ONE

Water, the Fundamental Resource

This is not a technological issue. The technology is easily available. It is a political and organizational issue. Water is a social good.

—Peter Gleick, in Marq de Villiers (2000:17)

This book represents the first systematic, worldwide study of water management in antiquity. It surpasses previous surveys (Downing and Gibson, eds. 1974; Stewart, ed. 1955; Scarborough and Isaac, eds. 1993) by providing greater breadth. It also proposes fresh concepts and models for understanding water management from ancient times to the present day. These ideas are exemplified in six case studies—three in the Eastern Hemisphere and three in the Western Hemisphere—of early states or state-like developments. Although my bias as an archaeologist is clearly evident, I have also drawn liberally upon ethnographic (anthropological) studies of living peoples to enrich my knowledge of water management in general and to illuminate the prehistoric and protohistoric materials.

As was true in the past, water is the most precious natural resource we can manipulate and control. For organic matter, humans included, the presence of water means life itself. Humans require a minimum of 2 to 3 liters of water a day in a settled environment under normal living conditions (White et al. 1972:252). Obviously, this amount varies with work activity level, body type, and environmental conditions. In the dry sands of the Negev Desert, the settled Nabataeans of the first century AD made some of the earliest successful adaptations to severe aridity (Eadie and Oleson 1986; Oleson 1988). There, a present-day nomadic family (six people, two camels, one donkey, two dogs, and ten sheep) survives on 18 m^3 of water per year (Evenari et al. 1971:150). Compare this with the consumption habits of the average U.S. citizen, who uses more than 225 liters (0.225 m^3) of water daily, or more than 82 m^3 per year (White et al. 1972:table D).

Because water access and use resemble food, sex, and shelter—basic needs always satisfied within culturally prescribed rules—an anthropological approach to this subject is important. These cultural rules, broadly defined, direct the flow of this book.

By illuminating the social origins and maintenance activities associated with the development of complex water systems, we see how humans have engaged fundamental aspects of their economy, political organization, and power relationships. In fact, throughout time a deeply enduring set of factors have affected water allocation and use.

The Importance of Studying Water Management

Water management is—or should be—a pressing contemporary concern as both natural and artificial water resources become severely stressed. For instance, the recent damming of the Euphrates' upstream margins will strengthen an expanding Turkish economy, but the resulting downstream water deficit to Syria and Iraq will surely inflame regional hostility. Interestingly, this very region gave birth to one of history's earliest recorded treaties (second millennium BC), an agreement between the city-states of Umma and Lagash that settled water claims along this same Euphrates drainage.

Developed economies, most dramatically typified in the western United States, have altered their most rugged terrain to drain vast regions in directing and concentrating water to other, more arid zones much smaller than the watersheds of origin. The technology and physical effort required for these massive, earthmoving enterprises have cost billions of dollars. Rivers such as the Colorado have been so heavily dammed and diverted that scarcely a trickle of their once raging waters now reaches the sea. Throughout the United States, thousands of miles of concrete canal length complement monumental dam construction. The environmental cost has been heavy. The most recent catastrophe caused by decades of damming and flood control comes not from the semiarid western reaches of the Colorado or Columbia, however, but from the largest river in North America. The engineering history of containing the Mississippi's margins has enabled the building of homes and businesses on the ancient waterway's floodplain. The cost of this reclaimed land will always be high because at unpredictable intervals the generationally recurrent floods will push beyond and rise above the most fortified retaining walls.

Only now, and only in a few affluent Western democracies, the conventional wisdom permitting the highly centralized state to control water systems is giving way. For example, the recent flushing of a short segment of the Colorado River by removing one of its smaller dams is an initial attempt to restore that river's environmental health. This effort acknowledges the severe threat to these great natural watersheds, a perception not yet accepted by much of the developing world.

China's highly publicized Three Gorges Dam, soon to straddle the Yangtze, typifies the current, global water management crisis. Despite the West's widely circulated cautionary tales, the Chinese government insists on constructing this dam of dams, the world's largest hydraulic monument, across one of the great, seasonally inundating rivers of Asia. This technology will contain the "River of Sorrows," aptly named because of its annually destructive swollen force. Most Western civil and hydraulic

engineers would argue strongly against the dam's construction. Of major concern is its location in an area of seismic faulting. Also, the dam will eventually retain tremendous amounts of agriculturally rich sediment, preventing distribution to needy farming communities along the Yangtze's lower reaches. Most frightening, however, is the possible structural weakness from the weight of accumulating sediment against the dam's interior surface, in association with even a mild seismic tremor. Like much of the developing world, though, China regards the West as suspect at best, believing that we do not want to share our wealth and most certainly not our technological advancement. To China, our objection is simply a predictable ideological reaction to its recently acquired technological prowess. China's stance is not necessarily unwarranted, but it places yet another area of the planet in peril.

Many developing-world governments view massive hydraulic installations not only as a significant way to increase food production but also as monumental political symbols challenging the legacy of dependency. Unfortunately, major environmental planning errors may occur in this nationalistic scramble to establish political and economic sovereignty over territorial resources. All too frequently, these errors translate into economic and political turmoil.

A case in point is the Aswan Dam, Egypt's material and symbolic statement against the legacies of British colonialism. The High Dam did help tame the Nile and did generate much-needed electricity. However, it also trapped the rich Ethiopian sediment load that alluviated a ribbon of Egyptian desert for millennia, making possible the food production that supported the world's second-oldest state. Not only has this negatively affected cropping cycles, but also the Nile Delta is eroding because of Mediterranean current action against it—a force formerly neutralized by the prograding deltaic sediments deposited from the river's heavy silt load. Furthermore, the impossibility of effectively dredging the dam means that it will eventually hold much less water as an abundance of fertile but unrealized planting soils displaces its volume.

The Aral Sea is another case. In the last generation before the total meltdown of the Soviet economy, water from this freshwater sea was pumped and diverted for commercial cotton production many kilometers away. A substantial region now depends on this crop and the water it requires. Unfortunately, the sea has a very slow recharge rate, so sea level has dropped dramatically. Salinization is an increasing concern for both the faraway cotton fields and the expanding shoreline. The fishing industry has failed, and its fleets now rest on dry land.

Fortunately, conflict and disruption constitute just one aspect of water system organization. More frequently, water management and the allocation systems developed from the interplay between the physical and cultural environments accentuate cooperative organization. These result in the equitable sharing of water through a consensus often sanctioned by formality and law. As in religious systems, the more flexible and encompassing the rules of access and usage are, the more lasting and resilient the water management system. Stated differently, the systems with the best chance for uninterrupted longevity have slowly evolved on the highly variable landscapes from which people make a living. Even under appreciable stress, water

management systems tend to persevere because of their adaptability. This aspect of water management receives less attention because it is less spectacular than the origin or collapse of a system. Nevertheless, societal maintenance and sustainability deserve greater scrutiny in our rapidly changing world.

The Study of Ancient Water Management

This book treats water management in the early state as an economic and political force—an aspect of the production mode, the social relations organizing culture—to identify basic variables for assessing the adaptational effectiveness of cultural organization. Doing so entailed examining the everyday tasks and routines that influence decision making in the management of water resources. For this, I drew upon the ethnographic record to define the range and organization of mundane activities sustaining adequate water access and use in varied environments and sociocultural milieu. I then applied this knowledge to the material remains of the earliest civilizations (states) as an aid to understanding their water systems, economic scale, and political organization. I have attempted to show how water management affected ancient social structures and organization and how feedback from a highly engineered physical environment (transformed by the culture) influenced subsequent decision making as economic and political complexity increased.

Considerable variation exists among early states and the environments in which they evolved. Accordingly, I have very carefully selected six case studies that demonstrate the social and environmental conditions leading to sociocultural complexity (see figure 1.1). Cultural anthropologists may ask why I did not simply assess six contemporary groups from dissimilar environments and look for the kinds of underlying organizational themes I identify from the less nuanced archaeological record. Without putting too fine an edge on it, my rationale is that an examination of the earliest states exposes environments less abused and influenced by previous occupants, who were simple hunter-gatherers in some cases. Because archaeologists invest considerable energy in getting to know the natural environments of the ancient groups we study, we can address degrees of sustainability on the landscape through time. Thus, when archaeology—the study of the material remains, the unevenly preserved remnants, of an ancient past—is informed by the ethnographic record, its longitudinal time depth provides a better view of landscape and cultural sustainability than any other data set.

By examining six very different early state developments in widely varied environments, I present a broad range of cultural manifestations and the interplay of landscape and culture. Beneath their variability, we can discern certain fundamental, underlying economic relationships that react in broadly predictable ways when stimulated by similar environmental and cultural conditions. Divergent cultural paths, on the other hand, are attributable to the complexity of the variables confronted and the multiplicity of histories woven into past cultural patterns. This book attempts to elucidate the character of the economic variables present in complex societies. Although

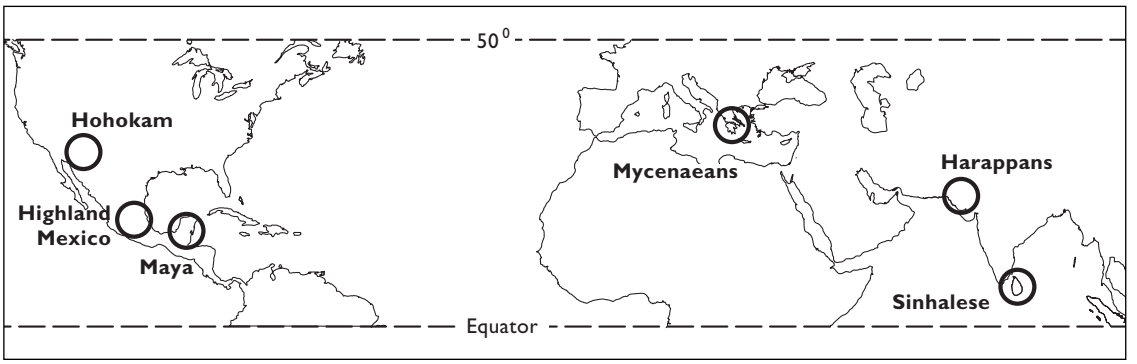

Figure 1.1 Location of the six regional case studies, prepared by Sarah Stoutamire.

I concentrate on the early state, many forces and social relations that gave rise to past sociocultural complexity are also relevant to today's world—despite huge quantitative differences in technology and qualitative differences in modes of production, means of distribution, and patterns of consumption.

My rationale for selecting certain early states or areas of the world and not others involved the following:

1. The scale and complexity of the groups involved
2. The climatic and geomorphological conditions affecting water management decision making
3. The quality and availability of information
4. My firsthand knowledge of certain archaeological data sets

The case selection enables such contrasts as those between the canal and lake/reservoir systems of highland Mexico and the human-made microwatersheds of the Maya Lowlands (Scarborough 1993a, 1994a, 1998; Scarborough and Gallopin 1991). In South Asia, early Harappan society tethered to the fertility of the lower Indus is juxtaposed with the huge tank systems of the ancient Sinhalese. These juxtapositions show that the organization of labor for constructing and maintaining watershed and reservoir sources differs markedly from purely distributary canal systems. Grounded in ecology and economy, such comparisons permit meaningful cross-cultural linkages.

Within their respective hemispheres, the New World (highland Mexico and the Maya Lowlands) and the Old World (the Indus Valley and north-central Sri Lanka) cases are in relative proximity and may have cross-fertilized each other's development. At the same time, though, each hemisphere allows the study of an arid setting and a humid setting. In addition, the book includes two secondary zones influenced by neighboring primary civilizations: the prehistoric, canalized U.S. Southwest and Late Bronze Age Greece (Mycenaeans). Inclusion of the Mycenaeans adds an example of spring-dependent hydraulic systems to the book's technical range. From these case studies, I make a formal division between still-water schemes (reservoirs, lakes, and spring containment) and flow-water schemes (canal organizations). This distinction permits a broad-based comparison of hydraulic adaptations among early states.

The selection of these examples reflects my contention that environment is a necessary variable in any discussion of water manipulation and the development of early archaic states. Accordingly, to make meaningful interhemispheric comparisons, similarity of environmental settings had to be a factor in my selection of prehistoric cases—three examples from the Old World juxtaposed with three from the New World. Additionally, the Maya Lowlands, the Basin of Mexico, and the Sonoran Desert of the U.S. Southwest form a logical comparative set within the New World, given their diverse environments and relative proximity. Their south-to-north latitudinal progression provides a degree of environmental control while spanning a semitropical rain forest setting, an elevated and topographically complex basin, and an arid surround interrupted by an important but diminutive set of drainages.

Two New World areas that gave rise to important early states—the Valley of Oaxaca and Peru—were not chosen, for the following reasons. The archaeology of the Valley of Oaxaca is not as well known with regard to water management, although I do refer to it on several occasions. Furthermore, I selected cases to provide contrasts, and Oaxaca is a diminutive version of what is better reported in the Basin of Mexico. I do not use Peru as a case study because I have not worked in the area and because the highland example I chose for the New World is the Basin of Mexico. However, this book does not ignore Peru's sizable corpus of water management data, much of it well documented and creatively interpreted. I present Peruvian data sets frequently throughout the book, especially in chapters 4, 5, and 6.

In the Old World, selection was more difficult because of the highly diverse set of cultures occupying the landscape through time. My selection of Harappan systems reflects, in part, my long-term fascination with that cultural area. Furthermore, by including it, I could juxtapose Old World environments in a manner similar to the New World comparisons. Using either Mesopotamia or Egypt as a principal case study would have prevented the highlighting of linkages between an arid, riverine setting (the Indus) and a semitropical setting (Ceylon) for the early archaic state. I occasionally discuss ancient Mesopotamia and Egypt, however, and present considerable Mesopotamian ethnographic material in various sections. Because the semiarid environments of the great riverine civilizations along the Nile, the Tigris and Euphrates, and the Indus have much in common, I decided to include only one of them (the Indus). By including Late Bronze Age Greece (Mycenae), I could examine a more topographically rugged water system associated with the early archaic state. It might be best contrasted with the Basin of Mexico. Again, what I strived to attain was a similar south-to-north comparative package of culture areas in the Old World and the New.

Much explanation is necessary, however, before using the six archaeological case studies to build an adequate anthropological framework for the study of water management. For two reasons, I begin with prominent ideas of past students of water management. First, we must not needlessly reinvent the good ideas of our predecessors or pretend that their ideas are our own inventions. Second, we must dissect their

work if we are to overcome some false starts that are inherent in the literature and impede further understanding. Chapters 2 and 3 accomplish these tasks. Chapters 4 and 5 carry out the next step, namely, explicating the physical properties of water that affect its management by humans, as well as the means of such cultural management in both Old and New Worlds. Because neither subject (water or water management) is self-evident or even familiar in useful detail to the average reader, chapters 4 and 5 provide a necessary prelude to the case studies. The economic outlays and political risks of water management, discussed in chapter 6, also require detailed discussion. The archaeological case studies follow in chapter 7 (New World) and chapter 8 (Old World). Chapter 9 readdresses the book's main themes and places them in the comparative context of the case studies. It also returns to the theme of centralization and addresses the significance of control and power.