconography (e.g., stelae and altars), water systems and imagery, hieroglyphic inscriptions, and emblem glyphs also suggest the inability of local elites to acquire much power over others. Dispersed settlement and plentiful land and water are factors not conducive to support rulership—there was not much a ruler could provide that elites and commoners themselves could not handle. It was thus not possible for minor centers to expand into secondary or regional centers. Elites, however, used the wealth acquired from agricultural surplus to procure what prestige goods (e.g., small nonroyal jade and obsidian items) they could, and they likely gifted some to commoners.

Annual rainfall at Saturday Creek is 2,160 millimeters, similar to that of Barton Ramie, 25 kilometers distant (fig. 7.2). The naturally moist alluvial soils above the river are excellently suited for cash crops like

cacao and cotton (Gómez-Pompa, Salvador Flores, and Aliphath Fernández 1990), not to mention maize, beans, and squash. Consequently, the relatively dispersed settlement may indicate that ancient Maya farmers planted fields interspersed among their houses (see Killion 1990) or that absentee landlords determined settlement and planting practices as estate owners. In addition, the Maya did not rely on water systems, because water was plentiful, and the flooding and subsiding of the river suited agricultural needs (recession agriculture). However, the annual inundation of the poor-draining soils of the river may have deterred the Maya from building or planting too close to the river. For example, at Saturday Creek occupants lived dispersed on the upper terraces along the Belize River, avoiding the lower, poor-draining terraces that are seasonally inundated.

The Belize Valley benefited from annual runoff from Guatemala and western Belize. The Maya would have had plenty of water to last throughout the year. The downside is that runoff also resulted in flooding and the deposition of clayey soils, which can remain saturated for most of the year. For example, in 1998 at Saturday Creek the lower river terrace was inundated during May and June, the end of the dry season. In May and June 1999, however, the lower terrace was completely dry and devoid of pre-Hispanic settlement.

While secondary centers (e.g., Lamanai, Piedras Negras, Dos Pilas, Seibal, Yalbac, and Xunantunich) show great variability, they have several factors in common: their location in hilly or upland areas along rivers (and other water sources) with dispersed pockets of agricultural land, their use of small-scale water systems, and how they differ from regional centers along or near rivers. Secondary rulers incorporated their immediate hinterlands and possibly nearby minor/small centers. They differ from minor centers in several ways. Settlement is denser in and around core areas, for example, up to 275 structures per square kilometer (Rice and Culbert 1990:table 1.1). Hinterland areas are slightly less dense than core areas, for example, up to about 145 structures per square kilometer. Farmers used small-scale water systems, including scattered dams, canals, and drainage ditches, which meant that their role in political machinations was less significant than was found at regional centers. Royals were able to acquire some tribute due to their proximity to harbors and/or pockets of agricultural land as well as their greater participation in and perhaps monopolization of prestige-goods exchange. They procured items that identified them as participants in the royal interaction sphere established by regional rulers, which also included alliances, intercenter marriages,

warfare, royal dynasties, and rites (see Marcus 1987). Their status as secondary polities is indicated in the inscriptions, which typically date later than those at regional centers (see Martin and Grube 2000).

Secondary rulers benefited when regional rulers temporarily or permanently lost political power and when they, for a relatively brief time, became primary rulers, though not to the same extent as at regional centers (e.g., Dos Pilas, Quiriguá, and Seibal). Rulers could not achieve long-term status as regional rulers because surrounding resources (surplus land and labor) were inadequate to support the concomitant political system. They sponsored public ceremonies and organized the construction of public works, ball courts, palaces (usually nonadministrative), and some funerary temples (e.g., Quiriguá and Piedras Negras). They also utilized carved texts and emblem glyphs. Water imagery, including water lilies, is found on monumental architecture and stelae as well as on mobile goods such as ceramic vessels (e.g., Rands 1953). Water lilies themselves, however, are not found in flowing rivers.

Annual rainfall ranges from 2,220 millimeters to over 2,800 millimeters (see fig. 7.2). At most secondary centers annual flooding may have affected inhabitants less than at minor centers, since they lived above rivers on ridges and hills. Saturated hillsides and steep slopes, however, still posed problems and influenced the Maya's building plans and agricultural practices, especially since well-drained upland soils are vulnerable to erosion during torrential rainstorms (Turner 1974).

Water may have played more of a political role regarding access to harbors and the potential to control the trade of exotics such as obsidian and jade. For example, occupants of Quiriguá, located along the lower Río Motagua, were involved in trading jade and obsidian from highland to lowland areas. Furthermore, Ashmore (1981:89) suggests that there may have been artificial levees and/or canals to control flooding and poor drainage. Even though Yaxchilan does not have a river front (Andrews 1975:145), former inhabitants likely still monopolized trade between the Guatemala and Chiapas highlands and the lowlands. Rulers of Yalbac, located along a perennial stream that drains into the Belize River, likely had access to trade items, not to mention agricultural land nearby (Lucero et al. 2004). Many areas of the Usumacinta Basin, however, have poor passage. At Piedras Negras the current is swift and dangerous but is located between two fertile valleys (Houston 1998), the latter of which provided the means for rulers to expand the political economy. Pendergast (1981) proposes that inhabitants of Lamanai may have planted crops in the seasonally inundated harbor. Dos Pilas, though not located on a river, has a

perennial spring close to the main plaza, and inhabitants also had access to underground water at caves near El Duende, the major temple (Brady et al. 1997), both of which likely were controlled by the political elite.

Regional river centers differ from secondary centers in several critical ways. Regional river centers such as Palenque and Copan are found along rivers with concentrated alluvium that supported dense populations and incorporated accessible and nearby lower-order centers (see table 7.1). Settlement is dense in and around these centers, with over 1,400 structures per square kilometer in the core of Copan (Rice and Culbert 1990:table 1.1). Settlement is more dispersed throughout hinterland areas, with up to about 100 structures per square kilometer in rural Copan. Rulers collected tribute because of their ability to control access to concentrated resources, in this case, large-scale water systems and concentrated agricultural land. For example, alluvial soils around Copan are found within a 24-square-kilometer area (Turner et al. 1983; Webster 1999), a situation that provided the means for leaders to access the surplus of farmers. They also dominated 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). A sharp escarpment lies to the south, and to the east and west “the mountainside becomes more karstic and areas of habitable land appear only in isolated pockets” (Barnhart 2001:71). Farmers may also have constructed irrigation canals on the plains below (Barnhart 2001:101). Rulers at both centers likely provided capital to maintain and repair water systems, especially since they were often damaged during heavy rainfall or flooding.

Primary rulers had peer relations with other regional capitals (e.g., Calakmul, Tikal) as well as unequal relations with smaller ones, a fact illustrated in the inscriptions at other centers about these rulers (e.g., Marcus 1976). Rulers funded large-scale political and ceremonial events in central plazas atop temples to incorporate and integrate farmers from the immediate area. They also organized the construction of public works, large administrative palaces, and funerary temples. Water imagery is pervasive at these centers, as Fash and Davis-Salazar (this volume) and French, Stuart, and Morales (this volume) amply illustrate. It is interesting to note that while water lilies cannot grow in Palenque’s springs and flowing streams, their clear presence in the iconography indicates their importance in political ideology and rituals. Rulers were critical in performing the rites necessary to propitiate gods and ancestors for the continuance of plenty.

Annual rainfall at Copan (1,316 millimeters) and Palenque (3,681 millimeters) varies dramatically (see fig. 7.2) and is either much more or less

than at secondary centers, a factor that is politically significant because of the need at these centers for large-scale water systems and seasonal maintenance. The basis for political power differs from nonriver centers in that rulers had more than one critical resource they dominated year-round—land and large-scale water systems, not to mention trade goods and routes. For example, in addition to concentrated alluvium, Copan also has artificial reservoirs, which Fash (2005) argues were managed and controlled by the political elite. Fash and Davis-Salazar (this volume) suggest that the presence of rural *aguadas* signifies some degree of self-reliance, at least during the rainy season. In the height of the dry season, however, rural farmers relied on reservoirs at Copan, since *aguadas* likely dried up. Inhabitants of Palenque, located in a hilly area with several streams (e.g., Otolum) and springs, built water systems consisting of aqueducts and canals to drain water away from the center—a not too surprising fact given their high annual rainfall (French, Stuart, and Morales, this volume). This is not to claim that economic factors alone supported rulership—ideology and water rituals were just as necessary to justify and legitimate political and economic inequality (e.g., Lucero 2003, 2006).

The other type of regional center is exemplified by Tikal, Calakmul, and Caracol, briefly mentioned above (see table 7.1). They are found in upland areas with large tracts of dispersed fertile land without lakes or rivers but with artificial reservoirs located next to major temples and palaces. These regional centers also differ from Palenque and Copan in other ways. Settlement is less dense in and around centers, for example, over 550 structures per square kilometer at Tikal (Culbert et al. 1990), and varies in hinterland areas, ranging from about 40 to over 300 structures per square kilometer (e.g., Folan et al. 1995). The lower hinterland densities typically are in areas with *bajos*, or seasonal swamps (see Dunning, Beach, and Luzzadder-Beach, this volume; Kunen, this volume). Rulers collected tribute because of their combined ability to control a restricted resource, reservoirs (e.g., Ford 1996; Scarborough 1996), as well as associated knowledge and rituals (Fash 2005; Scarborough 1998). Rulers funded large-scale ceremonial events in central places (plazas, temples) to attract, incorporate, and integrate farmers from the immediate area and beyond (Lucero 1999b).

Tikal has at least six major reservoirs, all located next to monumental architecture in the core area (Scarborough and Gallopín 1991). At Calakmul, which is basically surrounded by *bajos*, there are extensive canal systems and at least thirteen reservoirs (Folan et al. 1995). Caracol has at least two substantial reservoirs near monumental architecture and is surrounded by terraced hillsides for agriculture and water control (Chase

and Chase 1996; Healy et al. 1983); the latter is crucial, since well-drained upland soils are vulnerable to erosion during torrential rainstorms. Rainfall is typically less than at river centers, which would further indicate the importance of maintaining artificial reservoirs during the dry season. For example, annual rainfall at secondary centers ranges from over 2,200 millimeters to over 2,800 millimeters. At Tikal it is just under 1,900 millimeters, at Calakmul just under 1,700 millimeters, and at Caracol 2,100 millimeters. Water imagery is found throughout these centers and relates to rulers' role in water rituals and keeping water clean (Lucero 1999b).

Discussion

The degree of political power at centers differs and is influenced by seasonal water availability and the agricultural and settlement landscapes. Resources more concentrated and accessible and where people were tied to the land facilitated the development of political complexity, whereas dispersed and diverse resources typically did not. At all centers, however, elites and rulers used ritual to integrate people and legitimate economic and political differences. While water imagery has not been noted at minor centers, elites likely were involved in sponsoring and conducting local rites to propitiate water deities and other supernatural forces.

Water sustains life as well as Maya political systems. This model, however, does not and cannot account for every center, as the Cara Blanca area in central Belize illustrates. Less than 15 kilometers northwest of Saturday Creek is a string of twenty-two freshwater pools running east-west along the base of a limestone escarpment. Openings in the earth, such as water bodies and caves, were and are considered by the Maya as portals to the underworld, or Xibalba (Bassie-Sweet 1996), and include pools, cenotes, and lakes into which the Maya made offerings (Andrews and Corletta 1995; see also Borhegyi 1960; Borhegyi 1961, 1963).

Of the six investigated pools, only one (no. 1: 100 by 60 meters, 40 meters deep) has a settlement, consisting of seven structures near the pool's edge (Lucero et al. 2004) similar to the layout at two other sacred water bodies, Chichén Itzá and Dzibilchaltun. While Cara Blanca is too small to merit designation even as a minor center, it has water resources equal to at least a secondary or regional center, not to mention pockets of dispersed agricultural land. Immediately around the pools, however, are clayey soils not suitable for agriculture. In 1998 two scuba divers attempted to explore pool no. 1, especially near Structure 1. Because sheer walls, poor visibility (c. 10 meters), and depth (40 meters) prevented

divers from reaching the bottom of the pool, we do not know if the Maya made offerings, though we expect they did. Test excavations from Structure 1 (22 by 15 meters, 4 meters high) yielded mostly Late Classic wide-orifice jar rims (63 percent) (Kinkella 2000). The Maya may have collected sacred water for special religious and ceremonial events that take place either at the pool(s) or in nearby centers—Yalbac (c. 4 kilometers distant) and San Jose (c. 10 kilometers distant). For example, among the Zinacantecos of highland Chiapas shamans' assistants collect sacred water for curing ceremonies from each of the seven sacred water holes located around Zinacantan Center (Vogt 1993:63–65).

The concentration of so many pools in one area might indicate that Cara Blanca was a special, sacred place to the pre-Hispanic Maya, perhaps even as a pilgrimage center. We do not know if Cara Blanca was controlled by ruling elites, or if it was open for all to worship, or even if it was under the protection of religious personnel. While it is not possible at present to definitely explain the significance of Cara Blanca, the lack of settlement near large bodies of water would seem to indicate that it was a sacred place.

Conclusions

While political histories and water systems vary, a common factor with which all Maya had to contend was seasonal rainfall vagaries (e.g., dry-season water needs, annual flooding, hurricanes, and waterborne diseases). Water was and is plentiful in the lush tropics at certain times of the year. However, the quantity and/or distribution and quality of water and seasonal issues influenced agricultural schedules, settlement practices, ritual activities, and political histories. The use of water systems is the most obvious material response to meet seasonal water needs. I have already mentioned the problems that arise with standing water. It is possible, based on the discussion of regional centers such as Tikal and secondarily other center types, that a ruler's ability to provide clean water during the dry season served as a key means for the political elite to acquire and maintain political power at some centers.

As archaeologists we have all experienced problems with wet weather, even during the dry season. Washed-out roads, bridges, and ferries, impassable roads, rained-out days, quagmires where excavation units once were, flooding, and fast-moving and overflowing rivers are a few of the problems we face working in today's tropics. The ancient Maya faced the same conditions with a different technology and had great success for mil-

lennia. Even today the remains of pre-Hispanic life leave telling evidence of how their technology has withstood the test of time, from the smallest wattle-and-daub house to the tallest temple built of pure stone.

Drought was also a problem. For example, there is increasing evidence that long-term drought played a significant role in the demise of Classic Maya rulership in the AD 900s (e.g., Hodell et al. 2001; Lucero 2002, n.d.). Yearly drought also had an impact on the Maya, as it does at present. Predicting when the dry season ends (rather than when the rainy season begins) is and was critical for agriculture and for predicting the water supply in reservoirs, not to mention the quality of the water.

Material factors alone, however, are inadequate in and of themselves to appreciate fully the role of water in ancient Maya lifeways. Settlement decisions were not solely determined based on agricultural and seasonal issues. Cara Blanca suggests that Maya made settlement decisions based on nonmaterial factors. The decision to incorporate a place as a sacred space, even when doing so means relinquishing that place's water to meet material needs, clearly shows the importance of water in religious life.

We return nearly every season to conduct archaeological work and hear about hurricane and flood damage, and most of us can only imagine what those events were like. The fact that ancient Maya buildings largely remain standing is a testament to the skill that went into designing and constructing them. In conclusion, the material and sacred aspects of water were critical in ancient Maya life. This fact is further highlighted by the two distinct landscapes with which the Maya had to deal, the wet and the dry.

Acknowledgments

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8

Copan Water Ritual and Management Imagery and Sacred Place

BARBARA W. FASH AND KARLA L. DAVIS-SALAZAR

The ancient Maya site of Copan in western Honduras has been the focus of archaeological research for over a century. The site is famous for its intricate and high-relief stelae and altars, the likes of which are unsurpassed at any other site in Mesoamerica. Much of the research in the 1980s and 1990s was dedicated to the study and conservation of the tens of thousands of sculpted stone blocks that once adorned the numerous building facades in Copan but that over the centuries collapsed and became scattered about the ruins of both the Principal Group and large residential settlements (Fash 1991, 2001). So numerous and varied are these wonderful mosaic sculptures and the meanings they conveyed that they became the main focus of the Copan Mosaics Project, directed by William and Barbara Fash since 1985. The project led Barbara Fash to an analysis of water-related symbolism in the sculpture and its link with water management throughout the valley. Karla Davis-Salazar followed with investigations of the archaeological evidence for such systems in the 1990s as part of her doctoral dissertation research.

Much of the early water-related research in Mesoamerica focused on irrigation systems (e.g., Nichols 1988; Nichols, Spence, and Borland 1991; Palerm 1955; Price 1983; Sanders and Price 1968; Wittfogel 1957; Wolf and Palerm 1955; Woodbury and Neely 1972), but, more recently, increased attention has been given to still-water retention and diversion technologies (Harrison 1993; Scarborough 1993, 1996). The management of water runoff from the artificial architectural landscape into collection reservoirs appears to have been a technology that spread throughout the Maya region (Beach and Dunning 1997; Hansen 1991; Scarborough 1993, 2003), so much so that we venture to say that every site incorporated a suitable system into its original planning. This diversity of adaptations for reservoir/catchment-basin systems is made apparent in many chapters in this volume.

Although Rands (1953, 1955) and Puleston (1976, 1977) delved into Mesoamerican water symbolism, specifically mentioning the crocodile and water lily motifs on Copan's Altar T, this line of iconographic research was not continued. Others researched subsistence at the site, but water-management questions were largely ignored. Research has demonstrated, however, that diverse systems and technological adaptations of water management existed over the entire Maya area, making all regions of potential research interest for their particular adaptations (Dunning et al. 1999; Harrison 1993; Matheny 1978; Rice 1996; Scarborough 1993, 1996).

Our research combines the iconographic and archaeological evidence from Copan to examine the extent and implications of water management in ancient Maya societies. We explore the sociopolitical and religious significance of water, the hydraulic knowledge of the ancient Maya, and how these associations became manifested in the art, architecture, and sociopolitical structure of ancient Copan.¹ We attempt to show that the manipulation and management of water was one of the basic structural relationships lying at the core of social organization in ancient Copan. Using evidence from Copan's carved stone sculptures, settlement data, ethnographic material, and archaeological investigations, we suggest that a complex organization of communal groups in the Copan Valley played a direct role in the central government of the polity during Classic times. A fundamental resource, water bridges the sacred realm of Maya cosmology and the functional domains of technology, economics, and politics. The public architectural contexts of these water symbols were meant for general viewing in an effort to reinforce the system of governance. It brings into focus the relationship between community and center by means of their subsistence base, which may have been celebrated and controlled by a complex ritual calendar, something akin to what Lansing (1991) calls "ritualized ecological management" in his Southeast Asian studies. Following this framework and utilizing new archaeological data (Davis-Salazar 2001, 2003), we expand upon the water-management model proposed by Fash (2005) for sociopolitical organization in Late Classic (c. AD 650–850) Copan, which we believe unified its populace through the physical and ritual control of a sacred resource.

Geographic and Archaeological Data

Located in the semitropical mountains of the southeast Maya zone, the Copan Valley is a water-rich environment with an average annual rainfall of 1,700 millimeters, unlike the karstic terrain of the southern lowlands

and the semiarid landscapes of the northern lowlands. The Copan River flows year-round through the valley, fed by many tributaries and springs in the surrounding mountainous landscape (Turner et al. 1983). Springs, water holes, and mountain drainages were probably more abundant in ancient times, with many having dried up in modern lifetimes due to deforestation or neglect. Water from these mountain sources was presumably available and potable year-round, but river sources would have become undrinkable for most of the rainy season, as they do today (Abrams 1994; Fash 1992a, 2005). Once rainwater and runoff were retained in reservoirs, clean sources of drinking water and aquatic resources could have been continually available year-round. In comparison, reliance on springs and reservoirs is found in the water-rich environment of the Olmec for similar reasons (Cyphers 1999; Cyphers and Zurita-Noguera, this volume).

In the Principal Group located at a bend in the river, current water flow runoff patterns indicate a general southerly path toward the Copan River (see fig. 8.1). More specifically, on its west side the architectural runoff flows in a southwesterly direction, and on the east side it flows somewhat to the southeast, in each case draining directly into what once were densely populated urban areas. This pattern is undoubtedly, in part, a result of the massive barrier created by the artificial construction mass known as the Acropolis and therefore suggests a similar overall water flow pattern during occupation of the site. Indeed, many of the ancient city's hydraulic features that have been identified in these residential areas appear to have been constructed to combat the same drainage and flooding problems affecting the site today (Davis-Salazar 2001).

While further study of the geomorphology of the Copan landscape is needed to determine ancient drainage patterns, the central location of large lagoons in the urban wards of Copan allows for the possibility that rainfall diverted from the Acropolis courtyards and other plazas may have drained into these residential water sources (fig. 8.1). Significantly, archaeological data recovered from the excavation of two residential lagoons indicate that, while most likely natural features, the lagoons had been modified (minimally, through bolstered downstream edges) by ancient Copanecos to increase their collection potential (see Davis-Salazar 2003 for more detailed information). Furthermore, the frequency and distribution of artifacts found in the lagoons point to water procurement as well as ritual activities in and around these sources (Davis-Salazar 2003). Thus, the archaeological data strengthen the proposed iconographic connection between water management and social organization outlined by Fash (2005) and discussed below.

Archaeological evidence for an urban-drainage/flood-control system

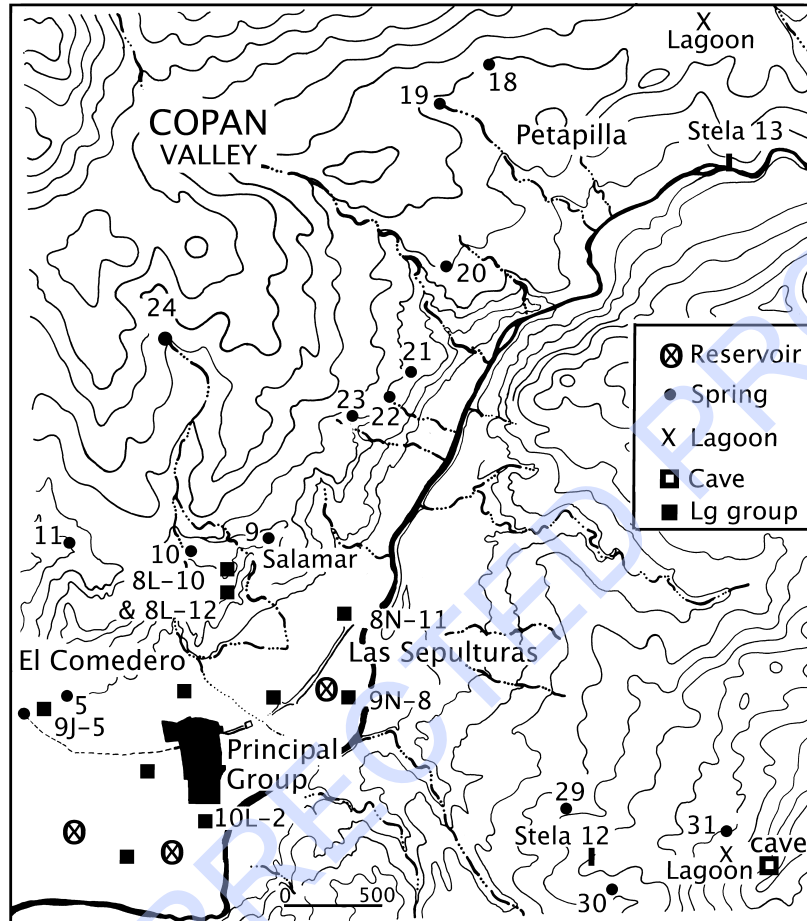


Fig. 8.1 The Copan Valley in Honduras, showing proposed reservoir areas near the Principal Group and Las Sepulturas; springs, lagoons, and caves in the hillsides; and outlines of four possible quadrants in the core area. (Compiled from Davis-Salazar 2001, Fash and Long 1983, and Lehman 2001)

indicates that the hydraulic technology necessary to control large amounts of water over an extensive area was known and used at Copan (Davis-Salazar 2001). Indeed, carefully engineered water systems of catchment and runoff were in operation at Copan from c. AD 400 to 650. From its initial stages, stucco and stone-lined drain channels ran through the Principal Group constructions (Sharer, Miller, and Traxler 1992) and

crisscrossed the landscape, draining the surrounding residential units (Andrews and Fash 1992).

Outside the urban core a survey of water holes, springs, and caves in the Copan Valley was conducted in conjunction with the authors' research. Over thirty such natural features were located within the valley's 25 square kilometers (see fig. 8.1) (Lehman 2001). The vast majority of springs were found along the Quarry Hill promontory, just north of the Principal Group. It can be reasoned that many of the settlements along this ridge benefited from their proximity to these water sources and the regional center (Fash 1983; Leventhal 1979, 1981; Lucero, this volume). Excavations in this region might reveal other modifications to the landscape that further enhanced water-retention capabilities in ancient times.

Many Maya settlements appear to have been laid out into four quadrants in conjunction with the cardinal directions (Ashmore 1991). In the Copan Valley we suggest that within each quadrant there was a location of significance used as a possible shrine area in ancient times, each associated with a cardinal direction and natural features. Water, caves, or openings in the earth, in particular, seemed to play a role in the selection of these sacred locales and ancient shrines. Ritual offerings of jade, ceramics, and sculpture fragments were found associated with these four locations and features in the 1950s (Nuñez Chinchilla 1972). Following Nuñez Chinchilla's (1972) identification of the La Laguna fissure as a site for votive offerings, we further speculate that the lagoon and fissure activities were not isolated but linked to the sacred geography of the valley. Lagoons could easily have been an aquatic habitat exploited by the ancient Copanecos for protein and plant sources such as fish, snails, freshwater shellfish, reeds, and edible and medicinal plants, thus becoming strongly associated with fertility.

We suggest that La Laguna (south), Stela 10 (west), Stela 12 (east), and Cerro de las Mesas (north) were the valley's four mountaintop shrine areas. The summit of Cerro de las Mesas is marked today by a cross and is the destination of the May 3 (Día de la Cruz) ceremony. Turner and colleagues' (1983) geographical study of the valley noted small depressions that filled with water at the summit. Fash (2005) has suggested that these potentially formed part of a water shrine on this mountain and that the still-existing procession on May 3 is a vestige of previous ceremonies that occurred within a ritual calendar, not unlike what takes place in other traditional Mesoamerican communities, such as Zinacantan, Chiapas, and Chilapa, Guerrero. Stelae 10 (west) and 12 (east) may have been markers for shrines on their respective mountaintops, both being associated with

nearby caves and water sources that are also mentioned in their hieroglyphic texts.

Residential Occupations

In addition to the Principal Group three large residential areas figure into the discussion of evidence for water management in the Copan Valley (see fig. 8.1). The residential groups are referred to here by their map designations. Groups 8N-11 and 9N-8 are located in the eastern section of the valley near the river in a zone called Las Sepulturas by the modern population. Group 9N-8 has a long chronology stretching from 1400 BC through to the Late Classic, with the final Structure 9N-82 having the most elaborate sculpture facade within the Late Classic compound (Fash 1988; Webster 1989). Located at the terminus of the raised road, or *sacbe*, Group 8N-11 has a much shallower occupation history restricted to the Late Classic (Webster et al. 1998). Although the group has not been completely excavated, two prominent buildings on the main plaza, 8N-66C and 8N-66S, yielded rich sculptural facades (Webster et al. 1998).

Group 10L-2 is the Late Classic royal residential compound directly south of the Acropolis and Principal Group (Andrews and Fash 1992), an area commonly referred to as “El Cementerio” because of the numerous elaborate burials that were found there during the early investigations of the Peabody Museum Expedition of 1892. Structures 10L-29 and 10L-32 are the largest buildings in the group of more than twenty-five buildings arranged around three rectangular plazas and were elaborately decorated with mosaic sculpture.

Water Symbolism in Copan Art and Architecture

Ancient Mesoamerican cities and ceremonial complexes can be viewed as architectural replicas of the sacred landscape (Benson 1985; Broda, Carrasco, and Matos Moctezuma 1987; Dunning et al. 1999; Schele and Freidel 1990; Vogt 1981). The pyramids were mountains that provided an axis of communication with the gods and spirits; the courtyards surrounding them were the valleys and depressions that collected runoff, thereby creating shallow, watery ponds. In some cases sites were surrounded by moats or built on islands to place temples in the center of this cosmovision, symbolically floating on the primeval waters of creation (e.g., Tenochtitlan). Nahuatl terms recorded from the Aztec in sixteenth-century chronicles reveal how the water-mountain concept remained central to architectural programs into the Postclassic period; *altepetl*, a term for village

or community, translates as “mountain of water” or “mountain filled with water” (Bierhorst 1985; Broda, Carrasco, and Matos Moctezuma 1987:93; Lopez Austin 1997; Stark 1999a).

At Copan the multiple-plaza design of the Acropolis provided a three-fold catchment system utilizing the East Court, the West Court, and the Court of the Hieroglyphic Stairway. The southerly directional flow of rainfall running off smooth plaster surfaces into the plazas was noted early on by George Byron Gordon of the Peabody Expedition in 1894. Iconography of the West Court, marked by the presence of conch shells and God G1 on the Reviewing Stand, has been interpreted as an underwater world by Miller (1986:83, 1988:161–62). It is possible that the enclosed plaza of the East Court with channels emptying east toward the river functioned to retain water for short periods of time, creating a shallow pond for ritual purposes by sealing the famous *ventanas*, or large stone-lined drains.

We can reconstruct an earlier version of water imagery and flow on the Copan Acropolis from the evidence of internal pyramidal drains found on Indigo Structure, an earlier version of Structure 10L-22 in the Eastern Court. This sacred water cascaded down plastered roofs into and out of the mouths of sculptured earth and water deities on the structure's facade (Fash 1992a, 2005). Later, gargoyles and other sculptures on Structure 10L-22 further elaborated on the theme of sacred mountains and water.

Below we summarize and evaluate three iconographic elements related to water in Copan that we believe represent key aspects of water management in ancient times (Fash 2005). When compared with their occurrences elsewhere in the Maya region and Mesoamerica as a whole, these elements may shed additional light on individual regional interpretations.

The Water Lily and Water Lily Headdress

Rands (1953) and Puleston (1976) years ago called attention to Maya iconography and symbolism that had a strong aquatic element, including depictions of fish, water lilies, waterbirds, turtles, snails, eels, water snakes, and crocodiles. They noted that these flora and fauna are associated with sluggish streams, rivers, ponds, *aguadas* (rain-fed natural basins), swamps, and river floodplain environments. Aguadas and reservoirs around Copan would have stayed clean and clear naturally if aquatic creatures were encouraged to proliferate, providing obvious economic benefits. Lagoons would have been an aquatic habitat exploited by the ancient Copanecos for protein sources, edible and medicinal plants, and useful plants such as tule (rushes) used for weaving mats and baskets. In the corpus of Late Classic sculpture from Copan these aquatic elements were

portrayed repeatedly (Fash 2005), signifying the importance of this environment and that the animals and plants it supported were cultivated, maintained, and revered by the ancient Maya. Indeed, the name Tollan, or “place of the reeds” (Stuart 2000), is descriptive of such an environment, which seemingly was at the core of founding sacred cities throughout Mesoamerica. This combination of hydraulic sensibility and ritual formulas was the basis for a regional “ethnohydrology” and ensured continuity of water maintenance over time.²

Fash (2005) suggests that, when worn by rulers and nobles, the water lily headdress (fig. 8.2a) explicitly relates to a social structure of water-management duties and the wearer’s divine ritual role of ensuring fertility and sustenance (Lucero 1999b; Scarborough 1998). Possibly the specific headdress of regional water masters, the headdress consists of important elements in elite and royal symbolism: the long-nosed god, also known as the god of number thirteen and the water lily monster (Miller and Taube 1993; Taube 1992); the tied water lily pad; the inverted, stylized, beaded water lily; and the crossed-bands and disk sash (Fash 2005).

The Quatrefoil and Half-Quatrefoil Motif

The quatrefoil motif is recognized as representing portals in general, most frequently caves or openings to other realms (Freidel, Schele, and Parker 1993; Grove and Angulo 1987). In water hole and cave imagery it is the opening to these sources (Bassie-Sweet 1996). Schele and Grube (1990) argue that the plazas of the main courts of the Principal Group were represented in the iconography by quatrefoil motifs, designating them as water lily places and read as *naab*. Caves and water holes as well as the portals leading to them shared similar iconographic depictions because they were understood to be aspects of the same natural phenomena and the abode of the earth deity (Bassie-Sweet 1996; Freidel, Schele, and Parker 1993; Manzanilla 2000; Thompson 1970; Vogt 1969, 1981). Caves, sites of ritual offerings, burials, and ancestor worship must also be considered part of ancient Maya settlement systems (Hammond 1981:177; Pendergast 1971). From the time of the Spanish Conquest until today Maya groups have tenaciously held on to the cave and water ceremonies in an effort to sustain their religious beliefs. Throughout Mesoamerica the cave, often likened to the womb (Heyden 1981) and the water environment, is a focal point in ancient and modern worldviews, namely as a place of creation.

Often at Copan one half of the quatrefoil is shown as a stepped or T-shaped niche, which has also been described as representing the earth

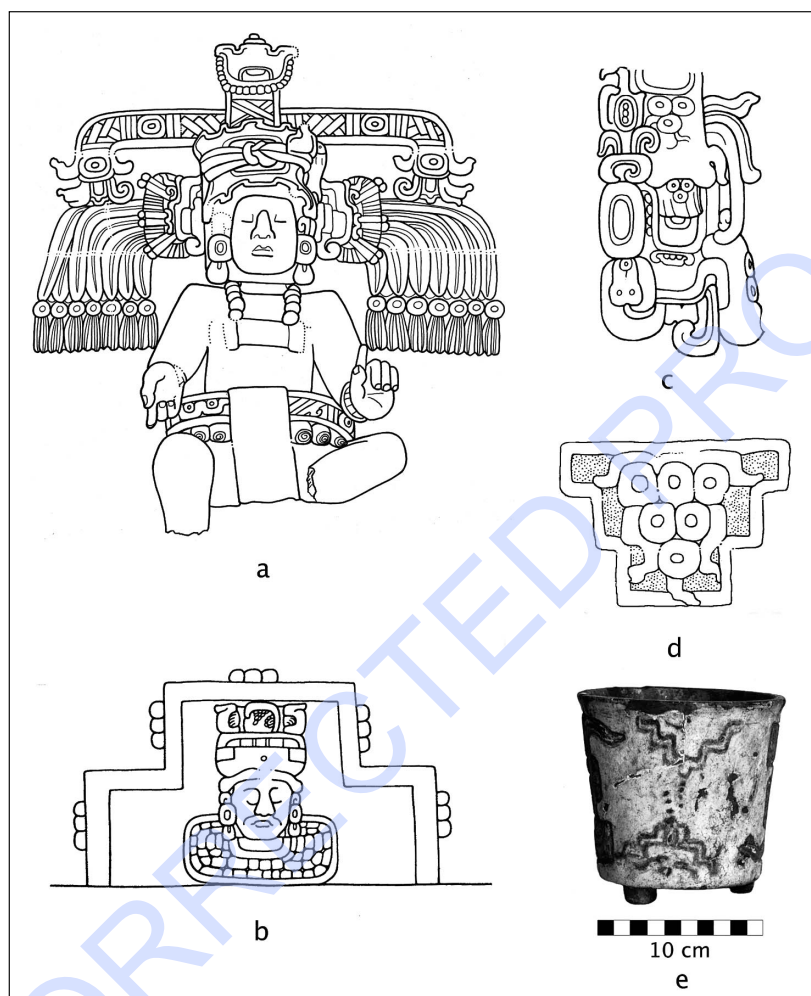


Fig. 8.2 Water-related motifs from Copan: (a) water lily headdress worn by figure from Structure 10L-32 facade, El Cementerio (Group 10L-2); (b) half-quatrefoil motif from Structure 8N-66S facade, Las Sepulturas (Group 8N-11); (c) tuun sign on witz monster, Stela B; (d) tuun sign from Structure 10L-41 facade, El Cementerio (Group 10L-2); (e) vessel with painted stucco tuun design, burial near Structure 10L-41.

or a cave (fig. 8.2b; Baudez 1994:140). At Chalcatzingo Grove (1999) also identifies the half-quatrefoil as representing caves. Following mythology reported by Bassie-Sweet (1996) regarding horizon caves that were imagined to be homes to gods and ancestors, Fash (2005) has suggested that the half-quatrefoil can be explained visually as depicting such a cave opening at the horizon with the other half of the full quatrefoil understood as unseen below the surface of the earth. Similar depictions appear in codices and manuscripts and suggest that half-quatrefoils can symbolize both holes in the earth and water sources (a spring, a river, drip water, or mist) within the mountains or emanating from them. Throughout Mexico mountains or toponyms are often depicted as variations on the half-quatrefoil theme (e.g., Oaxaca, Acanceh). We suggest they can also name places and shrines on ritual circuits as well as sacred pools or reservoirs within the engineered urban landscape. In sum, the symbol's meaning combines water hole, mountain with cave, and ancestor abode into one, with the importance of water in this configuration frequently overlooked.

The *Tuun* Sign

Water dripping in a cave is considered extremely sacred and pure. It is collected for the preparation of ritual drinks and healing potions (Thompson 1970). The symbol for this sacred water is the *tuun* sign (previously referred to as the *cauac* cluster), which adorns the heads of *witz* monsters at Copan, both on facades and stelae (fig. 8.2c; Bassie-Sweet 1996; Fash 2005). It serves to label the entity as the embodiment of sacred space. Fash believes that stepped motifs from Copan are representations of the drip-water formations in caves and are labeled as such by the *tuun* cluster. Supporting evidence is found from Structure 10L-41, which has stepped motifs embedded with *tuun* signs on its upper facade (fig. 8.2d; Johnson 1993). Additionally, a carved modeled brownware vessel from a burial associated with Structure 10L-41 was covered in postfired light blue stucco and painted with a black design showing two stepped motifs with infixed *tuun* signs placed one above another and droplets dripping between them (fig. 8.2e; Bill 1997; Fash 2005).

Outside of Copan's Principal Group facade sculptures on eighth-century residential structures displayed repeating stepped half-quatrefoil niches resting on their medial molding and figures or masks with water lilies as a prominent part of their costume (Andrews and Fash 1992; Fash 1983, 2005; Webster et al. 1998). At the royal residential area of El Cementerio (Group 10L-2) south of the Acropolis water iconography predomi-

nates on the principal structure, 10L-32. Figures adorning this building's facade all wear water lily headdresses (see fig. 8.2a). Additionally, a carved stone fish was cached as a floor offering in a small crypt during the building's final phase (Andrews and Fash 1992). Originating in the Acropolis, water was drained from sunken plaza areas, flowing southward possibly into a reservoir, or *bajo*, in the El Bosque region adjacent to the residential group. Fash (2005) suggests that the aquatic iconography may be evidence that the families of Group 10L-2 managed this reservoir and considered it their domain.

Social Model

When considered in light of ethnographic material, this specific iconographic evidence from Copan stone sculpture suggests to us that a complex organization of corporate groups unified by water-management activities existed in the Copan Valley that may have exercised a direct role in the central government of the city during the seventh and eighth centuries (Fash 2005). Corporate systems that function today among the living Maya show continuity since the time of the conquest, suggesting that similar levels of managerial systems may have been well developed at the peak of Maya civilization (Farriss 1984; Vogt 1969). The Yucatecan model identifies the water hole as essentially the basepoint for defining the geographical boundaries of a given community and the saints (in ancient times "deities") associated with that water source (Farriss 1984). Yucatecan territories are defined primarily by their distance from and their association with a specific water source. Community groups "were organized by territory, rather than lineage, occupation or some other principle" (Farriss 1984:330–31).

Among the Chorti, the Maya group closest to Copan, ethnographer Charles Wisdom noted that *aldeas* are always located along streams, usually straddling them, and are referred to by the name of the stream (1940: 217–18). Considering the importance of water, William Fash (1983) proposed using the Chorti *sian otot* (equivalent to the Spanish *aldea*) as a social unit for understanding Copan settlements. Indeed, the *sian otot* settlements designated by Fash for Copan generally cluster around major streams as well (Fash 1983; Leventhal 1979, 1981). In Copan today most of the largest compounds (Type 4; Willey and Leventhal 1979) outside of the main center and the surrounding areas are still known and referred to by the names of their closest water sources, for example, Comedero, Salamar, Petapilla, Titichón. Additionally, Stuart and Houston (1994) explain that Maya place-names in the hieroglyphic texts frequently include a ref-

erence to water locales or “black holes.” This combined evidence implies that a sense of social distinctiveness developed among residential settlements situated near and sharing the same water sources.

Ethnographic evidence available from Zinacantan in highland Chiapas, Mexico (Vogt 1969), provides an additional model to understand Late Classic social organization in Copan (Davis-Salazar 2003; Fash 2005). In Zinacantan a group of several *snas*, or lineage-based residential units that share and inherit landholdings, together form a larger water hole group centered on the shared use and maintenance of a common water source. This cooperative group mutually maintains its source, which includes annual cleaning and ritual offerings to earth mountain deities and lineage ancestors. The water hole group elects a head to supervise construction work and maintenance, collect dues, and regulate the water hole ceremonies in accordance with the calendar, a role likely requiring scribal skills. Words used to describe sacred locales for each community, such as *vits*, *ch'en*, and *vo?*, notably are all cave or water related (Vogt 1981), emphasizing the central importance these geographical features still hold.

In Copan, at the large residential sector of Las Sepulturas, east of the Principal Group, the dominant building, Structure 9N-82, was adorned with a sculpture facade bearing a central figure wearing a water lily headdress flanked by two seated figures wearing maize headdresses (Fash 1988). Following the ethnographic models described above, we interpret the figures depicted with maize headdresses as representatives of individual *snas* (the agriculturally based lineage groups) from this valley sector. The more important central figure wearing the water lily headdress perhaps represents the head of the water hole group who carried out duties similar to those of the modern-day Zinacantan water managers or even conceivably regulated irrigation and planting cycles (Fash 2005).

In an effort to explain why Copan residences needed to form water hole groups when they were so close to river sources, we must look to the evidence on reservoirs. Directly west of Group 9N-8 of the Las Sepulturas area is one of the large rectangular depressions in the valley (see fig. 8.1; Fash 1983; Turner et al. 1983). Davis-Salazar (1994, 2001) investigated this area and found evidence to support the idea that it was an ancient reservoir. Reservoirs may have served as fish ponds, as has been suggested for lowland canal and laguna systems around raised fields (Puleston 1976; Thompson 1974). They also provided a clean water source during the heavy rainy season, when rivers became muddy and dangerously swift. To what extent the reservoir was exploited is still unclear, but maintaining a system of water retention on that scale for a dense population would require a significant degree of organizational management.

Interpretations

The archaeological evidence alone for water management is not enough to build a sociopolitical model for how the system functioned and affected politics in a Maya kingdom. However, taken together with the geographic, iconographic, and ethnographic evidence, we can suggest a model for Copan that was probably specific to the region alone. The architectural and especially the iconographic evidence from Copan could help to shed light on the structure and dynamics of other systems in the Maya area such as Palenque.

Here we would like to expand on a previously posited model for community organization in Copan that was based on the interpretation of Structure 10L-22A as the community council house, or *popolnah*, and the residential groupings of *sian otot* (Fash 1992b, 2005; Fash et al. 1992; Fash 1983). Structure 10L-22A is decorated with ten woven mat motifs and nine place-names. Above each place-name are seated figures believed to represent a position akin to that of *holpop*, a name given to regional representatives to the *popolnah* in Yucatán (Fash and Fash 1991; Fash et al. 1992). The toponymic glyphs often contain a reference to a water source, cave, or black hole, three physical features that fall under the same category of *ch'en* among modern Maya speakers (Vogt 1981). Furthermore, as we have seen, a Maya village is often named after a distinctive feature or past event associated with the main body of water or water source within its territory (Vogt 1969, 1981; Wisdom 1940). It is conceivable the nine Copan toponyms may be references to ancestral water and cave features within the landscape of the specific wards to which they give their name.³ It has been argued by some that the toponyms are known supernatural references and not actual places. However, ancestral water sources in the Andes often carry names that refer to supernatural locations or replicate sacred locations from the important capital of Cuzco (Sherbondy 1992). If this held true for the Maya, it could explain why some of the toponyms in Copan are names that refer to supernatural locales in texts from other sites.

We believe our archaeological data and iconographic interpretations support a model of ancient sociopolitical organization within the Copan Valley centered on water hole groups that sent a representative or regional water master to the council house (Davis-Salazar 2003; Fash 2005). Although conceivably more autonomously managed regions initially, as population in the valley increased and the pressures of the governing system rose to critical levels, these nine representatives may have come under the central rule of the king, who in the instance of Ruler 15 is carved on Stela N in the water lily headdress described earlier. The model places

land-based lineage groups at the base level, akin to *snas* in Zinacantan, probably patrilineal and symbolized by maize icons in their headdresses. Multiple *snas* united together into larger water hole groups were potentially represented by half-quatrefoil niches, water lilies, water lily headdresses with a fish nibbling a flower, and the beaded water lily necklace. These larger social units would have been drawn together by their common use of a water source or management of an urban system such as a reservoir. A water hole group would have reinforced territorial boundaries by the group's shared participation in a belief system that required ceremonial offerings to the water hole spirits and ancestral patrons in conjunction with maintenance of the water hole and related shrines. A person at the *ah cul na* (Coe 1965a:103) or *aj k'uhun* (Stuart 1992) level of social hierarchy was perhaps the head of each water hole group. We suggest their responsibilities, while including scribal duties (Jackson and Stuart 2001), included local coordination and maintenance of their water source as well.

Residential settlements throughout the valley may have incorporated two or more water hole groups to form even larger clusters defining aldeas or *sian otot*.⁴ The *holpop* sent to the central council house (*popolnah*) could have been from the ranks of *aj k'uhun* and chosen from any particular water hole group within a *sian otot*. Fash (2005) suggests that the reconstructed half-quatrefoil niches with interior icons found on particular residential facades might be a motif used to frame the water-related toponym or ancestral patron of a *holpop*'s residence (fig. 8.2b). The structures with the half-quatrefoil niches additionally may designate shrines on a ritual circuit, especially involving water ceremonies.

A specific example to illustrate this idea comes from the Las Sepulturas (Group 9N-8 and Group 8N-11) sector. Following this model and utilizing Jackson and Stuart's (2001) decipherment for a title on the hieroglyphic bench, Structure 9N-82 would be an *aj k'uhun*'s residential compound (figures with water lily and maize headdresses), while Structure 8N-66S would be from a *holpop*'s residential compound (half-quatrefoil niche; fig. 8.2b). On Structure 8N-66S half-quatrefoil niches enclose supernatural figures with *katun* symbols as headdresses. These repeating figures could represent the supernatural patron of the lineage's ancestral cave/water hole, which gave the water source its name. The orientation of the main building on the 8N-11 plaza was aligned with the zenith passage, which occurs in Copan around May 3 (Bricker and Bricker 1999). This is the time of the ritual ceremony currently held on Cerro de las Mesas at the start of the rainy season, perhaps a vestige of a ritual circuit that once included Group 8N-11 on this date.

The numerous representations of half-quatrefoil niches serve as examples of cave/water hole imagery we propose lies at the core of the belief system and political hierarchy for which the ruler eventually became the pivotal figure. Water engineering became an important function for insuring a vital resource for the polity's growing communities. Rulers and lineages centered themselves in the landscape and invoked their ancestral deities in the sacred geography to legitimate their power and associate themselves with their local communities. Similar half-quatrefoil cave niches with human personages appearing on Pacal's sarcophagus lid at Palenque and water lily headdresses donned by nobles on the Bonampak murals cause us to speculate whether a similar model was in existence at those sites and others in the Maya area.

Although the population was diverse and changing, water management within local communities was potentially a cohesive force and created local identity. Religious belief and rituals would have revolved around this structure. As the dynasty's power weakened, nonroyal elites may have been able to use this ideology to reassert their water-management duties and legitimate their expanding power bases.

Conclusions

The collapse of the water-management system in Late Classic times, whether by force or by neglect, would have had severe consequences for the commoner population remaining in the valley after the abandonment of the ritual center and the elite compounds. Perpetuation of shrine ceremonies and ritual circuits at sacred water locales could have little effect on such matters as the sedimentation and contamination of the reservoirs, which instead converted to stagnant pools without reliable drinking water or aquatic resources. Within a short time they may have become breeding grounds for diseases, bringing death to major sections of the population or causing them to flee.

The power of water evolved over the centuries of Mesoamerican civilizations, with resource management adaptations appropriate for each different geographical setting. It was a resource manipulated by social and political complexities to be as much an economic commodity as an ideological instrument for ritual. Our Copan research provides insight into the particular circumstances that we suggest gave rise to a dynamic socio-political organization and ideology that remain visible today in the architectural sculpture and freestanding stone monuments, which were tools to promote this establishment and its agenda.

9

Archaeological and Epigraphic Evidence for Water Management and Ritual at Palenque

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AND ALFONSO MORALES

The presence of freshwater is inviting for any civilization, but for the Maya it was symbolic as well. The *Popol Vuh* refers to a place where “the channels of water were separated; their branches wound their ways among the mountains” (Tedlock 1985:74). Built on a narrow escarpment located in the foothills of northern Chiapas, Palenque’s natural topography creates a series of watery mountains with fifty-six recorded springs within the site boundary (fig. 9.1). A place such as this must have been emblematic to the ancient Maya.

The Classic Maya of Mesoamerica have long been famous for their technological and architectural achievements. Among the most famous Maya centers is Palenque, located in Mexico’s southernmost state of Chiapas. Most large Maya centers, such as Tikal and Caracol, are located in environments that generate a heavy dependency on rainfall for consumption and agriculture. Palenque, in contrast, is unique for its water-saturated landscape. While most other centers were concerned with storing water, the Palenqueños were devising methods of managing an abundance of it.

Many water-management features became evident during the survey conducted by the Palenque Mapping Project, directed by Edwin Barnhart under the auspices of Mexico’s Instituto Nacional de Antropología e Historia (INAH) and supported by grants from the Foundation for the Advancement of Mesoamerican Studies, Inc. (FAMSI), and the Pre-Columbian Art Research Institute (PARI). Kirk D. French (2002), senior project archaeologist, recorded these features as aqueducts, bridges, dams, drains, walled channels, and pools. The Maya built such features in order to manage the numerous perennial springs located throughout the site. With nine separate watercourses found in Palenque, water was widely incorporated into the city plan both symbolically and functionally. The presence of such copious rushing water enabled the Palenqueños to cre-

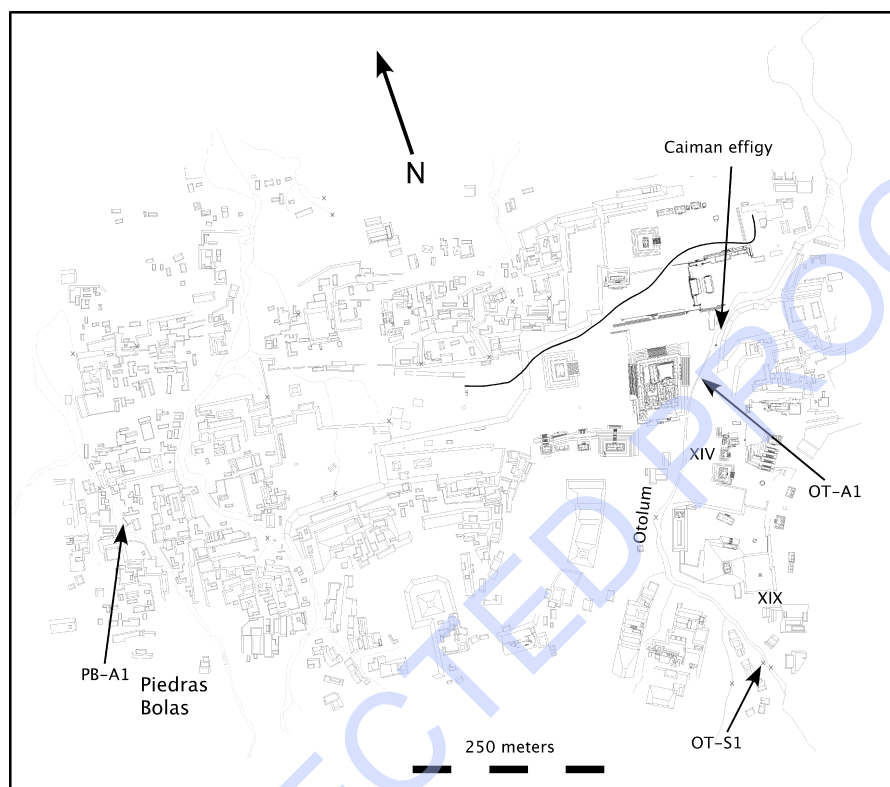


Fig. 9.1 Palenque's watercourses and springs. (Map courtesy of Ed Barnhart)

ate a water-management system unique among the Maya. The goal of this chapter as well as this volume is to demonstrate the many ways the Maya interwove ideology and function through water. By utilizing the studies of epigraphy, archaeology, iconography, and ethnography we will reveal the threads that define Palenque's water management.

Epigraphy

We have known for some years that the place-name Lakamha', meaning "Wide Waters," was the ancient name of Palenque and is cited in numerous texts throughout the site (Stuart and Houston 1994). Arguably, Lakamha' was the name given to the Otolum Stream, which passes through the very center of Palenque before spreading among extensive

cascades on the hillside below. Recent excavations on Temple XIX by the Proyecto Grupo de las Cruces, directed by Merle Greene Robertson, have shed light on the importance of the Otolum's source, Spring OT-S1.

Before 1999 Temple XIX drew little attention from researchers and visitors to Palenque. Its location within the larger architectural complex of the Cross Group and its orientation facing directly toward the imposing Temple of the Cross provide some indication that it was an important building, but because it was a collapsed structure, nothing more could be said of its date or significance. During the 1999 field season Alfonso Morales, the principal investigator, uncovered a beautifully inscribed throne or platform on the east side of Temple XIX. One of the more interesting features of the platform inscription is the closing phrase on the front tablet, ending with the epic narrative of gods and rulers. Like many other Palenque texts, the inscription ends with a formal phrase that emphasizes the location and environmental setting of the tablet and the temple containing it. Project epigrapher David Stuart (n.d.) deciphers the text as "ut-iiy tan ch'een Lakamha'" [it happened in front of the well at Lakamha']. The "well at Lakamha'" can only be the Spring OT-S1, located on the mountainside directly behind Temple XIX from which the Otolum flows.

The placement of such an imposing temple in close proximity to Spring OT-S1 was probably intentional. From what we understand of caves and springs in Maya religion and cosmology, it is likely that the spring was a natural feature of considerable ritual importance within the ancient community of Lakamha', the name that also branded the stream emanating from it. Not only is Temple XIX located next to it, but the earlier Temple of the Cross—the most imposing structure of the Cross Group—directly faces the spring. Springs and caves were major ritual loci in Maya and Mesoamerican religion, and we know that many temple pyramids have direct relationships to such natural features (Scarborough 1998). Perhaps the most familiar case is the Temple of Kukulcan at Chichén Itzá, connected by a causeway to the great cenote. Palenque's Otolum, emerging from the mountain spring, offers an ideal Maya example of what the Mexica Aztec called the *altepetl*, or "water mountain," which became a powerful symbol of state and community (Bierhorst 1985; Broda, Carrasco, and Matos Moctezuma 1987; Lopez Austin 1997; Stark 1999b; see also Fash and Davis-Salazar, this volume). Spring OT-S1 thus provided an ideal locale for the construction of a major ceremonial complex known today as the Cross Group.

Symbolic representations of the watery mountain appear to be a re-occurring element in the structural design of Palenque. There are twelve

springs within the site boundary that disperse water from beneath their associated structure. By erecting architecture directly atop of or in close proximity to springs, the city planners were able to transform many structures into watery mountains. Yet another depiction of the watery mountain is symbolized in the architectural design of the various subterranean aqueducts that were documented during the survey. Stuart believes that the corbelled arch portrays the image of a mountain, just as the temples that house the arches do. The observation of water exiting the corbelled arched aqueducts and flowing back into the stream provides a view of the symbolic watery mountain being re-created.

Archaeology

Like other areas in the Maya Lowlands, Palenque experiences a four-month dry season. The reduction in rainfall from January to April would not have seriously affected the ancient Palenqueños due to the forty-one known perennial springs within the site boundary—the absence of water storage features supports this claim. After an extensive three-year survey not a single reservoir was found. Water management at many Maya Lowland sites was devised for the purpose of storage. Palenque's water management dealt with moving an abundance of water throughout the city in an efficient and productive manner.

In contrast, many other lowland centers relied on artificial reservoirs. For example, Tikal was plagued with a seasonal scarcity of water. Located in the Petén of Guatemala, Tikal is without a perennial water source (Scarborough and Gallopín 1991). In order to sustain and support a growing population, the Maya devised inventive ways of capturing and storing water. They constructed large reservoirs fed by clay-lined drainage ditches. The runoff from human-modified watersheds drains into and easily fills the reservoirs (Scarborough and Gallopín 1991). Tikal's six major reservoirs would fill with water during the rainy season. Once filled, the reservoirs would supply the city throughout the four-month dry season. Residents of other sites in the Maya area, such as Caracol and La Milpa, designed similar catchment reservoirs in order to sustain life (Scarborough 1994a).

With nine separate perennial watercourses flowing throughout the city of Palenque, scarcity of water was rarely an issue. The availability of water allowed architects the opportunity to develop a unique system of water management that was unlike those found in other Maya Lowland sites. Constructing channels was the method of choice for the Maya of Palenque. While the architects of other lowland sites created ingenious ways

of capturing water, the Palenqueños invented new ways of conveying it through their urban landscape.

One way in which they did so was through the use of an aqueduct, PB-A1, located in the Arroyo Piedras Bolas. The source of the Piedras Bolas is unknown because the arroyo extends beyond the site boundary to the south. With the addition of three aqueducts, two pools, and two major drains, the Piedras Bolas appears to have been managed quite extensively. Approximately 75 meters of the stream is littered with a massive amount of cut stones, suggesting an extinct walled channel. PB-A1 is the first water-management feature encountered by the stream as it flows north from the mountains. The original entrance to PB-A1 is unknown, but a collapse of roof stones revealed its interior. The main chamber of PB-A1 measures 1.2 meters in height by 80 centimeters in width. This chamber extends 4 meters from the collapsed roof. At this point the aqueduct abruptly decreases in size and enters another chamber that measures 46 by 46 centimeters. This smaller chamber then continues for 2.5 meters before terminating, thus allowing flow to reenter the streambed.

At present very little water passes through the aqueduct due to the roof collapse. The majority of the water flow is forced to the western edge of the arroyo. During the rainy season a massive quantity of water surges through the Piedras Bolas. When fully functional, PB-A1 would have created a considerable amount of water pressure by forcing a square meter of water into a square half-meter chamber. The absence of excavations in the area leads to only speculations on the purpose of having water pressure at this location. It could have been used to take water up and out of the arroyo to a residential group or possibly to create a fountain.

The general motive behind fountains is typically one of adornment. Ornamentation is not an occupation seriously undertaken in times of civil distress. Therefore, the success of a city can often be measured by its gardens and water features, which were developed directly as a consequence of the well-being of that city. A fountain displays pride of civic place for both citizens and visitors and illustrates the power of a community. Palenque's abundance of rushing water may have provided the architects the opportunity to embellish water-management systems.

Palenque was not without dilemmas caused by water. Built on a narrow escarpment, surrounded by steep hills, sheer cliffs, and deep arroyos, Palenque was plagued with a scarcity of livable terrain. The flat topography that did exist at the site was usually burdened with waterways. For this reason, the residents of Palenque constructed a large number of subterranean aqueducts in order to create areas large enough to maintain normal civic life within a major Maya center. These aqueducts covered preexist-

ing streams, and by doing so they increased the size of the plazas. The plaza area serves as an economic and political melting pot for visitors, laborers, and rural elite from the hinterlands (Scarborough 2003). As the city of Palenque grew, so did the demand for larger plazas. The Otolum's largest aqueduct, OT-A1, is a prime example; the aqueduct provided more plaza space east of the Palace and created uninterrupted space between the main plaza and the Cross Group (French 2001).

Iconography

The iconography on the Temple XIV tablet may shed light on the role Chan Bahlum played in the water management of Palenque. The panel (fig. 9.2) depicts the ruler of Palenque, Chan Bahlum (AD 684–702), dancing atop a lower register marked by the shell and stacked rectangles that signify the surface of water (Schele 1988). An upper division and a lower division of architecture, which contains a row of water dots, define the center band. According to Schele and Miller (1986), the lower band represents the surface waters of the underworld because of its alternating syllabic signs spelling *ba, na, ba, na, ba*, meaning *naab*, which translates into water lily, or large bodies of water. The iconographic representation of a subterranean chamber containing water intermediately positioned between Xibalba, the underworld, and the material world could represent OT-A1.

The second factor that supports Chan Bahlum's involvement with water management is the location of Temple XIV and its proximity to the original entrance of the Palace aqueduct. The entrance to the aqueduct during Classic times is the same entrance this walled channel has today, which is 43 meters and approximately due west from Temple XIV (see fig. 9.2). This southern section of the aqueduct is far too wide to support a corbelled vault, but recent excavations have provided evidence that the original foundation for the aqueduct was of adequate distance to support the vault (Arnoldo Gonzales-Cruz, director of archaeology of the site of Palenque, personal communication, 2001). Blom (1925) explains that the aqueduct was fully collapsed on its southern portion when he began to map the site in 1923. When workers in the 1950s rebuilt the channel walls, they were forced to build the channel wider due to erosion (French 2001). Temple XIV, the closest structure to the Palace aqueduct, was constructed so that it aligns on a cardinal direction with the entrance to the Palace aqueduct.

Kinich K'an Joy Chitam II (AD 702–20), the builder of Temple XIV, may have paid homage to Chan Bahlum for his involvement in the con-

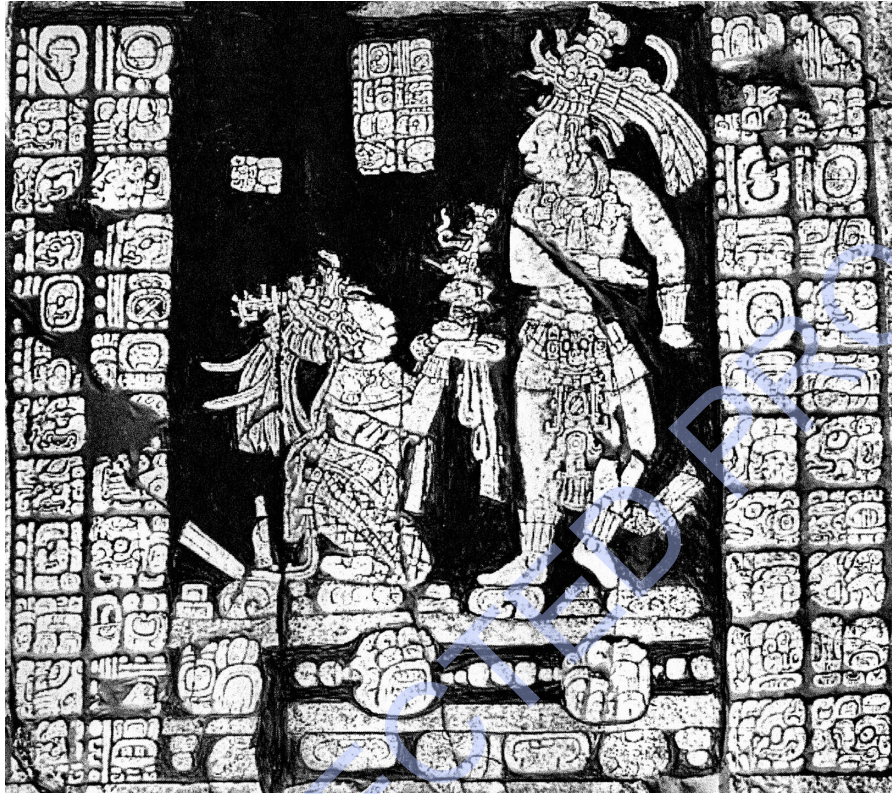


Fig. 9.2 Temple XIV Tablet. (Rubbing by Merle Greene Robertson © Pre-Columbian Art Research Institute, 1995, used with permission)

struction of OT-A1. We know from the iconographic and epigraphic record that Chan Bahlum built the Cross Group, but Temple XIV and the panel it houses suggest that he also oversaw the construction of the Palace aqueduct in order to create unity between the main plaza and “his” Cross Group.

As the waters of the Otolum exit OT-A1, an enormous cayman effigy appears on the east side of the channel at the wall’s termination (fig. 9.3). The effigy is an extraordinary work of art that sits approximately 1 meter above the flowing water. The stone measures 3.5 meters in length, 1.1 meters in height, and almost 1 meter thick, or roughly 3.5 cubic meters. There is a regional belief around Palenque today that if someone wants to keep a water source flowing on their property, they need to bring a small cayman to live in the spring, and this will ensure the water’s constant pro-

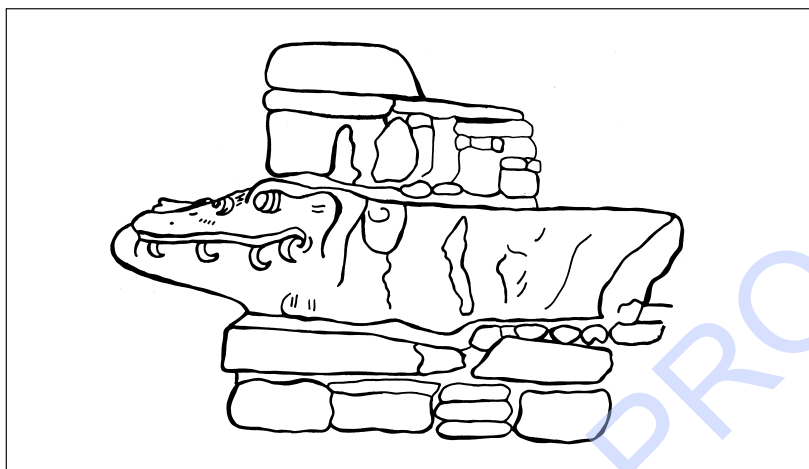


Fig. 9.3 Cayman effigy. (Blom 1925:fig. 132; courtesy of the Middle American Research Institute, Tulane University)

ductivity. One reason for this would be that the cayman digs a cave into the water source, keeping the source flowing freely. The carved cayman located at the end of the aqueduct may represent an ancient Maya effort to guarantee the Otolum's water flow.

A Chorti agricultural priest at Cayur Guatemala sheds light on another possible explanation for the position and location of the carved cayman. The priest describes a gigantic cayman that lives at the center of the sky in an expectant position. When he hears a human imploring for water, he opens his mouth, and torrents of water escape from it (Girard 1949). After the Otolum has traveled beneath the plaza floor via the aqueduct, the stone cayman symbolically releases the water back into the arroyo for those in need.

Conclusions

From the evidence presented here it appears that the ancient Maya of Palenque chose their geographic location largely because of its water-rich environment. The parallels between the natural terrain and Maya mythology are evident by the placement of temples near springs as well as the records carved in stone the Maya left behind. The abundance of fresh perennial water sources allowed the Palenqueños the opportunity to produce many symbolic representations of creation and ritual while at the

same time serving as a source for growth and expansion. Palenque's water management is in need of more attention. Iconography should be thoroughly studied to reveal a more integrated picture concerning the role the rulers played in the ideology of water at the site. In the future, we intend to pursue further investigation into the water systems at Lakamha'. A test pit program in and around Palenque's water-management features would most definitely shed new light on the subject.

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3

WATER SYSTEMS IN POSTCLASSIC MESOAMERICA

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Hydraulic Elements at the Mexico-Texcoco Lakes during the Postclassic Period

MARGARITA CARBALLAL STAEDTLER AND
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Archaeological research in the Basin of Mexico demonstrates that it has a long history, was culturally diverse, and was transformed in large measure by its lacustrine environment. In this chapter we focus on the Postclassic (AD 750–1519) hydrologic characteristics of the Basin, how they were controlled by a complex system of hydraulic features, and the environmental modifications involved in their construction.

We present some inferences about several hydraulic elements associated with Tenochtitlan on the Isla de México (Mexico Island), the capital of the Triple Alliance between the cities of Tenochtitlan, Tlacopan, and Texcoco. Due to its central geographical location, it was heavily involved in the water management of Lake Texcoco. Geographical features such as the thermal springs of Peñón de los Baños between Lake Texcoco and Lake Mexico also prompted ritual ceremonies, archaeological evidence of which reveals a belief in water's sacredness and connection to supernatural realms.

Our principal goal is to highlight the complex political and economic factors involved in the building of pre-Hispanic water-management systems, which were intertwined with ritual practices. All rulers in the region participated in different alliances, beginning c. AD 856 with the Culhuacan-Tullan-Otumba alliance, later with the association of Culhuacan-Cohuatlinchan-Azcapotzalco in AD 1047 (Chimalpahin 1991: 7, 15), and finally with the Tenochtitlan-Tlacopan-Texcoco alliance, which lasted until the Spanish Conquest in AD 1521 (Chimalpopoca Códice 1975: 63). Throughout this history the chronology and location of hydraulic elements were important in conjunction with the natural characteristics of the Basin of Mexico.

The information presented here is part of the results of the project entitled Research of the Environment of Texcoco Lake, directed by the authors, which started in 1982. The research involves data analysis from pic-

torial and historical sources, including essays by contemporary authors, and especially from the data collected at construction sites excavated by members of the Dirección de Salvamento Arqueológico of the Instituto Nacional de Antropología e Historia (INAH).

Lacustrine Characteristics and History of the Basin of Mexico

The Basin of Mexico was formed in the last 50 million years in seven phases, during which there was intensive volcanic activity associated with numerous and extensive tectonic events (Mooser 1975:9–38). In the last 700,000 years the volcanic activity took place in the south, with powerful lava eruptions from Chichinautzin that obstructed water flow and drainage toward the Balsas River. As a result, the valleys were transformed into a closed basin.

By the Postclassic period the Basin of Mexico, covering an approximate area of 9,600 square kilometers, included seven lakes: Apan, Techac, Tecocomulco, Zumpango, Xaltocan, Texcoco, and Chalco-Xochimilco. The first three were independent. Texcoco, the largest saline lake with the lowest water level, was located in the middle of the basin (with Lake Mexico being a later division); to the north were two other smaller saline lakes, Zumpango and Xaltocan; and to the south was Chalco-Xochimilco, a freshwater lake (fig. 10.1). These lakes, due to the richness of their resources, offered a fertile environment for early human habitation. Initially, the shores were inhabited by groups that relied on the exploitation of lake resources. The transition from an economy based on hunting and gathering to a mixed economy in which lake resources were complemented with agricultural products took several thousand years.

Fauna from the lakes and their immediate surroundings consisted primarily of fish and aquatic birds, which were important food sources. The Azcatitlan Codex and early colonial maps have illustrations of indigenous people in canoes angling and net fishing (fig. 10.2a), while others hit the water with sticks, scaring the fish and birds into the spread nets (Soustelle 1956). Settlers of the islands and shores were called Atlacachimeca, which probably means “los chichimeca con atlatl” [chichimeca with spear-throwers] or “los del cordel/linaje de perro hombres del agua” [those of the cordage/water dog men lineage] (Molina 1977:8, 78, 95), and their tools consisted of the net, the *atlatl* (spear-thrower), and the harpoon.

It is clear that the environmental conditions of the lakes provided rich resources. Pedro Armillas notes:

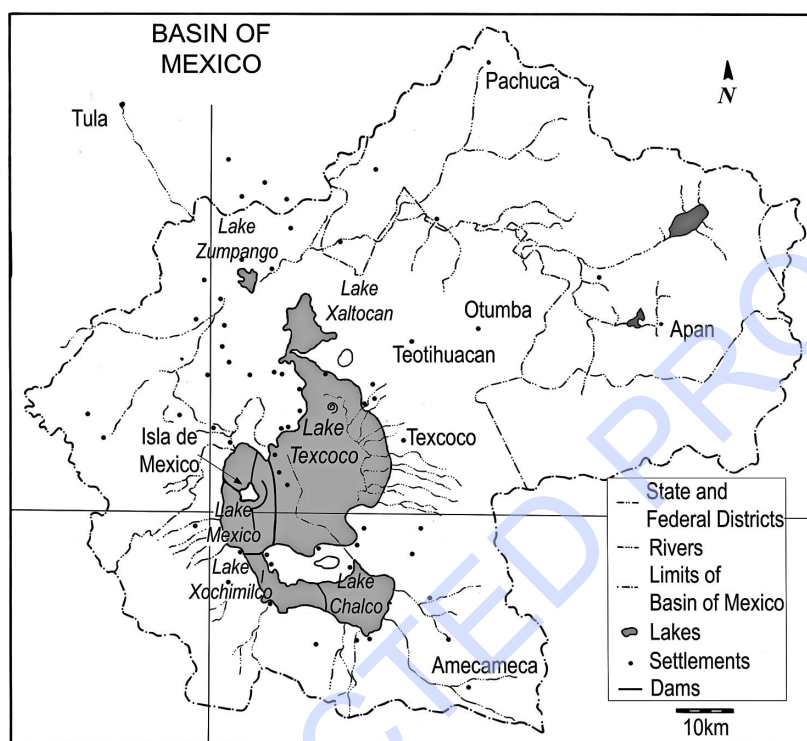


Fig. 10.1 Geographic map of the Basin of Mexico showing the central lakes with hydraulic works, causeways, and dikes of the sixteenth century. (After Gurriá Lacroix 1978:pl. 2)

Debemos considerar, relacionado con las condiciones ambientales, el importante papel que el Valle de México desempeñó en Mesoamérica, al parecer desde tiempos de la etapa Formativa:

... Indudablemente, la razón de esa importancia se debe al carácter lacustre de esa gran cuenca. ...

... la abundancia de caza y pesca. Economía mixta, basada en el cultivo y productos lacustres, explica la permanencia de los poblados. ...

... La facilidad de comunicación por agua ... tenía extraordinario valor dado lo primitivo de las técnicas de transporte Mesoamericanas. Debido a ella, todo el Valle ... formaba una sola unidad económica. (1985:27)

[We must consider the importance of the Valley of Mexico since Formative times in Mesoamerica in relation to the environmental conditions:

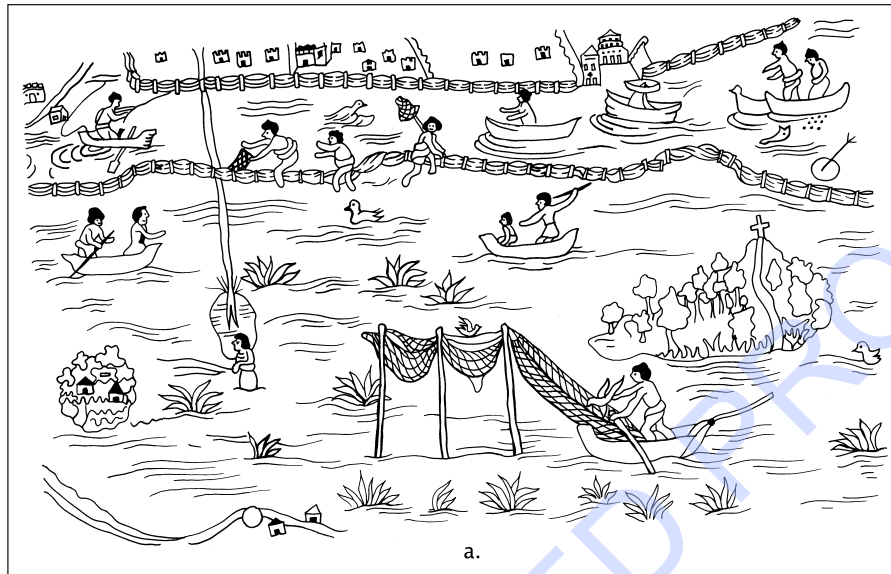


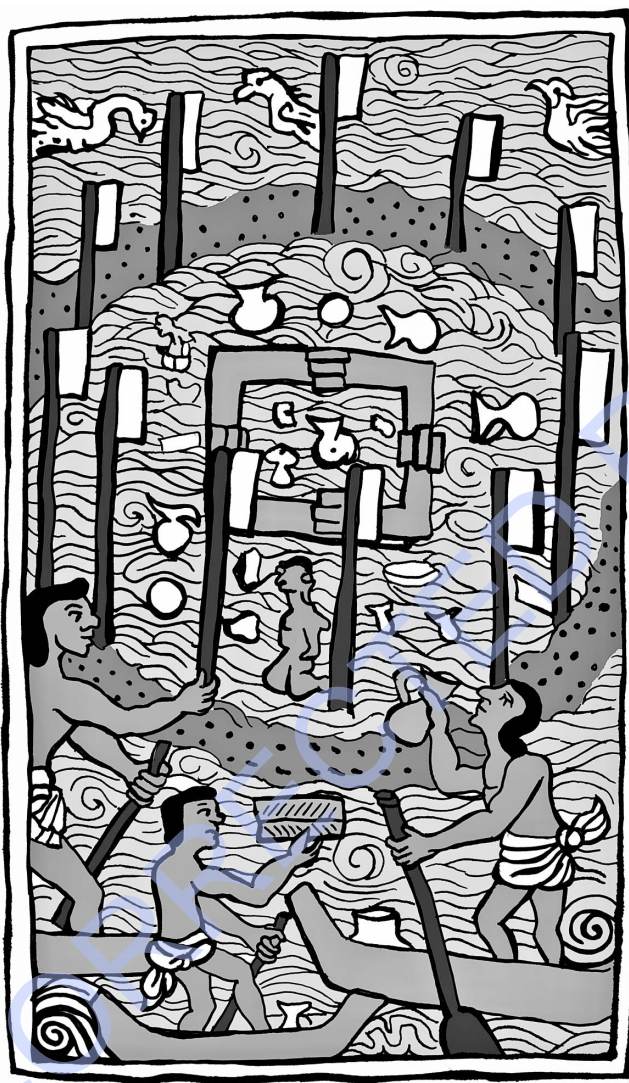
Fig. 10.2 Above: detail of the Uppsala map (1550) showing lake activities and exploitation of the natural resources. Right: image of Pantitlan in the Florentine Codex.

. . . Undoubtedly, the reason for its importance was due to the lacustrine characteristics of this great basin. . . .

. . . the abundance of hunting and fishing. The mixed economy based on cultigens and lake products explains its permanent population. . . .

. . . The ease of communication via water . . . had an extraordinary value given the primitive transport technology of the Mesoamericans. Because of the lake environment, the entire valley formed one unified economy.]

According to Palerm (1973:17), the water level of the lakes fluctuated according to the season (wet or dry), and those changes affected the shoreline settlements as well as those on the islands. Over the long term, environmental changes were a result not only of the gradual and irreversible transformation of the lakes due to major climatic changes but also of human-induced technological processes and innovations to regulate the lacustrine environment (Palerm 1973:17). While occupation was limited to the shores and some of the islands, people were involved in major constructions such as irrigation channels, ridges, dams, and diversions in rivers and *chinampas* (land created artificially for housing and agricul-



tural purposes) that, according to Armillas, “were local enterprises, built and preserved with the resources from only one community” (1985:39).

We can surmise that the occupation of the islands within the lakes took place as a response to four specific circumstances: (1) decrease of the lake level caused by climate changes; (2) demographic pressure; (3) exploitation of specific resources; and (4) use as a religious site. The first factor undoubtedly happened periodically during the Pleistocene, when

droughts lasted so long that the exposed surfaces hardened, allowing animals to reach water and food (Carballal S. et al. 1997:83–119; Lorenzo 1986:73–76). During the Classic period (AD 150–750), when conditions apparently became critical due to a growing population and increased demand for resources, these four factors took effect. Evidence for contemporaneous occupations was found at the city of Tlatelolco (Espejo 1944) and the Tepetzinco, or Peñón de los Baños, near today's Mexico City International Airport (Carballal Staedtler and Flores H. 1993). Armillas (1985:27) makes a convincing case that one of the conditions that made the Classic period population increase possible was the exceptional productivity of the chinampa agricultural system, which arose and developed in the lake environment.

By the end of the thirteenth century most of the islands of Lake Texcoco were occupied, and by the fourteenth century, when the Mexica arrived in the Basin of Mexico, they were all settled (Carballal Staedtler and Flores H. 1989a:77), including the lakeshore (Alvarado Tezozomoc 1998:31). Subsequently, the large cities of Tlatelolco and Tenochtitlan were built on an island in Lake Texcoco, commonly known today as the Isla de México. The fact that the main cities were located on islands in the lake with the lowest water level meant that their occupants, maximizing all available space, were constantly faced with the threat of dangerous floods. Settlers thus developed water systems to control water levels, and these systems evolved into the complex system the Spanish saw and wrote about, including causeways (*calzadas*), dikes, channels, chinampas, and bridges (fig. 10.3).

The key role water ritual and management had for rulers and their courts is evident in their recorded titles. Susan Gillespie (1989:156) notes one instance where a judicial title given to the second in command and principal ambassador of Motecuhzoma II was Atempanecatī or Atecpanecatī, meaning “lord of the water palace” or “lord of the edge of the water” (see Alvarado Tezozomoc 1980:270), possibly a reference to the person's role as a water manager. Atempanecatī's divine counterpart was Cihuacoatl, a mother earth goddess said to come from the southern sociopolitical ward, Atempan. This is the area where the Culhua people resided and the chinampa agricultural system was maintained. Atempan was also a place-name in Aztlan, the Mexica place of origin and a watery paradise (Davies 1973:83). “Thus the ritual landscape was equated with the political, and the actions of the gods were firmly tied to their semi-divine representatives on earth” (Gillespie 1989:156).

To understand the development of Mexica (Aztec) society, specifically the role of water in it, it is important to consider many factors, such as the



Fig. 10.3 Archaeological evidence for registered canals and dikes in Mexico City, map, and cross sections.

environment, the economy, titles, and the political situation. Prior to the founding of Tenochtitlan in 1521 the Aztec lived in many places, including other islands in the Basin of Mexico. In the year 3 *tecpatl* (1248) they lived at Pantitlan near Tepetzinco (Peñón de los Baños) and then lived for four years in Tlalcocomolco (Chimalpahin 1997, 1:199, 221) and Coatl Yayauhcan (Alvarado Tezozomoc 1975:38). They returned to Pantitlan just before the founding of the settlement on the Isla de México in the center of Lake Texcoco (Alvarado Tezozomoc 1998:61). These unstable circumstances prompted their decision to inhabit the isolated island, even though they realized that conditions were not ideal and that they had to adjust to seasonal and climatic changes in the water levels. Finally, the political fallout resulting from a war they waged against Culhuacan, one of the principal political rulers of the region, forced their move to the Isla de México. The founding of a settlement in the middle of Lake Texcoco, a drastic decision by the Mexica, is considered to have been the last option for the group, since it imposed many restrictions on them. Their leader, Tenoch, offered a religious explanation of their origin to the Mexica people in an effort to explain and rationalize their hardship in the middle of the lake without enough water, food, and land.

Palerm (1973), Rojas Rabiela (1974), and Rojas Rabiela, Strauss, and Lameiras (1974), writing extensively on the water systems, have proposed a hypothetical reconstruction of water systems and their functions through the analyses of historical documents. They have shown that different construction systems were used to control water based on specific contexts such as surface, shore, and lake areas. Palerm (1973) notes that it is important to recover information on the water systems as well as the environmental conditions that resulted in the need to build them. The following quote serves to identify, locate, and name the various types of water systems while defining the functions attributed to them in documentary sources:

Los sistemas hidráulicos pertenecientes propiamente a la zona lacustre; o sea, las chinampas que he denominado de “laguna adentro” y las de “tierra adentro.” Ambas corresponden, probablemente, a una misma categoría de tecnología y envolvían obras hidráulicas semejantes: calzadas-dique y albarradones; obras de defensa contra inundaciones y trabajos de drenaje; construcción de suelos artificiales para agricultura y poblamiento; conducción de agua dulce por medio de canales, acequias y acueductos; formación de lagunas y pantanos artificiales. (Palerm 1973:22)

[The hydraulic systems pertain directly to the lake zone, specifically, the chinampas, which are referred to as the “interior lagoons” or “interior land.” All of this probably refers to the same category of technology involving grand hydraulic works: causeways and dikes, flood prevention and drainage works, construction of artificial landfill for agriculture and settlement, freshwater canals and aqueducts, formation of artificial lagoons.]

Pantitlan and the Mexica Rain Ceremonies

Pantitlan at Peñón de los Baños, directly east of the Isla de México, was the ancient site of ritual ceremonies for supplicating Tlaloc and the Tlaloques, the water deity and his assistants, in an effort to avoid misfortune. One of the principal research goals of the salvage work at Route 5 of the Mexico City subway was to investigate and record Pantitlan (Carballal Staedtler and Flores H. 1993). In 1248 Pantitlan was one of the locations occupied by the Mexica before they moved to the Isla de México and established the city of Tenochtitlan.

The ritual site of Sumidero de Pantitlan was very important for the Mexica because it was a place of worship where Tlaloc could be asked for rain, as represented in the Codex Florentine (see fig. 10.2b). Some historical documents note that Pantitlan was a fountain; others describe it as a *sumidero*, or drain; a third opinion refers to both—a fountain and *sumidero*. In the month Atlcahualo, “to let . . . the water” (Molina 1992:13), of the Nahuatl calendar (Codex Florentine 1950–59:15–17), Pantitlan was one of the locations on the circuit of sites that were visited during the Tlaloc ritual. At each place it is said the Mexica sacrificed a child, first at Quauhtepetl, followed by Ioltepetl, Tepetzinco, Poyauhtecatl, Pantitlan, Cocotlicpac, and Yiauhqueme.

Although the archaeological record only yields Aztec III pottery from water dredging, geological research can provide many important clues due to the presence of geological faults. Test pit profiles exposed some stratigraphic anomalies—vertical ruptures filled with volcanic ash, the origins of which were 8 meters deep. One of them, La Falla de los Focos Termales, runs west–east and shows a continuous line of thermal fountains between the Tepetzinco, or Peñón de los Baños, and the Tepepulco, or Peñón del Marques (Carballal S., Flores Hernández, and Mooser n.d.), which could explain the Pantitlan fountain.

Regarding Pantitlan’s possible function as a *sumidero*, we need to consider that in the dry season the water could be drained by the cracks. This

Table 10.1 Hydraulic elements associated with the Isla de México

<i>Calzadas</i>	Dikes	Channels within the Isla de México
Tepeyac	Nezahualcoyotl	La Viga
Tenayuca	Ahuizotl	Acequia Real
Azcapotzalco		channel parallel to calzada Iztapalapa
Tacuba		Xocongo
Chapultepec		San Jeronimito Atlixco
Iztapalapa		Delicias
		Nonoalco

natural phenomenon could be the reason why the pre-Hispanic people were attracted to Pantitlan and considered it a sacred location for conducting rituals.

In the following sections we describe several elements of the hydraulic system by function and physical characteristics. These elements were located and identified in ancient and contemporary pictorial documents and were traced in aerial photographs from 1941. Inferences about their characteristics were made based on historical and archaeological data (Carballal Staedtler and Flores H. 1993).

Calzadas (Causeways)

Through the analysis of documents, ancient maps, and, most important, information obtained from the archaeological record, the calzada features were grouped according to the following criteria: (1) raw materials; (2) dimensions, under or over 15 meters in width; and (3) geographic location within the limits of Lake Texcoco or inside Lake Mexico (Carballal Staedtler and Flores H. 1989a).

Calzadas oriented north-south, east-west, or southeast-northwest were all built differently (fig. 10.3). The east-west calzadas were extensive earthenworks and consisted of compact clay finished in a *talud* (sloped wall). Colonial maps show several gaps with bridges, which are referred to in the descriptions of the Spanish chroniclers, especially for the calzada of Tacuba, which allowed water flow through the channels.

Bernal Díaz del Castillo, quoted in Palerm, states:

Ibamos por nuestra calzada adelante, la cual es ancha de ocho pasos, y van tan derecha a la ciudad de México, que me parece que no se torcía poco ni mucho . . . y en la calzada muchos puentes de trecho en

Table 10.2 Calzada/Causeway Data from the Archaeological Record

	Raw material		
	1 Stone held by wooden stake	2 Stone and clay finished in <i>talud</i>	3 Clay finished in <i>talud</i>
Name	Tepeyacac	Iztapalapa	Nonoalco
Width	10–11 meters	near 20 meters	near 15 meters
Total thickness	10–11 meters	1.6 meters	2.1 meters
Location	Mexico-Texcoco Lake north	Mexico-Texcoco Lake south	Mexico Lake west
Direction	north–south	north–south	east–west

Table 10.3 Calzada/causeway data from historical sources

	Tenayuca	Tacuba	Chapultepec
Width	nearly 15 meters	nearly 22 meters	nearly 12 meters
Location	Mexico Lake northwest	Mexico Lake west	Mexico Lake southwest
Direction	northwest–southeast	east–northwest	east–southwest

trecho . . . ya que llegamos donde se aparta otra calzadilla que iba a Coyuacán, que es otra ciudad. (1973:148)

[We went along our causeway ahead, which is 8 feet wide and goes so straight to the city of Mexico, it seems to me to not turn anywhere at all . . . and there are many bridges from section to section . . . until we arrive, where it separates to another small causeway that goes to Coyuacán, which is another city.]

The north–south calzadas, in contrast, were built in stone and have few gaps. Moreover, they were built near Lake Texcoco, which, since 1449, was separated by the Nezahualcoyotl dike, thus resulting in the creation of Lake Mexico. Because of these characteristics the calzadas of Tepeyac and Iztapalapa were built to protect the Isla de México, confirming Palerm's (1973) proposed hypothesis for a double function for dikes and causeways.

A general analysis of the calzadas' construction patterns and documentary sources demonstrates their multiple functions; nevertheless, in order to define their primary function a wider discussion, including his-

torical data, is necessary. However, such data do not always refer to when or by whom the water features were built.

It must be noted that even though by 1521 all the hydraulic structures were controlled by the Tenochca polity (Tenochtitlan), this does not mean that they built them. The Isla de México, where the cities of Tlatelolco and Tenochtitlan were established, were independent until 1473, when the Tlatelolca were subjugated by their neighbors, the Tenochca. According to the information recorded about each causeway (Carballal Staedtler and Flores H. 1989a, 1989b), it is evident that before 1473 the calzadas of Tepeyac, Tenayuca, and Nonoalco were controlled by Tlatelolco, while the ones of Tacuba, Chapultepec, and Iztapalapa were controlled by Tenochtitlan.

More precise data are found in the historical sources in reference to the calzadas' construction dates. According to the *Anales de Tlatelolco* (Toscano 1948) and the *Código en Cruz* (Castillo Farreras 1984:146), the building of the calzada of Tepeyac was finished in 1429. Dates as early as late in the thirteenth century and early in the fourteenth are mentioned for the calzada of Tenayuca (Corona Nuñez 1962; González Aparicio 1973), and the Nonoalco calzada is dated to the fourteenth century (Angel María Garibay, from González Aparicio 1973).

In reference to the water systems at Tenochtitlan, Durán (1967) mentions two dates. The calzada of Iztapalapa was built by the fall of Azcapotzalco, about 1432. The *Chimalpopoca Código* (1975) notes that a Texcoco ruler built the calzada of Tacuba and its branch to Chapultepec in 1466 (Durán 1967:53).

Based on the above data, several hypotheses can be proposed. First, considering the geographic location and the period when the structures were built, except Iztapalapa, it can be proposed that the Tlatelolca and/or Tenochca must have built them. Second, if the structures were built in the fifteenth century before the fall of Azcapotzalco, the Tepaneca capital and its dominion (the Tepaneca were the most important Postclassic rulers of the Mexico Basin before the Mexica [Aztec]), the constructions must have been directed by the Tepaneca for their own needs. Third, the earthen calzadas, built before 1432 (Tenayuca, Nonoalco, and Tacuba), appear to have established the water rights of the localities they joined, both for Tepaneca dominions and subjugated towns. This hypothesis is possible if these towns served as boundaries, and thus it would not be unusual that they demarcated water rights and other resources. Furthermore, the causeways, leading from the island to several shore localities, subdivided this sector of the lake into different parts and delimited the water rights of island settlers and those who based part of their economy on hunting, fishing, and other lake resources (Palerm 1973), including salt, one of the

most valuable pre-Hispanic products (Sánchez Vázquez 1984). The presence of constructed water systems in the lake altered water circulation, consequently modifying the environment by affecting its salinity and the distribution of plants and animals (Palerm 1973). This is most evident in the case of the calzadas under the control of Tepeyac and Tenayuca, whose shoreline and island occupants were salt producers. On the other hand, the more substantial calzadas (built with stone), such as Tepeyac and Iztapalapa, located against the frontal waves of the eastern sector of Lake Texcoco, denote their primary function as a dike. Finally, we think the term *calzadas* is somewhat of a misnomer, since it is a Spanish term for “communication roads”; we agree with Palerm (1973:19) and Armillas (1985:25) when they state that in actuality the most efficient means of transportation in the lake was through water navigation, not roads, since there were no beasts of burden or wheels. In summary, the information presented shows that calzadas had multiple functions satisfying hydraulic, urban, political, and economic needs, which were modified through time (Carballal Staedtler and Flores H. 1989b).

Dikes

Even though there are references in documents to the existence of many dikes (*albarradas*) throughout the lakes, we will only discuss the Nezahualcoyotl and Ahuizotl dikes. The construction of both dikes, according to historical sources, was in response to two floods that the Isla de México suffered in 1449 and 1499 (Chimalpopoca Códice 1975:58; Torquemada 1975, 1:175).

The Nezahualcoyotl Dike

The Nezahualcoyotl dike was built in 1449 by the ruler of Texcoco and bears his name. Documentary sources and contemporary essays describe the Nezahualcoyotl dike as having an approximate length of 16 kilometers and a width of around 7 meters; it was designed to go from “Iztapalapa . . . in [a] straight line to Atzacolco, passing near the ‘Peñón de los Baños’” (Ramírez 1976:35). Even though its function as a divider between the lake areas seems clear, the timing of its construction requires further discussion.

The Ordenanza de Cuauhtemoc (1524) depicts the territorial limits established in 1432 by Cuauhtlatoa and Itzcoatl, rulers of Tlatelolco and Tenochtitlan. In it a structure is illustrated and described joining the south slope of the “Sierra de Guadalupe” and the “Peñón de los Baños” in the

lake. We compared the Ordenanza map to the Santa Cruz one, dated in 1550, and both were compared with a 1941 aerial photograph. The dikes were represented as roads (*caminos*) in the Ordenanza and as wooden fences in the Santa Cruz, the outlines of which are very clearly drawn from the Sierra de Guadalupe to the slopes of the Peñón.

The Ordenanza provided information about the presence of dikes that by 1428–32 restricted the circulation of water from northwest Lake Texcoco, thus largely protecting Tlatelolco. Also mentioned are two stages for the construction of the structure, one previous to 1428 and the other in 1449.

The Ahuizotl Dike

This dike was built after a major flood occurred around 1499 and reduced the settlements on the eastern edge of Isla de México. It is evident that its primary function was to protect the site against floods. This dike was built in response to a heavy rainy period during the rulership of Ahuizotl, who was accused of destroying Tenochtitlan in his effort to provide the city with water from the Acuexatl fountain at that time (Chimalpopoca Códice 1975:58). The primary purpose of this dike, as was that of the Nezahualcoyotl one, was to protect the lacustrine settlements of the Isla de México.

Channels

In several ancient maps, especially the Santa Cruz map, a series of channels are represented that crisscross the lake area, most of them oriented east–west, some north–south, and a few northwest–southeast or northeast–southwest. Information was collected from a sample of thirty-two channels located in thirteen areas of Mexico City, including multiple features such as dimensions, shape of the walls, plan and profile, contents, context, direction, and location (see fig. 10.3). Of the thirty-two channels, twenty-five are pre-Hispanic, fourteen are oriented east–west, nine are oriented south–north, one is oriented northeast–southwest, and eighteen had foundations. Their functions can be inferred through specific characteristics, such as drainage and communication via navigation (Carballal S., Flores Hernández, and Miranda n.d.). The first function—drainage—is inherent; the second—navigation—requires specific qualities. To understand the function and distribution of these channels one must refer again to the Santa Cruz map, where the next configuration is observed.

Within the Isla de México there are two types of channels, one ori-

ented north-south and the other east-west; the latter is of considerable extent and depth. The minor channels, oriented north-south, deposited their water into the major east-west ones. These east-west courses collected water that drained from the island, crossing the Ahuizotl dike on the east. It is possible that the design of the east-west channels could have been adapted to the natural drainage of the lake area, which follows the natural topography of the land. Therefore, it is possible that the natural slope of the land and of the riverbed and its courses were taken into account during the design of the channels. It is important to note that the mountainous areas to the west, which include the Serranía de las Cruces and the Sierra de Monte Alto y Monte Bajo, all have steep slopes and torrential river flows that constitute the major sources of water for the north-western sector of the basin. We believe that some of the irregularities observed in the foundations of the channel walls are related to the natural slope of the land, since in many cases the layout of the channels was meant to modify the natural drainage.

Conclusions

The Basin of Mexico has been under investigation since the second half of the twentieth century in efforts to understand the ancient ground mechanics and water-management systems.¹ Pre-Hispanic inhabitants clearly used their knowledge about the lake's topography and environmental characteristics in their engineering decisions. This is supported by archaeological evidence of hydraulic features and documentary references by specialists, related to their construction and preservation.

In summary, these features constituted an extensive and technologically complicated water-management system that by the end of the Post-classic period had diverse functions. These features had various functions, especially dikes, which also served as causeways, water channel supports, and territorial boundaries. Furthermore, it is clear that orientation, location, and construction characteristics define function. For example, calzadas and dikes were typically oriented north-south (Iztapalapa, Tepeyac, Nezahualcoyotl, and Ahuizotl) and built with stones confined by wooden sticks with almost no gaps.

In the northwestern sector of Lake Texcoco, hydraulic constructions date to the Tepaneca period, as early as year 4 *acatl*, or 1431 (Alvarado Tezozomoc 1998:109; Chimalpopoca Códice 1975:49), as indicated in historical sources that mention their construction just before the Mexica hegemony.² These were built, in our opinion, primarily for economic purposes to exploit the varied and valuable lake resources. By dividing the

lake into several sectors, they defined water rights of the shore towns dependent on Azcapotzalco. The political agenda of the rulers and their court who commissioned, built, and managed the vast hydraulic features was an equally influential element in the Mexica's empire building. The intertwined relationship of water management to water ritual helped to organize and maintain the overall system.

Controlling water flow also suited two practical purposes: to prevent flooding and to control the flow of freshwater. After doing a quick analysis of the record of floods reported in historical sources (1382, 1449, 1499, 1517, 1555, 1604–7, 1627–30, 1674, 1707, 1714, 1747, 1763, 1819, and 1875), we can see that in pre-Hispanic times these occurred periodically every fifty to sixty years on average, with shorter intervals during the Colonial period. Considering the relation of the determining factors we can make two suggestions. First, it is possible that floods were more frequent in pre-Hispanic times but that their effects were diminished by the construction of hydraulic structures and their constant maintenance. Second, the use of hydraulic constructions from the Tepaneca period onward involved the function of protecting not only the population inside the lake but also those who lived on the shore and depended on lake resources. During the Colonial period the seasonal flood intervals became more frequent and the effects more violent. The Europeans had different needs and methods and introduced important economic changes, including their agriculture practices, the herding of cattle, and the accelerated cutting of forests. These modifications, however, resulted in deforestation, with the consequential environmental changes following. In addition, since the Spanish viewed lake cities with a European eye (e.g., Venice), they did not appreciate the need to continually maintain the dikes, channels, and other water features, which fell into misuse until the flood of 1550, after which the Spanish authorities reactivated the pre-Hispanic systems. Despite these attempts, flooding continued to affect lake settlements and life, as it does at present, and residents of Mexico City continue to deal with the consequences of living within a lake.

11

Water Sources at Mayapán, Yucatán, Mexico

CLIFFORD T. BROWN

Mayapán, the Late Postclassic cultural capital of Maya society (c. AD 1200–1450), is in the arid northwestern corner of the Yucatán Peninsula (fig. 11.1). This region is pitted with several kinds of cenotes that are the sole sources of water and were the focus of ancient settlement and ritual. As axes of the sacred landscape, the cenotes were the keys to the political and spatial organization of the site. The nearby lakes of the Cenote Zone probably supplied various resources and would have been important to the local economy.

This chapter is about the water sources in and around Mayapán. I begin by presenting historic evidence suggesting that the name Mayapán was related to water sources. Then I discuss aspects of the environment, climate, hydrology, geology, and geomorphology of the area related to water sources and their connections to settlement. I describe the two different types of water sources. Next, I review the historic and archaeological evidence for the economic and religious significance of these water sources. Finally, I appraise their influence on the social structure and settlement patterns at Mayapán.

Mayapán

Mayapán was the political capital of most of northern Yucatán and the largest Maya settlement during the Late Postclassic period. The city was the seat of a “joint government” (*mul tepal*), or political confederacy, that ruled the region for about two hundred years. To the Maya and Spaniards of the Colonial period the rise and fall of Mayapán formed the most salient drama in Maya history. Archaeologically, Mayapán is the premier center in the region: the ruins encompass 4.2 square kilometers inside a 9-kilometer-long defensive wall within which over four thousand ancient

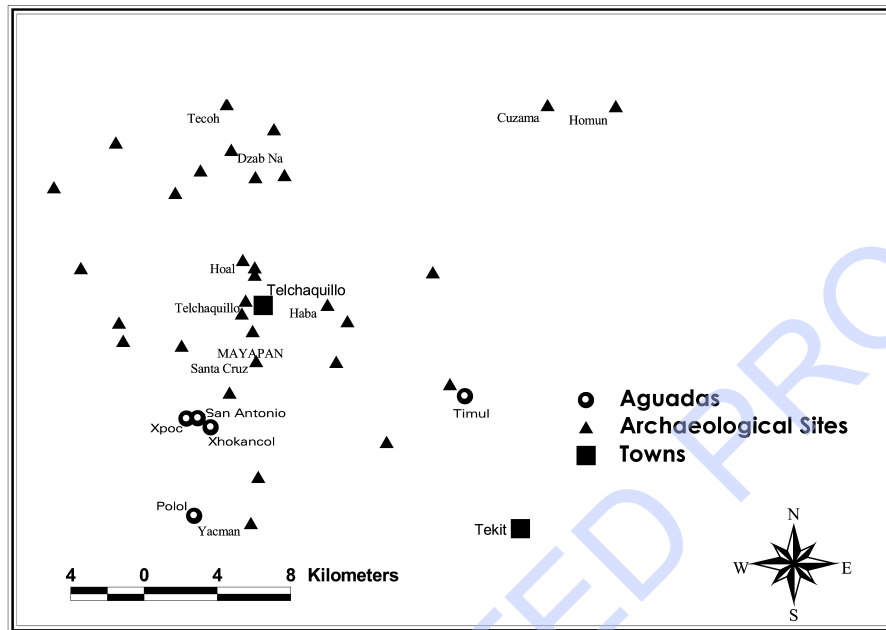


Fig. 11.1 Mayapán and vicinity, showing towns, archaeological sites, and the small lakes mentioned in the text.

structures are densely packed. Mayapán's lofty political and economic status probably also conferred upon it preeminence in art and literature.

Mayapán was the archetype of the Late Postclassic Maya city. The name Mayapán, Bishop Landa tells us, "means *Pendant of the Maya*, because the language of the land is called *Maya*; and the Indians call the city *Ychpa*, which means *within the walls*" (1986:13, my translation). The metaphor of Mayapán as the walled city (*ich paa Mayapan*) was ubiquitous in Colonial Maya literature. Thus, this central place and political capital was also the trope and mirror of Maya urban life. Landa's statement implies that */-pan/* came from *pantli*, Nahuatl for "flag" (Karttunen 1992:186). Landa's testimony about Mayapán is highly credible because he interviewed the children and grandchildren of the city's rulers. Pantli, though, has a homonym that means "wall" (Karttunen 1992:187). If we read Mayapán as the "Wall of the Maya," then *ich paa Mayapan* (e.g., in the Books of Chilam Balam [Edmonson 1982:9, 10, 1986:53, 54, 91]) becomes a bilingual kenning or couplet in which "wall" is the repeated element (see Edmonson 1982, 1986; Edmonson and Bricker 1985 on kennings and couplets in these texts). Edmonson (1982:9–10 n. 144), in contrast, suggested that Mayapán

should be scanned as *may*, Yucatec Maya for “cycle,” and *-apan*, Nahuatl for “water place.” This idea gains support from a passage in the Book of Chilam Balam of Chumayel: “Hol tun ake acanqueh ti cooh ti ch’ah-il ti-chac mayapan ych paa y-ok-ol haa” (Bricker 1990a:596; cf. Edmonson 1986:91), which can be glossed as “Holtun, Ake, Acanceh, Tecoh, Tich’ahil, Telchaquillo, Mayapán in the walls, over the water.” The capitalized words are place-names, in a general north-south geographical order, except Tich’ahil, which could be an as-yet-unrecognized toponym. So Mayapán may have been known for its water sources. Yucatecan towns were often named after their water sources (Brown 1999:526–31); some even think that Yucatec phrases like “the caves, the wells” also meant “the towns, the villages” (Edmonson 1982:89).

Environment and Rainfall

Mayapán lies some 40 kilometers south-southeast of Mérida, Yucatán. This northwest sector of the Maya Lowlands is hot, dry, and flat. Precipitation in the lowlands decreases progressively to the north and west; the northwest tip of the peninsula is a virtual desert. Around Mayapán annual precipitation is estimated by the Instituto Nacional de Estadística, Geografía e Informática (INEGI) to be 1,081.37 millimeters, with a range of 686–1,366.20 millimeters. These statistics derive from twenty-six years of observations made in Telchaquillo, a Maya village 2 kilometers from the ruins (INEGI 1985b). The rain is enough, usually, for traditional swidden agriculture, which is practiced throughout the area. In Telchaquillo about 200 millimeters of rain falls in the dry “winter” from November to April (INEGI 1983a); the balance, about 900 millimeters, falls in the wet season “summer,” between May and October (INEGI 1983b). The corn, especially the fast-growing *x-mehen-nal* race, is watered by summer thundershowers that distribute rain in a patchy way across the landscape. One cornfield can enjoy plentiful rains and yield a bumper crop, while only a couple of kilometers away a similar milpa may dry up completely. For this reason, among others, a *milpero* may plant in more than one place to improve the chances of having at least a partial crop. Later in the year significant precipitation comes from cold fronts that drift slowly across the peninsula, bringing chill winds and long rainy days. These “northers” water the slow-ripening corn, called *x-nuk-nal* in Mayan, and the beans in the milpa. More late-season rain comes from tropical storms and hurricanes.

As the statistics show, the dry season at Mayapán is quite arid. During two or three months between December and March it may not rain at all. High temperatures *average* 30°C from November to April (INEGI

1983a), and extreme temperatures above 40°C occur. In this climate reliable water sources are indispensable for sedentary settlement.

Water Sources

The Yucatán Peninsula is a karstic limestone shelf blessed with few streams and almost none in the north. Because of the karst most drainage is internal, with rapid infiltration and little runoff. In general, the limestone is lower, flatter, and younger in the north of the peninsula and higher, older, and rougher in the south (Sharpton et al. 1993:fig. 1; West 1964:68–73). The heat, the dryness, and the young, thin soils of the north lead to the growth of a low, scrubby thorn forest. Notwithstanding the low level of relief, the land is actually sharp, stony, and broken. At Mayapán elevation only varies about 5 meters (see Jones 1952), but it varies continually: ubiquitous ridges, knolls, and cockpits make for high average slopes, which contribute to the thinness of the soil and the difficulty of travel. This tumbled, broken landscape is created by the solution and corrosion of the limestone. The collapse dolines—sinkholes formed by the collapse of the caprock into underground voids—at the site are deeper than the solution dolines—depressions formed by chemical dissolution of limestone. The former are up to 13 meters deep.

In general, all the water sources in the Mayapán area are karstic solution features of one kind or another. In one sense, then, all are “cenotes.” The word “cenote” comes from the Yucatec Maya word *ts’ono’ot*, meaning “sinkhole” or “doline” (Bricker, Po’ot Yah, and Dzul de Po’ot 1998). The broad use of the term “cenote,” however, masks variability related to the geomorphology, function, and significance of these features. I prefer to divide water sources into at least two groups: *ch’e’eno’ob’*, or “wells,” and the small lakes of the Cenote Zone. In the first category I include all collapse dolines and caves that have water in them. These are common, nearly ubiquitous, features throughout Yucatán, and they are the only kind of water source within the wall of Mayapán. One can subdivide this group into solution caverns, vertical (“true”) cenotes, and funnel-shaped dolines (West 1964:72) using morphology or hydrologic history. The small lakes of the Cenote Zone are often called cenotes by both the local Maya and geologists, but compared to the *ch’e’eno’ob’* they have a distinctive geologic history, morphology, hydrology, distribution, and social function. Therefore, I discuss these lakes separately, after which I talk about the *ch’e’eno’ob’* of Mayapán.

The use of the words *ts’ono’ot*, *ch’e’en* (literally, “well”), and *’áaktun* (literally, “cave”) in modern Yucatec is complicated enough to merit com-

ment (Bricker, Po'ot Yah, and Dzul de Po'ot 1998:2, 54, 82). The ranges of denotation for these words appear to overlap considerably. The term *ch'e'en* refers not only to some natural caves and cenotes that have water in them but also to modern artificial wells. One might hypothesize that a *ch'e'en* is open to the sky, whereas an *'áaktun* is a natural tunnel or chamber that is roofed. But some caves with water in them are called *ch'e'eno'ob'*, falsifying that hypothesis. The word *'áaktun* is also used to denote caves with water in them as well as dry caves. On several occasions I have attempted to elicit systematically the differences among these terms from native Yucatec speakers, and I have also tried to observe the different usages in modern spoken Yucatec discourse. I have not, however, succeeded in deciphering the ethnotaxonomy underlying this semantic domain or relating it to a geomorphic classification.

Lakes of the Cenote Zone

The Chicxulub Crater is the major geological structure nearest to Mayapán. It is one of the largest craters in the inner solar system (Sharpton et al. 1993) and has been dated to the end of the Cretaceous period, 65 million years ago (Swisher et al. 1992). The aftermath of the impact evidently caused the extinction of the dinosaurs (Alvarez et al. 1980; Alvarez 1997). The crater, a complex structure, is buried under 300–1,000 meters of Tertiary (i.e., post-Cretaceous) limestone deposits (Pope, Ocampo, and Duller 1993). Most of the inferences about the morphology of the crater come from gravity measurements (Hildebrand et al. 1995; Morgan, Warner, and the Chicxulub Working Group 1997; Sharpton et al. 1993) and observations of secondary surface features. The crater's diameter has been a topic of much debate. It may have multiple rings and a central peak (Sharpton et al. 1993; Morgan, Warner, and the Chicxulub Working Group 1997).

The carbonates (i.e., limestones and dolomites) inside the crater differ from those outside it. The surfaces outside the crater are higher in elevation than those inside. Possibly, the crater was not completely infilled by the later marine carbonates, so it still forms a slight depression. Also, ejecta seem to have landed around the crater's edges. The limestone outside the crater is older than that inside because the former (being higher) was exposed by marine regression earlier than the limestone that formed in the depression within the crater. The limestone outside the crater is both eroded (by solution, corrosion, and weathering) and fractured, whereas the deposits within the crater exhibit less fracturing and erosion. The soils and their degree of development also provide evidence

that the geomorphic units inside the crater are younger than the surfaces outside it (Pope, Ocampo, and Duller 1993; Pope et al. 1996). The differing characteristics of the interior and exterior carbonates, particularly the degree of fracturing, mean that the boundary between the two dramatically affects the local hydrology.

Along that boundary is a semicircular ring of cenotes, called the Cenote Zone on INEGI maps. These cenotes lie within a topographic trough several meters deep (Pope, Ocampo, and Duller 1993). The Cenote Zone has a complicated impact on the regional hydrology. The water level declines in the area of the Cenote Zone, and the ring of cenotes captures groundwater flow and shunts it to the sea (Perry et al. 1995). Mayapán lies on the inner edge of the trough (Kevin Pope, personal communication, 2001). At least a dozen cenotes of the Cenote Zone lie about 5 kilometers south of Mayapán (INEGI 1985c). As mentioned earlier, these are not typical Yucatecan cenotes but more like small lakes in depressions that are much larger than the typical collapse dolines in the area.

These lakes, their hydrology, and the general environment of the Cenote Zone influenced the archaeological settlement patterns and cultural landscape of the area. Since these lakes are the only open bodies of water in the vicinity of Mayapán, we must consider the possibility that their presence influenced the decision to found Mayapán in the spot where it lies today. Furthermore, the resources offered by the lakes very likely formed part of the economy of Mayapán. Thus, my review of the water sources at Mayapán would be incomplete if I did not include an appraisal of these lakes. Therefore, I discuss below the historical and archaeological evidence for human settlement and economic exploitation of the Cenote Zone.

The water quality in these cenotes varies but is generally poor. INEGI (1985a) found that some are highly saline. The cenote Polol, for example, one of the largest, is about 12 kilometers south-southwest of Mayapán; it is highly saline and apparently impotable. The water is the hardest tested (CaCO_3 concentration = 1,129 mg/l) of some 330 samples. The U.S. government classifies anything over 180 mg/l as very hard. The level of total dissolved solids is also very high (3,351 mg/l). Farther west, the cenote Nicanche is also very hard, highly saline, and impotable, as is an unnamed lake (sample 157) geographically intermediate between the previous two. The cenote Xpoc, one of the nearest of these lakes to Mayapán, is listed as having "tolerable" water quality (total dissolved solids [sample 169] = 1,288 mg/l). It is also hard (CaCO_3 concentration = 533.5 mg/l). The water of all the lakes tested is reported to be poor for irrigation and is generally used for animal husbandry. The poor water quality may be caused by the

lack of outlets in these lakes. The high heat and low humidity in the area lead to high evaporation rates that help concentrate salts and solids.

Predictably, the people in Telchaquillo report that the water in these lakes is poor and generally impotable. People fish in some lakes, while cattle are watered at others. Most lakes seem to have wells dug near the water's edge. I have visited several of these lakes, and they have remarkably diverse characteristics. The cenote San Antonio is the lake nearest to Mayapán, about 5 kilometers south-southwest of the site, halfway between Xkanchakan and Mahzucil. It produces small, tasty fish for the occasional fisherman. Within its depression the water is surrounded by wild groves of *caña brava*, a large variety of native bamboo. Like bamboo elsewhere, *caña brava* has many possible uses (e.g., construction, furniture, spear and arrow shafts, etc.).

Across the road small rings of unsquared stones surround the cenote Xpoc. These rings are 2 or 3 meters wide and 30 or 40 centimeters high (just a few courses of rough stone) and are filled with soil. Several concentric circles of these rings surround the lake, although none were visible along a precipitous portion of the shoreline. The inner circles are partly inundated, and all are close to the water. We know nothing about the function of these features or even if they are prehistoric. The ruins of a historic ranch or hacienda lie above the lake near the edge of the depression, so the circular features may be historic. It is not unreasonable to speculate that they might have been used either as planters for raising an economically important tree crop such as cacao (see Kepecs and Boucher 1996 for a parallel example from northeast Yucatán) or as pens for raising animals (see below).

The cenote Xhokancol is a few hundred meters farther south on the road to Mahzucil. It is seasonally dry, and, when it is dry, grass grows across its flat bottom. The foundations of a small structure with an unusual plan are visible in the bottom of the basin near a shallow well that reaches the water table. I briefly discuss this structure later.

The cenote Timul is about 11 kilometers southeast of Mayapán, west of the old hacienda road between Tekit and Tecoh, south of San Isidro Ochil. Timul is the largest of the lakes in the vicinity, with the exception of Polol. As its name suggests (*mul* = "mound, pyramid"), Timul has a modest ruined pyramid on its edge. The pyramid has been robbed for stone, probably for the nearby ranch. The ancient building is now a shapeless hulk.

The role of these water sources in pre-Hispanic Maya society can be inferred in part through the descriptions of them that appear in the *Relaciones histórico-geográficas de la gobernación de Yucatán*, which were written only some thirty years after the Spanish Conquest. The *Relación de*

Mama y Kantemo quite accurately describes six lakes that are obviously the lakes of the Cenote Zone that are closest to Mayapán. The *Relación* states that the lakes have fish in them and also mentions that the lakes have “alligators” (probably iguanas) that were “put there by hand” (de la Garza, Izquierdo, and León y Tolita Figueroa 1983:112). I say “iguanas” because elsewhere in the *Relaciones* iguanas are described as “lagartos” (e.g., de la Garza, Izquierdo, and León y Tolita Figueroa 1983:96). Clearly, the Maya exploited the lakes in surprising ways. The *Relación de Tekit* also describes some of the lakes, emphasizing the unhealthy quality of the water (de la Garza, Izquierdo, and León y Tolita Figueroa 1983:287). The *Relación de Tiab y Tiek* makes a similar comment and goes on to say that the natives used the lakes to raise small turtles for food (de la Garza, Izquierdo, and León y Tolita Figueroa 1983:320). The historical use of these lakes for raising turtles and iguanas is surprising. Perhaps the small stone circles at the cenote Xpoc were part of a turtle hatchery, or maybe the odd stone foundation in the cenote Xhokancol was related to iguana farming. The economic potential of these lakes seems to have been overlooked by archaeologists.

Each of the lakes I have visited is noticeably different. This diversity, the unusual topography, and the restricted distribution of resources offered by these lakes should have led to the development of a distinctive pattern of ancient settlement. Part of the area, especially to the east of Mayapán, is poorly surveyed, so we cannot draw firm conclusions. The *Atlas arqueológico del estado de Yucatán* (Garza Tarazona and Kurjack Basco 1980) shows us very few sites in the Cenote Zone. The site of Timul (16Qd(7):166), mentioned above, appears to be an exception. Unfortunately, little is known about its age or function. There may well be other small sites in the Cenote Zone, but it seems unlikely that there are really large ones that remain unknown. Thus, the most salient feature of settlement in the Cenote Zone is its absence. The author of the *Relación de Sotuta y Tibolon* reached the same conclusion (de la Garza, Izquierdo, and León y Tolita Figueroa 1983:148) and ascribed the lack of settlement to the bad water of the lakes.

Ch'e'eno'ob'

All the water sources within the great wall of Mayapán fall into the category of ch'e'eno'ob', which, as I explained earlier, literally means “wells” (fig. 11.2). In geomorphological terms they are either natural collapse dolines that reach the water table or karst solution caverns that have pools of water in them. None of the cenotes at Mayapán look much like the Cenote of Sacrifice at Chichén Itzá: a round depression with vertical sides

calcite crystals. An elder from Telchaquillo told me that this *ch'aak xiix* was ground up and used as temper in ceramics. There is little clear calcite temper in the ceramics of Mayapán, but various kinds of clear calcite temper are common in the Late and Terminal Classic ceramics of the Cehpech and Sotuta complexes (Smith 1971).

Adams (1953:153, 171, 175) reported that stalactites were used as vertical tenons or supports to form three modeled stucco statues in front of Structure Q-71, a shrine in the ceremonial center. The small figures were evidently modeled and painted. The stalactites must have come from a cave or cenote, and in some of the caves of Mayapán, such as Ch'en K'ulu, most of the stalactites have been cut off or broken off.

Caves were also used for interments. I observed human remains in Ch'en Mul, Ch'en K'ulu, and Yo Dzonot and in the main cenote in the plaza of Telchaquillo. The Carnegie Institution also found burials in caves, including the cenotes X-Coton (Shook 1952a; Smith 1953a, 1971:116) and Ch'en Mul.

Fish live in Yucatecan cenotes, particularly *Cichlasoma* sp., which is eaten by the local people; the same species apparently live in the lakes of the Cenote Zone (Pollock and Ray 1957:649–51). These were among the most common fishes that were excavated by the Carnegie Institution at Mayapán. Although they were recovered in only a couple of lots, the minimum number of individuals was the highest of all the fishes found (Pollock and Ray 1957). Little, however, is known about the Carnegie's recovery methods, although they were surely not systematic; therefore, it is difficult to evaluate Pollock and Ray's quantitative conclusions. The archaeological remains also include large numbers of turtles and iguanas that may have come from cenotes or lakes. In my excavations in residential middens, in which the soil matrix was systematically screened, fish bones occurred in small numbers. It is fair to infer from these data that the water sources of Mayapán provided material and resources that influenced the economy of the community.

The ritual and religious use of cenotes at Mayapán influenced the spatial organization of the site and probably its social and political organization as well. Three important cenotes were associated with ceremonial architecture: Ch'en Mul, X-Coton, and Itz'mal Ch'en. The cenote Ch'en Mul is located in the heart of the ceremonial center at the foot of the Temple of Kukulcan. This location has clear symbolic significance in the context of Mesoamerican religion. It incarnates the link between the cave, the water, and the pyramid-mountain, which in Mesoamerican thought was a single idea — *alteptl* — of community or town (Bierhorst 1985; Broda et al. 1987:93; Lopez Austin 1997; Stark 1999a; see also French, Stuart, and

Morales and Fash and Davis-Salazar, this volume). The juxtaposition embodies the geography of the heavens, the underworld of the cavern, and the multilayered firmament. The religious center of the city is thus an *axis mundi*, representing the levels of the Maya cosmos (Eliade 1954:12). Moreover, the Temple of Kukulcan is a radial temple, likely associated with completion, specifically with calendrical termination rituals, such as katun endings and New Year ceremonies (Brown n.d.; Carlson 1981; Coggin 1980, 1983). The temple also presents an astronomical hierophany on the winter solstice (Aveni, Milbrath, and Peraza Lope 2004), which highlights the building's ritual significance as the center of the community.

There is direct evidence that the Temple of Kukulcan at Mayapán acted as an axis mundi that united the heavens, the earth, and the underworld. Like its analog at Chichén Itzá, the Temple of Kukulcan at Mayapán had nine terraces (Shook 1954:93), equal to the number of levels in the Maya underworld (Carrasco 1990:67). The connection to the underworld is made explicit, however, by the presence of a natural cave below the temple. Robert Smith reported that an arm of the cenote Ch'en Mul extended approximately west-northwest beneath the Temple of Kukulcan (1953b:280, 1954). It has since been discovered that caves or tunnels occur beneath several major pyramids in Mesoamerica, including the Temple of the Sun at Teotihuacan (Heyden 1975, 1981, 1989), the Temples of K'ucumatz and Tojil at Uxatlan (Fox 1991), and the El Duende pyramid at Dos Pilas (Brady 1997). These tunnels and caves appear to be related symbolically to the Central Mexican creation myths and to the Maya underworld, Xibalba, of the Quiche Maya Popol Vuh. The cave beneath the Temple of Kukulcan probably possessed similar mythic significance.

My exploration of the cenote Ch'en Mul indicates that the tunnel that passes beneath the Temple of Kukulcan departs from the southwestern edge of the collapse doline and runs southwest and then west, apparently near the southern edge of the temple. Looking at my measurements, taken casually years ago, and comparing them to the existing maps (fig. 11.3) (Smith 1954; ceremonial center map drawn by Proskouriakoff, in back pocket of Pollock et al. 1962), I first noted that Smith's map was inaccurate. The tunnel marked with an arrow as going "to the West Water Hole" is the one that passes below the Temple of Kukulcan. On Smith's map it is not drawn in but appears to be oriented north of west. In fact, my notes show this tunnel running from the southwest corner of the collapse doline and bearing slightly south of west, with an average azimuth of about 257° (mag.) for more than 30 meters. I used the U.S. National Oceanic and Atmospheric Administration's online calculator (<http://www.ngdc.noaa.gov/cgi-bin/seg/gmag/fldsnt1.pl>) to calculate the changes in magnetic

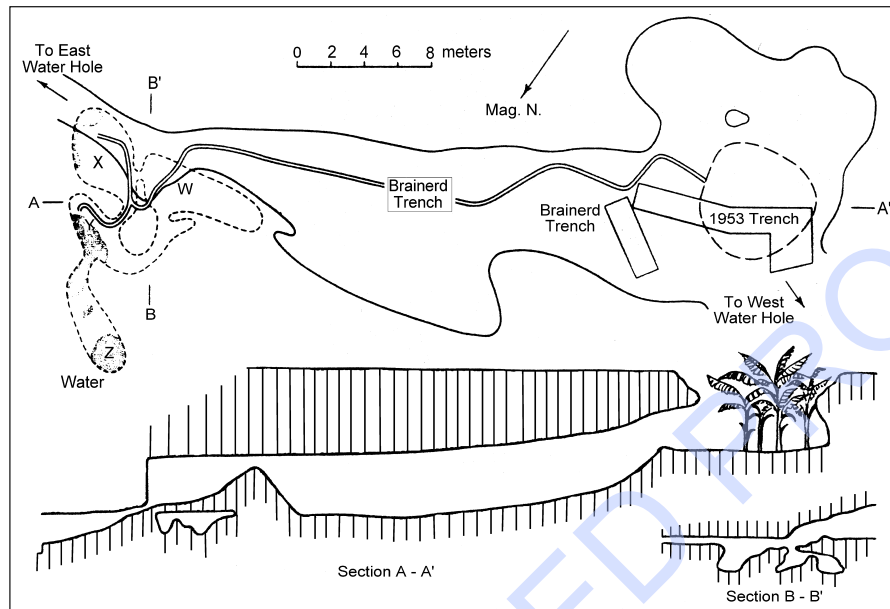


Fig. 11.3 Partial plan and profile of the cenote Ch'en Mul, located in the ceremonial center of Mayapán. (After Smith 1954; courtesy of the Carnegie Institution of Washington)

declination since the Carnegie Institution's work, which is necessary because Smith's map is oriented to magnetic north. All things considered, I believe that at least part of the western tunnel passes beneath the southern edge of the Temple of Kukulcan. A careful survey would, however, be required to be certain. I do not believe that the precise orientation of the tunnel or its exact spatial relationship to the overlying pyramid alters the interpretation of the spot as an axis mundi. The placement of the pyramid at the edge of the cenote is evidence enough of the Maya's symbolic message.

Scholars have missed a similar phenomenon of equal or greater interest, although Pugh (2001) recently noted this. The main tunnel of Ch'en Mul runs about 40 meters northeast, and a side branch ends in a group of small lobate pools of water directly beneath the platform of Structure Q-152, the largest round temple at the site, sometimes called the Caracol or Observatory after its analog at Chichén Itzá. Thus, Structure Q-152, the second most prominent religious construction and the stela platform of the site, is another axis mundi, perhaps associated with rituals differ-

ent from those of the Temple of Kukulcan (Pollock et al. 1962:113–17). In the Maya area round temples seem to be evidence of Central Mexican influence, as they may be at Mayapán. Among the Aztec in Central Mexico round temples were dedicated to Ehécatl, lord of the wind and an avatar of Quetzalcoatl (Aveni 1980:262; Carrasco 1990:72). Since Kukulcan is the Maya incarnation of Quetzalcoatl, both of the principal temples at Mayapán may celebrate different aspects of the same deity. That two tunnels of the same cave extend beneath both structures may be an allusion to this parallelism.

While Ch'en Mul may be the most significant sacred cenote at the site because of its central location, X-Coton and Itz'mal Ch'en also exhibit evidence of sacredness. X-Coton has human burials and a small platform within it. Proskouriakoff (Pollock et al. 1962:130) thought that the city wall had been extended to encompass this cenote. Two small ceremonial buildings sit on the rim of the cenote, Structures T-70 and T-72. Structure T-70 is a rare double temple (Shook 1952a, 1953), reminiscent of Central Mexican ones, which are best exemplified by the Templo Mayor of Tenochtitlan. Itz'mal Ch'en is a dramatic hole in the ground. The men of Telchaquillo have held their *ch'a'ah-chaak* rain-bringing ceremony at Itz'mal Ch'en for many years (Shook 1952a).

Two cenotes also have an evil supernatural reputation. Sac Uayum is a large cenote located just south of the city wall. I have suggested (Brown n.d.) that the exclusion of the cenote from the city was intentional and that the course of the wall was deflected for this purpose. Sac Uayum is held to be the home of a feathered serpent that eats children. Yucatecan mythology is filled with caves (Burns 1983:244–57). In these legends they are often the homes of serpents. Sometimes the flying serpent, called Hapai Can, eats children (Dzul Poot 1985:47–53). Other stories emphasize the cave serpent's role as protector of the cenotes and the sacred *zuyha*, or "virgin water," used in ceremonies such as the *ch'a'ah-chaak* (Tec Chí et al. 1992:22–24). The cenote Cosil is also considered a dangerous place. My employees refused to enter it with me. These facts bespeak a storied sacred landscape heavy with meaning.

Water, Ritual, and Ancestors

Equally important is the relationship among water sources, ritual, and kinship. Vogt (1969, 1976, 1981) and others (e.g., Brady 1997; Collier 1975) have meticulously documented the geographic and ritual interconnections among lineages, ancestor worship, and settlement in the highlands of Chiapas and Guatemala. Similar systems are documented poorly

among the Yucatec Maya. I have noted (Brown n.d.) passages in the Books of Chilam Balam that imply that a similar association of lineages, rituals, and caves existed at Mayapán. The clearest passage on this theme is from the Book of Chilam Balam of Tizimin:

Tutz'oc ucuch katun	The burden of the katun is finished
Ti to uil yokol <i>Mayapan</i>	Which is one moon over Mayapan,
Ti uchom may cu	The cycle seat,
Uyetz'	His setting,
Uch'ibal	His lineage,
Tuch'enil	At the wells,
Ti yactunil	At the welling fountains.
Tix uchom cimcehil	And there occurred deer death
Ma ya cimlal	And painless death.
(Bricker 1990b)	(Edmonson 1982:110)

This passage indicates that caves and cenotes were ritually and religiously associated with lineages at Mayapán. The translation has some problems, such as the rendering of *yactunil* as “welling fountains” rather than as “cave,” its literal, commonplace meaning. Edmonson does, however, provide the basic meaning. A nearly identical passage appears in the Pérez (Miram 1988, 3:90).

Considerable evidence suggests that the government of Mayapán was organized around the kinship system, which was certainly patrilineal and probably bilineal (Brown 1999). Therefore, political power and legitimacy must have been interwoven with cenote rituals and ancestor worship. As the principal lineages, the Cocom and Xiu may have vitalized their power through their association with certain water sources and the deities who dwelled in them. Perhaps Ch'en Mul was affiliated with the ancestors, tutelary deities, and political power of the Cocom, the city's founding lineage, or the Xiu, who also claimed to have been a paramount lineage at the site.

Many ch'e'eno'ob' occur outside the great wall, but their density is unknown. They are common, but without reliable survey data we will never know whether the cenote density within Mayapán is exceptional. The Carnegie Institution investigated almost eighty caves and cenotes within a radius of about 19 kilometers of Telchaquillo. Over sixty caves contained Mayapán-type ceramics, and some have Mayapán period architecture nearby. The survey was not exhaustive; some nearby cenotes were not included. For example, the cenote Chaak, which is in Telchaquillo and gives the town its name, is not listed. The number of cenotes visited hints at both their ubiquity and the density of Mayapán period settlement in the region.

Conclusion

Water sources played several important roles in the culture of Mayapán. They supplied water in a dry land. They offered food and raw materials for pottery and construction. The small lakes of the cenote zone were sources of food and perhaps other materials, although the water is poor. The lakes were used for raising iguanas and turtles. Many cenotes had sacred or supernatural associations. In Mayapán residential settlement was related to cenotes. Given a patrilocal and patrilineal kinship and residence system, the cenotes would have been associated with specific patrilineages, as they are in the Maya Highlands. Passages from the Books of Chilam Balam suggest there were specific rituals and sacrifices related to lineages that took place at cenotes. The ethnohistorical data clearly imply that government at Mayapán was organized around principles of kinship (Brown 1999). Therefore, the cenotes were tightly integrated into the system of political power and legitimacy.

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WATER SYSTEMS IN THE SOUTHWEST

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12

Animated Waters Ritual Technology at Casas Grandes, Chihuahua

WILLIAM H. WALKER AND GAEA MCGAHEE

When considering the relationship between politics and religion in middle-range societies, an important stumbling block is the dichotomy between technology and religion (Walker 2001). Technologies in many societies embody ritual activities and religious beliefs. Artificially distinguishing between the practical and spiritual aspects of these technologies, therefore, can mask evidence of political power (Walker and Lucero 2000). Water is a fundamental resource whose differential control promotes inequality. Water management in particular often includes ritual activities (e.g., Lansing 1991; Scarborough 1998; Wittfogel 1957). Similar to agricultural land, hunting territories, and trade routes, water as well as the tools associated with its use follow cultural biographies (acquisition, use, and abandonment) that are punctuated by ritual activities. Archaeological studies have embraced the centrality of ritual and religion in economic, political, and social dimensions of water technology in state-level societies (Kolata 1993; Lansing 1991; Lucero 1999b; Scarborough 1998; Wittfogel 1957). The importance of ritual activities for water management in middle-range societies remains less well understood. The Pueblo societies of the American Southwest provide a useful case for studying the linkage between ritual and technological activity.

Water technologies begin with the manipulation of natural water sources. Not surprisingly, both natural (springs, rivers, and tanks) and artificial (wells, canals, reservoirs) sources of water are places of ceremonial activity worldwide (e.g., Brenneman and Brenneman 1995; Griffith 1992). Often such ritual involves serpent deities and ancestral veneration (e.g., Bourke 1984 [1884]; Hambly 1931; La Barre 1962; Mundkur 1983; Parsons 1936). The relationship between natural sources of water and natural symbols such as serpents, clouds, and humanlike beings (ghosts, ancestors, nature spirits) is particularly pronounced in middle-range societies. The

cultures of the American Southwest exemplify the relationship between political power and ritually sanctioned water technologists.

In the first section of this chapter we review southwestern examples of what Wittfogel (1957) called hydraulic societies. We emphasize that the relationship between ritual power and theocratic power is particularly striking in middle-range societies. In such societies activities defy the practical/impractical dichotomy that archaeologists often impose on technology and religion (Walker 1995, 1998). Practical-looking objects, such as metates and water jars, often have ritual uses, and only through considerations of contextual evidence independent of artifact forms will the ritual components of such technologies become clear. In the second section we discuss how to identify hydrologic ritual activities in the archaeological record. We then illustrate these ideas in a case study of the late prehistoric town of Casas Grandes, Chihuahua. In the final section of the chapter we discuss the implications of this case study in light of southwestern cultures and middle-range societies more generally.

Hydraulic Society in the American Southwest

A number of southwestern cultures (e.g., Papago, Pima, western Pueblos, and eastern Pueblos) conform to what Wittfogel (1957) has called hydraulic societies. To a greater or lesser degree, these cultures carry out practical water-management activities (e.g., spring clearing and cleaning, canal building, construction of drainage ditches, well digging) that contribute to their economic productivity. In Wittfogel's comparative study of power the most hydraulically inclined southwestern cultures, the eastern Pueblos of the Rio Grande valley, provide a comparative foil that draws out the attributes of the more complex societies in his study (e.g., ancient Peru, Mesopotamia, and the ancient Maya).

Wittfogel (1957:166) classified all the Pueblos along a continuum of hydraulic activities. On one end are the marginal or "loose" hydraulic groups such as the Hopi. Largely dry farmers, these peoples practice hydraulic activities such as the construction of reservoirs and maintenance of springs (Wittfogel 1957:191). Their economy, however, only loosely depends on these activities. On the other end are more "compact" groups such as the Rio Grande Pueblos, who derive their subsistence almost exclusively from irrigated fields (Wittfogel 1957:164). Their hydraulic activities include attending to drinking water needs as well as the construction and maintenance of canals. The Zuni fall somewhere in between, employing canals and dry farming. In all these societies town leaders were also religious leaders, and a substantial number of their ritual activities in-

volved water, frequently in the context of water management (Wittfogel 1957:88). Nonetheless, these “priests” were also farmers and practiced their religious duties alongside other household responsibilities. These southwestern Pueblo societies, while economically egalitarian, possessed status differences that derived from access to ritual power.

In light of the general relationship between ritual and technology, this theocratic tendency is telling. Southwestern leaders, whether members of hydraulic societies or not, were ritual specialists. Nonhydraulic societies such as those of the Apacheans (Apache, Navajo) and Pai (Yavapai, Havasupai, Walapai) cultures had leaders for communal activities (group hunts, initiations, war) who employed ritual to achieve favorable results. The roots of hydraulic ritual power lie in the mechanics of ritual power itself.

The first societal managers worldwide were ritual specialists, and it is not surprising that their management persisted with the rise of hydraulic technologies (Walker 2001). In these egalitarian societies natural symbols and natural sources of water were already heavily ritualized. Middle-range societies are less egalitarian because they have institutionalized these sources of power into the hands of kinship and sodality organizations headed by priests. The power of such leaders, however, rests in the strong ties these institutions have with the natural world rather than with particular economic or political resources.

These middle-range societies are middle range in part because they maintain that communal religious intimacy in the face of changing social and economic conditions. These are rituals that organize daily life. Their goals are communal in scope. They ask for rain, crop fertility, and village well-being. They are regularized into calendars and involve large subsets (e.g., warriors, moieties, clans, phratries) of the community. Leaders of these rituals will also lead these subsets. Their ritual roles may in fact express sacred relations between these groups and the larger community's history. Rituals serve to commemorate event(s) (e.g., migrations, creations, victories) important to the community or a large subset of the community. The communal power such priests wield to control nature and technology can also hinder the expansion of social power. In middle-range societies consensus decision making among leaders is common. It is rare that some kinship segment or other economic unit is able to amass enough power, ritual and otherwise, to claim differential control of rain, disease, land, crops, and labor. As a result, it is difficult for that segment or unit to defy consensus decision making and break out of the communal mesh of relations that characterize these societies.

In the Hopi pueblos, for example, sodality leaders are drawn from the

leadership of different kin groups (Eggan 1950:90; cf. Whiteley 1998:49–51). These sodalities share ritual responsibilities in a complex annual ceremonial calendar. Members of diverse matrilineal clans can join different sodalities, but preferences are expressed. The exception is the Katsina society, which is open to all members of the community. Among the Hopi, people became clouds at death and were identified with katsinas—generalized ancestral beings whose annual ritual activities brought life-giving rains (Fewkes 1896:196; Hieb 1994:25–27; Titiev 1944:171–73). To make drastic changes in this form of social organization would be extremely difficult because both the natural and supernatural worlds would have to change. The consolidation of economic and ritual power would require rewriting cosmological ties with most existing natural resources.

As a result, Hopi and other Pueblo groups possess mechanisms for social change that minimize the disruptive effects of environmental and social changes (Geertz 1994:338–39). Pueblo leaders employ their ritual knowledge and skills to naturalize change. Prophecy, for example, serves as a means for rendering continuity out of discontinuity. Changes, including village abandonments, migrations, and the incorporation of new ethnic groups and ceremonies, are presented as fulfillments of supernatural fate.

Not surprisingly, natural objects also often serve as symbols (e.g., ancestral beings, serpents, clouds, lightning, concretions, axes, and fossils) in various Pueblo religious technologies. Religious systems can preserve continuity in appearance by employing the same well-known objects. Indeed, this may underlie the general assumption that ritual itself tends to change more conservatively than other social institutions.

When faced by environmental crises, prehistoric Pueblo societies tended to aggregate, pooling resources communally. Such aggregations would certainly entail the modification of cultic practices and variation in architecture but did not radically change either. In only a few exceptions, such as the Chaco Canyon phenomenon and the Casas Grandes culture, did social organization and architecture appear to change enough to spark debate about social complexity (Plog 1995). The cultural hegemony of these cultures, unlike other Pueblo cultures, appears to have expanded beyond a community scale to embrace large regions. Early cultural centers, such as those associated with Mesa Verde or Kayenta or the Mogollon Mimbres, possess material culture homogeneity but did not have supravillage political organization (e.g., Lipe 2002:231). The Casas and Chacoan drives to complexity, however, were relatively short-lived. In the case of the social structure of Casas Grandes, the power of leaders derived from the integration of ritual power and control of water.

Identifying Archaeological Evidence of Hydrologic Ritual Activity

Archaeological studies of prehistoric water management in the American Southwest have successfully identified a range of pragmatic attributes of water technology (e.g., Bayman, Palacios-Fest, and Huckell 1997; Crown 1987b; Doolittle 1993; Hack 1942; Raab 1975; Scarborough 1988; Toulouse 1945; Walker 1938; Wheat 1952). Details of the ritual aspects of this technology, however, remain understudied (but see Snead, this volume). Casas Grandes, a late prehistoric town in Chihuahua, Mexico, provides an important example of the rigid hand of theocratic control that middle-range societies can exercise over water management. Casas Grandes was the center of a large interaction sphere between AD 1250 and 1450 that spanned northern Chihuahua and southern New Mexico (Schaafsma and Riley 1999:244). Understanding the material evidence of technology at the site requires a behavioral understanding of the relationship between technological variability and artifact function (Walker 1996).

Ethnographic evidence from the American Southwest suggests that ritual artifacts and architecture, including those relating to water management, possess both practical and impractical functions that blur the analytical distinction between the two (e.g., Dorsey and Voth 1902; Fewkes 1891, 1895; Stephen 1969). Three interesting analytic lessons can be drawn from such evidence: (1) object form; (2) object life histories; and (3) technological solutions. The forms of objects do not necessarily betray their uses. Therefore, the contextual evidence of artifact use is more important than artifact design. Because artifact uses often include interaction with animate forces, activities typically possess a blend of what appear to be practical and magical aspects. Ironically, actors' goals are often subjectively perceived as practical (e.g., insuring successful crops, plentiful water, and healthy communities). Archaeological evidence of such technologies will likely exhibit this contradiction in the variable activities played out in the life histories of the artifacts and architecture.

The Illusion of Object Forms. Consider the variability in everyday objects that may have ritual uses in water control and management. Stone axes chop wood, shape stone, and serve as bludgeons in war. Axes are also worn by katsina dancers (Roediger 1991:131) and become parts of Pueblo altar assemblages designed to bring rain (Fewkes 1902). Images of katsinas in rock art and mural painting also depict axes (Schaafsma 2000; Smith 1952). Similarly, water jars hold liquids in houses and serve as containers for snakes in Hopi serpent ceremonies. Even human scalps, bodily tro-

phies of war, are also used as water-bringing devices (Ellis 1951). In Zuni they are known as water and seed beings (Stephen 1969:97 n. 1).

Object Life Histories. Scalps, water jars, stone axes, and other objects have these diverse histories in part because they have differentially come into contact with animating forces. For southwestern peoples as well as many others water is one of the more concentrated sources of such spiritual power. Not surprisingly, “natural” sources of water—clouds, springs, rivers, tanks—and human-made devices—canals, reservoirs, and wells such as those at Casas Grandes—are places of ritual activity. The animacy of these places gets imparted to objects and the people who interact with them. That animacy affects the life histories of artifacts and architects, shaping the ways they are deployed in technologies.

Technological Solutions. To identify the contribution of such animism to prehistoric technologies, one can track the life histories or cultural biographies of objects backward from their depositional contexts. Each stage of their lives (construction, distribution, use[s], reuse[s], discard) provides a potential example. For example, in some cultures there are ritual technologies for building construction that require placement of offerings as foundation deposits. In such cases, the offerings are considered vital components of the construction process. They are no more optional than strong roofing beams or hardy load-bearing walls. The knowledge and power to construct tools may include prayers and songs as well as engineering knowledge. This is particularly true of the use and discard of powerful tools. Such variability will lay bare traces of the ritual events in these objects’ lives and, by extension, the lives of the people interacting with these objects.

Some buildings, such as Hopi kivas and Navajo hogans, for example, have ritualized life histories from beginning to end, including construction ritual, foundation deposits, naming ceremonies, feasts, healing, and rainmaking ceremonies (Walker 1999:394–97). In these events Puebloan priests and Navajo singers are significant participants. By analogy, similar ritual leaders would have participated in the life history events associated with prehistoric homes and ceremonial structures (Walker 1998, 1999). These are relatively straightforward ritualized histories.

Most artifacts have far more variable biographies. Hopi water jars, for example, may have relatively mundane construction and initial uses. Some may undergo reuses as chimney tops and enter the archaeological record as roofing debris. Others, however, may become containers for serpents used in the Snake Dance. These are stored and eventually aban-

doned at shrines. The previously mentioned axes have equally variable life histories, moving from construction and war uses into altar assemblages and offerings. How can we use this life history evidence to learn about the politics of water technology? It is critical to realize that the power harnessed by those who control water is as much a spiritual power as it is a practical one. Indeed, the distinction in many cultures would not be meaningful. The central issue is that an underlying power is harnessed by the technology.

Therefore, a primary lesson from these ethnographic data is that we cannot simply look at the practical or technological components of artifacts and assume we have exhausted their functions. Instead, we need to consider contextual traces of their histories that may betray evidence indicative of relative forms of animacy or power. In the Southwest such contextual studies have resulted in the recognition that much of the burning associated with the life histories of structures and sites resulted from ritual events rather than warfare or accidents (Walker 2002).

Similarly, the life history of the Casas Grandes water-management system, particularly the abandonment of its walk-in well, reveals a ritualized technology with dramatic political implications. In the American Southwest Pueblo societies aggregated and dispersed several times between AD 700 and 1450 (Cordell 1997:283). For the Pueblos this heralded social changes but did not end Puebloan culture. Environmental and social problems were smoothed over through settlement mobility. Ritual abandonment activities associated with such moves acted as economic and political leveling mechanisms.

In hydraulic societies more socially and economically complex than those of the American Southwest abandonment is a rare phenomenon representing a radical reorganization usually described as a "collapse" or "catastrophe." The ancient Maya abandoned their centers, their system of elite interaction, and their water technologies only when Classic Maya civilization ended (Lucero 2002). The large-scale communal ritual associated with site and community abandonment found among the southwestern Pueblos was channeled into other more stable forms than in more complex societies. The dedicatory building projects and the elaboration of political rituals preserved not only cultural continuity in those cases but also social and economic inequality.

Casas Grandes

Casas Grandes, or Paquimé, was a large town inhabited between AD 1200 and 1450, consisting of a series of single- and multiple-story adobe

pueblo-style room blocks with internal courtyards (Di Peso 1974; Di Peso, Rinaldo, and Fenner 1974). These structures were surrounded by plazas and ceremonial buildings, including earth and stone effigy mounds, pyramidal mounds, and I-shaped ball courts. An elaborate water system provided drinking water, sewage control, flood control, and irrigation needs.

This large town fascinates southwestern scholars in part because it appears more religiously, economically, and socially complex than other southwestern towns and pueblos. In addition to the large construction projects at the site there were also large amounts of exotic or nonlocal products indicative of sustained long-distance exchange. Millions of sea-shells have been found at Casas Grandes. Also recovered from the site were 503 macaws; 64 percent (322) of these were scarlet macaws native only to the jungles of Central and South America (Di Peso 1974, 2:733 n. 1; McGahee 2002). Indeed, numerous pens for raising macaws occur throughout the roof and plaza spaces in the town. Relative to other prehistoric southwestern sites, large amounts of turquoise, obsidian, and copper also occur.

Until the 1980s these data suggested to many scholars that this town represented a Mesoamerican trading enclave (Di Peso 1974, 2:620–22). It was believed that these traders offered shells, copper, macaws, and a powerful religion in exchange for turquoise, obsidian, and labor for the construction and maintenance of their town and possibly surrounding satellite communities (Di Peso 1974, 2:622–33; but see Whalen and Minnis 2001:51). According to conventional wisdom, the site, already in decline, ended abruptly when it was sacked and burned by invaders, possibly from the west (Di Peso, Rinaldo, and Fenner 1974, 4:205).

Subsequent scholarship has recognized that the contextual evidence does not necessarily support this interpretation. The macaws, for example, appear to have been kept only until approximately one year of age. They were then sacrificed and buried in the town's plazas, often with their feathers intact (McGahee 2002). Rather than objects raised for trade, they were consumed by the town's inhabitants. Contextual evidence of shell and obsidian deposits also indicates their importance for consumption in foundation and closure deposits rather than for manufacture and trade activities. Casas Grandes now appears to most scholars to be a homegrown experiment in southwestern social complexity that derived from preexisting trade patterns, agricultural practices, ritual practices, and religious symbols.

Casas Grandes is a Mogollon site and shares culture traits with earlier Mogollon peoples, particularly the Mimbres culture (AD 900–1200) located in southern New Mexico. The Mimbres practiced canal irrigation

and were familiar with adobe construction techniques. The horned serpent was known prior to the rise of Casas Grandes. Macaws had been found in ritual contexts in small and large Mimbres ceremonial chambers (kivas and great kivas). Finally, the ethnographic boundaries of the Southwest culture area in historic times extended farther south, almost to Durango, Mexico. What appear to be Mesoamerican traits, such as the ball courts and pyramidal mounds, are likely culture traits common to the central and southern Southwest and not exclusive to Mesoamerica.

Water Technology at Casas Grandes

The life histories of the artifacts and architecture of water management at Casas Grandes reveal a water system that was in some senses a sophisticated machine for harnessing water as well as the power contained in water. Although originally described as a Mesoamerican technology diffused to the Southwest (Di Peso 1974), more recent scholarship suggests its origin is local (Doolittle 1990, 1993). Indeed, the valleywide system of canals, reservoirs, and cisterns and the deep walk-in well form one of the better-engineered water projects in North America. A network of canals fed from the Casas Grandes River served the agricultural fields in the valley. A separate spring-fed canal (Acequia Madre) brought water to the town, where it was stored in reservoirs and distributed to cisterns and sewers across the site. Courtyards and plazas also possessed drains that channeled rainwater out of the town. Finally, a 12-meter-deep walk-in well was constructed in the pueblo's largest multistory room block. Based on stratigraphic evidence, the life history of this water system and the site as a whole can be divided into three periods of activity: initial construction, growth, and abandonment.

Initial Construction. In the mid- to late 1200s a series of single-story compounds were constructed. Dispersed in *ranchería* fashion across the site, these complexes were served by a central canal, a large reservoir, and several feeder canals (fig. 12.1). On the west side of the town a 100-meter-long horned serpent mound was constructed adjacent to a large compound appropriately named the "house of the serpent." This effigy mound also functioned as a water diversion dam for a nearby arroyo. Apparently, it served to ritualize the water system; it points due north to a large spring approximately 6 kilometers distant whose rock walls are also adorned by swimming horned serpent pictographs (Schaafsma 2000). This same spring feeds the water running into the town's main canal.

Serpents, often horned, are universally associated with water in the

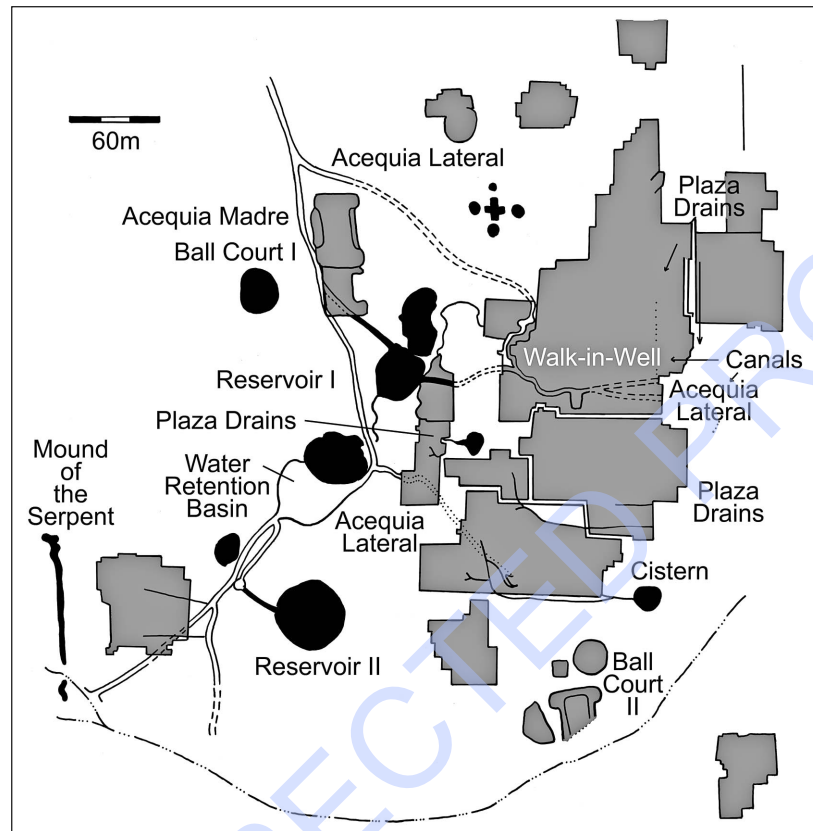


Fig. 12.1 Casas Grandes. (Redrawn from Di Peso, Rinaldo, and Fenner 1974, 5:fig. 285-5)

American Southwest and Mexico (e.g., Bourke 1984 [1884]; Dorsey and Voth 1902; Fewkes 1891, 1895; Griffith 1992; Parsons 1936, 1974 [1933], 1996 [1939]; Voth 1903). Linking their ritual use to cosmological order is often played out in directional rituals. For example, the Hopi Snake Dance at Oraibi involves laying offerings at springs/shrines located in the four cardinal directions around the town. Snakes are also washed in spring waters, and horned serpents are metaphorically merged with lightning bolts and then depicted in sand paintings on the floor of the Snake Kiva. In almost all Pueblo ceremonies movement occurs in a counterclockwise direction, imitating the movement of the sun (Fewkes 1891, 1895).

The house of the serpent also contained a large ceremonial chamber

that resembles a Mogollon great kiva. As noted previously, such kivas were a common form of integrative architecture prior to the rise of Casas Grandes culture. Given its association with the effigy mound, this compound may have been the focus of early water ritual and ceremonial organization at the site.

Growth. Sometime around AD 1300 the building types and placement in the town changed. A large multistory building complex and central ritual precinct were constructed that included new pyramidal and effigy mounds, ball courts, and a number of specialized ritual rooms. Chihuahuan Ramos Polychrome ceramics and architectural elements also appeared over a wide area of northern Chihuahua and southern New Mexico at this time. In tandem with the expanding influence of this center and its public and ceremonial additions, the original central reservoir was replaced by a second reservoir (see fig. 12.1). In this second reservoir a foundation deposit was recovered that contained the majority of the site's turquoise artifacts as well as several bison horn cores. The excavators suggested the possibility that this deposit had originally been in the first reservoir and then was transferred to this later one (Di Peso 1974, 2:671 n. 48).

A number of plaza drains and cisterns also accompanied this building project, as did the excavation of a walk-in well. One entered the well from a small room located off a central plaza. Embedded in the floor of this room was a human skull cap. Although its meaning is far from clear, this bone artifact appears to have asserted a supernatural association between human animacy and water management. The water level of the well was approximately 12.5 meters below the surface. From this entry room one descended a north-south stairway, turned 90 degrees, and continued down an east-west stairway, passing under a ceremonial room constructed against the ceiling of the stairwell. The only entry to this hanging room would have been from a ladder placed on the north-south stairs.

These new constructions also coincided with a loss of earlier architectural forms. The large ceremonial room in the house of the serpent had been ritually terminated or abandoned at this point in the site's life history (Walker 2002), and no further such kivas were constructed. The structure's ramp entry had been sealed, and the structure was burned down over a youth and several macaws. This ritual closure and the new central plaza constructions indicate that the town's ritual organization had been centralized in the process of its elaboration. The ritually laden construc-

tion of the walk-in well within the heart of a new multistory room complex epitomizes this centralization. Similarly, a series of mounds and ball courts were constructed to replace the kiva in the house of the serpent.

Abandonment. Sometime between the early and mid-fifteenth century Casas Grandes was abandoned. Most of the last occupied rooms in the site were burned, prompting scholars to interpret this destruction as the result of war. The walk-in well had been filled with a number of obvious ritual artifacts as well as mundane artifacts. This deposit was described as a mixture of desecrated artifacts cast into the room as well as randomly deposited debris from the collapse of the hanging ceremonial room in the stairwell (Di Peso, Rinaldo, and Fenner 1974). Prior to this deposition, however, the stairs of the walk-in well had been covered by a 5-centimeter-thick layer of fine sand. This sand seal is analogous to ritual abandonment practices associated with pit houses and kivas in the Southwest (Walker 1998:259–64, 280–82). It was not unusual for a clean layer of sand to be placed in floor features prior to their abandonment. In some cases sand was uniformly layered across the entire floor of a structure.

The fill above the sand layer that contains the hypothetical debris of warfare and accident can be divided into four superimposed strata (from bottom to top): (1) the well and well landing; (2) the north–south stairway; (3) the east–west stairway; and (4) the stairway entrance (see fig. 12.1). In the lowest or first stratum axes and shell jewelry predominate. In the second stratum axes and pronghorn bone predominate, although resting on the lowest steps were several obvious ritual objects, including stone and shell effigies, concretions, and bowls (fig. 12.2). In the third stratum axes and other ground-stone artifacts predominate, and stratum four contains a small sampling of various artifacts. Axes were a component of all four strata; shell artifacts were the most common objects. The purposeful placement of a number of ceremonial objects in the second stratum, the frequency of shell objects and axes in all strata, and the layering of pronghorn and ground-stone objects in layers two and three all suggest a ritually structured deposit (see Walker 2002). This sequence of deposits does not conform with what one might expect from a catastrophic raid.

The abandonment of this well, although often cited as a strong case for war, may simply represent the ritual termination of the life history of the well and the Casas Grandes water system more generally. The placement of axes in the well may have resulted from earlier encounters with animate forces. Although we argue that the well and the site were not destroyed in war, it may, ironically, have been in warfare contexts that some

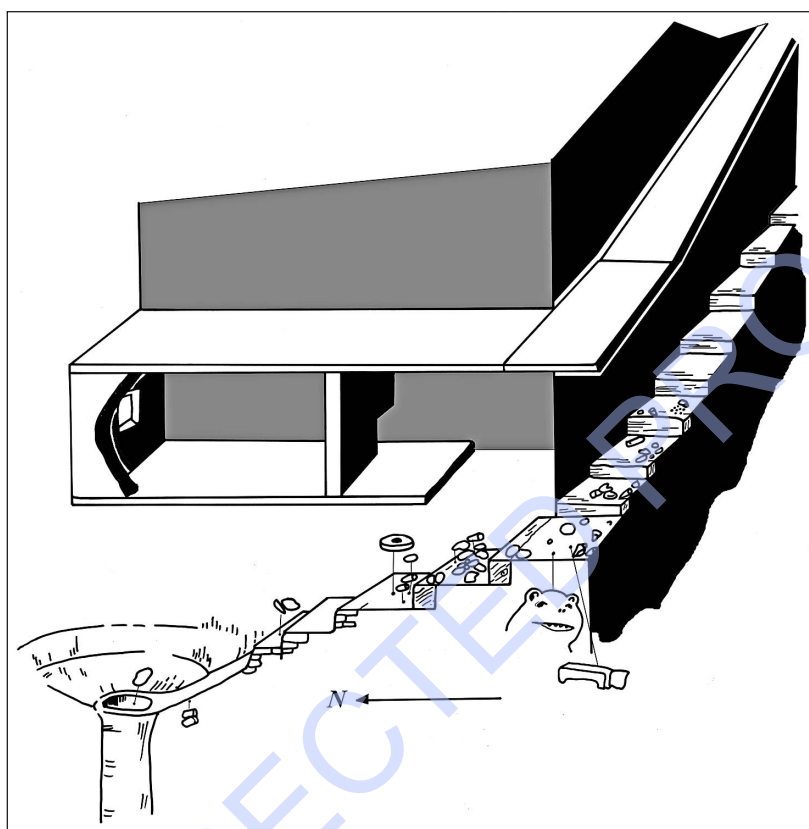


Fig. 12.2 Walk-in well. (Redrawn from Di Peso, Rinaldo, and Fenner 1974, 4:figs. 272-4, 273-4)

of the axes came into contact with an animating power. Such encounters, like the previously mentioned scalp taking in the ethnohistoric pueblos, could have guided these tools to this final resting place.

Sometime near the end of the occupation, human burials were also placed in several plaza drains and feeder canals. It is not clear where in time these deposits occur in relation to the closure of the well. Nonetheless, they suggest that the drains were abandoned before the final occupants left the site.

In summary, the water system appears to have played a central role in the founding and growth of the site. The ritual events marking the history of this technology continued into its death. Like the possible ritual

closure of the site's first reservoir, the large walk-in well was also ritually abandoned.

Discussion

What does the life history of this water technology tell us about political power at Casas Grandes and social power in the greater Southwest and middle-range societies more generally? At Casas Grandes the control of water was tied to ritual from the beginning. People built upon existing Mogollon ritual organization associated with great kivas. As the site grew in size both the ritual and technology were elaborated and centralized. It was for a time successful and allowed for the investment of labor in nonhydraulic activities, including complex exchange practices and the construction of multistory room block architecture, large ball courts, and temple pyramids.

Indeed, at the height of these activities ritual leaders appeared to have concentrated their power around a walk-in well that had the attributes of an inverted or subterranean temple. It was entered through a ritual path that included passing by an embedded human skull. One descended into the ground, a realm of power and ancestors in contemporary Pueblo worldviews, where an inner chamber or sanctum hovered over the water. This may have been a new, more centralized shrine or altar for the community and possibly the regional system. None of this would have been necessary if the goal was simply to provide the town with a well.

The eventual abandonment of the site and its water system is a pivotal moment in the history of water and power at Casas Grandes. Had it been simply abandoned or, as the original excavators thought, destroyed in war, then one could argue that the power of the leaders had simply been undercut by environmental troubles, foreign aggression, or both. Its abandonment would not then reveal much about the nature of ritual and politics at the site. Yet the abandonment appears to have been as purposeful as the original construction of the canals, reservoirs, and wells. Its manner of abandonment makes clear that it was the ritual leaders themselves and not external forces that designed the demise of their own water technology and presumably the site. A threshold of power distinguishing the middle range from the truly complex may have been approached at this site, but it was not crossed.

Instead, the inhabitants of Casas Grandes, similar to those of other large mid-fifteenth-century southwestern pueblos and *ranchería* towns, pulled back, as they had done in previous generations. A cycle of aggregation had ended, and one of dispersal was initiated. Like the earlier Mim-

bres culture or the more distant Chaco Canyon phenomenon, the Casas Grandes culture was a dramatic blip among the ancient farming communities of the Southwest. Similar to these earlier cultural expansions, it did not result in a sustained trajectory of economic or political inequality (but see Lekson 1999).

To understand how such a radical decline might occur, we can consider the ethnohistoric case of the abandonment of the Hopi pueblo of Oraibi in the early twentieth century. At that time a number of environmental and social problems were plaguing the Hopi. Oraibi, the largest Hopi town, was hard-hit by U.S. government interference, drought, and epidemic disease leading to famine. The ceremonial leaders interpreted these problems through the lens of prophecy and sought a solution consistent with their mythologically informed understanding of history. They acted to fulfill prophecies of the town's demise by engineering a dispute between those who supported a "traditional" view of Hopi practices and "friendlies" willing to accommodate changes suggested by the Americans (Whiteley 1988b). The community fissioned, building two new towns. This thwarted the persistence and possible consolidation of power at Oraibi.

Clearly, the Casas Grandes case was a different social context, but the Oraibi context provides an example of how leaders might have reacted to a crisis in a society similar in scale. The same ritually laden technology that empowered these leaders would also have guided their decisions about its dissolution. In their capacity as leaders, priests at Casas would have been responsible for the natural as well as supernatural worlds. In middle-range societies where these worlds are tightly fused, problems in one sphere (drought, famine, conflict) would have meant problems in both spheres. Prophetic explanations of action are common throughout southwestern cultures and, indeed, many middle-range cultures worldwide. Prophecy provides a leveling mechanism that on the one hand preserves the continuity of cultures through various social configurations (e.g., Mogollon and Casas Grandes cultures) and on the other rationalizes change.

Casas Grandes resembles one of the most complex societies in the ancient Southwest. Yet its abandonment ultimately conforms to the aggregation and dispersal patterns found in earlier and contemporary cultures of the Southwest. Indeed, throughout the Southwest during the early to mid-fifteenth century large prehistoric towns were abandoned and reorganized. Climatic patterns experienced dramatic swings at this time, and environmental predictability was low. Widespread abandonments characterized this period across the Pueblo world. Populations eventually concentrated along the Rio Grande and at still-extant western Pueblo com-

munities at Hopi, Zuni, Ácoma, and Laguna. In the southern Southwest the Casas Grandes and Hohokam cultures reorganized into smaller, more self-sufficient communities. Had the Spanish not arrived during the mid-sixteenth century, the Casas Grandes valley might have eventually witnessed the rise of another ritually driven hydraulic society.

13

Mirror of the Earth
 Water, Landscape, and Meaning in the
 Precolumbian Southwest

JAMES E. SNEAD

He wants, first of all, *water*.

— Adolph Bandelier, *Final Report of Investigations among the Indians
 of the Southwestern United States*

The arid and apparently desolate environment of much of the American Southwest made a great impression on nineteenth-century ethnologists. Ephraim Squier, after reviewing dispatches from military surveyors, expressed skepticism about the native inhabitants of such a bleak region. He characterized them as surviving on “a scanty subsistence in grasshoppers, the larvae of ants, and . . . the withered roots of their desolate abodes” (1848:503). The scholars who ventured into the Southwest thereafter developed a more balanced perspective, but environmental determinism remained central to their views on the indigenous societies of the region. Adolph Bandelier’s argument that the distribution of water was the key to understanding Puebloan settlement was accepted by many (cf. Powell 1895–96:lxvii).

Water is, of course, essential to agricultural life, but one legacy of the deterministic views of nineteenth-century scholars has been that their successors have viewed the relationship between water and Ancestral Pueblo peoples exclusively in such functional terms. As they hypothesized about the southwestern past, however, Bandelier and others were also recording a rich body of water lore embedded in the ceremonial life of Puebloan society. Lakes, rivers, and springs had strong historical and ritual associations that were shared by material items associated with these waters. Elsie Clews Parsons showed a ceremonial water vessel to informants at the Pueblo of Jemez, where it “was commented upon with the same expression of appreciation and pleasure as would be elsewhere a piece of the true cross or water from the Ganges” (1925:121). It can be argued that the sacred character of bodies of water is logical given their

importance for subsistence and comparative scarcity, but water symbols had power beyond these correlations. In Pueblo society water was both economic and political capital, a component of agricultural production but also a source of authority and legitimacy.

In traditional archaeological perspectives consideration of water exclusively in functional terms not only is due to the belief that access to water was the critical variable of subsistence (e.g., Dickson 1979:44) but also has been a matter of available data. Excavation of domestic contexts and large-scale settlement analysis provided limited information on the details of cultural landscapes, where patterns of water use are most visible. These circumstances have changed significantly in recent decades, and a wealth of published information about water-control features is available (e.g., Crown 1987a; Fish and Fish 1984; Maxwell and Anschuetz 1992; Toll 1995; Vivian 1990). These features are, however, generally evaluated in terms of economic strategies and technology. Canals, check dams, gravel-mulch fields, and similar manifestations are considered to be parts of a “vernacular landscape” (cf. Jackson 1984), local responses to strictly material needs. Although there is widespread acknowledgment that shrines and other socially integrative features comprised sacred/ritual/ideological landscapes in the Ancestral Pueblo world (cf. Snead and Preucel 1999), this network of sites is generally conceived as existing parallel to but distinct from the vernacular landscape represented by features associated with “subsistence.”

It is increasingly clear, however, that the dichotomy between sacred and vernacular landscapes is an abstraction that obscures the complex relationship between subsistence and society in Ancestral Pueblo contexts (cf. Anschuetz 1998). Trails, for instance, are another “vernacular” manifestation that are nonetheless laden with symbolism (Snead 2002). As manifest in the landscape, water, and the control of water, would have been a powerful expression of community beliefs. It is one thing, however, to acknowledge that such perceptions would have existed and another to analyze them archaeologically. In the absence of truly monumental architecture associated with water symbolism as exists in Mesoamerica (e.g., Brady and Ashmore 1999:137), the most appropriate strategy to elicit such information from the southwestern archaeological record is through a detailed analysis of archaeological features and their interrelationships.

The southwestern ethnographic/ethnohistoric record is also a source of valuable insights into perceptions (and manipulations) of landscape. Classic ethnographies such as those of Parsons (1996 [1939]) suggest that Puebloan landscapes across the Southwest were structured in common ways and, in particular, reflect shared perceptions of water, which in the

context of more recent work (e.g., Ortiz 1969; Whiteley 1988b) provides a framework within which data from *archaeological* landscapes can be further examined. Such an approach acknowledges historical continuities in Puebloan societies while remaining sensitive to temporal and cultural changes.

In this chapter I will discuss an ethnographically informed study that addresses the issue of water and landscape in the Ancestral Pueblo world as manifest in one category of water-control feature, the reservoir. Widely documented in the southwestern archaeological record, reservoirs and similar constructions remain poorly understood and are emblematic of the incomplete development of landscape archaeology in the region. As bodies of water, reservoirs are entirely artificial but were inevitably freighted with some of the symbolism of water held by the groups that created them. Drawing on data associated with the Late Coalition/Classic periods (AD 1200–1550) of New Mexico's northern Rio Grande region, I will explore this relationship, ultimately returning to the issue of vernacular/sacred landscapes in archaeological interpretation.

Ancestral Pueblo Reservoirs in the Northern Rio Grande

Reservoirs were documented within the archaeological record of the Southwest early on. Victor and Cosmos Mindeleff (1989 [1891]:81, 91) recorded reservoirs at several locations in the late nineteenth century in the course of their survey of Pueblo architecture. Subsequent interest was sporadic, and not until the 1980s was any effort made to organize the body of raw data on such features that had been accumulating over the intervening century (Crown 1987b).¹ Building from Crown's work, a few recent studies have attempted to place reservoirs into local landscape contexts. Wilshusen, Churchill, and Potter (1997), for instance, identified interesting continuities between the distribution of reservoirs and residential sites of various periods in the Mesa Verde region. They also noted the considerable potential for future research on such landscape features, lamenting the "lost opportunities" represented by the large number of these sites that remain undocumented (Wilshusen, Churchill, and Potter 1997:678).

Archaeological research on reservoirs in the northern Rio Grande region of New Mexico followed a similar trajectory. Despite early interest in the reservoirs of the Pajarito Plateau and Galisteo Basin (Hewett 1904:643; Nelson 1914:47), more systematic documentation did not occur until the 1980s (Bice 1980; Turney 1985, 1990). The wealth of data collected by recent large-scale inventory surveys means that it is now possible to analyze these features within specific contexts (table 13.1).

Table 13.1 Data for thirty-one reservoirs at Ancestral Pueblo sites in the northern Rio Grande region of New Mexico

Site name	Site number	Feature number	Dimensions (meters)	Height (meters)	Construction	Catchment	Associations
Arroyo Hondo	12	1	20 × 8	1.72	slab	pueblo	adjacent to pueblo
Blanco	40	1	15 × 4	—	masonry	pueblo	within pueblo
		2	138 L	3	earth	arroyo	260 meters north of pueblo
		3	100 L	—	earth	arroyo	400 meters west of pueblo
		4	—	—	—	—	300 meters south of pueblo
Caja del Rio North	174	1	20 × 5	2	earth	arroyo	100 meters east of pueblo
	90737	2	30 × 15	.6	earth	slope	800 meters south of pueblo
Chupaderos Mesa	21605	1	15 × 12	—	—	pueblo	within community
Colorado	62	1	—	—	earth	pueblo	within pueblo
Guaje Mesa	12700	1	—	—	masonry	pueblo	within community
		1	—	—	—	pueblo	within pueblo
Otowi	169	1	15 × 7	—	masonry	pueblo	within pueblo
Pecos	14091	1	60 × 30	—	earth	slope	west of pueblo
	118919	1	18 × 3	—	rubble	arroyo	northeast of pueblo

Ponsipa-Akeri	297	1	—	—	pit/berm	pueblo	within pueblo
San Cristobal	80	1	—	—	earth	pueblo	within pueblo
		2	100 × 17	5	earth	arroyo	southwest of pueblo
		3	—	—	earth	arroyo	south of reservoir 2
San Lazaro	91	1	41 × 7	—	—	arroyo	northeast of pueblo
		2	2 × 1	.71	bedrock	Slope	south of pueblo
San Miguel	370	1	12 × 8	.3	masonry	pueblo	within pueblo
	3834	2	11 × 7	.3	masonry	Slope	200 meters east of pueblo
Shey	239	1	100 × 10	1	—	—	west of pueblo
		2	—	—	—	—	near "spring"
Tsankawi	211	1	20 × 17	—	earth	pueblo	northeast of pueblo
		2	30 × 15	—	earth	pueblo	east of pueblo
		3	26 × 18	—	earth	pueblo	southeast of pueblo
Tsirege	170	1	—	—	—	arroyo	north of pueblo
Yapashi	250	1	25 × 37	—	earth	slope	adjacent to pueblo
	70790	2	19 × 15	.35	earth	slope	south of pueblo
	70798	3	24 × 22	.45	earth	slope	south of reservoir 1

Note: Site numbers are Laboratory of Anthropology (LA) numbers maintained by the New Mexico State Historic Preservation Division. The multiple reservoirs at Blanco, San Cristobal, San Lazaro, Shey, and Tsankawi were all recorded under the number assigned to the site as a whole.

In general, reservoirs in the region can be characterized as **U**- or arc-shaped earthen embankments, some with masonry foundations or enhancements, oriented perpendicular to gentle slopes or minor drainages in order to capture runoff. In some cases more substantial masonry constructions were built. They are often relatively modest in size. The reservoir at Puyé, for example, has a catchment basin approximately 19 by 37.5 meters in size, with embankments currently measuring 8.3 meters across the base and 1.2 meters in height (Turney 1985:53). Erosion can make it difficult to distinguish reservoirs from other types of features, and in at least one case what has been identified as the substructure of a reservoir may actually be a shrine (Richard I. Ford, personal communication, 2003). The absence of excavation makes it currently impossible to evaluate the depth of the reservoir basins and thus estimate their capacity.

The temporal and spatial associations of reservoirs are consistently patterned (fig. 13.1). It is probably safe to assume that reservoirs were not significant features of the built environment much prior to AD 1275, and the majority of those for which ceramic dates can be derived were constructed during the Classic period (AD 1325–1550). Typically, these are located in close proximity to residential sites, in particular, the large community houses and community centers of the period.² In only one case has a reservoir been identified at a distance greater than 500 meters from a community house (LA 90737; see below). In some cases, such as at Tsankawi, multiple small reservoirs are associated with a community house (Powers et al. 1999:146). The near-exclusive association between reservoirs and residential areas is interesting, since fieldhouses and other features are found in considerable numbers at distances ranging up to 8–10 kilometers from associated community houses. Although the landscape was heavily utilized, reservoirs clearly were present only in particular places.

There are some regional patterns to the reservoir data as well. Features in the Galisteo Basin, some of which have dams more than 100 meters in length (cf. Nelson 1914:46, 83, 88), are dramatically larger than those recorded elsewhere.³ Reservoirs are present at almost all of the community houses of the Pajarito Plateau but seem to be less common in the Chama district, where only two have been provisionally documented. This is unlikely to be a result of variable data collection, since most of the community centers found in the Chama Valley have been systematically mapped.

The general consensus among southwestern archaeologists regarding such small reservoirs is that they served largely as sources of water for domestic consumption (e.g., Lipe 1995:155). There is little evidence for Precolumbian ditch irrigation in the northern Rio Grande. Reservoirs are

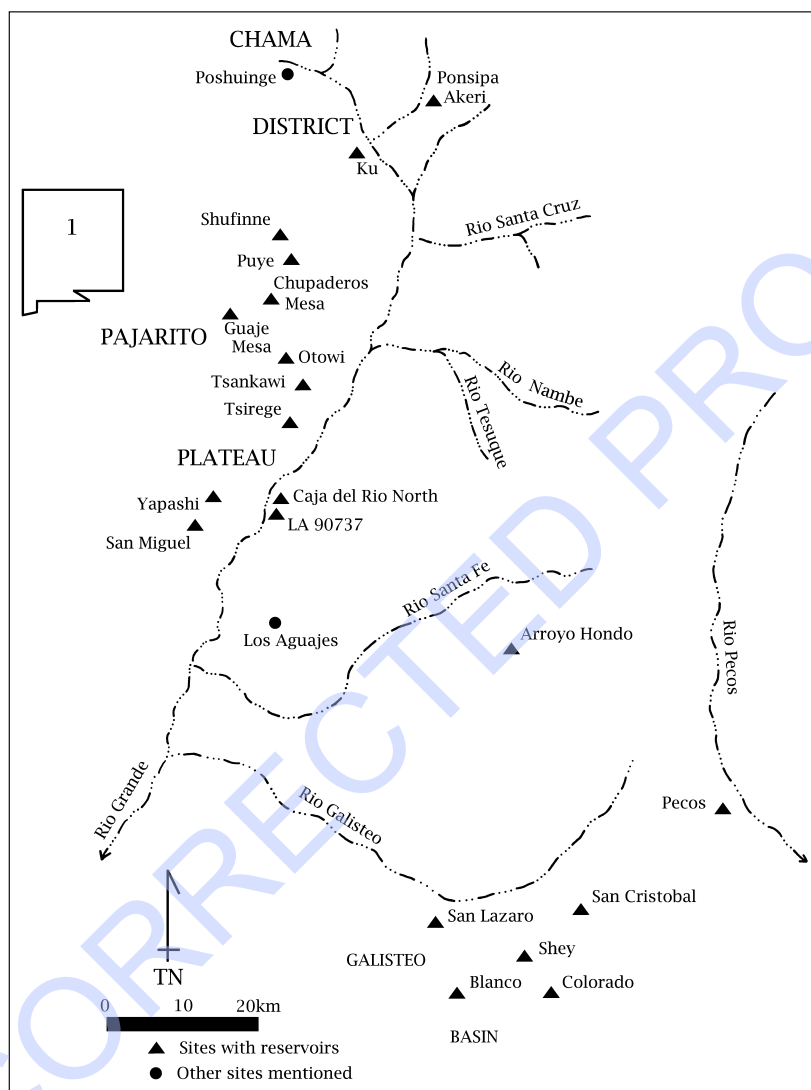


Fig. 13.1 The northern Rio Grande region of New Mexico, illustrating sites discussed in the text.

distinct from the complex water-control systems developed by the indigenous inhabitants to capture and retain rainfall for growing crops, although it has been argued that they could have supplied water for pot irrigation (Turney 1992:206). Small pits are associated with the gravel-mulch fields found in some of the large, Classic period communities, features that are argued to have been both sources of the gravel itself and small moisture pockets for specialized plant production (Anschuetz 1995:33, 1998:328; Lightfoot and Eddy 1995:466). These have no resemblance to reservoirs in either size or location. There is also no evidence for large water-holding tanks/ditch systems such as that theorized for Mummy Lake at Mesa Verde (Rohn 1977:104). In the absence of excavation other possibilities—such as that reservoirs were in fact borrow pits produced during the building of the pueblos or were used as sources of water for other construction-related activities (cf. Van Zandt 1999:329)—cannot yet be evaluated.

The spatial distribution of reservoirs is explicable, at least in part, in functional terms. Having sources of water for domestic use in close proximity to residences would obviously have been desirable. The differential presence and scale of reservoirs in the Chama, Pajarito, and Galisteo districts can also be attributed to the proximity of reliable water sources. Most of the large Chama community centers, for which reservoirs were absent, are within a few kilometers of the Rio Chama or other perennial streams. One of the two reservoirs documented in the district is at the site of Ku, which is located on a mesa relatively isolated from the river. In contrast, few of the streams near the Pajarito communities carried significant flows of water even in wet years, and many cannot be considered perennial. The Galisteo represents perhaps the driest environment in the region, with communities often located several kilometers away from the nearest sources of perennial water. Springs are present at several of these sites, but maximization of the domestic water supply would have been at a premium. Scale and ubiquity of reservoirs thus can be correlated with the state of the local water supply. A similar argument has been made for southern Arizona, where there is archaeological evidence that the distribution of reservoirs used as sources of domestic water correlates with distance from perennial streams (Bayman and Fish 1992:291).

There are, however, nagging anomalies to such a strictly functional explanation. The placement of the reservoirs often seems to defy hydrologic sense, with many located in places that offer little opportunity to capture rainwater. The mesa tops where many of the Pajarito reservoirs are found appear to have such a slight gradient that surface water would have flowed across them only in unusual circumstances. Catchments also

appear to have been quite small. In at least two of the Pajarito cases, the Guaje Mesa site and the Chupaderos Mesa Village, room blocks were constructed across the open end of putative reservoirs, severely restricting potential surface flow (Steen 1977:38). In these cases the amount of water within the reservoir would have been inadequate for the daily drinking needs of the community.

Water quality would also have been an issue in many of the reservoirs included here. In several cases reservoir catchments lie entirely within the residential areas of the sites. At Arroyo Hondo water flowing into the reservoir would have consisted entirely of runoff from adjacent room blocks and trash mounds. Similar circumstances would have prevailed at Tsankawi and Yapashi. Given the probability that domestic refuse was scattered across living areas, the quality of water that reached the reservoirs would not have been high. The growth of algae is a problem in all reservoirs (Turney 1985:46), circumstances that would have been exacerbated when recharge was rare.

Functional interpretations of reservoirs can be stretched to account for some of these anomalies. The hard-packed adobe plazas and roofs of residences, for instance, would have enhanced runoff (cf. Turney 1988:178), and controversial features such as those at the Guaje Mesa site may not have been reservoirs at all. Other reservoirs, particularly those in the Galisteo Basin, collected water from reasonable catchments, and some may have contained enough water at different times to overflow (cf. Pueblo Blanco: see Turney 1988). Since none of the features have been excavated, our evaluation of their capacity may also be inaccurate, particularly if embankments have suffered considerable erosion.

It seems clear, however, that a large percentage of the reservoirs that have been identified in the northern Rio Grande were less than ideal sources of domestic water. This is in substantial contrast to the water-collecting systems documented in the Mesa Verde region (Wilshusen, Churchill, and Potter 1997) and the Papaguería of southern Arizona (Raab 1975), both of which feature larger reservoirs and more appropriate catchments. What, then, accounts for the association between reservoirs and particular places? And why would Ancestral Pueblo people go to considerable effort to build a reservoir that, rather than a pool of clear water, would be a damp corner filled with reeds and cattails?

Lakes, Springs, and Landscape

Water sources play a central role in the ceremonial life of Pueblo people. Springs, for instance, are the setting for a variety of rituals. Initiates into

the K'osa society at Nambé are immersed in the waters of a mountain lake (Hill 1982:298), while the war captains at Ácoma visit various springs and shrines when they are installed in their offices (Parsons 1996 [1939]:593). Springs near the Keres villages are the subject of pilgrimages and retreats by the members of societies that are charged with bringing rain (White 1962:234). Water from these springs is also brought back to the community, where it plays an important ritual role (White 1935:91). Some historical and mythological events occurred at particular springs, which thereafter continued to evoke those memories (cf. Harrington 1916:163). Even small pockets of water, such as holes in a bedrock outcrop near Laguna Pueblo that collect rainwater, are symbolically important (Curtis 1935 [1907]:459).

Bodies of water also provide access to other worlds. Supernatural beings associated with water, such as the water serpent among the Hopi (Lomatuway'ma, Lomatuway'ma, and Namingha 1993:18) or *awanyu* among the Tewa (cf. Parsons 1929:230), are to be found within them. Harrington describes a water-filled depression on a riverbank near the town of Alcalde that was home to *awanyu* (1916:201). *Katsinas*, cloud beings associated with rain and the dead, also live within lakes. Dry ponds can be described as places abandoned by the *katsina* (Parsons 1929:269). The Zuni "Dance Hall of the Dead" lies beneath a lake (Cushing 1920:88). In the Tewa origin myth, as recounted by Parsons, the ancestors emerged into this world through a lake: "There was a big lake. . . . There were a lot of people in there. They stayed underneath the water. Then they were talking about it, how to go up from the water, how to get ready to go up" (1994 [1926]:9).

The lake associated with Tewa origins has been linked to a specific location in southern Colorado, but all similar bodies of water are metaphorically associated with that place of emergence. The lakes that are found near the four cardinal peaks that bound the Tewa world invoke this event (Ortiz 1969), and the same is true with the conceptual boundaries of individual Tewa communities. Harrington identified four bodies of water associated with San Ildefonso (1916:310). At least in Harrington's day, some of these were ephemeral, represented by marshy ground or places where water had once been present.

Bodies of water are thus integral parts of the conceptual terrain that structures Tewa society. We have less direct evidence of this for other groups, but the Keres people envision their world in similar ways (e.g., Snead and Preucel 1999; White 1942). These sacred landscapes incorporated built features as well. Shrines made of piled stones could represent the place of emergence, reflections of the natural landmarks that them-

selves reflected primordial places (cf. Ellis 1994). The focus of these complex networks was the villages themselves, each a metaphorical “center” of its own.

If a stone shrine could represent the place of emergence, it stands to reason that an artificial body of water could play a similar role within the sacred landscape. And if establishing a community required construction of shrines as a hallmark of legitimacy, then building reservoirs can also be seen as symbolically essential. The presence of water, with all its sacred associations, would have been fundamental to local identity, “an essential thing in every community” (Hewett 1953:132), just as much as having water to drink would have been fundamental to the preservation of life.

Under these conditions the “efficiency” of such reservoirs would have been a relatively minor consideration, since their purpose was as much to ensure the presence of water as to provide a reliable domestic supply. As metaphors for lakes and springs they would have fulfilled their purpose by holding small amounts of water after rainfall and the occasional down-slope flow, perhaps sufficient enough over time to sustain a microenvironment of water-related plants and animals. A muddy pool with frogs and cattails would have provided an occasional jar of water but, more important, would have represented an ideological link between that community and the wider world.

Direct ethnographic evidence for a correlation between reservoirs/springs/shrines is limited, since the construction and maintenance of sacred sites is a topic for which information is particularly scarce. All of the modern Rio Grande pueblos lie close to perennial rivers or streams, so conditions prevalent in the drier, more remote locations of earlier settlements no longer prevail. Nonetheless, some hints exist. In the few detailed examples of the founding of new communities, the establishment of shrines appears to have been an important activity. Such a process is described in Ellis’s account of the founding of Laguna Pueblo (1979:441). When the Hopi community of Oraibi split in 1906, the new village of Bacavi was built along traditional lines, a process that included the establishment of shrines (Whiteley 1998:126). Among other features constructed at Bacavi were two “ponds” at the limits of the residential area. While not of any particular significance as sources of domestic water, the fact that these pools were “ritually established and cared for” (Whiteley 1988a:99) suggests that the Hopi treated them as they did other natural water sources such as springs. As other chapters in this volume suggest, such correspondences may be widespread in greater Mesoamerican society (e.g., Fash and Davis-Salazar, this volume).

Discussion

Associating reservoirs, shrines, and the sacred landscape makes water-catchment features in the northern Rio Grande more comprehensible. The “blocked” reservoir at the Guaje Mesa site, for instance, still holds moisture today but is more comprehensible if we accept that these circumstances resemble its original state rather than imagining it as having once been a deep pool of clear water. A small, elaborately constructed reservoir at the Galisteo Pueblo of San Lázaro, with an elaborate series of bedrock grooves that channel water into a bathtub-sized tank, represents a level of planning and labor investment out of proportion to the amount of water captured; indeed, there is a spring at the site and a larger, more conventionally designed reservoir nearby (Turney 1990, 1992). If the simple *presence* of water is seen as a fundamental component of Ancestral Pueblo communities, however, the rationale for such a feature becomes clearer.

A good illustration of the functional/symbolic associations of reservoirs within the Ancestral Pueblo landscape comes from the fourteenth-century Tsikwaiye Community (fig. 13.2). The community house of Caja del Rio North has the central plaza, kivas, and shrines associated with socially integrative functions. A reservoir is also present, with a catchment draining the flanks of adjacent low summits.

A second reservoir, LA 90737, is located 800 meters south of Caja del Rio North (fig. 13.3). The site consists of a U-shaped earthen berm with a silted-up catchment basin on an open hillslope. No residential or obvious agricultural features have been identified in the vicinity, nor is there evidence of ditches leading away from the storage pool. Inference of domestic use is problematic, since while fieldhouses are present in the area they are also common elsewhere in the community, often in association with formal garden features. On top of the hill above the reservoir, however, is a large shrine (LA 90739), consisting of a ring of basalt cobbles with a slab-lined entryway facing east. This feature appears to have been the major shrine of the community. The close association of the shrine and the reservoir, which collectively represent the greatest measurable investment of community labor in the vicinity (cf. Kolb and Snead 1997:620), strongly indicates that the two represent a joint component of the sacred landscape of the Tsikwaiye community.

There are a few examples from elsewhere in the northern Rio Grande of reservoirs associated with shrines. Water catchments have been noted close to a major shrine near the site of Poshuinge (Jeancon 1923:72), and a reservoir at Pecos Pueblo is close to the north shrine associated with that site.⁴ It is not to be expected that all major shrines will have artificial

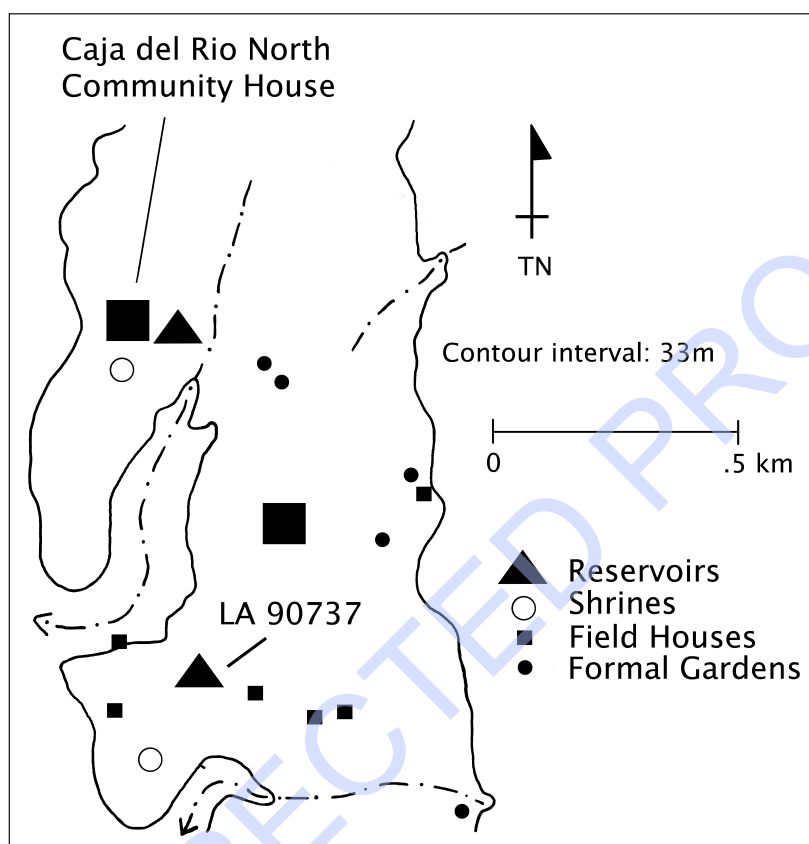


Fig. 13.2 The Tsikwaiye community core, illustrating relationships between reservoirs, shrines, residential space, and agricultural areas.

bodies of water nearby, and some, like that in the Los Aguajes community, are associated with natural springs or tanks (Snead and Preucel 1999:181). The linkage appears to be common enough in archaeological cases, however, to support their interpretation via an ethnographic model such as that suggested here.

It is also clear that the northern Rio Grande reservoirs were distinct in design and function from others documented in the Southwest. The excavated lined basin near El Paso described by Scarborough (1988) and the spring-fed feature recorded by Sharrock, Dibble, and Anderson (1962) bear only a general resemblance to the reservoirs of the Pajarito Plateau. Wheat's (1952) discussion of reservoirs in the Mogollon Rim country emphasizes their rarity, while Wilshusen, Churchill, and Potter (1997:677)

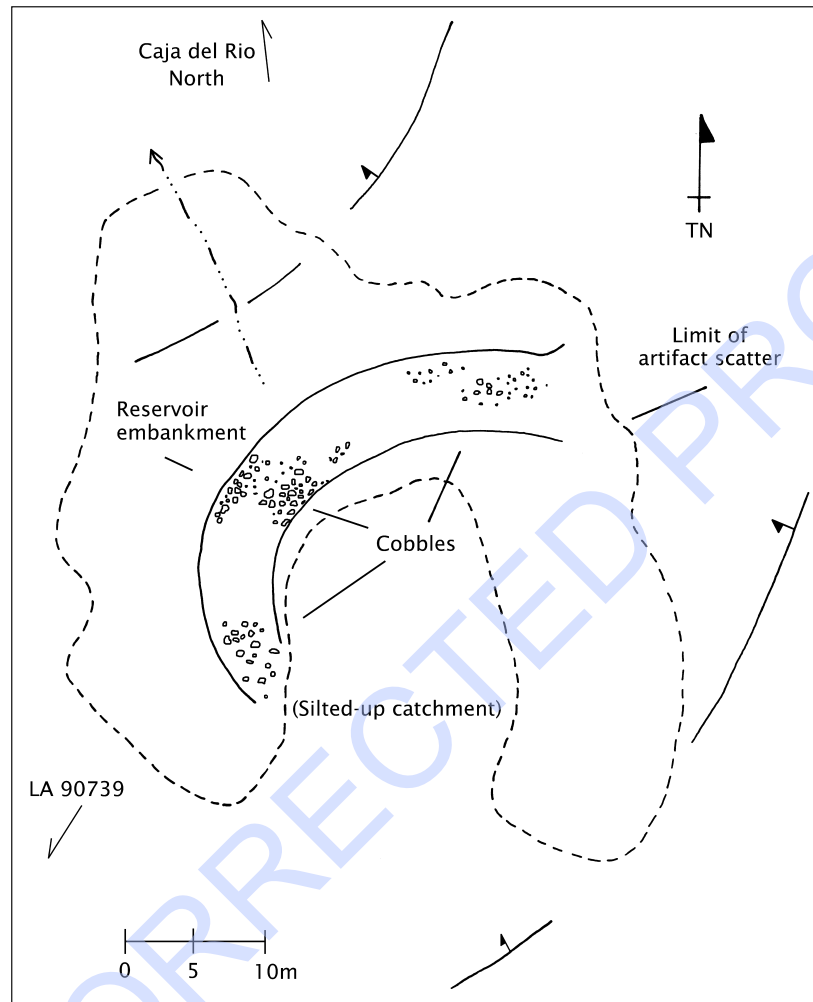


Fig. 13.3 LA 90737, an isolated reservoir in the Tsikwaiye community.

argue that thousands may be present in the greater Mesa Verde region. This diversity suggests both that it is difficult to generalize from the Rio Grande example and that associated symbolism may be of regional significance.

There are some provocative similarities, however, between the northern Rio Grande reservoirs and those in the Mesa Verde region. Wilshusen, Churchill, and Potter (1997:677) identify isolated water-catchment features as a part of the Chacoan architectural suite, and their position in the

landscape may reflect a distinct pattern of landscape organization. This changed with the collapse of the Chacoan system, and reservoirs dating to the post-1250 period are more closely associated with residential areas like those discussed here. It is possible that the sudden appearance of reservoirs in the northern Rio Grande in the late 1200s is correlated with the arrival of Mesa Verde immigrants (cf. Ford, Schroeder, and Peckham 1972). If reservoirs were in part the expression of an Ancestral Pueblo worldview, then the origins of such perspectives may be related to the social transformations that wracked the Southwest in the mid-1200s.

Conclusion

Elsewhere I have argued (Snead and Preucel 1999), following archaeologists of landscape such as Barrett (1999:253), Bradley (2000:104), and Tilley (1994:18), that sacred landscapes served to domesticate and naturalize local topography and that associated elements of the built environment link human identity and legitimacy to the natural order (cf. Basso 1996). Considering the sacred landscape to include features such as reservoirs, traditionally thought to reflect material necessity, deepens this correlation and begins to blur the distinction between function and symbol (see also Knapp and Ashmore 1999). At one level, reservoirs address a human need in a dry climate; on another, the presence of water evokes the importance of water sources as historical and conceptual landmarks in the Ancestral Pueblo tradition.

The art historian Walter Gibson (1989) coined the phrase “mirror of the earth” to describe sixteenth-century Flemish landscape paintings that reflect changing perceptions of European society of the day. The sacred landscape of the Ancestral Pueblo people of the northern Rio Grande mirrored the earth even more directly, with shrines and reservoirs replicating the structure of the universe at a variety of scales. The metaphor of the mirror is particularly appropriate for reservoirs as bodies of water, sources of sustenance at both physical and ritual levels. A Zuni tale retold by Frank Hamilton Cushing describes the earth mother filling a bowl with water for her listeners, describing it as “the world, the rim its farthest limits” (1920:23). Through the archaeology of landscapes and their features we can begin to appreciate the richness of such perspectives, re-integrating history, symbolism, and empirical data into a more compelling narrative of the past.

Acknowledgments

This chapter is the product of discussions with several colleagues over a period of years; in particular, I would like to thank Jan Biella, Michael Bremer, Rory Gauthier, Genevieve Head, and Brad Vierra for sharing their thoughts. Scott Geister, of the New Mexico Historic Preservation Division, provided assistance with the state site database. My own interest in reservoirs originated in the course of dissertation research in the Tsikwaiye community during 1992–93. Out of my excellent field crew I would particularly like to thank Roscoe Loetzerich for his fine map of LA 90737.

5

SYNTHESIS AND CONCLUSION

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14

An Overview of Mesoamerican Water Systems

VERNON SCARBOROUGH

Over the last decade there has been a marked and renewed interest in water-management studies and their implications for the political economy, that is, how a society employs power relationships between groups to organize the use of resources. This volume takes that fundamental foundation, building on the earlier efforts of several of the present contributors, and asserts the role of ideology. To the credit of the editors, each contributor was asked to first contextualize the material record, grounded on careful data acquisition and interpretation, before incorporating iconographic remains—an approach supporting that timeworn adage of field archaeology, “work from the known to the unknown.”

This closure will review aspects of the collection by providing a broad economic and ecological context for water-management systems. By functionally separating still-water systems (reservoirs, lakeshores, or reclaimed wetlands) from moving-water systems (canal irrigation) in Mesoamerica and the Southwest, we are better positioned to interpret cultural decision making at several levels, both functionally through time and symbolically. At the outset I briefly introduce a facet of the intellectual history associated with water studies affecting the direction of current work.

Before further introducing the topic at hand, let me insert one caveat. The corpus examining water-management practices from the ancient Southwest is at least as textured and sizable as that known for the entirety of neighboring Mesoamerica, though my comments here will focus primarily on the latter. The role and influence of the Southwest in water-management studies has long been pivotal for an understanding of arid and semiarid ecosystems globally (cf. Evenari, Shanan, and Tadmor 1971). Although several prominent archaeologists and geographers have affected this work, Emil Haury (1976) and his years of professional association with Snaketown, Arizona, and the import of Hohokam canalization merit

special attention. When coupled with the growing database from Cultural Resource Management efforts, the Southwest provides some of our most critical insights into the ecological parameters faced by past and present arid-lands occupants. Limitations of space prevent an in-depth assessment of these water systems, though the reader is referred to Snead (this volume) and Walker and McGahee (this volume).

Background

Historically, water management in Mesoamerica became a significant scholarly endeavor through the force and influence of William Sanders and Barbara Price (Price 1971; Sanders and Price 1968). Drawing from the discipline-wide influence of Karl A. Wittfogel (1957) and Julian Steward (1955a, 1955b), Sanders developed a set of field methodologies partly based on the hydraulic hypothesis (irrigation and its management bureaucracies triggering the archaic state) and cultural ecology ("human-land" relationships emphasizing subsistence practices). Sanders (Sanders, Parsons, and Santley 1979) institutionalized a comprehensive and systematic field survey within the Basin of Mexico, giving anthropological archaeology a rigor and significance capable of addressing the breadth of societal divisioning through time and, thus, the political economy. Because water is the most precious of controllable resources by humans, water management became a critical data set for meaningfully interpreting the past.

However, by the mid-1980s anthropological discussion shifted away from water management, primarily because debate over the hydraulic hypothesis had not evolved beyond a polemic between those in favor and those opposed—little attempt was invested in assessing the subtleties of water manipulation on socioeconomic and sociopolitical organization (Scarborough 2003). Despite the obvious importance of water management in structuring everyday decisions, to say nothing of its influence on a discussion of the rise and fall of civilizations, water management was tossed out, the baby with the bathwater. Any theoretical subtleties applicable to a local level of interpretation were deemed untimely and uninteresting to many archaeologists.

Part of the problem with earlier water-management studies was their narrow focus on irrigation systems. In the Basin of Mexico so few ancient canals were reported that those scholars opposed to the hydraulic hypothesis had the equivalent of a null hypothesis. It took a wetlands geographer to broaden the definition of water management and expose the variety and complexity of ancient Mesoamerican water and agricultural systems. With Alfred Siemens and Dennis Puleston's (1972) identification

of ancient raised fields in Campeche, a near immediate storm of controversy arose as to the intensity of agricultural production among the Lowland Maya. At stake was the supremacy of the highland Mexican state within greater Mesoamerica and the role that conventional irrigation may have played in that primacy. Without the cadre of students and accompanying professionals that buoyed Sanders's excellent surveys, Siemens (1978, 1982, 1983, 1996, 1998; Siemens and Puleston 1972; Siemens et al. 1987, 2002) and his collaborators slowly championed the role of wetlands agriculture throughout eastern and southeastern Mesoamerica over the next three decades.

Although anthropological archaeology owes a considerable debt to our colleagues in geography, tension between the disciplines has existed since the brilliant careers of Berkeley geographer Carl Sauer (1952), with his assessment of wetlands in Southeast Asia, and, in opposition to his immediate contemporary, Cambridge don V. Gordon Childe (1952), who emphasized the Near Eastern oasis. The current contributions of Mesoamerican geographers Nicholas Dunning, Timothy Beach, and Sheryl Luzzadder-Beach (Dunning et al. 1999; Dunning, Luzzadder-Beach, et al. 2002; Dunning, Beach, and Luzzadder-Beach, this volume) as well as William Doolittle (1990) and Thomas Whitmore and B. L. Turner (2001) attest to the significance of their spatial and environmental perspectives, less affected by the myopic view of sites and artifacts held by some archaeologists. Nevertheless, it remains Alfred Siemens's long-term commitment to the ancient past, drawn from within today's most marginal environs, that demonstrates an intellectual patience and scholarly deliberation only now fully appreciated and understood. His work provides a crucial balance to water-management studies lacking from assessments of irrigation agricultural systems alone (cf. Doolittle 1990).

Functional Water-Management Systems

At a functional level, the chapters in this collection can be differentiated between moving-water systems versus still-water systems, though clear overlap in technique occurs. For much of the remainder of this chapter I wish to examine this separation through time and region and its implications for the political economy and aspects of ideology.

Still-Water Systems

Preclassic Developments. This collection introduces the earliest evidence for water manipulation within still-water settings. Both Valdés and Cyphers and her colleagues examine the earliest reported still-water sys-

tems in Mesoamerica. Cyphers and her team indicate that the *islotes*, or swamp islands, near San Lorenzo are engineered constructions by 1200 BC and suggest the first evidence for sophisticated landscape alterations beyond the appearance of a few relatively small centers within the greater Olmec sphere. This early technique of island building by way of reclaiming shallow though otherwise unusable swampland for agricultural plots was noted by Armillas (1971) over thirty years ago for the lakes of the southern Basin of Mexico during the Preclassic period. Called *tlateles*, these islands were the oldest proto-*chinampa* fields then known. Nevertheless, the earliest wetland agriculture now appears to occur in those geographic zones with the greatest natural abundance of swamp, the southeastern Gulf Coast and the Maya Lowlands, challenging the primacy of highland agricultural intensification for Mesoamerica.

In the Maya Lowlands Late Preclassic water systems were likely dependent on shallow lakes and swamp-margin settings, or *civales* (Jacob 1995; Dunning, Beach, and Luzzadder-Beach, this volume; see Dunning, Luzzadder-Beach, et al. 2002; Hansen et al. 2002). These low-lying areas were modified frequently to enhance the amount of water contained for consumption by villages and towns in the immediate proximity. Kunen (this volume) introduces the concept of “*bajo* communities” in the context of the Classic period Lowland Maya. However, her insight that ancient community organization frequently gravitated toward wetland settings in harvesting their organic abundance, with subsequent environmental engineering, is likely a deeply rooted organizing principle throughout time and across much of low-lying Mesoamerica. Whether perennial lake margins or seasonally wet-dry depressions, the utilization of these settings produced a subsistence base very different from that associated with conventional models of irrigation derived from the earliest semiarid states of the Old World, especially those along the Tigris-Euphrates rivers (Adams 1965, 1981) (fig. 14.1).

Another *bajo* community setting was the highland lake at Kaminaljuyu during the Preclassic period. Lake Miraflores was a diminutive version of the lake system within the Basin of Mexico. Valdés (this volume) provides recently reported dates for Kaminaljuyu and its manipulation of the lake waters. Of special note is the scalar exaggerated canal segment issuing from the lake’s southern downslope margins. By far the largest canal in Mesoamerica and likely in the New World by 600 BC, 3.3 meters wide by 5.8 meters deep and 1 kilometer long, it rivaled the next largest single canal segment previously known, the Cuauhtitlan diversion canal excavated in the Basin of Mexico during the Late Aztec period (Palerm 1955). By the Late Preclassic period the water system was likely a prin-

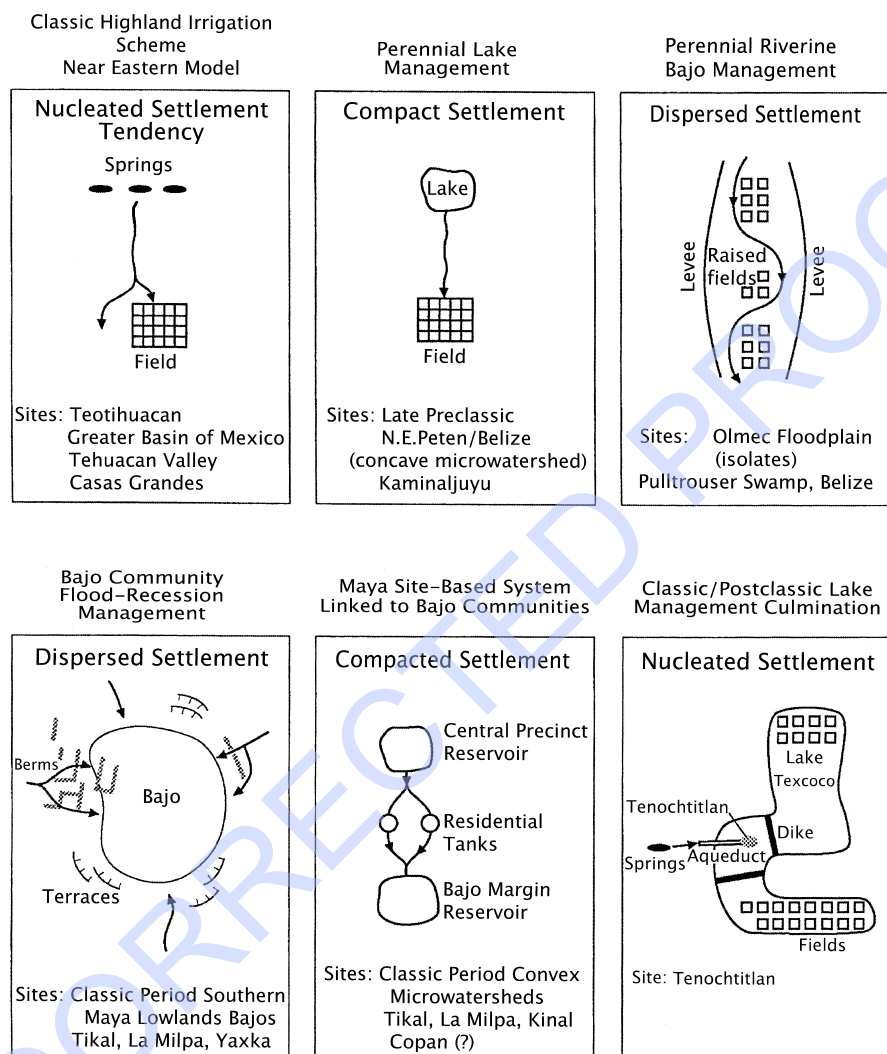


Fig. 14.1 Types of water-management systems in Mesoamerica.

cial reason for Kaminaljuyu's success. Trade and exchange are emphasized as the catalyst for Kaminaljuyu (Michels 1979a; Sanders 1974), but the economic role of the lake and its diverted waters must be reconsidered. Valdés presents some of the most exciting new information, coupled with the work of Marion Hatch (1997) and the hydrologist Charles Ortloff (1997), for the lake/bajo community from Kaminaljuyu.

At a comparable date to the lake manipulation of Highland Guatemala, Frederick (Nichols, Frederick, Morett Alatorre, and Sánchez Martínez, this volume) carefully identifies a Middle Formative canal segment at the lakeshore margins of the northern Basin of Mexico, a canal 5 meters wide and 1 meter deep and yet widened during the Late Formative. Together with the recent evidence for canalization by 1000 BC in the Tucson Basin, Arizona (Mabry 1996), and near Zuni Pueblo, New Mexico (Damp, Hall, and Smith 2002), as well as the 700 BC date for northern Chihuahuan terracing (Hard and Roney 1998), it is now apparent that Middle Preclassic water management and land-use experimentation were shared pan-Mesoamerican and southwest traditions.

Classic Period. In the central Maya Lowlands, evidence demonstrates that landscape engineering associated with elevated reservoirs excavated at the summits of hillocks and ridges allowed cities to flourish (Dunning et al. 1999; Lucero 2002; Scarborough 1998). Because of the erratic though seasonally abundant rainfall as well as the lack of surface water during the four-month-long dry season, reservoir management became crucial to the survival of the ancient Maya (Scarborough 1993, 1994a; Scarborough and Gallop 1991; contra Weiss-Krejci and Sabbas 2002).

At the eastern and western peripheries of the Maya Lowlands water was more accessible, permitting some centers to excel economically and politically. For example, Palenque and Copan were much more important centers than their population sizes indicate, in part revealed by their iconographic preservation. In the case of Copan and to a degree at Palenque the inscribed record provides a tremendous boost to water-management studies. Fash's (2005) work over the last decade is especially noteworthy—it is only partially outlined in this volume. Both Copan and Palenque show that natural water availability was less of an issue than noted in the central Maya Lowlands (though one would not think so, given the iconographic loading), Copan with a perennial river in immediate proximity and Palenque with an elevated rainfall regime and year-round emergent springs (French, Stuart, and Morales, this volume; Lucero, this volume). Fash and Davis-Salazar's (this volume) point that water purity was compromised in the rainy season because of the swollen and turbid waters of the Copan River suggests that the identified rainfall-catchment reservoir system was significant during this period. A similar condition may have influenced water-rich Palenque (French 2002; French, Stuart, and Morales, this volume). The model of community-wide dependency on reservoirs and tanks during the dry season associated with the large sites of the Petén is reversed, though a water resource dependency

relationship to the local environmental setting continued at both Copan and Palenque (Lucero 2002; Lucero, this volume).

In addition to the wet and dry seasonality of much of Mesoamerica, another water duality exists between purity, or potable, supplies and agricultural, or less potable, supplies. At Casas Grandes (Di Peso, Rinaldo, and Fenner 1974) the reservoir system and the walk-in well were designed for domestic use, while the nearby river was put to agricultural ends (Doolittle 1993). The Aztecs took this dichotomy to new heights with their massive construction efforts to separate saline lake waters from sweet freshwater (Doolittle 1990; Carballal Staedtler and Flores Hernández, this volume). Brüggemann's (2001) comparative study emphasizes this difference at both rainfall-adequate though seasonally erratic Classic period Tajín and rainfall-deficient Postclassic period Zempoala.

Bajos (Place of Reeds)

Epigraphers frequently associate origin myths in Mesoamerica with swamplike settings (Schele and Mathews 1998). Given the contribution of Cyphers, Hernández-Portilla, Varela-Gómez, and Grégor-López (this volume), this comes as little surprise. More and more, the empirical evidence from archaeology accents the engineering of the bajo landscape (Dunning, Beach, and Luzzadder-Beach, this volume; Dunning, Luzzadder-Beach, et al. 2002). The great swamps of the Yucatán, composing more than 40 percent of the peninsula, have been clearly undervalued by scholars. Kunen's (this volume; Kunen and Hughbanks 2003) work is the first to focus on a systematic archaeological investigation of an entire bajo—albeit a diminutive one. This work moves the discussion from a site-centered bias to a swamp-centered one—a discussion with a set of discrete problems that addresses fundamental issues previously considered intractable by many Mayanists. The high incidence of berms and terraces along the margins of several bajos suggests the important role of flood-recession agriculture during the Classic period (see fig. 14.1). Complementary evidence from my own work (Scarborough 1993, 1998) and with Dunning and others (Dunning et al. 1999; Dunning, Luzzadder-Beach, et al. 2002; Dunning, Beach, and Luzzadder-Beach, this volume) entailed the excavation of eighteen 3–4-meter-deep backhoe trenches within Kunen's bajo and indicated a lake or perennial wetland during the Late Preclassic period, a setting not unlike that outlined at Middle and Late Preclassic Kaminaljuyu (Valdés, this volume).

The model (Scarborough 1993, 1998) that the Maya moved from a concave bajo microwatershed adaptation to a convex "water mountain"

microwatershed during the Classic period is now provided with a functional mechanism for change. The rapid infilling of the bajo wetlands of Belize and portions of the northeastern Petén, as revealed by Patrick Culbert and Vilma Fialko's work near Yaxha, suggests the displacement of Late Preclassic populations (Dunning, Luzzadder-Beach, et al. 2002; Dunning, Beach, and Luzzadder-Beach, this volume; also see Hansen et al. 2002). Probably induced by deforestation as a result of population growth and immigration, soil loss from surrounding lake-margin slopes excited by extensive slash-and-burn activity forced a different settlement design. The new land-use and settlement pattern was adapted to the summits of hillocks and ridges and the deliberate construction of paved water-catchment surfaces and elevated reservoirs. That this corresponds with a radical change in Preclassic to Classic technologies and worldview is not just coincidence. Environments make a cultural difference.

Symbolism

Most of the chapters allude to symbolic water elements as evidenced by the iconographic record. Frequently, there is an association with the political economy and how access to and distribution of water, land, and food separates society and leads to methods of sociopolitical control. Fash's (2005; this volume) investigation of the iconography associated with the *cauac* monster and the full or half-quatrefoil is especially significant. The long-known association of water lily imagery with elite prominence is fully developed by both Lucero (1999b; this volume) and Fash and Davis-Salazar (this volume). Both contributions note concern over waterborne diseases and the association of the water lily to purification, though the plant does not do its cleansing alone. Fash makes the very important point that water lilies can be viewed as indexical plants, their presence signaling the potability of the source. It takes a variety of purifying organisms to make still-water systems fit for drinking. Nevertheless, the ability of the water lily to reveal an aspect of purity was not lost on the Maya elite and their use of water symbolism.

Palenque demonstrates the diversity of water systems found in the Maya area, and the site's iconographic messages add to the complexity of interpretation. The water-pressure system discovered by French (2002; French, Stuart, and Morales, this volume) suggests a Classic period functional innovation (cf. Nichols, Frederick, Morett Alatorre, and Sánchez Martínez, this volume). Because of the abundance of water at Palenque, it is likely that this feature was for show—a fountain or a grand symbolic display of water control. Interestingly, the basal water bands on several

of the piers and sizable tablets at Palenque reflect the immediacy of the watery world underfoot, given the extent of aqueducts coursing under plaza space at Palenque. The pier from House D in the Palace Complex at Palenque is particularly illustrative. Like Fash and Davis-Salazar's references to water mountains at Copan, the dirt archaeology at Palenque physically dramatizes the depicted imagery.

By including the intermediate zone of northern Mexico (Mesoamerica) and the Southwest in this study, this volume also ventures to use water management and ideology to compare and link landscape utilization in two areas that are often kept culturally separate. Walker and McGahee's (this volume) identification of termination rituals at Casas Grandes, specifically within the walk-in well, may be the first empirically demonstrated evidence for the ritual abandonment of an ancient water source. The high incidence of turquoise, not surprisingly, indicates the feature's association with water. The role of snakes and axes, which has deep Mesoamerican roots, is an important observation raised by Walker and McGahee and by Snead (this volume). Axes, flint, lightning, thunder, and rain would seem a logical progression, and the axe permitted the construction of ground-breaking canal segments and reservoir excavation (Scarborough 1998).

Moving-Water Systems

Much more attention has been directed toward identifying and interpreting irrigation systems than reservoir storage and lakeshore manipulations of water. In addition to Wittfogel's focused attention on canal irrigation, bureaucracy, and the archaic state, considerable ethnographic work has examined the implications and nuances of local town and village organization as affected by formal irrigation (Scarborough 2003:chap. 3). Archaeology was significantly influenced by both the hydraulic hypothesis and the impact of contemporary irrigation communities (see Mabry 1996), which resulted in several timely examinations frequently designed to test the hydraulic hypothesis. Much of the initial field archaeological effort was invested in the Near East (Adams 1966), where canalization was clearly defined, and again in Mesoamerica (Sanders and Price 1968), where it was less spectacular. Ironically, the well-preserved Near Eastern material associated with the earliest states was used to argue against irrigation as the triggering mechanism for social complexity, while the poorly identified evidence for irrigation from Mesoamerica was marshaled and directed as proof of the hydraulic hypothesis. Canalization remains an important component in any study of the built environment in Mesoamerica, but another kind of water management best characterizes this

region (as conveyed above) when compared to the Near East. Nevertheless, a brief review of canalization in Mesoamerica is appropriate.

Preclassic and Classic Periods. The earliest evidence for conventional canalization is from Teopantecuanitlan in northern Guerrero dating to 1200 BC (Cyphers, Hernández-Portilla, Varela-Gómez, and Grégor-López, this volume; Doolittle 1990). By 700 BC canal segments in semi-arid settings are likely employed broadly, if only expediently, because of the absence of sizable and predictable stream gradients and flows (Nichols 1982, 1987) (see fig. 14.1). Where springs were the source of canalization, greater emphasis was placed on irrigation systems. Sanders (Sanders, Parsons, and Santley 1979) makes the case for spring waters feeding his hypothesized field system outside and sustaining Teotihuacan as early as the first century AD.

The extensive canalization effort initially reported by Woodbury and Neely (1972) and recently revisited by Neely and his team (Neely 2001) within the Tehuacan Valley, Puebla, represents a significantly altered geographical zone midway between the Valley of Oaxaca (specifically Monte Alban) and the Basin of Mexico. Away from the sizable and presumably controlling centers of highland Mexico, these ancient spring-fed systems are now shown to be extensive and datable (Neely 2001; Winsborough et al. 1996), second in complexity only to those reported in the Hohokam region of southern Arizona (Howard 1993; see Doolittle 1990). Drawing on spring sources, these systems carry highly mineralized waters that preserved the ancient canal courses by depositing minute particles of calcium carbonate, resulting in “fossilized” canal segments frequently built up naturally above the irrigated plain (Neely 2001; Winsborough et al. 1996). Locally referred to as “stone snakes” (*tecoatle*), these features suggest a significant degree of labor coordination and investment.

Given the absence of large urban centers in the Tehuacan Valley, how was labor amassed and organized to construct and maintain the water-management system? Of special merit is the huge Purron Dam, by AD 300 the largest and most elaborate such structure in the New World but located well over 100 kilometers from a truly influential center or set of centers. Is it possible that the public works that this feature represents were more than a functional investment in the hinterlands? Since this feature is comparable in size to that of the Pyramid of the Moon at Teotihuacan, perhaps the investment was a way of defining corporateness within a densely populated zone, one less easily subject to the expansionist tendencies of more centralized neighbors. The overbuilt appearance of the Purron Dam is akin to an assessment of Nassar’s Aswan Dam or the cur-

rent investment in mainland China at the Yangtze River site of the Three Gorges Dam.

In this latter scenario canalization efforts in the Tehuacan Valley were likely maintained by way of heterarchical organizational tendencies rather than hierarchical vertical layerings (Crumley 1987, 1995; Scarborough and Valdez 2003). Although the hydraulic hypothesis (after Wittfogel 1957) stridently argued for hegemonic centrality based on a steeply pitched, vertically exaggerated, sociopolitical pyramid of control, the extensive canal systems of the Tehuacan Valley suggest a dispersed set of cooperating communities responsible for the coordination of water and land resources and the labor tasks necessary for subsistence success.

Caran et al. (1996) stress the hydrologic backdrop for the Tehuacan Valley. They show the significance of a predictable distribution of water tied to recharged springs and surface-water discharge permitting year-round water access. Nevertheless, they point to the role of episodic disruption of water access by drought cycles and the likely role of seismic activity capable of displacing populations, a position mentioned in the ethnographic record (Caran et al. 1996:5). The influence of a dropping water table associated with earthquake activity is suggested in several other settings in which a complex society was initiated—the role of mountain building in the truncating of the Moche period Intervalley Canal (Ortloff 1993), the stream-capture arguments for the desiccation of the Sarasvati of the Mature Indus period (Possehl 2000), and my own work in the Late Bronze Age Argolid, Greece (Scarborough 1994b, 2003).

The horizontal or tunnel wells (*galerías*) also reported in the Tehuacan Valley reveal a technology and labor investment of consequence for a semiarid setting. In the Old World these systems are reported by 1000 BC (Garbrecht 1987), and today they are constructed by skilled craftsmen organized in guilds (English 1966). Their ancient history within the New World is enigmatic, with considerable debate rising over an indigenous inception as opposed to an importation from Spain. Barnes and Fleming's (1991) work in Chile with ancient tunnel wells (*puquios*) suggests a Spanish origin for this ingenious, complicated, and unique water system, but Schreiber and Lancho Rojas (1993, 2003) argue otherwise. The dependency relationships that populations occupying the Tehuacan region have had to adequate water stores from the advent of the earliest components of the Purron Dam—perhaps 700 BC—suggest that an indigenous population was capable of investing heavily in public waterworks. If water were to disappear as a consequence of earthquake activity or extended drought during the Classic period, as suggested by Neely's team (Caran et al. 1996), labor capable of adding to and creating the 18-

meter-high Purron Dam may have been put to the task of tunnel well building.

The population of the Tehuacan Valley was well adapted to an intensive agriculture, an extended community aware of wells, sizable reservoirs and dams, and extensive canal systems. Still, the tunnel well system was known to the Spaniards and would have been a dazzling use of Old World technology to justify Iberian superiority—expedited with metal digging tools, beasts of burden, and the use of block and tackle. Dating the tunnel well system is difficult, but perhaps the appearance of the glyphs (Neely 2001:505) associated with one of the surface canals will give this exploration hope. Given the appearance of shrines in tunnel well systems today (Caran et al. 1996:8), it is not unjustifiable to suggest that these same places were the locations for ancient inscriptions or related ritualized depictions. Spring sources in Peloponnese Greece are frequently associated with chapels today, locations of known veneration as far back as the Late Bronze Age (Scarborough 1994b, 2003).

Symbolism

Although moving-water systems have received the greatest amount of scholarly attention, their symbolic associations are not as well understood as they are among still-water systems. The “fossilized canals” or “stone snakes” of the Tehuacan Valley surely evoked symbolic images, but little ethnographic or iconographic information exists to elucidate these features, although in Belize, some distance from the semiarid settings associated with conventional irrigation, our local workmen frequently associate heavy rains with a marked increase in the number of snakes sighted. The absence of symbolic associations to irrigation may be a consequence of the lack of usable riverine settings for diverting large amounts of water (see fig. 14.1). The physical and functional emphasis on still-water systems in Mesoamerica resulted, in part, from a reduced number of manageable streams and rivers for canalization, given the available technology, which precluded sites and site areas for developed displays of ideological representation. Sources of water for much of Mesoamerica were of fundamental importance, and standing bodies of water were frequently manipulated to accommodate agricultural ends. Springs were many times the source for canalization and appear iconographically as isolated eyes in a moving body of water—*ojo de agua*—in highland Mexico.

One of the more intriguing data sets of water-management symbolism is cave imagery. Much literature is devoted to these recesses, with considerable attention directed to caves as sources for water (Brady 1997;

Stone 1995). If the tunnel wells of Tehuacan were to date to pre-Hispanic times, then one would expect considerable evidence for water symbolism from within this context, given the underground extent of these features. Brown (this volume) indicates the importance of *zuhya*, or virgin water, seeping from cave settings in the Maya Lowlands. The collection of these waters for ritual purposes has implications for several aspects of ancient Mesoamerican ideology. The waters coursing through the tunnel wells of Tehuacan Valley would have had significance far beyond a potable source. Given the antiquity and importance of the Tehuacan spring waters, even among present-day bottled-water consumers, there exists the likelihood that the subterranean history (and possible prehistory) of the tunnel wells accented the sacredness of these waters.

Conclusions

Until recently, it was difficult to discuss water management in ancient Mesoamerica and the Southwest as sets of functional systems. Semiarid canals were identified as cross sections in erosion cuts frequently buried by deep accumulations of sediment. Wetland data were not thought credible and dismissed by a “highland paradigm.” However, data sets are now adequate, even robust, to initiate meaningful debate about water-management systems. The irrigation system within the Tehuacan Valley is comparable in complexity to those highly visible irrigation systems of the ancient Hohokam in Arizona. Crown’s (1987a) incorporation of Hunt’s (1988) “irrigation community” can now be juxtaposed with Kunen’s “bajo community.” Nevertheless, still-water systems in Mesoamerica can now be understood as the subcontinent’s legacy to the economic and political evolution of the archaic state. Examining ancient water-management systems as inextricably linked to aspects of social complexity will elucidate economic, political, and ideological aspects of the Precolumbian past.

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NOTES

Chapter 2. A Land That Tastes of Water

1. All dates used here are uncalibrated.
2. Taube (1996) reaches a similar conclusion based on his identifications of maize iconography and its proliferation in the Middle Preclassic.
3. Grove et al. (1993) and Gillespie (2002:110) have suggested that certain isolated monuments served as boundary markers delimiting sacred or political space because they found no surface artifacts at the respective sites (i.e., Loma de la Piedra and El Cardonal). This suggestion is not applicable to all sites with monuments because artifacts are reported for the majority of the sites mentioned here. It should be remembered that the lack of surface ceramics at coastal sites is not an adequate indicator of site type because plowing is uncommon and dense secondary or grassland vegetation often covers them (von Nagy 1997; Symonds, Cyphers, and Lunagómez 2002).
4. Medellín Zenil (1971) reported this monument from the Soteapan municipality, but when Tatahuicapan de Juárez was declared a *municipio libre* in 1997, Zapotitlan was included in its territorial limits.
5. At the present time, no clear noniconographic evidence for warfare, such as weapons, fortifications, indications of violent death, or other, has come to light.

Chapter 8. Copan Water Ritual and Management

1. The authors' individual research converges in this volume to bring archaeological and architectural remains and the ritual and iconographic evidence together. At a U Penn Maya Weekend ten years ago Fash gave a paper noting indications of water and cave imagery on stone carvings at Copan that led to questions regarding the hydraulic engineering designs built into the architecture and city planning and an analysis of the imagery as political system. Davis-Salazar spent several seasons investigating the archaeological remains of water management at the site and completed her doctoral thesis on the subject (Davis-Salazar 2001). Understanding how the functionality of the water-management system and its iconographic manifestations were manipulated by Copaneco rulers became central to both our studies.
2. The term *ethnohydrology* is used in Andean studies (Sherbondy 1992).
3. For example, the glyph deciphered as *ik nab nal*, meaning "black water lily place" or "black hole place" (Stomper 1996), on the northwestern corner of the council house perhaps refers to a reservoir such as the one in the Las Sepulturas sector.
4. See William Fash (1983) for a discussion of *sian otot* organization proposed for the Copan Valley.

Chapter 10. Hydraulic Elements at the Mexico-Texcoco Lakes during the Postclassic Period

1. The studies entitled “Gravimetrica Maxim” and “Theory of Differential Density of the Ground” as well as several investigations conducted in the Instituto de Geografía/UNAM stand out. Currently, more than twelve hundred minor basins related to the distribution of the igneous mass in the subsoil have been recorded.

2. “En este año 4 acatl se apercibio para la guerra Itzcoahuatzin, rey de Tenochtitlan. Aún no se manifestaba bien entonces. . . . En el mismo año 4 acatl se torció y cambio el río de la ciudad de Cuauhtitlan. . . . La causa por que se cambió, fue que muchas veces sucedió que todo arrastraba el agua y se derrumbaban las casas en tiempo de avenida” (Chimalpopoca Códice 1975:49).

Chapter 11. Water Sources at Mayapán, Yucatán, Mexico

1. The walls of some tunnels seem to be stained with clay at levels well above the top of the current clay stratum. I also saw a few small pits in the clay deposit that might have been old excavations, but I do not consider this conclusive evidence of mining. So I conclude that although the clay from Ch'en K'ulu *can* clearly be used to manufacture pottery, whether the pre-Hispanic inhabitants of Mayapán *did* use it to make ceramics is uncertain. This question could be resolved through chemical and petrographic analysis of the clay and the archaeological ceramics.

Chapter 13. Mirror of the Earth

1. Crown (1987b:210) developed a typology of water storage features based upon function and setting. Although here I use the term “reservoir” in the generic sense and in deference to traditional usage, most features of this type in the northern Rio Grande would, under her suggested nomenclature, be called “catchment basins” or “retention basins” (see also Wilshusen, Churchill, and Potter 1997:665).

2. I use these in preference to other descriptive terms, such as “towns,” which may conjure up erroneous associations. Community houses are large single pueblos with some residential and socially integrative functions. Varien defines a community center as a “relatively permanent . . . densely settled area usually associated with public architecture” (1999:4). Such a classification fits the large, multi-room block pueblos constructed in the northern Rio Grande during the fourteenth and fifteenth centuries AD as well as the room block clusters of earlier periods, although they were established on a smaller spatial scale than the community centers for which Varien’s terminology was initially developed.

3. It has been suggested that some of the Galisteo reservoirs were constructed by nineteenth- and twentieth-century ranchers as stock tanks, although Nelson’s photographs of one such feature at Pueblo Blanco (LA 40) illustrates the vertical slab foundations typical of Ancestral Pueblo construction.

4. The information from Pecos comes from site data on file at the New Mexico Historic Preservation Division and was brought to my attention by Genevieve Head, director of the Pecos Survey for the National Park Service. It has been suggested to me that the “tanks” noted by Jeancon at the Poshuinge shrine would today be identified as

pits from which gravel was obtained to create mulch for nearby garden plots. As Kurt Anschuetz (1998:335) has demonstrated, however, features of this type have complex functional and symbolic associations with water, suggesting relationships similar to those between shrines and more formal reservoirs.

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REFERENCES CITED

- Abrams, Elliot M.
1994 *How the Maya Built Their World: Energetics and Ancient Architecture*. Austin: University of Texas Press.
- Adams, R. E. W.
1980 Swamps, Canals, and the Location of Ancient Maya Cities. *Antiquity* 54: 206–14.
1993 Rebuttal to Pope and Dahlin. 2. *Journal of Field Archaeology* 20:383.
- Adams, R. E. W., W. E. Brown Jr., and T. P. Culbert
1981 Radar Mapping, Archaeology, and Ancient Maya Land Use. *Science* 213: 1457–63.
- Adams, R. E. W., T. P. Culbert, W. E. Brown Jr., P. D. Harrison, and L. J. Levi
1990 Rebuttal to Pope and Dahlin. *Journal of Field Archaeology* 17:241–44.
- Adams, Robert McC.
1965 *Land behind Baghdad*. Chicago: University of Chicago Press.
1966 *The Evolution of Urban Society: Early Mesopotamia and Prehistoric Mexico*. Chicago: Aldine.
1981 *Heartland of Cities*. Chicago: University of Chicago Press.
- Adams, Robert M.
1953 *Some Small Ceremonial Structures of Mayapan*. Current Reports 9. Cambridge: Carnegie Institution of Washington.
- Alvarado Tezozomoc, Fernando
1975 *Crónica Mexicayotl, 1598*. Mexico City: Universidad Nacional Autónoma de México, Instituto de Investigaciones Históricas.
1998 *Crónica Mexicáyotl*. Instituto de Investigaciones Históricas, Primera Serie Prehispánica 3. Mexico City: Universidad Nacional Autónoma de México.
- Alvarez, Luis W., Walter Alvarez, Frank Asaro, and Helen V. Michel
1980 Extraterrestrial Cause for the Cretaceous-Tertiary Extinction: Experimental Results and Theoretical Interpretation. *Science* 208:1095–1108.
- Alvarez, Walter
1997 *"T. rex" and the Crater of Doom*. Princeton, NJ: Princeton University Press.
- Andrews, Anthony P., and Robert Corletta
1995 A Brief History of Underwater Archaeology in the Maya Area. *Ancient Mesoamerica* 6:101–17.
- Andrews, George F.
1975 *Maya Cities: Placemaking and Urbanization*. Norman: University of Oklahoma Press.
- Andrews, E. Wyllys, V., and Barbara W. Fash
1992 Continuity and Change in a Royal Maya Residential Complex at Copan. *Ancient Mesoamerica* 3:63–88.

- Angulo Villaseñor, Jorge
- 1987a The Chalcatzingo Reliefs: An Iconographic Analysis. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 132–58. Austin: University of Texas Press.
 - 1987b El sistema Otli-apantli dentro del área urbana. In *Teotihuacan: nuevos datos, nuevas síntesis, nuevos problemas*. Emily McClung and Evelyn Rat-tray, eds. Pp. 267–74. Serie Antropológica 72. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México, Arqueología.
 - 1988 Siete sistemas de aprovechamiento hidráulico localizados en Chalcatzingo. *Arqueología* 2:37–83. Dirección de Monumentos Prehispánicos, Instituto Nacional de Antropología e Historia, Mexico City.
 - 1993 Water Control and Communal Labor during the Formative and Classic Periods in Central Mexico (ca. 1000 BC–AD 650). In *Economic Aspects of Water Management in the Prehispanic New World*. Vernon L. Scarborough and Barry L. Isaac, eds. Pp. 17–69. Research in Economic Anthropology, Supplement 7. Greenwich, CT: JAI Press.
- Anschuetz, Kurt F.
- 1995 Saving a Rainy Day: The Integration of Diverse Agricultural Technologies to Harvest and Conserve Water in the Lower Rio Chama Valley, New Mexico. In *Soil, Water, Biology, and Belief in Prehistoric and Traditional Southwestern Agriculture*. H. Wolcott Toll, ed. Pp. 25–40. New Mexico Archaeological Council, Special Publication 2.
 - 1998 Not Waiting for the Rain: Integrated Systems of Water Management by Pre-Columbian Pueblo Farmers in North-Central New Mexico. Ph.D. dissertation, University of Michigan.
- Arie, Jane C.
- 2001 Sun Kings and Hierophants: Geocosmic Orientation and the Classic Maya. M.A. thesis, New Mexico State University, Las Cruces.
- Armillas, Pedro
- 1971 Gardens on Swamps. *Science* 174(4,910):653–61.
 - 1985 Tecnología, formaciones socio-económicas y religión en Mesoamérica. In *Mesoamérica y el centro de México*. J. Monjaraz-Ruiz, R. Brambila, and E. Pérez Rocha, eds. Pp. 25–40. Mexico City: Instituto Nacional de Antropología e Historia.
- Ashmore, Wendy
- 1981 Precolumbian Occupation at Quirigua, Guatemala: Settlement Patterns in a Classic Maya Center. Ph.D. dissertation, University of Pennsylvania, Philadelphia.
 - 1991 Site-Planning Principles and Concepts of Directionality among the Ancient Maya. *Latin American Antiquity* 2:199–226.
- Aveni, Anthony F.
- 1980 *Skywatchers of Ancient Mexico*. Austin: University of Texas Press.
- Aveni, Anthony F., Susan Milbrath, and Carlos Peraza Lope
- 2004 Chichén Itzá's Legacy in the Astronomically Oriented Architecture of Mayapán. *RES* 45:123–43.
- Avineri, Shlomo
- 1969 *Karl Marx on Colonialism and Modernization*. Garden City, NY: Anchor Books.

- Bandelier, Adolph F.
1892 *Final Report of Investigations among the Indians of the Southwestern United States, Carried on Mainly in the Years from 1880 to 1885*. Part 2. Papers of the Archaeological Institute of America, American Series, 4. Cambridge, MA: John Wilson and Son.
- Barnes, M., and D. Fleming
1991 Filtration-Gallery Irrigation in the Spanish New World. *Latin American Antiquity* 2:48–68.
- Barnhart, Edwin E.
2001 The Palenque Mapping Project: Settlement and Urbanism at an Ancient Maya City. Ph.D. dissertation, University of Texas at Austin.
- Barrett, John C.
1999 The Mythical Landscapes of the British Iron Age. In *Archaeologies of Landscape: Contemporary Perspectives*. W. Ashmore and A. B. Knapp, eds. Pp. 253–65. Oxford: Blackwell.
- Bassie-Sweet, Karen
1996 *At the Edge of the World: Caves and Late Classic Maya World View*. Norman: University of Oklahoma Press.
- Basso, Keith H.
1996 *Wisdom Sits in Places*. Albuquerque: University of New Mexico Press.
- Baudez, Claude F.
1994 *Maya Sculpture of Copan: The Iconography*. Norman: University of Oklahoma Press.
- Bayman, James M., and Suzanne K. Fish
1992 Reservoirs and Locational Shifts in Sonoran Desert Subsistence. D. R. Croes, R. A. Hawkins, and B. L. Isaac, eds. Pp. 267–306. Research in Economic Anthropology, Supplement 6. Greenwich, CT: JAI Press.
- Bayman, James M., Manueak R. Palacios-Fest, and Lisa W. Huckell
1997 Botanical Signatures of Water Storage Duration in a Hohokam Reservoir. *American Antiquity* 62:103–11.
- Beach, Timothy, and Nicholas Dunning
1997 An Ancient Maya Reservoir and Dam at Tamarindito, El Petén, Guatemala. *Latin American Antiquity* 8:20–29.
- Beach, T. P., N. Dunning, S. Luzzadder-Beach, J. Lohse, and D. Cook
n.d. Ancient Maya Impacts on Soils and Soil Erosion. *Catena*. In press.
- Beach, Timothy P., S. Luzzadder-Beach, N. Dunning, J. Hageman, and J. Lohse
2002 Upland Agriculture in the Maya Lowlands: Ancient Maya Soil Conservation in Northwestern Belize. *Geographical Review* 92:372–97.
- Beach, Timothy P., S. Luzzadder-Beach, N. Dunning, and V. Scarborough
2003 Depression Soils in the Lowland Tropics of Northwestern Belize. In *Lowland Maya Area: Three Millennia at the Human-Wildland Interface*. A. Gómez-Pompa, M. Allen, S. L. Fedick, and J. J. Jiménez-Osornio, eds. Pp. 139–73. Binghamton, NY: Hawthorn Press.
- Becker, Marshall
1971 The Identification of a Second Plaza Plan at Tikal, Guatemala and Its Implications for Ancient Maya Social Complexity. Ph.D. dissertation, University of Pennsylvania, Philadelphia.
1988 Caches as Burials, Burials as Caches: The Meaning of Ritual Deposits

- among the Classic Period Lowland Maya. In *Recent Studies in Precolumbian Archaeology*. N. Saunders and O. de Montmollin, eds. Pp. 117–42. BAR International Series 421. Oxford: British Archaeological Reports.
- 1999 *Excavation in Residential Areas of Tikal: Groups with Shrines*. Tikal Report 21. Philadelphia: University Museum, University of Pennsylvania.
- Benson, Elizabeth P.
1985 Architecture as Metaphor. In *Fifth Palenque Round Table 1983*. Merle Green Robertson and Virginia Fields, eds. Pp. 183–92. San Francisco: Precolumbian Art Research Institute.
- Bernal, Ignacio
1969 *The Olmec World*. Berkeley: University of California Press.
- Beverido, Francisco
1970 San Lorenzo Tenochtitlan y la civilización Olmeca. M.A. thesis, University of Veracruz, Xalapa.
- Bice, Richard A.
1980 An Instrument Survey of Gallina Sites on Rattlesnake Ridge. *Papers of the Archaeological Society of New Mexico* 5:141–63.
- Bierhorst, John
1985 *A Nahuatl-English Dictionary and Concordance to the Cantares Mexicanos*. Stanford, CA: Stanford University Press.
- Bill, Cassandra
1997 Patterns of Variation and Change in Dynastic Period Ceramics and Ceramic Production at Copan, Honduras. Ph.D. dissertation, Tulane University, New Orleans.
- Blanton, Richard, Gary M. Feinman, Stephen Kowalewski, and Peter Peregrine
1996 A Dual-Process Theory for the Evolution of Mesoamerican Civilization. *Current Anthropology* 37:1–14.
- Blom, Frans
1925 *Tribes and Temples*. Vol. 1. New Orleans: Tulane University of Louisiana.
- Blomster, Jeffrey P., Hector Neff, and Michael D. Glascock
2005 Olmec Pottery Production and Export in Ancient Mexico Determined through Elemental Analysis. *Science* 307:1068–1072.
- Borhegyi, Stephan F.
1960 Underwater Archaeological Studies in Lake Amatitlan, Highland Guatemala. *American Philosophical Society Yearbook* (Philadelphia). Pp. 547–51.
- Borhegyi, Suzanne de
1961 Gifts to the Rain God. *Lore* 11(4):122–28. Milwaukee: Milwaukee Public Museum.
1963 The Horse God of Peten Itza. *Lore* 13(4):114–19. Milwaukee: Milwaukee Public Museum.
- Borstein, Joshua
2001 Tripping over Colossal Heads: Settlement Patterns and Population Development in the Upland Olmec Heartland. Ph.D. dissertation, Pennsylvania State University, University Park.
- Boserup, Esther
1965 *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Chicago: Aldine.

- Bourke, John G.
1984 [1884] *Snake-Dance of the Moquis*. Tucson: University of Arizona Press.
- Bradley, Richard
2000 *An Archaeology of Natural Places*. London: Routledge.
- Brady, James E.
1997 Settlement Configuration and Cosmology: The Role of Caves at Dos Pilas. *American Anthropologist* 99:602–18.
- Brady, James E., and Wendy Ashmore
1999 Mountains, Caves, Water: Ideational Landscapes of the Ancient Maya. In *Archaeologies of Landscape: Contemporary Perspectives*. Wendy Ashmore and A. Bernard Knapp, eds. Pp. 124–45. London: Blackwell.
- Brady, James E., Ann Scott, Allan Cobb, Irma Rodas, John Fogarty, and Monica Urquizú Sánchez
1997 Glimpses of the Dark Side of the Petexbatún Project: The Petexbatún Regional Cave Survey. *Ancient Mesoamerica* 8:353–64.
- Braswell, Geoffrey E.
1996 A Maya Obsidian Source: The Geoarchaeology, Settlement History, and Ancient Economy of San Martín Jilotepeque, Guatemala. Ph.D. dissertation, Tulane University. Ann Arbor: University Microfilms.
- Breiner, Sheldon, and Michael D. Coe
1972 Magnetic Exploration of the Olmec Civilization. *American Scientist* 60(5): 566–75.
- Brenneman, Walter L., Jr., and Mary G. Brenneman
1995 *Crossing the Circle at the Holy Wells of Ireland*. Charlottesville: University Press of Virginia.
- Brenner, M.
1994 Lakes Salpeten and Quexil, Peten, Guatemala. In *Global Geological Record of Lake Basins*. Vol. 1. E. Gierlowski-Kordesch and K. Kelts, eds. Pp. 377–80. Cambridge: Cambridge University Press.
- Brenner, M., M. F. Rosenmeier, D. A. Hodell, and J. H. Curtis
2002 Paleolimnology of the Maya Lowlands. *Ancient Mesoamerica* 13:141–57.
- Bricker, Harvey, and Victoria Bricker
1999 Astronomical Orientation of the Skyband Bench at Copan. *Journal of Field Archaeology* 26:435–42.
- Bricker, Victoria R.
1990a *A Morpheme Concordance of the Book of Chilam Balam of Chumayel*. Middle American Research Institute Publication 59. New Orleans: Tulane University.
1990b *A Morpheme Concordance of the Book of Chilam Balam of Tizimin*. Middle American Research Institute Publication 58. New Orleans: Tulane University.
- Bricker, Victoria R., Eleuterio Po'ot Yah, and Ofelia Dzul de Po'ot
1998 *A Dictionary of the Maya Language as Spoken in Hocabá Yucatán*. Salt Lake City: University of Utah Press.
- Broda, Johanna
1987 Templo Mayor as Ritual Space. In *The Great Temple of Tenochtitlan: Center and Periphery in the Aztec World*. Johanna Broda, David Carrasco, and

- Eduardo Matos Moctezuma, eds. Pp. 61–123. Berkeley: University of California Press.
- Broda, Johanna, David Carrasco, and Eduardo Matos Moctezuma
1987 *The Great Temple of Tenochtitlan: Center and Periphery in the Aztec World*. Berkeley: University of California Press.
- Brokaw, N. V. L., and E. P. Mallory
1993 *Vegetation of the Rio Bravo Conservation and Management Area, Belize*. Manomet, MA: Manomet Bird Observatory.
- Brookfield, H. C.
1972 Intensification and Deintensification in Pacific Agriculture: A Theoretical Approach. *Pacific Viewpoint* 13:30–48.
1984 Intensification Revisited. *Pacific Viewpoint* 25:15–44.
- Brown, Clifford T.
1999 Mayapán Society and Ancient Maya Social Organization. Ph.D. dissertation, Tulane University, New Orleans.
2005 Caves, Karst, and Settlement at Mayapán, Yucatán. In *In the Maw of the Earth Monster: Mesoamerican Ritual Cave Use*. James Brady and Keith Prufer, eds. Pp. 373–402. Austin: University of Texas Press.
- Brüggemann, Jürgen K.
2001 Differential Water Management in the Prehispanic Cities of Tajin and Zempoala. Paper presented at the 66th annual meeting of the Society for American Archaeology, April 18–22, New Orleans.
- Brüggemann, Jürgen K., and Marie-Areti Hers
1970 Exploraciones arqueológicas en San Lorenzo Tenochtitlan. *Boletín del Instituto Nacional de Antropología e Historia* 39:18–23. Mexico City: Instituto Nacional de Antropología e Historia.
- Brumfiel, Elizabeth M.
1994 Ethnic Groups and Political Development in Ancient Mexico. In *Factional Competition and Political Development in the New World*. Elizabeth M. Brumfiel and John W. Fox, eds. Pp. 89–102. Cambridge: Cambridge University Press.
- Burns, Allan
1983 *An Epoch of Miracles*. Austin: University of Texas Press.
- Burton, Thomas M., Darrell L. King, Robert C. Ball, and Thomas G. Baker
1979 *Utilization of Natural Ecosystems for Waste Water Renovation*. United States Environmental Protection Agency, Region 5. Chicago: Great Lakes National Programs Office.
- Cancian, Frank
1980 Risk and Uncertainty in Agricultural Decision Making. In *Agricultural Decision Making*. P. F. Benlett, ed. Pp. 161–76. New York: Academic Press.
- Caran, S. C., J. A. Neely, B. M. Winsborough, F. Ramirez Sorensen, and S. Valastro Jr.
1996 A Late Paleo-Indian/Early Archaic Water Well in Mexico—Possible Oldest Water-Management Feature in the New World. *Geoarchaeology* 11:1–35.
- Carballal S., Margarita, Román Chávez T., María Flores H., Luis A. López W., Ma. de la Luz Moreno C., Francisco J. Ortuño C., and Ma. de Jesús Dánchez V.
1997 Los materiales: Restos óseos de fauna pleistocénica. Región de los lagos centrales de la Cuenca de México. In *A propósito del Cuaternario: Homenaje*

- al Prof. Francisco González Rul. Salvamento Arqueológico, ed. Pp. 83–118. Mexico City: Instituto Nacional de Antropología e Historia.
- Carballal Staedtler, Margarita, and María Flores H.
- 1989a Las calzadas prehispánicas de la Isla de México. Algunas consideraciones acerca de sus funciones. *Arqueología* 1:71–80. Dirección de Monumentos Prehispánicos, Instituto Nacional de Antropología e Historia, Mexico City.
- 1989b El registro arqueológico de las calzadas. In *Memoria de la XIX Mesa Redonda de la SMA*. Pp. 197–213. Universidad Autónoma de Querétaro—Sociedad Mexicana de Antropología. Mexico City.
- 1993 Investigación del medio ambiente del Lago de Texcoco. *Boletín de la Subdirección de Salvamento Arqueológico* 1:5–7. Instituto Nacional de Antropología e Historia, Mexico City.
- Carballal S., Margarita, María Flores Hernández, and Fernando Miranda
- n.d. Definición de un elemento del sistema de obras para el control hidráulico durante el Postclásico Tardío: Los canales. Congreso Ecológico-Cultural Histórico sobre la Región de los Lagos de México. Biblioteca Nacional de Antropología e Historia y Gobierno Municipal de Tecámac, Edo. de México, July 1990.
- Carballal S., Margarita, María Flores Hernández, and Federico Mooser
- n.d. Pantitlan, Cuenca de México: Una posible solución geológica al problema arqueológico del sumidero. Grupo México: 18 Mesa Redonda de la Sociedad Mexicana de Antropología, Taxco.
- Cárdenas de la Peña, Enrique
- 1986 *Escondite de culebras, puente Coatzacoalcos II*. Mexico City: Secretaría de Comunicaciones y Transportes.
- Carlson, John
- 1981 A Geomantic Model for the Interpretation of Mesoamerican Sites. In *Mesoamerican Sites and World-Views*. Elizabeth P. Benson, ed. Pp. 143–211. Washington, D.C.: Dumbarton Oaks.
- Carrasco, David
- 1990 *Religions of Mesoamerica*. San Francisco: Harper and Row.
- Carrasco, Pedro
- 1999 *The Tenochca Empire of Ancient Mexico: The Triple Alliance of Tenochtitlan, Tetzaco, and Tlacopan*. Norman: University of Oklahoma Press.
- Caso, Alfonso
- 1965 ¿Existió un imperio olmeca? *Memoria de El Colegio Nacional* 5(3):11–60.
- Castañeda Salguero, C.
- 1995 *Sistemas lacustres de Guatemala: Recursos que mueren*. Guatemala: Universidad de San Carlos, Editorial Universitaria.
- Castillo Farreras, Víctor Manuel
- 1984 *Estructura económica de al Sociedad Mexica según las Fuentes documentales*. Instituto de Investigaciones Históricas, UNAM, México.
- Charlton, Thomas H., and Deborah L. Nichols
- 1997 Diachronic Studies of City-States: Permutations on a Theme—Central Mexico from 1700 B.C. to A.D. 1600. In *The Archaeology of City-States: Cross-Cultural Approaches*. Deborah L. Nichols and Thomas H. Charlton, eds. Pp. 169–208. Washington, D.C.: Smithsonian Institution Press.

- Chase, Arlen F., and Diane Z. Chase
 1996 A Mighty Maya Nation: How Caracol Built an Empire by Cultivating Its Middle Class. *Archaeology* 49(5):66–72.
 1998 Scale and Intensity in Classic Period Maya Agriculture: Terracing and Settlement at the “Garden City” of Caracol, Belize. *Culture and Agriculture* 20(2–3):60–77.
- Childe, V. Gordon
 1952 *New Light on the Most Ancient East*. New York: Praeger.
- Chimalpahin, Domingo de San Antón Muñón
 1991 *Memorial breve acerca de la fundación de la ciudad de Culhuacan*. Edición de Victor M. Castillo F. Instituto de Investigaciones Históricas, Serie de Cultura Náhuatl, series 9. Mexico City: Universidad Autónoma de México.
 1997 *Codex Chimalpahin: Society and Politics in Mexico, Tenochtitlan, Tlatelolco, Texcoco, Culhuacan, and Other Nahuatl Altepetl in Central Mexico*. Vols. 1–2. Arthur J. O. Anderson and Susan Shroeder, eds. and trans. Norman: University of Oklahoma Press.
- Chimalpopoca Códice
 1975 *Códice Chimalpopoca. Anales de Cuauhtitlan y leyenda de los soles*. Translated from Náhuatl by Primo Feliciano Velázquez. Instituto de Investigaciones Históricas. Mexico City: Universidad Autónoma de México.
- Clark, John E.
 1997 The Arts of Government in Early Mesoamerica. *Annual Review of Anthropology* 26:211–34.
- Clark, John E., and Michael Blake
 1994 The Power of Prestige: Competitive Generosity and the Emergence of Rank Societies in Lowland Mesoamerica. In *Factional Competition and Political Development in the New World*. Elizabeth M. Brumfiel and John W. Fox, eds. Pp. 17–30. Cambridge: Cambridge University Press.
- Clark, John E., and Tomás Pérez
 1994 Los Olmecas y el primer milenio de Mesoamérica. In *Los Olmecas en Mesoamérica*. J. E. Clark, ed. Pp. 261–75. Mexico City: Citibank and El Equilibrista.
- Clark, John E., and Mary E. Pye
 2000 The Pacific Coast and the Olmec Question. In *Olmec Art and Archaeology in Mesoamerica*. John E. Clark and Mary E. Pye, eds. Pp. 217–51. Washington, D.C.: National Gallery of Art.
- Cobean, Robert
 n.d. La Oaxaqueña, Veracruz: El estudio de un centro olmeca menor en su contexto regional. Report to the Instituto Nacional de Antropología e Historia, Mexico City.
- Codex Florentine
 1950–59 *General History of the Things of New Spain*. A. J. O. Anderson and C. E. Dibble, trans. Santa Fe: University of Utah and School of American Research.
- Coe, Michael D.
 1965a A Model of Ancient Community Structure. *Southwest Journal of Anthropology* 21:97–114.
 1965b The Olmec Style and Its Distribution. In *Handbook of Middle American*

- Indians*. Vol. 3. Robert C. West, ed. Pp. 739–75. Austin: University of Texas Press.
- 1968 *America's First Civilization: Discovering the Olmec*. New York: American Heritage Publishing.
- 1972 Olmec Jaguars and Olmec Kings. In *The Cult of the Feline*. Elizabeth Benson, ed. Pp. 1–18. Washington, D.C.: Dumbarton Oaks.
- Coe, Michael D., and Richard A. Diehl
- 1980 *In the Land of the Olmec*. 2 vols. Austin: University of Texas Press.
- 1991 Reply to Hammond's "Cultura Hermana: Reappraising the Olmec." *Review of Archaeology* 12(1):30–35.
- Coggins, Clemency
- 1980 The Shape of Time: Some Political Implications of a Four-Part Figure. *American Antiquity* 45:727–39.
- 1983 *The Stucco Decoration and Architectural Assemblage of Structure 1-sub, Dzibilchaltun, Yucatan, Mexico*. Middle American Research Institute Publication 49. New Orleans: Tulane University.
- Collier, George
- 1975 *Fields of the Tzotzil*. Austin: University of Texas Press.
- Conrad, Henry S.
- 1905 *The Waterlilies: A Monograph of the Genus Nymphaea*. Publication 4. Cambridge: Carnegie Institution of Washington.
- Cordell, Linda
- 1997 *Archaeology of the Southwest*. San Diego: Academic Press.
- Cordova, Carlos F. de A., Ana Lillian Martin del Pozzo, and Javier López Camacho
- 1994 Paleolandforms and Volcanic Impact on the Environment of Prehistoric Cuicuilco, Southern Mexico City. *Journal of Archaeological Science* 21:585–96.
- Corona Nuñez, Gustavo
- 1962 El luchador olmeca. *Boletín del Instituto Nacional de Antropología e Historia* 10:12–13. Instituto Nacional de Antropología e Historia, Mexico City.
- Covarrubias, Miguel
- 1957 *Indian Art of Mexico and Central America*. New York: Alfred A. Knopf.
- Cowgill, George L.
- 1975 On the Causes and Consequences of Ancient and Modern Population Changes. *American Anthropologist* 77:505–25.
- 1996 Discussion. *Ancient Mesoamerica* 7:325–31.
- 1997 State and Society at Teotihuacan, Mexico. *Annual Review of Anthropology* 26:129–61.
- Cowgill, U. M., and G. E. Hutchinson
- 1963 El bajo de Santa Fe. *Transactions of the American Philosophical Society* 53(7):3–44.
- Crown, Patricia L.
- 1987a Classic Period Hohokam Settlement and Land Use in the Casa Grande Ruins Area, Arizona. *Journal of Field Archaeology* 14:147–62.
- 1987b Water Storage in the Prehistoric Southwest. *Kiva* 52(3):209–28.
- Crumley, Carole L.
- 1987 A Dialectical Critique of Hierarchy. In *Power Relations and State Forma-*

- tion. T. C. Patterson and C. W. Gailey, eds. Pp. 155–59. Washington, D.C.: American Anthropological Association.
- 1995 Heterarchy and the Analysis of Complex Societies. In *Heterarchy and the Analysis of Complex Societies*. R. M. Ehrenreich, C. L. Crumley, and J. E. Levy, eds. Pp. 1–6. Archaeological Papers of the American Anthropological Association 6. Washington, D.C.: American Anthropological Association.
- Culbert, T. P., V. Fialko, B. McKee, B. L. Grazioso, and J. Kunen
- 1996 Investigación arqueológica en el Bajo La Justa: La temporada de 1996. In *X Simposio de Investigaciones Arqueológicas en Guatemala*. J. P. Laporte and H. L. Escobedo, eds. Pp. 367–71. Guatemala: Museo Nacional de Arqueología y Etnología de Guatemala.
- Culbert, T. P., Laura J. Kosakowsky, Robert E. Fry, and William A. Haviland
- 1990 The Population of Tikal, Guatemala. In *Precolumbian Population History in the Maya Lowlands*. T. Patrick Culbert and Don S. Rice, eds. Pp. 103–21. Albuquerque: University of New Mexico Press.
- Culbert, T. P., L. J. Levi, and L. Cruz
- 1990 Lowland Maya Wetland Agriculture: The Rio Azul Agronomy Program. In *Vision and Revision in Maya Studies*. F. S. Clancy and P. D. Harrison, eds. Pp. 115–24. Albuquerque: University of New Mexico Press.
- Curtis, Natalie
- 1935 [1907] *The Indians' Book*. New York: Harper and Bros.
- Cushing, Frank Hamilton
- 1920 *Zuñi Breadstuff*. Indian Notes and Monographs. Vol. 8. New York: Museum of the American Indian, Heye Foundation.
- Cyphers (Guillén), Ann
- 1984 The Possible Role of a Woman in Formative Exchange. In *Trade and Exchange in Early Mesoamerica*. K. G. Hirth, ed. Pp. 115–24. Albuquerque: University of New Mexico Press.
- 1992 Informe del proyecto espacios domésticos olmecas en San Lorenzo Tenochtitlan: Temporada 1992. Report submitted to the Consejo de Arqueología. Mexico City: Instituto Nacional de Antropología e Historia.
- 1993 Escenas escultóricas olmecas. *Antropológicas* 6:47–52. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.
- 1994 Olmec Sculpture. *National Geographic Research and Exploration* 10(3):294–305.
- 1997a La arquitectura olmeca en San Lorenzo Tenochtitlan. In *Población, subsistencia y medio ambiente en San Lorenzo Tenochtitlan*. A. Cyphers, ed. Pp. 91–117. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.
- 1997b El contexto social de monumentos en San Lorenzo. In *Población, subsistencia y medio ambiente en San Lorenzo Tenochtitlan*. A. Cyphers, ed. Pp. 163–94. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.
- 1997c La gobernanza en San Lorenzo: Inferencias del arte y patrón de asentamiento. In *Población, subsistencia y medio ambiente en San Lorenzo Tenochtitlan*. A. Cyphers, ed. Pp. 227–42. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.

- 1999 From Stone to Symbols: Olmec Art in Social Context at San Lorenzo Tenochtitlan. In *Social Patterns in Pre-Classic Mesoamerica*. David C. Grove and Rosemary A. Joyce, eds. Pp. 155–81. Washington, D.C.: Dumbarton Oaks.
- 2004 *Escultura olmeca de San Lorenzo Tenochtitlan*. Mexico City: Universidad Nacional Autónoma de México.
- n.d.a *Contextos sagrados y profanos de la escultura olmeca*. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México. In press.
- n.d.b *Escultura olmeca de San Lorenzo Tenochtitlan*. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México. In press.
- n.d.c Las excavaciones en San Lorenzo Tenochtitlan. Manuscript.
- n.d.d Thrones and the Configuration of Power in the Olmec World. Manuscript.
- Cyphers, Ann, and Alejandra Alonso
 1999 Patrón de asentamiento alrededor de Cerro El Mixe. In *Informe del proyecto arqueológico San Lorenzo Tenochtitlan: Temporada 1999*. Field Report. Mexico City: Consejo de Arqueología, Instituto Nacional de Antropología e Historia.
- Cyphers, Ann, and Joshua Borstein
 n.d. Laguna de los Cerros. Manuscript.
- Cyphers, Ann, and Alejandro Hernández
 n.d. Excavaciones en el Acueducto, SL-73. In *Las excavaciones en San Lorenzo Tenochtitlan*. Manuscript.
- Cyphers, Ann, and Artemio López
 1996 El joven de Chiquipixta. *Son del Sur* 3:46–47. Cosoleacaque, Veracruz: Chuchumbé, A.C.
- Dahlin, Bruce H.
 1989 Notes on the Paleoecology of the El Mirador Bajo. Manuscript.
- Dahlin, Bruce H., and A. Dahlin
 1994 Platforms in the Aklache at El Mirador, Peten, Guatemala and Their Implications. *Geoarchaeology* 9:203–37.
- Dahlin, Bruce H., J. Foss, and M. E. Chambers
 1980 Project Akalches: Reconstructing the Natural and Cultural History of a Seasonal Swamp: Preliminary Results. In *El Mirador, El Petén, Guatemala: An Interim Report*. Papers of the New World Archaeological Foundation 45. R. T. Matheny, ed. Pp. 37–58. Provo, UT: Brigham Young University.
- Damp, J. E., S. A. Hall, and S. J. Smith
 2002 Early Irrigation on the Colorado Plateau near Zuni Pueblo, New Mexico. *American Antiquity* 67:665–76.
- Davies, Nigel
 1973 *The Aztecs: A History*. New York: Macmillan.
- Davis-Salazar, Karla L.
 1994 Preliminary Field Report. Proyecto Arqueológico Acropolis Copan, Copan, Honduras.
- 2001 Late Classic Maya Water Management at Copan, Honduras. Ph.D. dissertation, Harvard University, Cambridge, MA.

- 2003 Late Classic Maya Water Management and Community Organization at Copan, Honduras. *Latin American Antiquity* 14:275–99.
- de la Fuente, Beatriz
- 1973 *Escultura monumental olmeca*. Mexico City: Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México.
- 1981 Toward a Conception of Monumental Olmec Art. In *The Olmec and Their Neighbors: Essays in Memory of Matthew Stirling*. E. Benson, ed. Pp. 83–94. Washington, D.C.: Dumbarton Oaks.
- de la Garza, Mercedes
- 1992 *Palenque*. Chiapas Eterno. Gobierno del Estado de Chiapas, Mexico.
- de la Garza, Mercedes, Ana Luisa Izquierdo, and
Ma. del Carmen León y Tolita Figueroa
- 1983 *Relaciones histórico-geográficas de la gobernación de Yucatán*. Vol. 1. Instituto de Investigaciones Filológicas, Centro de Estudios Mayas, Fuentes para el Estudio de la Cultura Maya 1. Mexico City: Universidad Nacional Autónoma de México.
- de León, Francisco, and Juan Antonio Valdés
- 2002 Excavaciones en Piedra Parada: Más información sobre el Preclásico Medio del Altiplano Central de Guatemala. In *Incidents of Archaeology in Central America: Essays in Honor of Edwin M. Shook*. M. Love, M. Popenoe de Hatch, and H. L. Escobedo, eds. Pp. 375–95. Lanham, MD: University Press of America.
- Delgado, Alfredo
- 1997 Nuevos antiguos monumentos. *Raíces* (Coatzacoalcas) 27:12–13.
- Demarest, Arthur
- 1989 The Olmec and the Rise of Civilization in Eastern Mesoamerica. In *Regional Perspectives on the Olmec*. R. J. Sharer and D. C. Grove, eds. Pp. 303–44. New York: Cambridge University Press.
- Demarest, Arthur A., and Geoffrey W. Conrad, eds.
- 1992 *Ideology and Pre-Columbian Civilizations*. Santa Fe: School of American Research Press.
- Dickson, D. Bruce
- 1979 *Prehistoric Pueblo Settlement Patterns: The Arroyo Hondo, New Mexico, Site Survey*. Arroyo Hondo Archaeological Series 2. Santa Fe: School of American Research Press.
- Di Peso, Charles C.
- 1974 *Casas Grandes: A Fallen Trade Center of the Gran Chichimeca*. Vols. 1–3. Flagstaff: Amerind Foundation, Dragoon, and Northland Press.
- Di Peso, Charles C., John B. Rinaldo, and Gloria J. Fenner
- 1974 *Casas Grandes: A Fallen Trade Center of the Gran Chichimeca*. Vols. 4–8. Flagstaff: Amerind Foundation, Dragoon, and Northland Press.
- Doolittle, William E.
- 1990 *Canal Irrigation in Prehistoric Mexico: The Sequence of Technological Change*. Austin: University of Texas Press.
- 1993 Canal Irrigation at Casas Grandes: A Technological and Developmental Assessment of Its Origins. In *Culture and Contact: Charles C. Di Peso's Gran Chichimeca*. A. I. Woosley and J. C. Ravesloot, eds. Pp. 133–51. Albuquerque: Amerind Foundation and the University of New Mexico.

- Dorsey, George A., and H. R. Voth
 1902 *The Mishongnovi Ceremonies of the Snake and Antelope Fraternities*. Field Columbian Museum Publication 66, Anthropological Series 3(3). Chicago: Field Museum of Natural History.
- Drucker, Philip
 1952 *La Venta, Tabasco: A Study of Olmec Ceramics and Art*. Bureau of American Ethnology Bulletin 153. Washington, D.C.: Smithsonian Institution.
 1981 On the Nature of Olmec Polity. In *The Olmec and Their Neighbors*. E. Benson, ed. Pp. 27–49. Washington, D.C.: Dumbarton Oaks.
- Dunning, Nicholas P.
 1995 Coming Together at the Temple Mountain: Environment, Subsistence, and the Emergence of Classic Maya Segmentary States. In *The Emergence of Lowland Maya Civilization: The Transition from the Preclassic to the Early Classic*. Nikolai Grube, ed. Pp. 61–70. Acta Mesoamericana 8. Möckmühl: Verlag von Flemming.
 1999 Preliminary Observations on Soils, Hydrology, and Cultural Features in the Bajo La Justa and Bajo Zocotzal, Peten, Guatemala (1999). Manuscript.
 2003 Birth and Death of Waters: Environmental Change, Adaptation, and Symbolism in the Southern Maya Lowlands. In *Espacios mayas: Usos, representaciones, creencias*. A. Breton, A. Monod Becquelin, and M. H. Ruz, eds. Pp. 49–76. Mexico City: Universidad Autónoma de México.
 2004 News from the Bajos. Preliminary report on NSF Grant BCS-0241757. Submitted to the National Science Foundation, Washington, D.C.
 n.d. Cambio ambiental y cultural en las tierras bajas antiguas mayas. In *El territorio maya: Memoria del V mesa redonda de Palenque*. L. Pescador Canton, ed. Mexico City: Instituto Nacional de Antropología e Historia. In press.
- Dunning, Nicholas, and Timothy Beach
 2004 Fruit of the *Luum*: Lowland Maya Soil Knowledge and Agricultural Practices. *Mono y Conejo* 2:2–25.
- Dunning, Nicholas P., Timothy Beach, P. Farrell, and Susan Luzzadder-Beach
 1998 Prehispanic Agrosystems and Adaptive Regions in the Maya Lowlands. *Culture and Agriculture* 20:87–100.
- Dunning, Nicholas P., Timothy Beach, and Susan Luzzadder-Beach
 2005 Variability among Bajo Soil Histories in the Southern Maya Lowlands. Paper presented at the annual meeting of the Association of American Geographers, April 5–9, Denver.
- Dunning, N. P., T. Beach, and D. Rue
 1997 The Paleoecology and Ancient Settlement of the Petexbatun Region, Guatemala. *Ancient Mesoamerica* 8:185–97.
- Dunning, Nicholas P., T. P. Culbert, V. Fialko, T. Sever, J. G. Jones, L. Grazioso, and D. Irwin
 2002 The Bajo de Santa Fe Revisited. Paper presented at the 67th annual meeting of the Society for American Archaeology, March 20–24, Denver.
- Dunning, Nicholas, John Jones, Timothy Beach, and Sheryl Luzzadder-Beach
 2003 Physiography, Habitats, and Landscapes of the Three Rivers Region. In *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula*. V. Scarborough, F. Valdez Jr., and N. Dunning, eds. Pp. 14–24. Tucson: University of Arizona Press.

- Dunning, Nicholas, Sheryl Luzzadder-Beach, Timothy Beach, John Jones, Vernon L. Scarborough, and T. Patrick Culbert
 2002 Arising from the Bajos: Anthropogenic Change of Wetlands and the Rise of Maya Civilization. *Annals of the Association of American Geographers* 92: 267–83.
- Dunning, Nicholas, Vernon Scarborough, Fred Valdez Jr., Sheryl Luzzadder-Beach, Timothy Beach, and John G. Jones
 1999 Temple Mountains, Sacred Lakes, and Fertile Fields: Ancient Maya Landscapes in Northwestern Belize. *Antiquity* 73:650–60.
- Durán, Fray Diego de
 1967 *Historia de las Indias de Nueva España e Islas de Tierra Firme*. Angel Ma. Garibay, ed. Mexico City: Editorial Porrúa, SA.
- Dzul Poot, Domingo
 1985 *Cuentos Maya*. Bilingual ed. Mérida, Mexico: Maldonado Editores/SEP-INAH.
- Earle, Timothy
 1987 Chieftdoms in Archaeological and Ethnohistoric Perspective. *Annual Review of Anthropology* 16:279–308.
 1991 Paths and Roads in Evolutionary Perspective. In *Ancient Road Networks and Settlement Hierarchies in the New World*. C. D. Trombold, ed. Pp. 10–16. New York: Cambridge University Press.
 2001 Economic Support of Chaco Canyon Society. *American Antiquity* 66:26–35.
- Edmonson, Munro S.
 1982 *The Ancient Future of the Itzá: The Book of Chilam Balam of Tizimin*. Austin: University of Texas Press.
 1986 *Heaven Born Mérida and Its Destiny: The Book of Chilam Balam of Chumayel*. Austin: University of Texas Press.
- Edmonson, Munro S., and Victoria R. Bricker
 1985 Yucatecan Maya Literature. In *Supplement to the Handbook of Middle American Indians*. Vol. 3: *Literatures*. Munro Edmonson, ed. Pp. 44–63. Austin: University of Texas Press.
- Eggan, Fred
 1950 *Social Organization of the Western Pueblos*. Chicago: University of Chicago Press.
- Eliade, Mircea
 1954 *The Myth of the Eternal Return or, Cosmos and History*. Willard R. Trask, trans. Princeton, NJ: Princeton University Press.
- Ellis, Florence Hawley
 1951 Patterns of Aggression and the War Cult in Southwestern Pueblos. *Southwestern Journal of Anthropology* 7:177–201.
 1979 Laguna Pueblo. In *Handbook of North American Indians*. Vol. 9: *Southwest*. Alfonso Ortiz, ed. Pp. 438–49. Washington, D.C.: Smithsonian Institution Press.
 1994 Pueblo Religious Patterns, Especially Types of Shrines and Areas for Collecting Herbs and Other Religious Necessities. In *Artifacts, Shrines, and Pueblos: Papers in Honor of Gordon Page*. Meliha S. Duran and David T. Kirkpatrick, eds. Pp. 101–12. Papers of the Archaeological Society of New Mexico 20.

- Emery, Kitty
n.d. Zooarqueología de Kaminaljuyu: Análisis de huesos de fauna del Proyecto Miraflores II. Archive of the project.
- English, P. W.
1966 *City and Village in Iran: Settlement and Economy in the Kirman Basin*. Madison: University of Wisconsin Press.
- Erickson, Clark L.
1988 An Archaeological Investigation of Raised Field Agriculture in the Lake Titicaca Basin of Peru. Ph.D. dissertation, University of Illinois at Urbana-Champaign.
- Evenari, M., L. Shanan, and N. Tadmor
1971 *The Negev: The Challenge of a Desert*. Cambridge, MA: Harvard University Press.
- Farriss, Nancy
1984 *Maya Society under Colonial Rule*. Princeton, NJ: Princeton University Press.
- Fash, Barbara W.
1992a Copan Mosaic Sculpture: Puzzles within Puzzles. Paper presented at the 10th Annual Maya Weekend, University Museum, University of Pennsylvania, April 4–5.
1992b Late Classic Architectural Sculpture Themes in Copan. *Ancient Mesoamerica* 3:89–104.
2005 Iconographic Evidence for Water Management at Copan, Honduras. In *Copan: History of an Ancient Maya Kingdom*. E. Wyllys Andrews and William L. Fash, eds. Santa Fe: School of American Research Press.
- Fash, Barbara W., and William L. Fash
1991 “He at the Head of the Mat”: Archaeological Evidence for a Classic Maya Council House from Copan. Paper presented at the 90th annual meeting of the American Anthropological Association, Chicago.
- Fash, Barbara W., William Fash, Rudy Larios, Sheree Lane, Linda Schele, Jeffrey Stomper, and David Stuart
1992 Investigations of a Maya Council House from Copan, Honduras. *Journal of Field Archaeology* 19:419–42.
- Fash, William L.
1983 Deducing Social Organization from Classic Maya Settlement Patterns: A Case Study from the Copan Valley. In *Civilization in the Ancient Americas, Essays in Honor of Gordon R. Willey*. Richard Leventhal and Alan Kolata, eds. Pp. 261–88. Albuquerque: University of New Mexico Press and Peabody Museum of Archaeology and Ethnology, Harvard University.
1987 The Altar and Associated Features. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 82–94. Austin: University of Texas Press.
1988 The Sculptural Façade of Structure 9N-82: Content, Form and Significance. In *House of the Bacabs, Copan, Honduras*. David Webster, ed. Pp. 41–72. Washington, D.C.: Dumbarton Oaks.
1991 *Scribes, Warriors and Kings: The City of Copan and the Ancient Maya*. 1st ed. London: Thames and Hudson.
2001 *Scribes, Warriors and Kings: The City of Copan and the Ancient Maya*. 2nd ed. London: Thames and Hudson.

- Fash, William L., and Kurt Z. Long
 1983 Mapa arqueológico del Valle de Copan. In *Introducción a la arqueología de Copan*. C. F. Baudez, ed. Vol. 3, pp. 1–48. Tegucigalpa: Secretaría de Estado en el Despacho de Cultura y Turismo.
- Fedick, Scott L.
 1994 Ancient Maya Agricultural Terracing in the Upper Belize River Area: Computer-Aided Modeling and the Results of Initial Field Investigations. *Ancient Mesoamerica* 5:107–27.
- Fedick, Scott L., and Anabel Ford
 1990 The Prehistoric Agricultural Landscape of the Central Maya Lowlands: An Examination of Local Variability in a Regional Context. *World Archaeology* 22:18–33.
- Fewkes, Jesse Walter
 1891 A Suggestion as to the Meaning of the Moki Snake Dance. *Journal of American Folk-lore* 4:129–38.
 1895 A Comparison of Sia and Tusayan Snake Ceremonials. *American Anthropologist*, o.s. 8:118–41.
 1896 The Prehistoric Culture of Tusayan. *American Anthropologist*, o.s. 9:151–71.
 1902 Minor Hopi Festivals. *American Anthropologist* 4:482–511.
- Fish, Suzanne K.
 1996 Dynamics of Scale in the Southern Deserts. In *Interpreting Southwestern Diversity: Underlying Principles and Overarching Patterns*. Paul R. Fish and J. Jefferson Reid, eds. Pp. 107–14. Anthropological Research Paper 48. Tempe: Arizona State University.
- Fish, Suzanne K., and Paul R. Fish, eds.
 1984 *Prehistoric Agricultural Strategies in the Southwest*. Anthropological Research Papers 33. Tempe: Arizona State University.
- Fisher, Christopher T., Helen P. Pollard, and Charles Frederick
 1999 Intensive Agriculture and Sociopolitical Development in the Late Pátzcuaro Basin, Michoacán, Mexico. *Antiquity* 73:642–49.
- Flannery, Kent V., and Joyce Marcus
 2000 Formative Mexican Chiefdoms and the Myth of the “Mother Culture.” *Journal of Anthropological Archaeology* 19:1–37.
- Folan, William J., Joyce Marcus, Sophia Pincemin, María del Rosario Domínguez Carrasco, Laraine Fletcher, and Abel Morales López
 1995 Calakmul: New Data from an Ancient Maya Capital in Campeche, Mexico. *Latin American Antiquity* 6:310–34.
- Ford, Anabel
 1996 Critical Resource Control and the Rise of the Classic Period Maya. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*. Scott L. Fedick, ed. Pp. 297–303. Salt Lake City: University of Utah Press.
- Ford, Richard I., Albert H. Schroeder, and Stewart L. Peckham
 1972 Three Perspectives on Puebloan Prehistory. In *New Perspectives on the Pueblos*. Alfonso Ortiz, ed. Pp. 19–40. Albuquerque: University of New Mexico Press.
- Fowler, Melvin L.
 1969 A Preclassic Water Distribution System in Amalucan, Mexico. *Archaeology* 22:208–15.

- 1987 Early Water Management at Amalucan, State of Puebla, Mexico. *National Geographic Research* 3:52–68.
- Fox, John W.
1991 The Lords of Light versus the Lords of Dark: The Postclassic Highland Maya Ballgame. In *The Mesoamerican Ballgame*. Vernon Scarborough and David Wilcox, eds. Pp. 213–38. Tucson: University of Arizona Press.
- Freidel, David
1992 Ahau as Idea and Artifact in Classic Lowland Maya Civilization. In *Ideology and Pre-Columbian Civilizations*. Arthur A. Demarest and Geoffrey W. Conrad, eds. Pp. 115–33. Santa Fe: School of American Research Press.
- Freidel, David A., and Linda Schele
1988 Kingship in the Late Preclassic Maya Lowlands: The Instruments and Places of Ritual Power. *American Anthropologist* 90:547–67.
- Freidel, David, Linda Schele, and Joy Parker
1993 *Maya Cosmos: Three Thousand Years on the Shaman's Path*. New York: William Morrow and Company.
- French, Kirk
2001 The Precious Otulum of Palenque. *PARI Journal* 2(2):12–16.
2002 Creating Space through Water Management at the Classic Maya Site of Palenque, Chiapas, Mexico. M.A. thesis, University of Cincinnati.
- Friedman, Jonathan
1975 Tribes, States, and Transformations. In *Marxist Analyses and Social Anthropology*. M. Bloch, ed. Pp. 161–202. New York: Wiley and Sons.
1998 *System, Structure, and Contradiction: The Evolution of "Asiatic" Social Formations*. 2nd ed. Walnut Creek, CA: Altamira Press.
- Friedman, Jonathan, and Michael J. Rowlands
1977 Notes toward an Epigenetic Model of the Evolution of "Civilisation." In *The Evolution of Social Systems*. J. Friedman and M. J. Rowlands, eds. Pp. 201–76. Liverpool: Duckworth.
- Fry, Robert E.
1969 Ceramic and Settlement in the Periphery of Tikal, Guatemala. Ph.D. dissertation, University of Arizona, Tucson.
- Furst, Peter
1968 The Olmec Were-Jaguar Motif in the Light of Ethnographic Reality. In *Dumbarton Oaks Conference on the Olmec*. E. Benson, ed. Pp. 143–62. Washington, D.C.: Dumbarton Oaks.
- Gamboa Cabezas, Luis M.
2000 El barrio de Puxtla: Área de Chinampas. *Tezontle: Boletín del Centro de Estudios Teotihuacanos* 3:6–8.
- Garbrecht, G.
1987 Irrigation throughout History: Problems and Solutions. In *Water for the Future*. W. O. Wunderlich and J. E. Prins, eds. Pp. 3–18. Boston: A. A. Balkema.
- Garza Tarazona, Silvia, and Edward Barna Kurjack Basco
1980 *Atlas arqueológico del estado de Yucatán*. Mexico City: Instituto Nacional de Antropología e Historia.
- Geertz, Armin W.
1994 *The Invention of Prophecy*. Berkeley: University of California Press.

- Geertz, Clifford
 1980 *Negara: The Theatre State in Nineteenth-Century Bali*. Princeton, NJ: Princeton University Press.
- Gelles, Paul H.
 2000 *Water and Power in Highland Peru: The Cultural Politics of Irrigation and Development*. New Brunswick, NJ: Rutgers University Press.
- Gibson, Walter S.
 1989 *"Mirror of the Earth": The World Landscape in Sixteenth-Century Flemish Painting*. Princeton, NJ: Princeton University Press.
- Gillespie, Susan D.
 1989 *The Aztec Kings: The Construction of Rulership in Mexica History*. Tucson: University of Arizona Press.
 2002 The Monuments of Laguna de los Cerros and Its Hinterland. In *Olmec Art and Archaeology*. J. E. Clark and M. E. Pye, eds. Pp. 94–115. Washington, D.C.: National Gallery of Art.
- Girard, Rafael
 1949 *Los chortís ante el problema maya: Historia de las culturas indígenas de América, desde su origen hasta hoy*. Mexico City: Antigua Librería Robredo.
- Gliessman, S. R., B. L. Turner II, F. J. Rosado May, and M. F. Amador
 1983 Ancient Raised Field Agriculture in the Maya Lowlands of Southeastern Mexico. In *Drained Field Agriculture in Central and South America*. J. P. Darch, ed. Pp. 91–110. BAR International Series 189. Oxford: British Archaeological Reports.
- Gómez-Pompa, Arturo, José Salvador Flores, and Mario Aliphat Fernández
 1990 The Sacred Cacao Groves of the Maya. *Latin American Antiquity* 1:247–57.
- González Aparicio, Luis
 1973 *Plano Reconstructivo de la Región de Tenochtitlan*, INAH, Mexico
- González Lauck, Rebecca
 1990 The 1984 Archaeological Investigations at La Venta, Tabasco, Mexico. Ph.D. dissertation, University of California, Berkeley.
 1991 Algunas consideraciones sobre los monumentos 75 y 80 de La Venta. *Anales del Instituto de Investigaciones Estéticas* 62:163–74.
 1996 La Venta: An Olmec Capital. In *Olmec Art of Ancient Mexico*. E. P. Benson and B. de la Fuente, eds. Pp. 73–81. Washington, D.C.: National Gallery of Art.
- Griffith, James S.
 1992 *Beliefs and Holy Places*. Tucson: University of Arizona Press.
- Grove, David C.
 1970 *The Olmec Paintings of Oxtotitlán Cave, Guerrero, Mexico*. Studies in Pre-Columbian Art and Archaeology 6. Washington, D.C.: Dumbarton Oaks.
 1972 Olmec Felines in Highland Central Mexico. In *The Cult of the Feline*. E. Benson, ed. Pp. 153–64. Washington, D.C.: Dumbarton Oaks.
 1973 Olmec Altars and Myths. *Archaeology* 26:128–35.
 1981 Olmec Monuments: Mutilation as a Clue to Meaning. In *The Olmec and Their Neighbors: Essays in Memory of Matthew W. Stirling*. E. Benson, ed. Pp. 49–68. Washington, D.C.: Dumbarton Oaks.
 1984 *Chalcatzingo: Excavations on the Olmec Frontier*. New York: Thames and Hudson.

- 1987 Chalcatzingo in a Broader Perspective. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 434–42. Austin: University of Texas Press.
- 1989a Chalcatzingo and Its Olmec Connection. In *Regional Perspectives on the Olmec*. R. J. Sharer and D. C. Grove, eds. Pp. 122–47. New York: Cambridge University Press.
- 1989b Olmec: What's in a Name? In *Regional Perspectives on the Olmec*. R. J. Sharer and D. C. Grove, eds. Pp. 8–14. New York: Cambridge University Press.
- 1994 La Isla, Veracruz, 1991: A Preliminary Report with Comments on the Olmec Uplands. *Ancient Mesoamerica* 5:223–30.
- 1999 Public Monuments and Sacred Mountains: Observations on Three Formative Period Landscapes. In *Social Patterns in Pre-Classic Mesoamerica*. David C. Grove and Rosemary A. Joyce, eds. Pp. 255–99. Washington, D.C.: Dumbarton Oaks.
- Grove, David C., and Jorge Angulo
- 1987 A Catalog and Description of Chalcatzingo's Monuments. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 114–31. Austin: University of Texas Press.
- Grove, David C., and Ann Cyphers Guillén
- 1987 The Excavations. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 29–36. Austin: University of Texas Press.
- Grove, David C., Susan D. Gillespie, Ponciano Ortiz C., and Michael Hayton
- 1993 Five Olmec Monuments from the Laguna de los Cerros Hinterland. *Mexicon* 15:91–95.
- Grube, Nikolai
- 1995 Transformations of Maya Society at the End of the Preclassic: Processes of Change between the Predynastic and Dynastic Periods. In *The Emergence of Lowland Maya Civilization: The Transition from the Preclassic to the Early Classic*. Nikolai Grube, ed. Pp. 1–7. Acta Mesoamericana 8. Möckmühl: Verlag von Flemming.
- Gunn, J. D., W. J. Folan, and H. Robichaux
- 1995 A Landscape Analysis of the Candelaria Watershed in Mexico: Insights into Paleoclimates Affecting Upland Horticulture in the Southern Yucatan Peninsula Semi-Karst. *Geoarchaeology* 10:3–42.
- Gunn, J. D., J. E. Foss, W. J. Folan, M. del Rosario Domínguez, and B. B. Faust
- 2002 Bajo Sediments and the Hydraulic System of Calakmul, Campeche, Mexico. *Ancient Mesoamerica* 13:297–315.
- Gurría Lacroix, Jorge
- 1978 El desagüe del Valle de México durante la época novohispana. Instituto de Investigaciones Históricas, Cuaderno Serie Histórica 19. Mexico City: Universidad Autónoma de México.
- Gutiérrez Mendoza, Edgar
- 1990 Una sociedad cacical agrícola: El sitio arqueológico Kaminaljuyu/San Jorge, Guatemala. *Boletín de Antropología Americana* 22:123–44. Instituto Panamericano de Geografía e Historia.
- Hack, John T.
- 1942 *The Changing Physical Environment of Hopi Indians of Arizona*. Papers of the Peabody Museum of Archaeology and Ethnology 35(1). Cambridge, MA: Harvard University.

- Hageman, John B., and Jon C. Lohse
 2003 Heterarchy, Corporate Groups, and Late Classic Resource Management in Northwestern Belize. In *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula*. V. Scarborough, F. Valdez Jr., and N. Dunning, eds. Pp. 109–21. Tucson: University of Arizona Press.
- Hambly, Wilfred D.
 1931 *Serpent Worship in Africa*. Field Museum of Natural History, Anthropological Series 21(1). Chicago: Field Museum of Natural History.
- Hammond, Norman
 1981 Settlement Patterns in Belize. In *Lowland Maya Settlement Patterns*. Wendy Ashmore, ed. Pp. 157–86. Albuquerque: University of New Mexico Press.
 1988 Cultura hermana: Reappraising the Olmec. *Quarterly Review of Anthropology* 9(4):1–4.
 2004 Position paper presented at the First Boundary's End Conference on Ancient America: The Origins of Maya Civilization. Mars Hill, NC.
- Hansen, Richard D.
 1991 The Maya Rediscovered: The Road to Nakbe. *Natural History* May:8–14.
 1992 The Archaeology of Ideology: A Study of Maya Preclassic Architectural Sculpture at Nakbe, Peten, Guatemala. Ph.D. dissertation, University of California, Los Angeles.
- Hansen, Richard D., Steven Bozarth, John Jacob, David Wahl, and Thomas Schreiner
 2002 Climatic and Environmental Variability in the Rise of Maya Civilization: A Preliminary Perspective from Northern Peten. *Ancient Mesoamerica* 13: 273–95.
- Hard, R. J., and J. R. Roney
 1998 A Massive Terraced Village Complex in Chihuahua, Mexico, 3000 Years before Present. *Science* 279:1661–64.
- Harrington, John P.
 1916 *The Ethnogeography of the Tewa Indians*. Bureau of American Ethnology, Annual Report 29, 1907–8. Washington, D.C.
- Harrison, Peter D.
 1977 The Rise of the Bajos and the Fall of the Maya. In *Social Process in Maya Prehistory*. N. Hammond, ed. Pp. 469–508. New York: Academic Press.
 1978 Bajos Revisited: Visual Evidence for One System of Agriculture. In *Pre-Hispanic Maya Agriculture*. Peter D. Harrison and B. L. Turner II, eds. Pp. 247–54. Albuquerque: University of New Mexico Press.
 1990 The Revolution in Ancient Maya Subsistence. In *Vision and Revision in Maya Studies*. F. Clancy and P. D. Harrison, eds. Pp. 99–113. Albuquerque: University of New Mexico Press.
 1993 Aspects of Water Management in the Southern Lowlands. In *Economic Aspects of Water Management in the Prehispanic New World*. Vernon L. Scarborough and Barry L. Isaac, eds. Pp. 70–119. Research in Economic Anthropology, Supplement 7. Greenwich, CT: JAI Press.
 1996 Settlement and Land Use in the Pulltrouser Swamp Archaeological Zone. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*. S. L. Fedick, ed. Pp. 177–90. Salt Lake City: University of Utah Press.

- Harrison, P. D., and B. L. Turner II
 1978 Implications from Agriculture for Maya Prehistory. In *Pre-Hispanic Maya Agriculture*. P. D. Harrison and B. L. Turner II, eds. Pp. 337–73. Albuquerque: University of New Mexico Press.
- Hassan, Fekri
 1994 Population Ecology and Civilization in Ancient Egypt. In *Historical Ecology: Cultural Knowledge and Changing Landscapes*. C. L. Crumley, ed. Pp. 155–81. Santa Fe: School of American Research Press.
- Hassig, Ross
 1985 *Trade, Tribute and Transportation: The Sixteenth-Century Political Economy of the Valley of Mexico*. Norman: University of Oklahoma Press.
 1991 Roads, Routes and Ties that Bind. In *Ancient Road Networks and Settlement Hierarchies in the New World*. C. D. Trombold, ed. Pp. 17–27. New York: Cambridge University Press.
- Hatch, Marion Popenoe de
 1993 Inferencias de la economía y la organización sociopolítica en Kaminaljuyu durante los períodos Preclásico y Clásico Temprano. In *Segundo y tercer foro de arqueología de Chiapas*. Pp. 33–42. Serie Memorias. Mexico City: Gobierno del Estado de Chiapas, Instituto Chiapaneco de Cultura.
 1997 *Kaminaljuyu/San Jorge: Evidencia arqueológica de la actividad económica en el Valle de Guatemala, 300 a.C. a 300 d.C.* Guatemala: Universidad del Valle de Guatemala.
 2000 Kaminaljuyu Miraflores II: La naturaleza del cambio político al final del Preclásico. In *XIII simposio de investigaciones arqueológicas en Guatemala, 1999*. J. P. Laporte et al., eds. Pp. 11–28. Guatemala: Museo Nacional de Arqueología y Etnología.
- Haury, Emil
 1976 *The Hohokam, Desert Farmers, and Craftsmen: Excavations at Snaketown*. Tucson: University of Arizona Press.
- Haviland, William A.
 1981 Dower Houses and Minor Centers at Tikal, Guatemala: An Investigation into the Identification of Valid Units of Settlement Hierarchies. In *Lowland Maya Settlement Patterns*. W. Ashmore, ed. Pp. 89–120. Albuquerque: University of New Mexico Press.
 1988 Musical Hammocks at Tikal: Problems with Reconstructing Household Composition. In *Household and Community in the Mesoamerican Past*. R. R. Wilk and W. Ashmore, eds. Pp. 121–34. Albuquerque: University of New Mexico Press.
- Hayden, Brian
 1995 Pathways to Power: Principles for Creating Socioeconomic Inequalities. In *Foundations of Social Inequality*. T. Douglas Price and Gary M. Feinman, eds. Pp. 15–86. New York: Plenum Press.
- Healy, Paul F., John D. H. Lambert, J. T. Arnason, and Richard J. Hebda
 1983 Caracol, Belize: Evidence of Ancient Maya Agricultural Terraces. *Journal of Field Archaeology* 10:397–410.
- Heine-Geldern, Robert
 1956 *Conceptions of State and Kingship in Southeast Asia*. Southeast Asia Program Data Paper 18. Ithaca, NY: Cornell University.

- Helms, Mary W.
 1993 *Craft and the Kingly Ideal: Art, Trade, and Power*. Austin: University of Texas Press.
 1998 *Access to Origins: Affines, Ancestors, and Aristocrats*. Austin: University of Texas Press.
- Hernández-Portilla, Alejandro
 2000 Investigaciones del contexto arqueológico del acueducto, el Monumento 73, de San Lorenzo, Veracruz. Licenciatura thesis, Facultad de Antropología, Universidad Veracruzana-Xalapa.
- Herrera, Sergio R., Ann Cyphers, Hector Neff, and Michael D. Glascock
 1998 Chemical Analysis of Early Formative Pottery from San Lorenzo Tenochtitlan, Veracruz, Mexico. Paper presented at the annual meeting of the Society for American Archaeology, Washington, D.C.
 1999 Chemical Compositional Analysis of Early Formative Pottery from San Lorenzo, Tlapacoya and Oaxaca. Paper presented at the annual meeting of the Society for American Archaeology, Chicago.
- Hewett, Edgar L.
 1904 Archaeology of Pajarito Park, New Mexico. *American Anthropologist* 6: 629–59.
 1953 *Pajarito Plateau and Its Ancient People*. Revised by Bertha P. Dutton. Albuquerque: School of American Research, University of New Mexico Press.
- Heyden, Doris
 1975 An Interpretation of the Cave underneath the Pyramid of the Sun in Teotihuacan, Mexico. *American Antiquity* 40:131–47.
 1981 Caves, Gods, and Myths: World-View and Planning in Teotihuacan. In *Mesoamerican Sites and World Views*. Elizabeth P. Benson, ed. Pp. 1–39. Washington, D.C.: Dumbarton Oaks.
 1989 *The Eagle, the Cactus, and the Rock: The Roots of Mexico-Tenochtitlan's Foundation Myth and Symbol*. International Series 484. Oxford: British Archaeological Reports.
 2000 From Teotihuacan to Tenochtitlan: City Planning, Caves, and Streams of Red and Blue Waters. In *Mesoamerica's Classic Heritage: From Teotihuacan to the Aztecs*. David Carrasco, Lindsay Jones, and Scott Sessions, eds. Pp. 165–84. Boulder: University of Colorado Press.
- Hieb, Louis A.
 1994 The Meaning of Katsina: Toward a Cultural Definition of "Person" in Hopi Religion. In *Kachinas in the Pueblo World*. Polly Schaafsma, ed. Pp. 23–33. Albuquerque: University of New Mexico Press.
- Hildebrand, A. R., M. Pilkington, M. Connors, C. Ortiz-Aleman, and R. E. Chavez
 1995 Size and Structure of the Chicxulub Crater Revealed by Horizontal Gradients and Cenotes. *Nature* 376:415–17.
- Hill, W. W.
 1982 *An Ethnography of Santa Clara Pueblo*. Albuquerque: University of New Mexico Press.
- Hirth, Kenneth G.
 1984 Trade and Exchange in Late Formative Morelos. In *Trade and Exchange in Early Mesoamerica*. Kenneth G. Hirth, ed. Pp. 125–46. Albuquerque: University of New Mexico Press.

- 1996 Political Economy and Archaeology: Perspectives on Exchange and Production. *Journal of Anthropological Research* 4:203–39.
- Hodell, David A., Mark Brenner, Jason H. Curtis, and Thomas Guilderson
2001 Solar Forcing of Drought Frequency in the Maya Lowlands. *Science* 292: 1367–70.
- Hodell, David A., Jason H. Curtis, and Mark Brenner
1995 Possible Role of Climate in the Collapse of Classic Maya Civilization. *Nature* 375:391–94.
- Houk, Brett A.
1996 The Archaeology of Site Planning: An Example from the Maya Site of Dos Hombres, Belize. Ph.D. dissertation, University of Texas at Austin.
- Houston, Stephen D.
1998 On the River of Ruins: Explorations at Piedras Negras, Guatemala, 1997. *Mexicon* 20:16–22.
- Howard, J. B.
1993 A Paleohydraulic Approach to Examining Agricultural Intensification in Hohokam Irrigation Systems. In *Economic Aspects of Water Management in the Prehispanic New World*. Vernon L. Scarborough and Barry L. Isaac, eds. Pp. 263–314. Research in Economic Anthropology, Supplement 7. Greenwich, CT: JAI Press.
- Hunt, Robert C.
1988 Size and Structure of Authority in Canal Irrigation Systems. *Journal of Anthropological Research* 44:335–55.
- Hunt, Robert C., and Eva Hunt
1976 Canal Irrigation and Local Social Organization. *Current Anthropology* 17: 389–411.
- INEGI (Instituto Nacional de Estadística, Geografía, e Informática)
1983a *Carta de efectos climáticos regionales noviembre-abril, Mérida, F16-10, escala 1:250,000*. Mexico City.
1983b *Carta de efectos climáticos regionales mayo-octubre, Mérida, F16-10, escala 1:250,000*. Mexico City.
1985a *Carta hidrológica de aguas subterráneas, Mérida, F16-10, escala 1:250,000*. Mexico City.
1985b *Carta hidrológica de aguas superficiales, Mérida, F16-10, escala 1:250,000*. Mexico City.
1985c *Carta topográfica Tecoh, escala 1:50,000, F16C62*. Mexico City.
- Inomata, Takeshi, and Stephen D. Houston, eds.
2001 *Royal Courts of the Ancient Maya*. Vols. 1 and 2. Boulder, CO: Westview Press.
- Jackson, John Brinckerhoff
1984 A Pair of Ideal Landscapes. In *Discovering the Vernacular Landscape*. Pp. 9–56. New Haven, CT: Yale University Press.
- Jackson, Sarah, and David Stuart
2001 The Aj K'uhun Title: Deciphering a Classic Maya Term of Rank. *Ancient Mesoamerica* 12:217–28.
- Jacob, J. S.
1995 Archaeological Pedology in the Maya Lowlands. In *Pedological Perspectives*

- in Archaeological Research*. D. M. Kral, ed. Pp. 51–80. Soil Science Society of America Special Publication 44. Madison, WI.
- Jeancon, J. A.
1923 *Excavations in the Chama Valley, New Mexico*. Bureau of American Ethnology Bulletin 81. Washington, D.C.: Smithsonian Institution.
- Jiménez, Oscar
1990 Geomorfología de la región de La Venta, Tabasco: Un sistema fluvio-lagunar costero del cuaternario. *Arqueología* 3:5–16. Mexico City: Instituto Nacional de Antropología e Historia.
- Johnson, Jodi
1993 Report on the Sculpture Facade of Structure 10L-41. Manuscript on file at the Centro Regional de Investigaciones Arqueológicas, Copan, Honduras.
- Jones, Morris
1952 *Map of the Ruins of Mayapan, Yucatan, Mexico*. Current Reports 1. Cambridge: Carnegie Institution of Washington.
- Joralemon, Peter D.
1971 *A Study of Olmec Iconography*. Studies in Pre-Columbian Art and Archaeology 7. Washington, D.C.: Dumbarton Oaks.
- Joyce, Rosemary A.
1999 Social Dimensions of Preclassic Burials. In *Social Patterns in Preclassic Mexico*. David C. Grove and Rosemary A. Joyce, eds. Pp. 15–47. Washington, D.C.: Dumbarton Oaks.
- Kaplan, Jonathan
2000 Monument 65. A Great Emblematic Depiction of Throned Rule and Royal Sacrifice at Late Preclassic Kaminaljuyu. *Ancient Mesoamerica* 11:185–98.
- Karttunen, Frances
1992 *An Analytical Dictionary of Nahuatl*. Norman: University of Oklahoma Press.
- Kepecs, Susan, and Sylviane Boucher
1996 The Pre-Hispanic Cultivation of *Rejolladas* and Stone-Lands: New Evidence from Northeast Yucatán. In *The Managed Mosaic: Ancient Maya Agriculture and Resources Use*. Scott L. Fedick, ed. Pp. 69–91. Salt Lake City: University of Utah Press.
- Killion, Thomas W.
1990 Cultivation Intensity and Residential Site Structure: An Ethnoarchaeological Examination of Peasant Agriculture in the Sierra de los Tuxtlas, Veracruz, Mexico. *Latin American Antiquity* 1:191–215.
- Kinkella, Andrew
2000 Settlement at the Sacred Pools: Preliminary Archaeological Investigations at the Late Classic Maya Site of Cara Blanca, Belize. M.A. thesis, California State University, Northridge.
- Kirch, Patrick Vinton
1994 *The Wet and the Dry: Irrigation and Agricultural Intensification in Polynesia*. Chicago: University of Chicago Press.
- Kirchhoff, Paul
1955 The Principles of Clanship in Human Society. *Davidson Journal of Anthropology* 1(1):1–10.

- Knapp, A. Bernard, and Wendy Ashmore
 1999 Archaeological Landscapes: Constructed, Conceptualized, Ideational. In *Archaeologies of Landscape: Contemporary Perspectives*. W. Ashmore and A. B. Knapp, eds. Pp. 1–32. Oxford: Blackwell.
- Kolata, Alan
 1993 *The Tiwanaku: Portrait of an Andean Civilization*. Oxford: Blackwell.
- Kolb, Michael J., and James E. Snead
 1997 It's a Small World after All: Comparative Analyses of Community Organization in Archaeology. *American Antiquity* 62:609–28.
- Kroeber, Alfred L.
 1939 *Cultural and Natural Areas of Native North America*. Berkeley: University of California Press.
- Krotser, Ramón
 1973 El agua ceremonial de los Olmecas. *Boletín* 2:43–48. Mexico City: Instituto Nacional de Antropología e Historia.
- Kulke, Hermann
 1986 The Early and the Imperial Kingdom in Southeast Asian History. In *Southeast Asia in the 9th to 14th Centuries*. D. G. Marr and A. C. Milner, eds. Pp. 1–22. Singapore: Institute of Southeast Asian Studies and the Research School of Pacific Studies.
- Kunen, Julie L.
 1996 The Ritual Technology of Water Management. Paper presented at the 95th annual meeting of the American Anthropological Association, San Francisco.
 2001 Study of an Ancient Maya Bajo Landscape in Northwestern Belize. Ph.D. dissertation, University of Arizona, Tucson.
 2004 *Ancient Maya Life in the Far West Bajo: Social and Environmental Change in the Wetlands of Belize*. Anthropological Papers 69. Tucson: University of Arizona Press.
- Kunen, Julie L., T. P. Culbert, V. Fialko, B. R. McKee, and L. Grazioso
 2000 *Bajo Communities: A Case Study from the Central Peten*. *Culture and Agriculture* 22(3):15–31.
- Kunen, Julie L., and Paul J. Hughbanks
 2003 Bajo Communities as Resource Specialists: A Heterarchical Approach to Maya Socioeconomic Organization. In *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan*. V. Scarborough, F. Valdez Jr., and N. Dunning, eds. Pp. 92–108. Tucson: University of Arizona Press.
- La Barre, Weston
 1962 *They Shall Take up Serpents*. New York: Schocken.
- Landa, Diego de
 1986 *Relación de las cosas de Yucatán*. Decimotercera edición. Mexico City: Editorial Porrúa.
- Lansing, J. Stephen
 1991 *Priests and Programmers: Technologies of Power in the Engineered Landscape of Bali*. Princeton, NJ: Princeton University Press.
 n.d. Perfect Order: Recognizing Complexity in Bali. Princeton, NJ: Princeton University Press. In press.

- Lathrap, Donald
1970 *The Upper Amazon*. New York: Praeger Publishers.
- Lehman, Marcus
2001 Not Your Average Lawn and Garden: Sacred Geography and Landscape in the Copan Valley, Honduras. Undergraduate thesis, Harvard University, Cambridge, MA.
- Lekson, Stephen
1999 *Chaco Meridian: Centers of Political Power in the Ancient Southwest*. Walnut Creek, CA: Altamira Press.
- Leventhal, Richard M.
1979 Settlement Patterns at Copan, Honduras. Ph.D. dissertation, Harvard University, Cambridge, MA.
1981 Settlement Patterns in the Southeast Maya Area. In *Lowland Maya Settlement Patterns*. W. Ashmore, ed. Pp. 187–209. Albuquerque: University of New Mexico Press.
- Leyden, B.
1984 Guatemalan Forest Synthesis after Pleistocene Aridity. *Proceedings of the National Academy of Sciences USA* 81:4856–59.
- Lightfoot, Dale R., and Frank W. Eddy
1995 The Construction and Configuration of Anasazi Pebble-Mulch Gardens in the Northern Rio Grande. *American Antiquity* 60:459–70.
- Lipe, William D.
1995 The Depopulation of the Northern San Juan: Conditions in the Turbulent 1200s. *Journal of Anthropological Archaeology* 14:143–69.
2002 Social Power in the Central Mesa Verde Region, A.D. 1150–1290. In *Seeking the Center Place: Archaeology and Ancient Communities in the Mesa Verde Region*. Mark D. Varien and Richard H. Wilshusen, eds. Pp. 203–32. Salt Lake City: University of Utah Press.
- Logan, Michael H., and William T. Sanders
1976 The Model. In *The Valley of Mexico: Studies in Pre-Hispanic Ecology and Society*. Eric R. Wolf, ed. Pp. 31–58. Albuquerque: University of New Mexico Press.
- Lomatuway'ma, Michael, Lorena Lomatuway'ma, and Sidney Namingha Jr.
1993 *Hopi Ruin Legends*. Ekehart Malotki, ed. Flagstaff: Northern Arizona University Press.
- Lopez Austin, Alfredo
1997 *Tamoanchan, Tlalocan: Places of Mist*. Bernard R. Ortiz de Montellano and Thelma Ortiz de Montellano, trans. Niwot: University of Colorado Press.
- Lorenzo, José Luis
1986 Mamutes excavados en la Cuenca de México (1952–1980). Departamento de Prehistoria, Cuadernos de trabajo 32. Instituto Nacional de Antropología e Historia, Mexico City.
- Lucero, Lisa J.
1999a Classic Lowland Maya Political Organization: A Review. *Journal of World Prehistory* 13:221–63.
1999b Water Control and Maya Politics in the Southern Maya Lowlands. In *Complex Politics in the Ancient Tropical World*. Elisabeth A. Bacus and Lisa J. Lucero, eds. Pp. 34–49. Archeological Papers of the American Anthro-

- logical Association 9. Arlington, VA: American Anthropological Association.
- 2002 The Collapse of the Classic Maya: A Case for the Role of Water Control. *American Anthropologist* 104:814–24.
- 2003 The Politics of Ritual: The Emergence of Classic Maya Rulers. *Current Anthropology* 44:523–58.
- 2006 *Water and Ritual: The Rise and Fall of Classic Maya Rulers*. Austin: University of Texas Press.
- Lucero, Lisa J., Scott L. Fedick, Andrew Kinkella, and Sean M. Graebner
- 2004 Ancient Maya Settlement in the Valley of Peace Area, Belize. In *Archaeology of the Upper Belize River Valley: Half a Century of Maya Research*. James F. Garber, ed. Pp. 86–102. Gainesville: University Press of Florida.
- Lunagómez, Roberto
- 1999 Patrón de asentamiento en la región de Medias Aguas. In *Informe del proyecto arqueológico San Lorenzo Tenochtitlan: Temporada 1999*. Field report. Consejo de Arqueología, Instituto Nacional de Antropología e Historia, Mexico City.
- Lundell, C. L.
- 1937 *The Vegetation of the Petén*. Publication 478. Cambridge: Carnegie Institution of Washington.
- Luzzadder-Beach, S.
- 2000 Water Resources of the Chunchucmil Maya. *Geographical Review* 90:493–510.
- Mabry, J. B.
- 1996 *Archaeological Investigations of Early Village Sites in the Middle Santa Cruz Valley, Part II: Analysis and Synthesis*. Anthropological Papers 19. Tucson: Center for Desert Archaeology.
- Manzanilla, Linda
- 2000 The Construction of the Underworld in Central Mexico. In *Mesoamerica's Classic Heritage: From Teotihuacan to the Aztecs*. David Carrasco, Lindsay Jones, and Scott Sessions, eds. Pp. 87–116. Boulder: University of Colorado Press.
- Marcus, Joyce
- 1976 *Emblem and State in the Classic Maya Lowlands: An Epigraphic Approach to Territorial Organization*. Washington, D.C.: Dumbarton Oaks.
- 1987 *The Inscriptions of Calakmul: Royal Marriage at a Maya City in Campeche, Mexico*. Technical Report of the Museum of Anthropology 21. Ann Arbor: University of Michigan.
- 1989 Zapotec Chiefdoms and the Nature of Formative Religions. In *Regional Perspectives on the Olmec*. R. J. Sharer and D. C. Grove, eds. Pp. 148–97. New York: Cambridge University Press.
- Mariaca Méndez, Ramón
- 1996 El ciclo marceño en Tierras Bajas Pantanosas de Tabasco: Producción tradicional de maíz altamente eficiente. *Agrociencia* 30:279–86.
- Martin, Simon, and Nicolai Grube
- 2000 *Chronicle of the Maya Kings and Queens: Deciphering the Dynasties of the Ancient Maya*. London: Thames and Hudson.

- Martínez Donjuán, Guadalupe
 1986 Teopantecuanitlán. In *Arqueología y etnohistoria del estado de Guerrero*. Pp. 55–80. Mexico City: Instituto Nacional de Antropología e Historia and El Gobierno del Estado de Guerrero.
 1994 Los Olmecas en el estado de Guerrero. In *Los Olmecas en Mesoamérica*. J. Clark, ed. Pp. 143–63. Mexico City: Citibank and El Equilibrista.
- Matheny, Ray T.
 1978 Northern Maya Lowland Water-Control Systems. In *Pre-Hispanic Maya Agriculture*. Peter D. Harrison and B. L. Turner II, eds. Pp. 185–210. Albuquerque: University of New Mexico Press.
- Maxwell, Timothy D., and Kurt F. Anshuetz
 1992 The Southwestern Ethnographic Record and Prehistoric Agricultural Diversity. In *Gardens of Prehistory: The Archaeology of Settlement Agriculture in Greater Mesoamerica*. Thomas W. Killion, ed. Pp. 35–68. Tuscaloosa: University of Alabama Press.
- McAnany, Patricia A.
 1995 *Living with the Ancestors: Kinship and Kingship in Ancient Maya Society*. Austin: University of Texas Press.
 1998 Ancestors and the Classic Maya Built Environment. In *Function and Meaning in Classic Maya Architecture*. S. D. Houston, ed. Pp. 271–98. Washington, D.C.: Dumbarton Oaks.
- McGahee, Gaea D.
 2002 Parallel Lives: Re-Interpreting the Life Histories of People and Parrots at Casas Grandes, Chihuahua. M.A. thesis, New Mexico State University, Las Cruces.
- Medellín Zenil, Alfonso
 1960 La estela 1 de Piedra Labrada. *La Palabra y el Hombre* 4(16):27–36.
 1971 Monolitos olmecas y otros en el Museo de la Universidad de Veracruz. *Corpus Antiquitatum Americanensium*, México. Vol. 5. Mexico City: Instituto Nacional de Antropología e Historia.
- Merry de Morales, Marcia
 1987 Chalcatzingo Burials as Indicators of Social Ranking. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 95–113. Austin: University of Texas Press.
- Michels, Joseph W.
 1979a *The Kaminaljuyu Chiefdom*. University Park: Pennsylvania State University Press.
- Michels, Joseph W., ed.
 1979b *Settlement Pattern Excavations at Kaminaljuyu, Guatemala*. University Park: Pennsylvania State University Press.
- Miller, Mary Ellen
 1986 Copan, Honduras: Conference with a Perished City. In *City-States of the Maya: Art and Architecture*. Elizabeth P. Benson, ed. Pp. 72–108. Denver: Rocky Mountain Institute for Pre-Columbian Studies.
 1988 The Meaning and Function of the Main Acropolis, Copan. In *The Southeast Classic Maya Zone*. E. H. Boone and G. R. Willey, eds. Pp. 149–94. Washington, D.C.: Dumbarton Oaks.
 1998 A Fresh Look at the Cenote of Chichen Itza. Paper presented at the 14th

- Texas Symposium, the Maya Meetings at Texas, University of Texas at Austin.
- Miller, Mary Ellen, and Karl Taube
 1993 *The Gods and Symbols of Ancient Mexico and the Maya: An Illustrated Dictionary of Mesoamerican Religion*. London: Thames and Hudson.
- Millon, Clara
 1973 Painting, Writing, and Polity in Teotihuacan, Mexico. *American Antiquity* 38:294–314.
 1988 A Reexamination of the Teotihuacan Tassel Headdress Insignia. In *Feathered Serpents and Flowering Trees: Reconstructing the Murals of Teotihuacan*. Kathleen Berrin, ed. Pp. 114–34. San Francisco: Fine Arts Museums of San Francisco.
- Millon, René
 1992 Teotihuacan Studies from 1950 to 1990 and Beyond. In *Art, Ideology, and the City of Teotihuacan*. Janet Katherine Berlo, ed. Pp. 339–430. Washington, D.C.: Dumbarton Oaks.
- Mindeleff, Victor
 1989 [1891] *A Study of Pueblo Architecture in Tusayan and Cibola*. Washington, D.C.: Smithsonian Institution Press.
- Miram, Helga-Maria
 1988 *Transkriptionen/Transcriptions/Transcripciones der/of the/de los Chilam Balam*. Maya Texte 1. Hamburg: Toro-Verlag.
- Molina, Alonso de
 1977 Vocabulario en lengua castellana y mexicana y mexicana y castellana (1585). Colección Sepan cuántos 44. Mexico City: Editorial Porrúa, SA.
 1977 Vocabulario en lengua castellana y mexicana y mexicana y castellana (1585). Colección Sepan cuántos 44. Mexico City: Editorial Porrúa, SA. Reprint.
- Mooser, Federico
 1975 Historia geológica de la cuenca de México. In *Memoria de la obra del sistema de drenaje profundo del D.F.* 1:9–38. Mexico City.
- Morgan, Jo, Mike Warner, and the Chicxulub Working Group
 1997 Size and Morphology of the Chicxulub Impact Crater. *Nature* 390:472–76.
- Mundkur, Balaji
 1983 *The Cult of the Serpent*. Albany: State University of New York Press.
- Navarrete, Carlos, and Luis Lujan
 1986 *El Gran Montículo de la culebra en el valle de Guatemala*. Mexico City: Universidad Nacional Autónoma de México and Academia de Geografía e Historia de Guatemala.
- Neely, J.
 2001 A Contextual Study of the “Fossilized” Prehispanic Canal Systems of the Tehuacan Valley, Puebla, Mexico. *Antiquity* 75:505–6.
- Neiman, Fraser D.
 1997 Conspicuous Consumption as Wasteful Advertising: A Darwinian Perspective on Spatial Patterns in Classic Maya Terminal Monument Dates. In *Rediscovering Darwin: Evolutionary Theory and Archeological Explanation*. C. Michael Barton and Geoffrey A. Clark, eds. Pp. 267–90. Archeologi-

- cal Papers of the American Anthropological Association 7. Arlington, VA: American Anthropological Association.
- Nell, Edward J.
 1979 Population Pressure and Methods of Cultivation: A Critique of Classless Theory. In *Toward a Marxist Anthropology: Problems and Perspectives*. Stanley Diamond, ed. Pp. 468–97. The Hague: Mouton.
- Nelson, Nels C.
 1914 *Pueblo Ruins of the Galisteo Basin, New Mexico*. Anthropological Papers of the American Museum of Natural History 15(1). New York: American Museum of Natural History.
- Netting, Robert McC.
 1990 Population, Permanent Agriculture, and Politics: Unpacking the Evolutionary Portmanteau. In *The Evolution of Political Systems: Sociopolitics in Small-Scale Sedentary Societies*. Steadman Upham, ed. Pp. 21–61. Cambridge: Cambridge University Press.
- Nichols, Deborah L.
 1982 A Middle Formative Irrigation System near Santa Clara Coatitlan in the Basin of Mexico. *American Antiquity* 47:133–44.
 1987 Risk and Agricultural Intensification during the Formative Period in the Northern Basin of Mexico. *American Anthropologist* 89:596–616.
 1988 Infrared Aerial Photography and Prehispanic Irrigation at Teotihuacan: The Tlajinga Canals. *Journal of Field Archaeology* 15:17–27.
 1989 Reply to Feinman and Nicholas: There Is No Frost in the Basin of Mexico. *American Anthropologist* 91:1023–26.
- Nichols, Deborah L., and Charles D. Frederick
 1993 Irrigation Canals and Chinampas: Recent Research in the Northern Basin of Mexico. In *Economic Aspects of Water Management in the Prehispanic New World*. Vernon L. Scarborough and Barry L. Isaac, eds. Pp. 123–50. Research in Economic Anthropology, Supplement 7. Greenwich, CT: JAI Press.
- Nichols, Deborah L., Michael W. Spence, and Mark D. Borland
 1991 Watering the Fields of Teotihuacan: Early Irrigation at the Ancient City. *Ancient Mesoamerica* 2:119–29.
- Niederberger, Christine
 1996 Olmec Horizon Guerrero. In *Olmec Art of Ancient Mexico*. E. Benson and B. de la Fuente, eds. Pp. 95–103. Washington, D.C.: National Gallery of Art.
 2000 Ranked Societies, Iconography, Complexity, and Economic Wealth in the Basin of Mexico toward 1200 B.C. In *Olmec Art and Archaeology in Mesoamerica*. John E. Clark and Mary E. Pye, eds. Pp. 169–92. New Haven, CT: National Gallery of Art and Yale University Press.
- Nomland, Gladys A.
 1932 Proboscis Statue from the Isthmus of Tehuantepec. *American Anthropologist* 34:591–93.
- Núñez Chinchilla, Jesus
 1972 Reconocimiento y exploración de una “Cueva Votiva” en la zona arqueológica de las ruinas de Copan. *Anales de la Academia de Geografía e Historia de Guatemala* 43:102–5. Guatemala: La Sociedad.

- Ohi, Kuniaki, and Nobuyuki Ito
 1993 Relación entre las estructuras y los objetos encontrados en Mongoy, Kaminaljuyu. In *Kaminaljuyu*. Kuniaki Ohi, ed. Vol. 1, pp. 177–82. Tokyo: Museo del Tabaco y Sal.
- Ortega, Edgar, and Nobuyuki Ito
 2000 Notas de campo en La Culebra, Kaminaljuyu. In *La Culebra, Kaminaljuyu*. Pp. 31–46. Tokyo: Museo del Tabaco y Sal.
- Ortiz, Alfonso
 1969 *The Tewa World: Space, Time, Being, and Becoming in a Pueblo Society*. Chicago: University of Chicago Press.
- Ortiz Pérez, Mario Arturo, and Ann Cyphers
 1997 La geomorfología y las evidencias arqueológicas en la región de San Lorenzo Tenochtitlan, Veracruz. In *Población, subsistencia y medio ambiente en San Lorenzo Tenochtitlan*. Ann Cyphers, ed. Pp. 31–54. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.
- Ortloff, C. R.
 1993 Chimu Hydraulic Technology and Statecraft on the North Coast of Peru, A.D. 1000–1470. In *Economic Aspects of Water Management in the Prehispanic New World*. Vernon L. Scarborough and Barry L. Isaac, eds. Pp. 327–68. Research in Economic Anthropology, Supplement 7. Greenwich, CT: JAI Press.
 1997 Hydraulic Analysis of the Kaminaljuyu Main Canal. In *Kaminaljuyu/San Jorge: Evidencia arqueológica de la actividad económica en el Valle de Guatemala, 300 a.C. a 300 d.C.* M. Hatch, ed. Pp. 22–27. Guatemala: Universidad del Valle de Guatemala.
- Palerm, Angel
 1955 The Agricultural Basis of Urban Civilization. In *Irrigation Civilizations: A Comparative Study*. J. H. Steward, ed. Pp. 28–42. Washington, D.C.: Pan American Union.
 1961 Distribución del regadío prehispánico en Teotihuacán y en el Pedregal. *Revista Interamericana de Ciencias Sociales* 1:242–67.
 1973 *Obras hidráulicas prehispánicas en el sistema lacustre del Valle de México*. Mexico City: SEP-INAH.
- Parsons, Elsie Clews
 1925 *The Pueblo of Jemez*. New Haven, CT: Yale University Press.
 1929 *The Social Organization of the Tewa of New Mexico*. Memoirs of the American Anthropological Association 36. Menasha, WI: American Anthropological Association.
 1936 *Mitla Town of the Souls*. Chicago: University of Chicago Press.
 1974 [1933] Some Aztec and Pueblo Parallels. In *The Mesoamerican Southwest*. B. C. Hedrick, J. C. Kelley, and C. L. Riley, eds. Pp. 131–46. Carbondale: Southern Illinois University Press.
 1994 [1926] *Tewa Tales*. Tucson: University of Arizona Press.
 1996 [1939] *Pueblo Indian Religion*. Lincoln: University of Nebraska Press.
- Parsons, Jeffrey R.
 1991 Political Implications of Prehispanic Chinampa Agriculture in the Valley

- of Mexico. In *Land and Politics in the Valley of Mexico: A Two-Thousand-Year Perspective*. Herb Harvey, ed. Pp. 17–42. Albuquerque: University of New Mexico Press.
- Parsons, Lee Allen
 1986 *The Origins of Maya Art: Monumental Stone Sculpture of Kaminaljuyu, Guatemala, and the Southern Pacific Coast*. Studies in Pre-Columbian Art and Archaeology 28. Washington, D.C.: Dumbarton Oaks.
- Pastrana, Alejandro, and Patricia Fournier
 1997 Cuiculco desde Cuiculco. *Actualidades Arqueología* 3(13):7–9.
- Paszatory, Esther
 1997 *Teotihuacan: An Experiment in Living*. Norman: University of Oklahoma Press.
- Pendergast, David M.
 1971 *Excavations at Eduardo Quiroz Cave, British Honduras (Belize)* Royal Ontario Museum. Art and Archaeology, Occasional Paper 219. Toronto: Royal Ontario Museum.
 1981 Lamanai, Belize: Summary of Excavation Results, 1974–1980. *Journal of Field Archaeology* 8:29–53.
- Perry, Eugene, Luis Marin, Jana McClain, and Guadalupe Velázquez
 1995 Ring of Cenotes (Sinkholes), Northwest Yucatan, Mexico. *Geology* 23:17–20.
- Plog, Stephen
 1995 Equality and Hierarchy: Holistic Approaches to Understanding Social Dynamics in the Pueblo Southwest. In *Foundations of Social Inequality*. T. Douglas Price and Gary M. Feinman, eds. Pp. 189–206. New York: Plenum Press.
- Pollock, H. E. D., and Clayton Ray
 1957 *Notes on Vertebrate Animal Remains from Mayapan*. Current Reports 41. Cambridge: Carnegie Institution of Washington.
- Pollock, H. E. D., Ralph L. Roys, Tatiana Proskouriakoff, and A. L. Smith
 1962 *Mayapan, Yucatan, Mexico*. Publication 619. Cambridge: Carnegie Institution of Washington.
- Pope, K. O., and B. H. Dahlin
 1989 Ancient Maya Wetland Agriculture: New Insights from Ecological and Remote Sensing Research. *Journal of Field Archaeology* 16:87–106.
 1993 Radar Detection and Ecology of Ancient Maya Canal Systems—Reply to Adams et al. *Journal of Field Archaeology* 20:379–83.
- Pope, Kevin O., Adriana C. Ocampo, and Charles E. Duller
 1993 Surficial Geology of the Chicxulub Impact Crater, Yucatan, Mexico. *Earth, Moon, and Planets* 63:93–104.
- Pope, Kevin O., Adriana C. Ocampo, Gary Kinsland, and Randy Smith
 1996 The Surface Expression of the Chicxulub Crater. *Geology* 24:527–30.
- Pope, Kevin O., Mary D. Pohl, and J. S. Jacob
 1996 Formation of Ancient Maya Wetland Fields: Natural and Anthropogenic Processes. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*. S. L. Fedick, ed. Pp. 165–76. Salt Lake City: University of Utah Press.

- Pope, Kevin O., Mary E. D. Pohl, John G. Jones, David L. Lentz, Christopher von Nagy, Francisco J. Vega, and Irvy R. Quitmyer
 2001 Origins and Environmental Setting of Ancient Agriculture in the Lowlands of Mesoamerica. *Science* 292:1370–73.
- Posschl, Gregory L.
 2000 The Drying up of the Sarasvati: Environmental Disruption in South Asian Prehistory. In *Environmental Disaster and the Archaeology of Human Response*. G. Bawden and R. Reyecraft, eds. Pp. 63–74. Albuquerque: Maxwell Museum of Anthropology and the University of New Mexico Press.
- Powell, John W.
 1895–96 Introduction. In *17th Annual Report of the Bureau of American Ethnology, 1895–96*. P. lxxii.
- Powers, Robert P., Tineke Van Zandt, James M. Vint, and Genvieve N. Head
 1999 Site Typology. In *The Bandelier Archaeological Survey*. Robert P. Powers and Janet D. Orcutt, eds. Pp. 117–218. Intermountain Cultural Resources Management, Professional Paper 57. Santa Fe: Intermountain Region, National Park Service.
- Price, Barbara J.
 1971 Prehispanic Irrigation Agriculture in Nuclear America. *Latin American Research Review* 6:3–60.
 1983 Prehispanic Irrigation Agriculture in Nuclear America. In *Explorations in Anthropology: Readings in Culture, Man, and Nature*. Morton H. Fried, ed. Pp. 211–46. New York: Crowell.
- Prindiville, Mary, and David C. Grove
 1987 The Settlement and Its Architecture. In *Ancient Chalcatzingo*. D. C. Grove, ed. Pp. 63–81. Austin: University of Texas Press.
- Pugh, Timothy W.
 2001 Flood Reptiles, Serpent Temples, and the Quadripartite Universe: The *Imago Mundi* of Late Postclassic Mayapan. *Ancient Mesoamerica* 12:247–58.
- Puleston, Dennis E.
 1976 The People of the Cayman/Crocodile: Riparian Agriculture and the Origins of Aquatic Motifs in Ancient Maya Iconography. In *Maya Symposium of North America: An Interdisciplinary Conference on the Art and Civilization of the Ancient Maya: Aspects of Ancient Maya Civilization*. St. Paul, MN: Hamline University.
 1977 Art and Archaeology of Hydraulic Agriculture in the Maya Lowlands. In *Social Process in Maya Prehistory: Studies in the Memory of Sir Eric Thompson*. Norman Hammond, ed. Pp. 449–67. London: Academic Press.
- Raab, L. Mark
 1975 A Prehistoric Water Reservoir from Santa Rosa Wash, Southern Arizona. *Kiva* 40(4):295–307.
- Ramírez, José Fernando
 1976 *Memoria acerca de las obras e inundaciones en la Ciudad de México*. Mexico City: SEP-INAH.
- Rands, Robert L.
 1953 The Water Lily in Maya Art: A Complex of Alleged Asiatic Origins. *Bureau of American Ethnology Bulletin* 151:75–153. Washington, D.C.: Smithsonian Institution.

- 1955 Some Manifestations of Water in Mesoamerican Art. *Bureau of American Ethnology Bulletin* 157:265–393. Washington, D.C.: Smithsonian Institution.
- Reilly, F. Kent, III
 1989 The Shaman in Transformation Pose: A Study of the Theme of Rulership in Olmec Art. *Record of the Art Museum* 48(2):4–21. Princeton, NJ: Princeton University.
- 1994a Cosmología, soberanismo y espacio ritual en la Mesoamérica del Formativo. In *Los Olmecas en Mesoamérica*. J. Clark, ed. Pp. 239–59. Mexico City: Citibank and El Equilibrista.
- 1994b Enclosed Ritual Spaces and the Watery Underworld in Formative Period Architecture: New Observations on the Function of La Venta Complex A. In *Seventh Palenque Round Table*. M. G. Robertson and V. M. Fields, eds. Pp. 125–35. San Francisco: Pre-Columbian Art Research Institute.
- 1999 Mountains of Creation and Underworld Portals: The Ritual Function of Olmec Architecture at La Venta, Tabasco. In *Mesoamerican Architecture as a Cultural Symbol*. J. K. Kowalski, ed. Pp. 14–39. New York: Oxford University Press.
- Rejmankova, E., K. O. Pope, M. D. Pohl, and J. M. Rey-Benayas
 1995 Freshwater Wetland Plant Competition in Northern Belize: Implications for Paleoecological Studies of Maya Wetland Agriculture. *Biotropica* 27:28–36.
- Rice, Don S.
 1996 Hydraulic Engineering in Central Peten, Guatemala: Ports and Inter-Lacustrine Canals. In *Arqueología Mesoamericana: Homenaje a William T. Sanders*. Pp. 109–22. Mexico City: Instituto Nacional de Antropología e Historia, Arqueología Mexicana.
- Rice, Don S., and T. Patrick Culbert
 1990 Historical Contexts for Population Reconstruction in the Maya Lowlands. In *Precolumbian Population History in the Maya Lowlands*. T. Patrick Culbert and Don S. Rice, eds. Pp. 1–36. Albuquerque: University of New Mexico Press.
- Ricketson, O. G., Jr.
 1937 *Uaxactun, Guatemala, Group E—1926–1931. Part 1: The Excavations*. Publication 477. Cambridge: Carnegie Institution of Washington.
- Robichaux, Hubert R.
 1995 Ancient Maya Community Patterns in Northwestern Belize: Peripheral Zone Survey at La Milpa and Dos Hombres. Ph.D. dissertation, University of Texas at Austin.
- Roediger, Virginia M.
 1991 *Ceremonial Costumes of the Pueblo Indians*. Berkeley: University of California Press.
- Rohn, Arthur H.
 1977 *Cultural Change and Continuity on Chapin Mesa*. Lawrence: Regents Press of Kansas.
- Rojas Rabiela, Teresa
 1974 *Aspectos tecnológicos de las obras hidráulicas coloniales*. Mexico City: SEP-INAH.

- Rojas Rabiela, Teresa, Rafael Strauss, and José Lameiras
 1974 *Nuevas noticias sobre las obras hidráulicas prehispánicas y coloniales en el Valle de México*. Mexico City: SEP-INAH.
- Rosenmeier, M. F., D. A. Hodell, M. Brenner, J. H. Curtis, and T. P. Guilderson
 2002 A 4,000-Year Lacustrine Record of Environmental Change in the Southern Maya Lowlands, Peten, Guatemala. *Quaternary Research* 57:183–90.
- Rust, William F., III, and Robert J. Sharer
 1988 Olmec Settlement Data from La Venta, Tabasco, Mexico. *Science* 242:102–4.
- Sahlins, Marshall
 1972 *Stone Age Economics*. Aldine: Chicago.
- Sánchez Vázquez, Ma. de Jesús
 1984 Zacatenco: Una unidad productora de sal en la ribera noroccidental del Lago de Texcoco. Licenciatura thesis, Escuela Nacional de Antropología e Historia, Mexico City.
- Sanders, William T.
 1957 *Tierra y agua (Soil and Water): A Study of Ecological Factors in the Development of Meso-American Civilizations*. Ph.D. dissertation, Harvard University, Cambridge, MA.
 1965 *Cultural Ecology of the Teotihuacan Valley*. Department of Sociology and Anthropology, Pennsylvania State University, University Park.
 1974 *Chiefdom to State: Political Evolution at Kaminaljuyu, Guatemala*. In *Reconstructing Complex Societies*. C. Morre, ed. Pp. 97–113. Cambridge, MA: MIT Press.
 1976 *The Agricultural History of the Basin of Mexico*. In *The Valley of Mexico*. Eric R. Wolf, ed. Pp. 161–78. Albuquerque: University of New Mexico Press.
- Sanders, William T., Jeffrey R. Parsons, and Robert S. Santley
 1979 *The Basin of Mexico: Ecological Processes in the Evolution of a Civilization*. New York: Academic Press.
- Sanders, William T., and Barbara J. Price
 1968 *Mesoamerica: The Evolution of a Civilization*. New York: Random House.
- Sanders, William T., and David Webster
 1978 *Unilinealism, Multilinealism, and the Evolution of Complex Societies*. In *Social Archaeology: Beyond Subsistence and Dating*. Charles Redman, Mary J. Berman, E. V. Curtin, W. T. Langhorne, Nine M. Versaggi, and J. C. Warrers, eds. Pp. 249–302. New York: Academic Press.
- Santley, Robert S.
 1993 Late Formative Period Society at Loma Torremote: A Consideration of the Redistribution vs. Great Provider Models as a Basis for the Emergence of Complexity in the Basin of Mexico. In *Prehispanic Domestic Units in Western Mesoamerica: Studies of Household, Compound, and Residence*. Robert S. Santley and Kenneth G. Hirth, eds. Pp. 67–86. Boca Raton: CRC Press.
- Sauer, C. O.
 1952 *Agricultural Origins and Dispersal*. New York: American Geographical Society.
- Scarborough, Vernon
 1988 A Water Storage Adaptation in the American Southwest. *Journal of Anthropological Research* 44:21–40.

- 1993 Water Management in the Southern Maya Lowlands: An Accretive Model for the Engineered Landscape. In *Economic Aspects of Water Management in the Prehispanic New World*. Vernon L. Scarborough and Barry L. Isaac, eds. Pp. 17–69. Research in Economic Anthropology, Supplement 7. Greenwich, CT: JAI Press.
- 1994a Maya Water Management. *Research and Exploration* 10:184–99.
- 1994b Water Management Studies at Midea and Adjacent Areas, Greece. Technical report submitted to G. Walberg and the Department of Classics, University of Cincinnati.
- 1996 Reservoirs and Watersheds in the Central Maya Lowlands. In *The Managed Mosaic: Ancient Maya Agriculture and Resource Use*. Scott L. Fedick, ed. Pp. 304–14. Salt Lake City: University of Utah Press.
- 1998 Ecology and Ritual: Water Management and the Maya. *Latin American Antiquity* 9:135–59.
- 2003 *The Flow of Power: Ancient Water Systems and Landscapes*. Santa Fe: School of American Research Press.
- Scarborough, Vernon L., and Gary C. Gallop
1991 A Water Storage Adaptation in the Maya Lowlands. *Science* 251:658–62.
- Scarborough, Vernon L., John W. Schoenfelder, and J. Stephen Lansing
1999 Early Statecraft on Bali: The Water Temple Complex and the Decentralization of the Political Economy. *Research in Economic Anthropology* 20:299–330.
- Scarborough, Vernon L., and Fred Valdez Jr.
2003 The Engineered Environment and Political Economy of the Three Rivers Region. In *Heterarchy, Political Economy, and the Ancient Maya: The Three Rivers Region of the East-Central Yucatan Peninsula*. V. Scarborough, F. Valdez Jr., and N. Dunning, eds. Pp. 3–13. Tucson: University of Arizona Press.
- Schaafsma, Curtis F., and Carroll L. Riley
1999 The Casas Grandes World: Analysis and Conclusion. In *The Casas Grandes World*. Curtis F. Schaafsma and Carroll L. Riley, eds. Pp. 237–49. Salt Lake City: University of Utah Press.
- Schaafsma, Polly
2000 *Warrior, Shield, and Star: Imagery and Ideology of Pueblo Warfare*. Santa Fe: Western Edge Press.
- Schele, Linda
1988 The Xibalba Shuffle: A Dance after Death. In *Maya Iconography*. E. P. Benson and Gillett G. Griffin, eds. Pp. 294–317. Princeton, NJ: Princeton University Press.
- Schele, Linda, and David Freidel
1990 *A Forest of Kings: The Untold Story of the Ancient Maya*. New York: William Morrow.
- Schele, Linda, and Nikolai Grube
1990 The Glyph for Plaza or Court. Copan Note 86. Copan Acropolis Archaeological Project and the Instituto Hondureño de Antropología e Historia, Honduras.
- Schele, Linda, and Peter Mathews
1998 *The Code of Kings*. New York: Simon and Schuster.

- Schele, Linda, and Mary Miller
 1986 *The Blood of Kings: Dynasty and Ritual in Maya Art*. Fort Worth: Kimble Art Museum.
- Schreiber, K., and J. Lancho Rojas
 1993 The Puquios of Nasca. *Latin American Antiquity* 6:229–54.
 2003 *Irrigation and Society in the Peruvian Desert: The Puquios of Nasca*. Lanham, MD: Lexington Books.
- Sharer, Robert J., Julie Miller, and Loa Traxler
 1992 Evolution of Classic Period Architecture in the Eastern Acropolis, Copan: A Progress Report. *Ancient Mesoamerica* 3:145–60.
- Sharpton, Virgil, Kevin Burke, Antonio Camargo-Zanoguera, Stuart A. Hall, D. Scott Lee, Luis E. Marín, Gerardo Suárez-Reynoso, Juan Manuel Quezada-Muñeton, Paul D. Spudis, and Jaime Urrutia-Fucugauchi
 1993 Chicxulub Multiring Impact Basin: Size and Other Characteristics Derived from Gravity Analysis. *Science* 261:1564–67.
- Sharrock, Floyd W., David S. Dibble, and Keith M. Anderson
 1962 The Creeping Dune Irrigation Site in Glen Canyon, Utah. *American Antiquity* 27:188–202.
- Sherbondy, Jeanette
 1992 Water Ideology in Inca Ethnogenesis. In *Andean Cosmologies through Time*. R. H. Dover, K. E. Seibold, and J. H. McDowell, eds. Pp. 46–66. Bloomington: Indiana University Press.
- Shook, Edwin
 1952a The Great Wall and Other Features of Mayapan. *Year Book* 51:247–51. Cambridge: Carnegie Institution of Washington.
 1952b Lugares arqueológicos del altiplano meridional central de Guatemala. In *Antropología e Historia de Guatemala* 4(2):3–40.
 1953 *The X-Coton Temples at Mayapan*. Current Reports 11. Cambridge: Carnegie Institution of Washington.
 1954 *The Temple of Kukulcan at Mayapan*. Current Reports 20. Cambridge: Carnegie Institution of Washington.
- Shook, Edwin, and Marion Hatch
 1999 Las tierras altas centrales: Períodos Preclásico y Clásico. In *Historia general de Guatemala*, 1:295–318. Asociación de Amigos del País, Fundación para la Cultura y el Desarrollo, Guatemala.
- Shook, Edwin, and Alfred Kidder
 1952 *Mound E-III-3, Kaminaljuyu, Guatemala*. Publication 596, Contribution 53. Washington, D.C.: Carnegie Institution of Washington.
- Siemens, A. H.
 1978 Karst and the Prehispanic Maya in the Southern Lowlands. In *Prehispanic Maya Agriculture*. P. D. Harrison and B. L. Turner II, eds. Pp. 117–43. Albuquerque: University of New Mexico Press.
 1982 Prehistoric Agricultural Use of the Wetlands of Northern Belize. In *Maya Subsistence: Studies in Memory of Dennis E. Puleston*. K. V. Flannery, ed. Pp. 205–22. New York: Academic Press.
 1983 Oriented Raised Fields in Central Veracruz. *American Antiquity* 48:85–102.
 1996 Benign Flooding on Tropical Lowland Floodplains. In *The Managed Mo-*

- saic: Ancient Maya Agriculture and Resource Use*. S. L. Fedick, ed. Pp. 132–44. Salt Lake City: University of Utah Press.
- 1998 *A Favored Place: San Juan River Wetlands, Central Veracruz, A.D. 500 to the Present*. Austin: University of Texas Press.
- Siemens, A. H., and D. E. Puleston
- 1972 Ridged Fields and Associated Features along the Candelaria River, Mexico: New Perspectives on the Lowland Maya. *American Antiquity* 37:228–39.
- Siemens, A. H., J. A. Soler Graham, R. Hebda, and M. Heimo
- 2002 “Dams” on the Candelaria. *Ancient Mesoamerica* 13:115–23.
- Siemens, A. H., R. J. Hebda, M. Navarrete Hernandez, D. R. Piperno, J. K. Stein, and M. G. Zota Baez
- 1987 Evidence for a Cultivar and a Chronology from Patterned Wetlands in Central Veracruz, Mexico. *Science* 242:105–7.
- Sisson, Edward
- 1976 Survey and Excavation in the Northwestern Chontalpa, Tabasco, Mexico. Ph.D. dissertation, Harvard University, Cambridge, MA.
- Smith, Michael E., and Lisa Montiel
- 2001 The Archaeological Study of Empires and Imperialism in Pre-Hispanic Central Mexico. *Journal of Anthropological Archaeology* 20:245–84.
- Smith, Robert E.
- 1953a *Cenote X-Coton at Mayapan*. Current Reports 5. Cambridge: Carnegie Institution of Washington.
- 1953b Pottery of Mayapan and Vicinity. *Year Book* 52:279–82. Washington, D.C.: Carnegie Institution of Washington.
- 1954 *Cenote Exploration at Mayapan and Telchaquillo*. Current Reports 12. Cambridge: Carnegie Institution of Washington.
- 1971 *The Pottery of Mayapan*. Papers of the Peabody Museum of Archaeology and Ethnology 66. Cambridge, MA: Harvard University.
- Smith, Watson
- 1952 *Kiva Mural Decorations at Awatovi and Kawaika-a, with a Survey of Other Wall Paintings in the Pueblo Southwest*. Papers of the Peabody Museum of Archaeology and Ethnology 37. Cambridge, MA: Harvard University.
- Snead, James E.
- 2002 Ancestral Pueblo Trails and the Cultural Landscape of the Pajarito Plateau, New Mexico. *Antiquity* 76:756–65.
- Snead, James E., and Robert W. Preucel
- 1999 The Ideology of Settlement: Ancestral Keres Landscapes in the Northern Rio Grande. In *Archaeologies of Landscape: Contemporary Perspectives*. Wendy Ashmore and Bernard Knapp, eds. Pp. 169–97. London: Blackwell.
- Soustelle, Jacques
- 1956 *La vida cotidiana de los Aztecas en vísperas de la Conquista*. Mexico City: Fondo de Cultura Económica.
- Spencer, Charles S.
- 2000 Prehispanic Water Management and Agricultural Intensification in Mexico and Venezuela: Implications for Contemporary Ecological Planning. In *Imperfect Balance: Landscape Transformations in the Precolumbian Americas*. David L. Lentz, ed. Pp. 147–78. New York: Columbia University Press.

- Squier, Ephraim G.
1848 New Mexico and California. *American Review*, n.s. 2(5):503–28.
- Stargardt, Janice
1986 Hydraulic Works and South East Asian Politics. In *Southeast Asia in the 9th to 14th Centuries*. D. G. Marr and A. C. Milner, eds. Pp. 23–48. Singapore: Institute of Southeast Asian Studies and the Research School of Pacific Studies.
- Stark, Barbara
1999a Commentary: Ritual, Social Identity, and Cosmology: Hard Stones and Flowing Water. In *Social Patterns in Pre-Classic Mesoamerica*. David C. Grove and Rosemary A. Joyce, eds. Pp. 301–17. Washington, D.C.: Dumbarton Oaks.
1999b Formal Architectural Complexes in South-central Veracruz, Mexico: A Capital Zone? *Journal of Field Archaeology* 26:197–225.
- Steen, Charlie R.
1977 *Pajarito Plateau Archaeological Survey and Excavations*. Los Alamos, NM: Los Alamos Scientific Laboratory.
- Stephen, Alexander M.
1969 *Hopi Journal*. 2 pts. E. C. Parsons, ed. New York: AMS Press.
- Steward, Julian H.
1955a Some Implications of the Symposium. In *Irrigation Civilization*. Julian H. Steward, ed. Pp. 58–78. Washington, D.C.: Pan American Union.
1955b *Theory of Culture Change*. Urbana: University of Illinois Press.
- Stirling, Matthew W.
1943 *Stone Monuments of Southern México*. Bureau of American Ethnology Bulletin 138. Washington D.C.: Smithsonian Institution.
1955 *Stone Monuments of the Río Chiquito*. Bureau of American Ethnology Bulletin 157:1–23. Washington D.C.: Smithsonian Institution.
- Stirling, Matthew, and Marion Stirling
1942 Finding Jewels of Jade in a Mexican Swamp. *National Geographic Magazine* 82:635–61.
- Stomper, Jeffrey
1996 *The Popol Na: A Model for Ancient Maya Community Structure at Copan*. Ph.D. dissertation, Yale University, New Haven, CT.
- Stone, Andrea J.
1995 *Images from the Underworld: Naj Tunich and the Tradition of Maya Cave Painting*. Austin: University of Texas Press.
- Stuart, David S.
1992 Hieroglyphs and Archaeology at Copan. *Ancient Mesoamerica* 3(1):169–84.
2000 “The Arrival of Strangers”: Teotihuacan and Tollan in Classic Maya History. In *Mesoamerica’s Classic Heritage: From Teotihuacan to the Aztecs*. David Carrasco, Lindsay Jones, and Scott Sessions, eds. Pp. 465–513. Boulder: University of Colorado Press.
n.d. *Detailed Commentary on Temple XIX Inscriptions*. PARI Monograph Series. San Francisco. In press.
- Stuart, David, and Stephen Houston
1994 *Classic Maya Place Names*. Studies in Pre-Columbian Art and Archaeology 33. Washington, D.C.: Dumbarton Oaks.

- Swisher, Carl C., III, José M. Grajales-Nishimura, Alessandro Montanari, Stanley V. Margolis, Philippe Claeys, Walter Alvarez, Paul Renne, Esteban Cedillo-Pardo, Florentin J.-M. R. Maurrasse, Garniss H. Curtis, Jan Smit, and Michael O. McWilliams
 1992 Coeval $^{40}\text{Ar}/^{39}\text{Ar}$ Ages of 65.0 Million Years Ago from Chicxulub Crater Melt Rock and Cretaceous-Tertiary Boundary Tektites. *Science* 257:954–58.
- Symonds, Stacey, Ann Cyphers, and Roberto Lunagómez
 2002 *Asentamiento prehispánico en San Lorenzo Tenochtitlan*. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.
- Taube, Karl A.
 1992 *The Major Gods of Ancient Yucatan*. Studies in Pre-Columbian Art and Archaeology 32. Washington, D.C.: Dumbarton Oaks.
 1996 The Olmec Maize God. *RES* 29/30:39–81.
 2000a *Ancient Americas I: The Writing System of Ancient Teotihuacan*. Bernardsville, NC, and Washington, D.C.: Center for Ancient American Studies.
 2000b Lightning Celts and Corn Fetishes: The Formative Olmec and the Development of Maize Symbolism in Mesoamerica and the American Southwest. In *Olmec Art and Archaeology in Mesoamerica*. John E. Clark and Mary E. Pye, eds. Pp. 297–337. New Haven, CT: National Gallery of Art and Yale University Press.
- Tec Chí, Andrés, José Zi Keb, Leovigildo Tuyub Colli, José González, Santiago Domínguez Aké, and Ma. Luisa Góngora Pacheco
 1992 *Cuentos sobre las apariciones en el Mayab*. Mérida: Maldonado Editores.
- Tedlock, Dennis
 1985 *Popol Vuh: The Definitive Edition of the Mayan Book of the Dawn of Life and the Glories of God and Kings*. New York: Simon and Schuster.
- Thompson, J. Eric S.
 1952 Aquatic Symbols Common to Various Centers of the Classic Period in Meso-America. In *The Civilizations of Ancient America*. Sol Tax, ed. Pp. 31–36. Chicago: University of Chicago Press.
 1970 *Maya History and Religion*. Norman: University of Oklahoma Press.
 1974 “Canals” of the Río Candelaria Basin, Campeche, Mexico. In *Mesoamerican Archaeology: New Approaches*. Norman Hammond, ed. Pp. 297–302. London: Duckworth.
- Tilley, Christopher
 1994 *A Phenomenology of Landscape*. Oxford: Berg.
- Titiev, Mischa
 1944 *Old Oraibi: A Study of the Hopi Indians of Third Mesa*. Papers of the Peabody Museum of American Archaeology and Ethnology 22(1). Cambridge, MA: Harvard University.
- Toll, H. Wolcott, ed.
 1995 *Soil, Water, Biology and Belief in Prehistoric and Traditional Southwestern Agriculture*. Special Publication 2. New Mexico Archaeological Council.
- Tolstoy, Paul
 1989 Coapexco and Tlatilco: Sites with Olmec Materials in the Basin of Mexico. In *Regional Perspectives on the Olmec*. Robert J. Sharer and David C. Grove, eds. Pp. 85–121. Cambridge: Cambridge University Press.

- Torquemada, Juan de
 1975 *Monarquía indiana*. 3 vols. Colección Sepan cuántos. Mexico City: Editorial Porrúa, SA.
- Toscano, Salvador
 1948 *Anales de Tlatelolco, unos annales históricos de la nación mexicana y código de Tlatelolco*. Heinrich Berlin, ed. Mexico City: Antigua Librería Robredo.
- Toulouse, Joseph H., Jr.
 1945 Early Water Systems at Gran Quivira National Monument. *American Antiquity* 10:362-72.
- Tourtellot, Gair
 1988 Developmental Cycles of Households and Houses at Seibal. In *Household and Community in the Mesoamerican Past*. R. R. Wilk and W. Ashmore, eds. Pp. 97-120. Albuquerque: University of New Mexico Press.
- Turner, B. L., II
 1974 Prehistoric Intensive Agriculture in the Mayan Lowlands. *Science* 185:118-24.
 1978 Ancient Agricultural Land Use in the Central Lowlands. In *Pre-Hispanic Maya Agriculture*. P. D. Harrison and B. L. Turner II, eds. Pp. 163-83. Albuquerque: University of New Mexico Press.
 1983 *Once beneath the Forest: Prehistoric Terracing in the Río Bec Region of the Maya Lowlands*. Boulder, CO: Westview Press.
 1993 Rethinking the "New Orthodoxy": Interpreting Ancient Maya Agriculture and Environment. In *Culture, Form, and Place: Essays in Cultural and Historical Geography*. K. W. Mathewson, ed. Pp. 57-88. Geosciences and Man 32. Geoscience Publications, Department of Geography and Anthropology, Louisiana State University, Baton Rouge.
- Turner, B. L., II, and P. D. Harrison
 1983 Pulltrouser Swamp and Maya Raised Fields: A Summation. In *Pulltrouser Swamp: Ancient Maya Habitat, Agriculture, and Settlement in Northern Belize*. B. L. Turner II and P. D. Harrison, eds. Pp. 246-69. Austin: University of Texas Press.
- Turner, B. L., II, W. Johnson, G. Mahood, F. Wiseman, and J. Poole
 1983 Habitat y agricultura en la región de Copan. In *Introducción a la arqueología de Copan, Honduras*. Claude F. Baudez, ed. Vol. 1, pt. 1, pp. 35-142. Tegucigalpa, Honduras: Secretaría de Estado en el Despacho de Cultura y Turismo.
- Turney, William F.
 1985 Prehistoric Water Reservoirs—The Southwest. In *Southwestern Cultural History: Collected Papers in Honor of Albert H. Schroeder*. Charles H. Lange, ed. Pp. 43-57. Papers of the Archaeological Society of New Mexico 10. Santa Fe: Ancient Press.
 1988 Prehistoric Reservoirs at Pueblo Blanco. In *Reflections: Papers on Southwestern Culture History in Honor of Charles H. Lange*. Anne V. Poore, ed. Pp. 173-83. Papers of the Archaeological Society of New Mexico 14. Santa Fe: Ancient Press.
 1990 Prehistoric Reservoirs at San Lazaro. In *Clues to the Past: Papers in Honor of William M. Sundt*. Meliha S. Duran and David T. Kirkpatrick, eds. Pp.

- 307–14. Papers of the Archaeological Society of New Mexico 16. Santa Fe: Ancient Press.
- 1992 Prehistoric Water Supply at San Lazaro Pueblo (Part II). In *Archaeology, Art, and Anthropology: Papers in Honor of J. J. Brody*. Meliha S. Duran and David T. Kirkpatrick, eds. Pp. 99–109. Papers of the Archaeological Society of New Mexico 18. Santa Fe: Ancient Press.
- United Nations
- 2003 *Water for People, Water for Life*. United Nations World Water Development Report, World Water Assessment Programme. Barcelona: UNESCO Publishing and Berghahn Books.
- Vaillant, George C.
- 1930 *Excavations at Zacatenco*. Anthropological Papers of the American Museum of Natural History 32(1). New York.
- 1931 *Excavations at Ticoman*. Anthropological Papers of the American Museum of Natural History 32(2). New York.
- 1935 *Excavations at El Arbolillo*. Anthropological Papers of the American Museum of Natural History 25(2). New York.
- Valdés, Juan Antonio
- 1995 Desarrollo cultural y señales de alarma entre los mayas: El Preclásico Tardío y la transición hacia el Clásico Temprano. In *The Emergence of Lowland Maya Civilization: The Transition from the Preclassic to the Early Classic*. Nikolai Grube, ed. Pp. 71–85. Acta Mesoamericana 8. Möckmühl: Verlag von Flemming.
- 1997 El proyecto Miraflores II dentro del marco Preclásico de Kaminaljuyu. In *X simposio de investigaciones arqueológicas en Guatemala, 1996*. J. P. Laporte and H. Escobedo, eds. Pp. 81–91. Guatemala: Museo Nacional de Arqueología y Etnología.
- 1998 Kaminaljuyu, Guatemala: Descubrimientos recientes sobre poder y manejo hidráulico. In *Memorias del Tercer Congreso Internacional de Mayistas, 1995*. Pp. 752–70. Mexico City: Centro de Estudios Mayas, Universidad Nacional Autónoma de México.
- Valdés, Juan Antonio, and Jonathan Kaplan
- 2001 Ground-Penetrating Radar at the Maya Site of Kaminaljuyu, Guatemala. *Journal of Field Archaeology* 27:329–42.
- Valdés, Juan Antonio, and Lori Wright
- 2004 The Early Classic and Its Antecedents at Kaminaljuyu: A Complex Society with Complex Problems. In *Understanding Early Classic Copan*. Ellen Bell, Marcello Canuto, and Robert Sharer, eds. Pp. 337–55. Philadelphia: University of Pennsylvania Museum.
- Van Zandt, Tineke
- 1999 Architecture and Site Structure. In *The Bandelier Archaeological Survey*. Robert P. Powers and Janet D. Orcutt, eds. Pp. 309–88. Intermountain Cultural Resources Management, Professional Paper 57. Intermountain Region. Santa Fe: National Park Service.
- Varela-Gómez, Marisol
- 2003 El contexto arqueológico del Monumento 14, San Lorenzo, Veracruz. Licenciatura thesis, Facultad de Antropología, Universidad Veracruzana-Xalapa.

- Varien, Mark D.
1999 *Sedentism and Mobility in a Social Landscape: Mesa Verde and Beyond*. Tucson: University of Arizona Press.
- Vega, Anthony
1999 Informe de las excavaciones arqueológicas en la planicie aluvial norte de San Lorenzo, 1998. In *Informe del proyecto arqueológico San Lorenzo Tenochtitlan: Temporada 1998*. A. Cyphers, ed. Mexico City: Consejo de Arqueología, Instituto Nacional de Antropología e Historia.
- Velásquez, Juan Luis
1994 Cronología preliminar del Montículo A-V-9 de Kaminaljuyu. In *I simposio de investigaciones arqueológicas en Guatemala, 1987*. J. P. Laporte and H. Escobedo, eds. Pp. 27–34. Guatemala: Museo Nacional de Arqueología y Etnología.
- Vickery, Michael
1986 Some Remarks on Early State Formation in Cambodia. In *Southeast Asia in the 9th to 14th Centuries*. D. G. Marr and A. C. Milner, eds. Pp. 95–116. Singapore: Institute of Southeast Asian Studies and the Research School of Pacific Studies.
- Vivian, R. Gwynn
1990 *The Chacoan Prehistory of the San Juan Basin*. San Diego: Academic Press.
- Vogt, Evon Z.
1969 *Zinacantan: A Maya Community in the Highlands of Chiapas*. Cambridge, MA: Harvard University Press.
1976 *Tortillas for the Gods*. Cambridge, MA: Harvard University Press.
1981 Some Aspect of the Sacred Geography of Highland Chiapas. In *Mesoamerican Sites and World-Views*. Elizabeth P. Benson, ed. Pp. 119–42. Washington, D.C.: Dumbarton Oaks.
1993 *Tortillas for the Gods: A Symbolic Analysis of Zinacanteco Rituals*. 2nd ed. Norman: University of Oklahoma Press.
- von Nagy, Christopher
1997 The Geoarchaeology of Settlement in the Grijalva Delta. In *Olmec to Aztec, Settlement Patterns in the Ancient Gulf Lowlands*. B. Stark and P. Arnold III, eds. Pp. 253–77. Tucson: University of Arizona Press.
- Voth, H. R.
1903 *The Oraibi Summer Snake Ceremony*. Field Columbian Museum, Publication 83, Anthropological Series 3(4).
- Walker, Edwin F.
1938 Desert Indian Wells. *Masterkey* 12(3):110–12.
- Walker, William H.
1995 Ceremonial Trash? In *Expanding Archaeology*. J. M. Skibo, W. H. Walker, and A. Neilsen, eds. Pp. 67–79. Salt Lake City: University of Utah Press.
1996 Ritual Deposits: Another Perspective. In *River of Change: Prehistory of the Middle Little Colorado River Valley, Arizona*. E. Charles Adams, ed. Pp. 75–91. Tucson: Arizona State Museum Archaeological Series.
1998 Where Are the Witches of Prehistory? *Journal of Archaeological Method and Theory* 5:245–308.
1999 Ritual, Life Histories, and the Afterlives of People and Things. *Journal of the Southwest* 41(3):383–405.

- 2001 Ritual Technology in an Extranatural World. In *Anthropological Perspectives on Technology*. M. B. Schiffer, ed. Pp. 87–106. Albuquerque: Amerind Foundation and the University of New Mexico Press.
- 2002 Stratigraphy and Practical Reason. *American Anthropologist* 104:159–77.
- Walker, William H., and Lisa J. Lucero
 2000 The Depositional History of Ritual and Power. In *Agency in Archaeology*. M. Dobres and J. Robb, eds. Pp. 130–47. London: Routledge.
- Webster, David L.
 1989 The Original Location, Date, and Possible Implications of Altar W'. In *House of the Bacabs, Copan, Honduras*. David Webster, ed. Pp. 108–11. Washington, D.C.: Dumbarton Oaks.
- 1999 The Archaeology of Copan, Honduras. *Journal of Archaeological Research* 7:1–53.
- Webster, David, Barbara Fash, Randolph Widmer, and Scott Zeleznik
 1998 The Skyband Group: Investigations of a Classic Maya Elite Residential Complex at Copan, Honduras. *Journal of Field Archaeology* 25:319–43.
- Webster, David, and Nancy Gonlin
 1988 Household Remains of the Humblest Maya. *Journal of Field Archaeology* 15:169–90.
- Weiss-Krejci, Estella, and Thomas Sabbas
 2002 The Potential Role of Small Depressions as Water Storage Features in the Central Maya Lowlands. *Latin American Antiquity* 13:343–57.
- West, Robert C.
 1964 Surface Configuration and Associated Geology of Middle America. *Handbook of Middle American Indians*. Vol. 1: *Natural Environment and Early Cultures*. Robert C. West, ed. Pp. 33–83. Austin: University of Texas Press.
- West, Robert C., N. P. Psuty, and B. G. Thom
 1969 *The Tabasco Lowlands of Southeastern Mexico*. Technical Report 17. Baton Rouge: Coastal Studies Institute.
- Whalen, Michael E., and Paul E. Minnis
 2001 *Casas Grandes and Its Hinterlands: Prehistoric Regional Organization in Northwest Mexico*. Tucson: University of Arizona Press.
- Wheat, Joe Ben
 1952 Prehistoric Water Sources of the Point of Pines Area. *American Antiquity* 17:185–96.
- White, Leslie
 1935 *The Pueblo of Santo Domingo, New Mexico*. Memoirs of the American Anthropological Association 43. Menasha, WI: American Anthropological Association.
- 1942 *The Pueblo of Santa Ana, New Mexico*. Memoirs of the American Anthropological Association 60. Menasha, WI: American Anthropological Association.
- 1962 *The Pueblo of Sia, New Mexico*. Bureau of American Ethnology Bulletin 184. Washington, D.C.: Smithsonian Institution.
- Whiteley, Peter M.
 1988a *Bacavi: Journey to Reed Springs*. Flagstaff: Northland Press.
- 1988b *Deliberate Acts: Changing Hopi Culture through the Oraibi Split*. Tucson: University of Arizona Press.

- 1998 *Rethinking Hopi Ethnography*. Washington, D.C.: Smithsonian Institution Press.
- Whitmore, T. M., and B. L. Turner II
 2001 *Cultivated Landscapes of Middle America on the Eve of Conquest*. Oxford: Oxford University Press.
- Wicke, Charles
 1971 *Olmec: An Early Art Style of Precolumbian Mexico*. Tucson: University of Arizona Press.
- Wiley, Gordon R., and Richard M. Leventhal
 1979 Prehistoric Settlement at Copan. In *Cambridge Symposium on Recent Research in Mesoamerican Archaeology*. Pp. 75–102. Austin: University of Texas Press.
- Williams, Howell, and Robert F. Heizer
 1965 Source of Rocks Used in Olmec Monuments. *Contributions of the University of California Archaeological Research Facility* 1:1–39.
- Wilshusen, Richard H., Melissa J. Churchill, and James M. Potter
 1997 Prehistoric Reservoirs and Water Basins in the Mesa Verde Region: Intensification of Water Collection Strategies during the Great Pueblo Period. *American Antiquity* 62:664–81.
- Wing, Elizabeth
 1980 Faunal Remains from San Lorenzo. In *In the Land of the Olmec*. M. D. Coe and R. A. Diehl, eds. Vol. 1, pp. 375–86. Austin: University of Texas Press.
- Winsborough, B. M., S. C. Caran, J. A. Neely, and S. Valastro Jr.
 1996 Calcified Microbial Mats Date Prehistoric Canals: Radiocarbon Assay of Organic Extracts from Travertine. *Geoarchaeology* 11:37–50.
- Wisdom, Charles
 1940 *The Chorti Indians of Guatemala*. Chicago: University of Chicago Press.
- Wisseman Christie, Jan
 1986 Negara, Mandala, and Despotic States: Images of Early Java. In *Southeast Asia in the 9th to 14th Centuries*. D. G. Marr and A. C. Milner, eds. Pp. 65–94. Singapore: Institute of Southeast Asian Studies and the Research School of Pacific Studies.
- Wittfogel, Karl A.
 1957 *Oriental Despotism: A Comparative Study of Total Power*. New Haven, CT: Yale University Press.
- Wolf, Eric R., and Angel Palerm
 1955 Irrigation in the Old Acolhua Domain, Mexico. *Southwestern Journal of Anthropology* 11:265–81.
- Woodbury, Richard B., and James A. Neely
 1972 Water Control Systems of the Tehuacan Valley. In *The Prehistory of the Tehuacan Valley*. Vol. 4: *Chronology and Irrigation*. Frederick Johnson, ed. Pp. 81–154. Austin: University of Texas Press.
- Wright, L. E. J. V. Genovéz, M. Vasquez, B. Burgos, I. Guerrero, and H. P. Schwarcz
 1998 La osteología de rescate en Kaminaljuyu y algunas observaciones acerca de la dieta prehispánica en el Valle de Guatemala. In *XI simposio de investigaciones arqueológicas en Guatemala, 1997*. J. P. Laporte and H. Escobedo, eds. Pp. 419–26. Guatemala: Museo Nacional de Arqueología y Etnología.

Zuñiga, Belem

- n.d. Informe sobre la identificación de fauna del proyecto arqueológico San Lorenzo Tenochtitlan. PASLT Archives.

Zurita-Noguera, Judith

- 1997 Los fitolitos: Indicaciones sobre dieta y vivienda en San Lorenzo. In *Población, subsistencia y medio ambiente en San Lorenzo Tenochtitlan*. A. Cyphers, ed. Pp. 75–87. Mexico City: Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México.

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