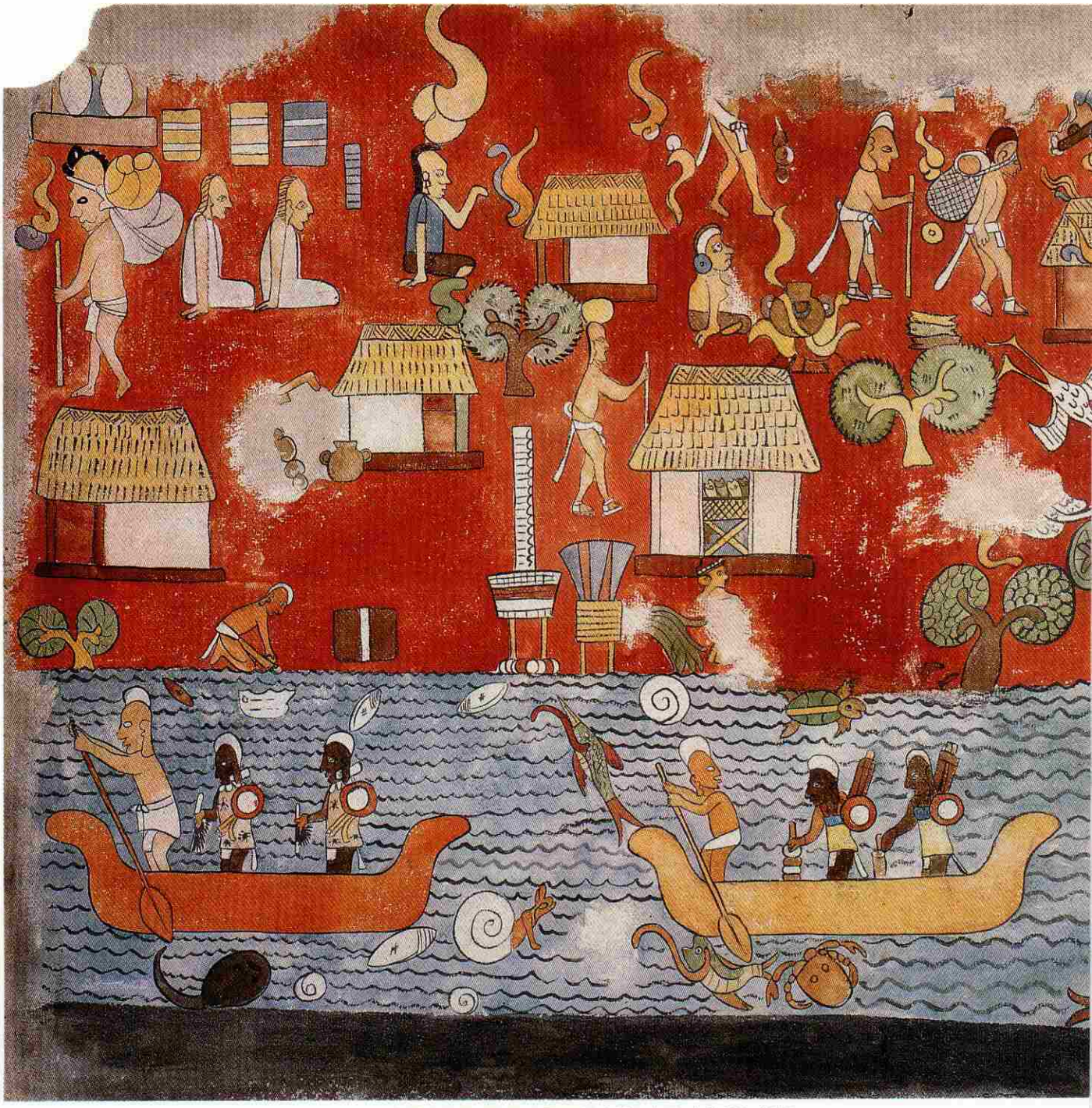
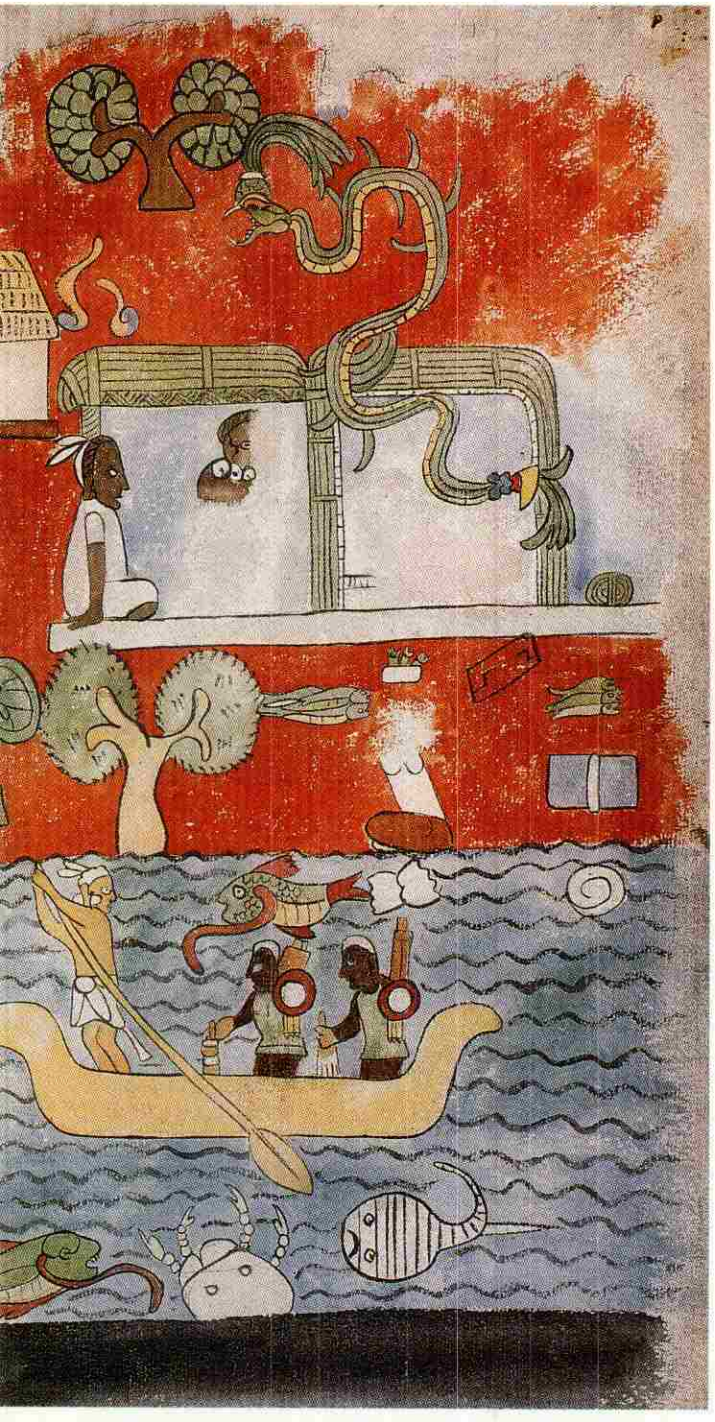
FLOW OF POWER

Water Reservoirs Controlled the Rise and Fall of the Ancient Maya



Maya Seacoast Village, *Chichén Itzá, Mexico, Terminal Classic Period, 800–1000* A.D.

by VERNON L. SCARBOROUGH



ABOVE THE LUSH CANOPY OF the Petén jungle in northern Guatemala, the ruins of Tikal loom like limestone ghosts. Towering pyramidal temples and intricately carved facades attest to the wealth and magnificence of the ancient city. At the height of its power Tikal is estimated to have supported as many as 90,000 people within a six-mile radius of the city center. Standing on the wide, paved central acropolis today, one can yet catch faint strains of conversations wrapped in the murmur of the thick afternoon breeze.

Tikal was one of a half-dozen huge city-states scattered about the southern Maya lowlands, which stretch south from the Yucatán peninsula through Guatemala and Belize and into Honduras. The Maya settled the region 3,000 years ago, articulating their history over the ensuing centuries with thousands of spectacular monuments in hundreds of towns and cities: Copán, Quiriguá, Seibal, Yaxhá. The civilization reached its apogee in the late classic period between the seventh and ninth centuries A.D. By the tenth century, however, that literate and sophisticated civilization had abruptly and enigmatically disappeared. New cities sprang up to the north on the Yucatán peninsula, while the urban centers of the south were abandoned, left to the encroaching jungle.

Viewed in the historical light of early statecraft, the rain forests of Central America hardly seem conducive to the emergence of a complex civilization. The first civilizations of the eastern hemisphere were tethered to major river systems: the Sumerian cities of Ur and Eridu blossomed along the Tigris and Euphrates rivers some 5,500 years ago; several centuries later Abydos and Memphis arose along the Egyptian Nile; and by 1700 B.C. Harappa and Mohenjo-Daro, prehistoric epicenters of Pakistani culture, had already disappeared from the banks of the Indus River. Tikal, in contrast, is virtually landlocked, far from any navigable water or from any permanent, drinkable water supply. Perhaps the landscape's only watery features are the vast and dismal swamps, or *bajos*, that characterize the Maya lowlands; but even those disappear in the dry season. Furthermore, unlike other early cities, whose populations tended to settle in clusters, the residents of Tikal were widely scattered throughout the rain forest, a feature that traditionally would make centralized political control all but impossible.

Yet in spite of their apparent oddities, cities such as Tikal did thrive, dominating the Maya landscape for century after century and thereby plaguing modern archaeologists with a perennial set of questions: How could so grand a civilization flourish in so formidable a setting and so far from any permanent water source? How could its leaders wield power over a population so widely dispersed? Given the complexity of the Maya society, on what principles was it organized? What allowed the civilization to coalesce?

One answer, it now appears, was water—or more precisely, the ability of Maya rulers to control what little water was available. In the past several decades enormous reservoirs and catch basins have been revealed in and around Tikal. Archaeologists now realize those reservoirs were part of a complex water-management system that allowed the Maya to collect and hold rainwater during the rainy season and distribute it during drier months. Command of the scarce resource may well have provided the

key to urban power, permitting the rulers of cities such as Tikal to sustain large populations of people, even when property and food resources were widely scattered. By the same token, some archaeologists think water may also provide clues to the Maya's sudden and violent demise, for a nation that derives its fortune from a technological innovation can just as easily become a slave to it.

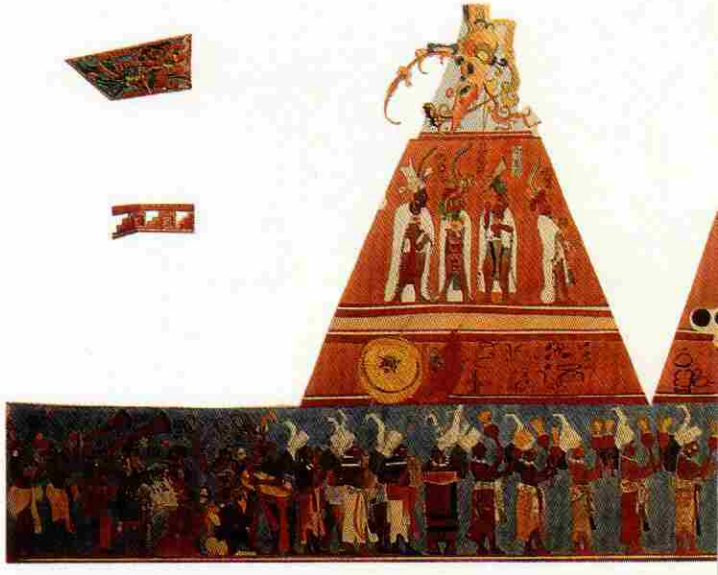
THE RUINS OF TIKAL were first stirred from their arboreal slumbers in 1848 by Modesto Mèndez and Ambrosio Tut, two Guatemalan officials in charge of the Petén region. The local Maya, naturally, had known of the site for centuries, but the two explorers' brief and rather fanciful description of vine-shrouded temples and their drawings of exquisitely inscribed stelae and lintels introduced the mysterious site to a wider audience. Several years earlier the lawyer John Lloyd Stephens and the artist Frederick Catherwood had explored the region and returned to publish a book, *Incidents of Travel in Yucatán*. The two did not visit Tikal and apparently were not aware of its existence. Nevertheless, their drawings and descriptions of other Maya ruins helped pique interest in the civilization, and they undoubtedly played a role in enticing subsequent archaeologists and explorers to Tikal.

Theories about Maya culture were created with wild abandon—which is hardly surprising, given the scant information then available and the region's exoticism in the eyes of North American and European archaeologists. Some argued the Maya were descendants of the lost tribes of Israel or perhaps survivors of legendary submerged continents. Amid the rampant speculation, though, more cautious minds were at work collecting hard data from the field. Chief among the investigators was Alfred P. Maudslay, an Englishman who in the 1880s devoted several years to surveying the contents of Tikal and eventually prepared the first map and photographs of the site. A more extensive map of the ruins, charting the largest temples in the central plaza, was completed in 1911 by explorers working under the sponsorship of Harvard University's Peabody Museum. From that information and from the discovery of hieroglyphs describing the Maya calendar, archaeologists concluded that the Maya were peaceful stargazers sheltered in vacant ceremonial centers.

The excavation of the ruins of the southern Maya lowlands, including Uaxactún, a city as old as Tikal and just ten miles to the north, intensified in the ensuing decades. Much of the attention, however, continued to focus on Tikal; its grandeur marked it as a major bellwether of indigenous American cultures. By the 1960s the complexity and immense proportion of the city had become apparent. Workers from the University of Pennsylvania uncovered several large mounds near the center of the site; each proved to be the platform for a house, indicating that the community was much more densely populated than archaeologists had thought. Further excavation and mapping showed that the population of Tikal was densest at the core and spread out with increasing distance from the core—a configuration typical of other Maya communities but distinct from the settlement patterns of early cities elsewhere in the world.

The continued excavation led to a revised picture of Maya life. Rich tombs, some containing rulers whose teeth had been inlaid with jade and who had been buried amid resplendent offerings—painted funerary vessels and highly crafted chipped-stone artifacts—made it evident that the ancient cities were centers of tremendous opulence and power. At the same time inspection of the Maya iconography revealed scenes of rival rulers being captured, tortured and sacrificed and made it clear that the Maya, contrary to their reputation as a nation of pacifists, were frequently at war. Glyphs at Tikal tell of numerous battles the city fought with neighboring rivals over the centuries. It was recently suggested that the city even spent several decades under the control of Caracol, a city to the east in present-day Belize, after a defeat in the sixth century.

The careful map work of the cartographers Robert R. Carr and James E. Hazard in the 1950s and 1960s led to even more intriguing discoveries. In addition to noting the boundaries of courtyards, palaces and ball courts (the



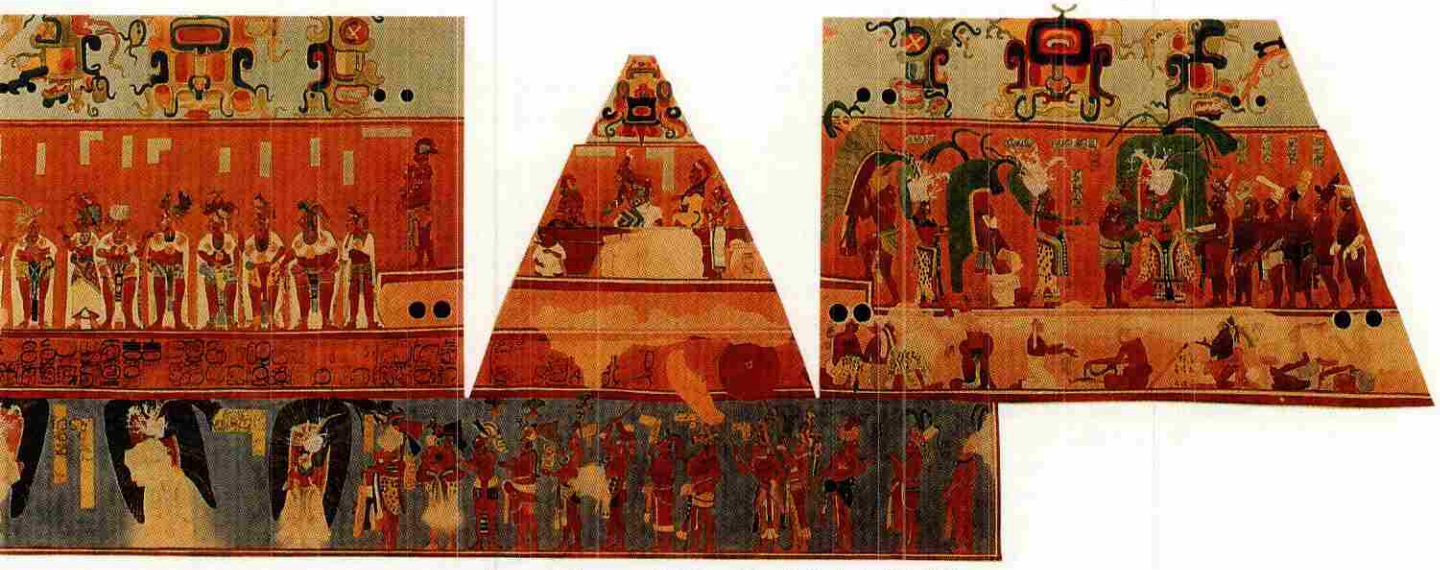
Maya were fond of a challenging game now described as hipball, a sport roughly equivalent to a mix of modern handball and soccer), Carr and Hazard pointed out the locations of low-lying depressions and overall changes in gradient. Earlier mapping expeditions had identified numerous large, well-defined and apparently man-made basins capable of storing water throughout the year. Carr and Hazard sketched maps of those reservoirs and noted their storage capacities. With the entire site as a backdrop, it became clear that Tikal had been landscaped to facilitate the drainage and manipulation of water. Archaeologists and linguists have since learned that in the ancient Maya tongue the name Tikal means place of the water hole.

THE VERDANT FORESTS of Central America are often, and mistakenly, thought to be wet year-round—a view that is particularly prevalent among observers living in more temperate climes. But although the southern Maya lowlands may receive as much as eighty inches of rain a year, the rain-

fall is concentrated in an eight-month season. In the four months that follow, the inhabitants must contend with virtual drought.

Archaeologists who study and work in the Maya lowlands tend to be especially cognizant of the presence or absence of water, because the success of an expedition depends on avoiding it during the rainy season and having enough of it in the dry season. The jungle roads are made of unsurfaced clay and are all but impassable when dampened. Even in the drier part of the year the journey can be rough going: on a recent trip to Rio Azul, a site in northeastern Guatemala near the border with Belize, my field team traveled only sixty miles in fifteen hours after a light rain fell unexpectedly in the dry season.

Usually, though, the more pressing concern is the lack of water. When Richard Hansen of the University of California at Los Angeles studies the 2,800-year-old site of Nakbé, many miles north of Tikal, in the dry months, he must carry water to his field camp by mule from a water hole more than three miles away. Archaeologists at Tikal learned early on to take advantage of the water-storage system developed by the Maya to surmount the climatic challenge. The camp water supply for the University of Pennsylvania expedition, the largest and longest-lived project in the Maya area, was emplaced immediately below one of the largest reservoirs in the ancient city.



Room 1, *Bonampak, Maya Classic Period, 790–800* A.D.

MANY ARCHAEOLOGISTS now recognize three kinds of reservoirs at Tikal, distinguishable by their location within the site. The core of the city, half a square mile containing several plazas, palaces and ceremonial temples, rests on a ridge slightly elevated above the other ruins. In and around this center are six reservoirs, each with a volume great enough to cover a football field several feet deep in water. Those water sources, known as central precinct reservoirs, would have been large enough to sustain through the dry months the 9,800 residents estimated to have occupied the city's core. Most of the storage basins are separated from one another by the elevated roads and causeways—named after the city's early explorers—that link the various portions of central Tikal.

Just below the central ridge and forming a concentric ring around it are the ruins of Tikal's dense residential neighborhoods, where the bulk of the population lived. Here archaeologists have found three sizable reservoirs and several smaller ones, which are little more than depressions, roughly thirty feet across and three feet deep. Those tanks and the three larger ones combined are capable of holding about half as much water on average as the reservoirs on the ridge. In spite of their small size, the reservoirs would have been more than capable of meeting the needs of nearby residents. And although those reservoirs do not appear to be connected to the larger ones above them, archaeologists assume that conduits did once exist. Living close to the reservoir also probably carried—or required—a certain social cachet. The University of California archaeologists Jeanne E. Arnold, of Los Angeles, and Annabel Ford, of Santa Barbara, have found that residential wealth in Tikal was concentrated unevenly around the city. Perhaps the reservoirs served as focuses for development, since the more desirable neighborhoods might have sprung up near such sources of potable water.

Downhill from the residential area, near the foot of the ridge on which central Tikal rests, is a third collection of reservoirs: four large basins approximately equidistant from one another and roughly marking the cardinal directions from the center of the city. In at least two cases they have been found to be connected to the elevated central precinct reservoirs by drainage channels. Because of their proximity to the low-lying wetlands that surround Tikal for miles, the storage basins are called bajo-margin reservoirs. Residents of other Maya cities of the same period are known to have reclaimed and cultivated such wetlands in a very sophisticated and intensive fashion. For that reason some archaeologists assume the bajo-margin reservoirs at Tikal served an agricultural purpose—perhaps to provide water for drained bajo gardens

during the dry season. No remnants of agricultural plots have been found at the site, but any solid evidence would have been destroyed centuries ago by the heavy, erosive rains of the tropics.

ALTHOUGH EARLY ARCHAEOLOGISTS recognized the effort required by the Maya to build such reservoirs, the complexity of the water-management system at Tikal was not fully appreciated until recently. In 1990 Gary G. Gallopin, a former graduate student of mine at the University of Cincinnati, and I reexamined the site maps drawn by Carr and Hazard and from them determined the magnitude and direction of water flow in the ancient city. Previous investigators had never asked precisely how the reservoirs were filled or how they were linked. Our analysis provided compelling insights.

It is now clear that the landscape of Tikal was sculpted to allow the physical force of gravity to draw water to the community. Gallopin and I focused in particular on six large paved or semipaved areas, ranging from twenty-two to 155 acres, in and around Tikal. Those areas may have been the sites of houses, markets or ritual activities. In addition, however, Gallopin and I noticed that the paved areas are slightly canted toward the reservoirs, which lay directly at their feet. We surmised that they directed rainfall that ran off the plastered surfaces of the temples and plazas and channeled it to the storage basins in the central precinct of Tikal or downhill into the bajo-margin reservoirs. In effect, the Maya had built a watershed.

By noting the rates of monthly rainfall and evapotranspiration, and by calculating how much water seeped through the individual catchments, Gallopin estimated the amount of water that entered the various reservoirs. The largest catchment area, for instance, located in the central precinct, allowed the least seepage through its plaster surface; Gallopin determined that it would collect more than 200 million gallons of water a year, easily filling the six large reservoirs on the ridge. Similarly, overflow from the central precinct catchment and runoff from the other five would fill to capacity the reservoirs farther downslope, including the ones at the bajo margins.

The watershed was designed to accommodate the seasonal variability of rainfall, the absence of permanent streams and springs, and the gentle topographical relief of the region. Putting gravity to work, the ancient Maya could replenish the water stores of the residential population within and near the central precinct, even during the dry season. Controlled release of water from elevated reservoirs to downslope storage basins also would have supplied crops with needed moisture in the months of drought. Although the water stored in the bajo-margin reservoirs might be contaminated with human by-products after passing through the residential neighborhoods, it would have been more than adequate for agricultural purposes.

WATER, OF COURSE, is crucial to economic success, especially in regions where that resource is scarce. The American West offers a case in point: By damming major rivers and tapping into vast underground aquifers, farmers have transformed an otherwise dry landscape into a verdant and profitable agricultural mecca. There, water is as valuable as gold or oil. Mounting evidence that the water supply is dwindling, however, has made it clear that the region's prosperity is fragile. Water rights grow more expensive as the supply shrinks, and disputes over who may have access to it become ever more fractious.

Circumstances would have been no different for the Maya of the late classic period. Although many ends—political, economic, religious—may have been satisfied in building a monumental city such as Tikal, the construction of a watershed would undoubtedly have accelerated its settlement. Initially, perhaps 2,500 years ago, pockets of civilization sprang up around isolated natural *aguadas*, or water holes, and small, man-made reservoirs. Such water sources could sustain no more than a handful of households, though, and that probably helps explain the dispersed pattern of settlement in the Maya lowlands. But over the centuries more monumental structures, such as the temples of Tikal, came to be built at the ridges of escarpments and hills. Their construction left behind huge rock quarries, many of which were judiciously converted into reservoirs. Water would have flowed from the paved surfaces at a city's center to surrounding reservoirs; the latter were linked by channels, thereby creating an impressively extensive water-management system.

NOW LARGE GROUPS of people could be supported year-round. The evidence at Tikal strongly suggests that large, elevated and centrally located water sources enabled relatively dense populations to aggregate in the immediate area. Not only was there more water for a greater number of domestic consumers; there was more water available for agrarian ends. Water in bajo-margin reservoirs would have kept raised fields moist and productive throughout the year; considering the average capacity of such reservoirs, at least 130 acres could have been supported at Tikal during the dry season, allowing two or perhaps three crops to be grown annually. The city would become even more centralized and its economy and social hierarchy more complex as the prospect of trade, better farming, and goods and services drew more people to it.

The rulers of Tikal no doubt had some physical means of diverting water from the central precinct reservoirs to the immediately surrounding population; schedules of release and access were probably especially strict during the dry season, when conservation was most important. The precise mechanism by which water was thus managed is not yet known. But one thing is certain: the city officials responsible for planning, constructing and maintaining the system and for dispensing the water would have commanded tremendous political leverage. In the modern age of bank scandals and senatorial improprieties, it is easy to look back and imagine corrupt water managers accepting bribes to provide certain Tikal neighborhoods with more than the usual allotment—or threatening to shut off the water supply altogether unless certain favors were granted. Whether such control was actually exercised to influence sectors of the community is perhaps less important than the fact that the elites in charge had the physical option.

The rapidity and severity of the classic Maya collapse has few parallels in human history, and numerous hy-

potheses have been put forth to account for it. Most of them focus on a rising militarism that appears to have swept through the lowland city-states in the seventh or eighth century. Recent discoveries of hastily built fortifications and a more complete decipherment of the existing hieroglyphs suggest that the Maya cities began practicing siege warfare on one another in that period. Arthur A. Demarest of Vanderbilt University in Nashville has speculated that that mode of battle—more destructive than the limited, ritualized forms of conflict that preceded it—may have quickly razed the fragile agricultural life the Maya had taken so many centuries to develop.

STILL, THE QUESTION REMAINS, What could have precipitated social unrest of such magnitude? No single cause is likely. But noting the complexity of the water-management system, Richard E. W. Adams, an archaeologist and Maya specialist at the University of Texas at San Antonio, and I have suggested that the availability of life's most precious resource may have been a significant factor leading to the Maya downfall. By collecting water and carefully managing its use, the Maya could survive seasonal dry spells; indeed, the reservoirs of Tikal and other cities were linchpins to the prosperity of such urban centers. Yet conversely, a civilization so heavily dependent on rainfall would have been severely tested by droughts—induced, perhaps, by a broad shift in climate, or exacerbated by overpopulation—that lasted much longer than the usual few months.

Reservoirs and aguadas at a distance from a major center might continue to hold water and support pockets of people. But in a city of tens of thousands, empty water tanks would have disrupted both the economy and the complex social, religious and political relationships that had developed around them. As the livelihood of the populace became threatened, faith in the rulers and trust in their power would have waned. Desperate for resources and lacking the established principles of societal organization, a thirsty city would likely have become increasingly divided and militant and gradually, after a number of fruitless and destructive territorial battles, extinct.

Archaeologists do not know for certain that the southern lowlands were struck by prolonged droughts in the ninth century. What is known is that the once flourishing Maya cities there were extremely vulnerable to such a threat. In the past few years farmers in California, Texas and the Midwest, as well as consumers who depend on the goods produced in those regions, have grown acutely aware of how overly dependent their wealth is on the earth's fluid bounty. Perhaps the Maya reached the same conclusion: the reservoirs, carefully crafted to allow the people to free themselves from the vagaries of nature, only bound the Maya fate more tightly to them. ●

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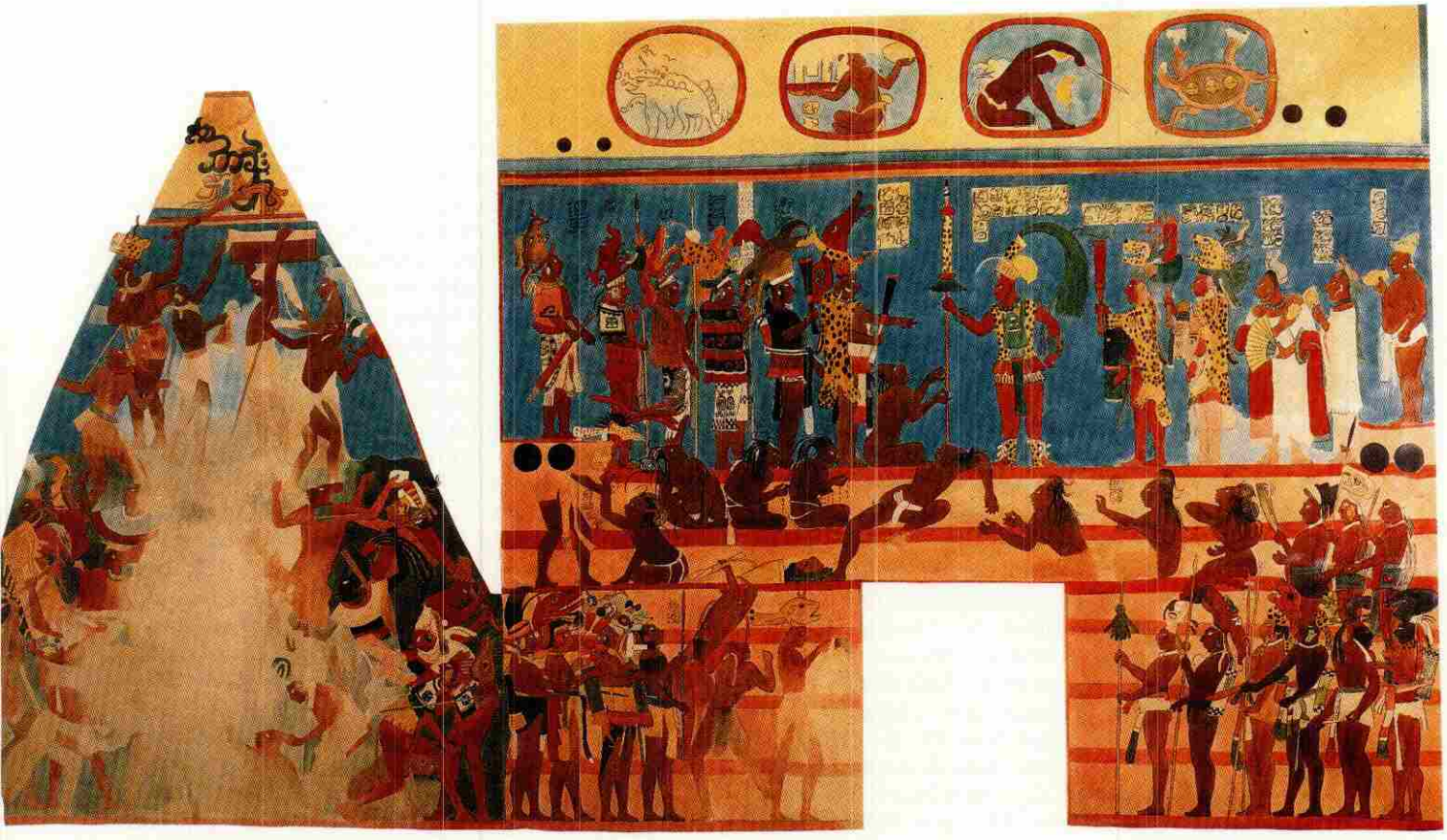

Room 2 *(detail), Bonampak, Maya Classic Period, 790–800 A.D.*