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THE GREAT WARMING

CLIMATE CHANGE AND THE RISE AND FALL OF CIVILIZATIONS

BRIAN FAGAN
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The Great Warming

Climate Change and the Rise and Fall of Civilizations

Brian Fagan

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CHAPTER 13

The Silent Elephant

I have seen a herd of elephants traveling through dense native forest... pacing along as if they had an appointment at the end of the world.

—Isak Dinesen, Out of Africa

AN ARID LANDSCAPE IMPRINTS ITSELF on your mind. I remember as if they were yesterday November days of over forty years ago in central Africa. Every morning, after weeks of intense heat, a brazen sun rose from a dusty horizon, not a cloud in the heavens. The temperature climbed as the shadows shortened. A dusty blue parabola of cloudless sky reflected the heat radiating from the parched earth. Occasional gusts of wind propelled williwaws across the grassland. Humans and beasts alike sought the mocking illusion of cool shade under trees or roof eaves. Cattle stood motionless, heads drooping, waiting patiently for the cool of evening. I watched farmers gaze stoically at the maize withering in the cracked fields, planted a month before when a heavy shower brought a promise of more rain. As the sun descended, you deluded yourself that the temperature was falling. But it was still 87 degrees F (30.5 degrees C) at midnight. Hunger was not far over the horizon.

By all accounts, the droughts of the next century will be infinitely worse than this one.

When I started researching this book, I was expecting to find widespread evidence of increasing temperatures a thousand years ago, of startling changes in agricultural practices, and of ocean voyaging and prosperity in environments basking in unaccustomed warmth. The earlier chapters indeed found me exploring a bustling Europe with bountiful harvests. I followed Norse voyagers across the North Atlantic as they developed fleeting contacts with the Inuit of the far north. So far so good—but when I traveled to the Eurasian steppes, to the West African Sahel, and to the Americas, I encountered major and prolonged droughts that changed history.

I stress the word "prolonged." The dry spells of a thousand years ago spanned not years, but generations. The medieval droughts in California's Sierra Nevada lasted for decades, far longer than those of modern times. A long drought cycle lasting half a century triggered major adjustments in Ancestral Pueblo life in the Southwest, as we have seen. Drought settled over Nebraska and the Plains.

The Southwest has always been arid, but is not the only part of North America to suffer drought. Pollen cores from the Piedmont Marsh of the lower Hudson River Valley on the East Coast chronicle drought conditions between A.D. 800 and 1300, times when the estuary became saltier. If similar drought conditions were to prevail in the same area today, the water supplies of millions of people would be endangered, among them the citizens of nearby Poughkeepsie, New York, which draws its water supplies from the Hudson, as do other suburban towns in the area.

Far to the south, in Central America, great Maya cities tottered under medieval drought while Andean civilizations wilted in the face of an evaporating Lake Titicaca and faltering runoff in coastal river valleys. Looking at the global picture, it is tempting to rename the Medieval Warm Period the Medieval Drought Period.
The Great Warming

The revolution in climatology began in earnest about thirty years ago, when techniques for deducing the climatic record from proxies, such as deep-sea cores, ice borings, coral, and tree rings, entered the scientific mainstream. Satellite observations and computer modeling joined the meteorological armory during an explosion of research into El Niños and the Southern Oscillation. Since the 1980s, humanly caused global warming has engaged the attention of climatologists in the face of well-documented, virtually continuous warming since 1860. Suddenly, the climate changes of the past two thousand years have assumed great importance in the public arena as anthropogenic warming has become a scientific reality and a major political issue. For this we must thank not only Al Gore and his documentary on global warming, but also a growing public consciousness that rising temperatures, more extreme climatic events, and higher sea levels are facts of life for humankind’s immediate future.

Almost immediately, the Medieval Warm Period assumed great importance to the debate over warming in many people’s minds.

“We’ve been through this before,” both supporters and debunkers of global warming cried. Claims and counterclaims rocketed across auditoria from Tokyo to Scandinavia, as scientists, journalists, and activists argued over whether the Medieval Warm Period was warmer than the rapidly heating world of today. As new tree-ring sequences and other evidence have become available, so the debate about Warm Period temperatures has intensified, with no end in sight.

The Medieval Warm Period is still a shadowy entity, but we know a great deal more about it than we did in Hubert Lamb’s day. A growing number of sources tell us that there was never long-lasting medieval warmth, but that between 1000 and 1200, temperatures were a few degrees warmer in some parts of the world, notably parts of China, Europe, and western North America.

Today’s preoccupation with medieval warmth is entirely understandable in a time of uncontrolled anthropogenic warming, with all the harrowing threats of melting Greenland ice sheets, rising sea levels, and increased storminess.

What would happen if the melting Greenland ice sheet partially shut down the Gulf Stream? Would Europe be plunged into a near-Ice Age, as indeed happened some twelve thousand years ago during the climatic episode known as the Younger Dryas, named after a polar flower?

What would happen to the Low Countries and to some Pacific atolls if sea levels rose as much as a foot (0.3 meters) or more by century’s end as a result of partially melted ice sheets?

These are perfectly legitimate concerns, which will require concerted political will to solve in coming generations. But our preoccupation with heat and rising sea levels ignores an even greater threat: drought. Why this surprising neglect? Undoubtedly the devastation of the Southeast Asian tsunami in 2004 and Hurricane Katrina the following year reinforced fears about extreme weather events and flooding in particular. But these two events, coming in two of the warmest years since the Ice Age, seem to have delivered a message that warmer centuries mean more rain, not less. Then there’s another reality: most, though not all, of the people likely to be affected by severe drought in the future live in the developing world, and we in the United States are still much preoccupied with the flooding brought by Katrina.

I could hear the Zambezi River riffling in the rocky shallows, in the distant background the unceasing roar of Mosi-oa-Tunya, “The Smoke That Thunders,” Victoria Falls. Dense bush pressed on the clearing, trees arching overhead, dry leaves rustling softly in the afternoon heat. I was completely alone—or so I thought. Then I heard the sound of trampling and crashing branches; I realized with horror that I had walked into the midst of a small herd of elephants. The great beasts were invisible but close by, seemingly unaware of my presence. I tiptoed back the way I had come until I emerged from the trees. As I reached the Zambezi, I looked back. A huge bull elephant flapped his ears at me, feet firmly set in the shallows. He watched closely, unmoving, as I beat a careful retreat.

Elephants can tread delicately when they wish and can easily become invisible until it is too late to avoid them.
When the novelist George Orwell, of *1984* fame, was a police officer in Burma in the 1930s, he was confronted with a beserk elephant in a bazaar. At a distance, “peacefully eating, the elephant looked no more dangerous than a cow.” But the beast had killed a man, and “a mad elephant had to be killed like a mad dog.” Orwell was struck by the violent contrasts in his by now seemingly placid prey. And so it is with drought. As my research progressed away from Europe, I realized that drought was the hidden villain of the Medieval Warm Period. Prolonged aridity was the silent elephant in the climatic room, and the unpredictable swings of the Southern Oscillation were what brought the beast through the door.

A surge in ENSO research over the past twenty years has revealed that El Niños, and their sister La Niñas, are not merely local phenomena, but, next to the passage of the seasons, among the most powerful factors in global climate change. Major ENSO events bring heavy rainfall and floods to the Peruvian coast and torrential precipitation to California; they reduce the frequency of tropical storms and hurricanes in the Atlantic. They also bring severe drought to Southeast Asia and Australia, to Central America and northeast Brazil, and to parts of tropical Africa. The less conspicuous, and often longer-lasting, La Niña can be just as destructive, especially in its ability to nurture drought over large tracts of the world—as was the case during the Medieval Warm Period, when the cool, dry sister of El Niño persisted for years on end.

But if you look at the warm centuries with a global perspective, the wide incidence of drought is truly striking and offers a sobering message about tomorrow’s world. Prolonged aridity was widespread in medieval times and killed enormous numbers of people. Evidence is mounting that drought is the silent and insidious killer associated with global warming. The casualty figures are mind numbing. About 111 million people between Kenya, Somalia, Ethiopia, and Eritrea were in serious danger of starvation as a result of multiyear droughts in 2006. The International Institute of Tropical Agriculture in Nigeria estimates that by 2020 around 300 million people in sub-Saharan Africa, nearly a third of the population, will suffer from malnutrition because of intensifying drought. (Relatively few people die of hunger during a drought. They perish from epidemics of dysentery and other diseases spread by poor living conditions. For instance, 1.6 million children a year die today because of a lack of access to good sanitation and clean drinking water.)

The long-term future is even more alarming. A study by Britain’s authoritative Hadley Centre for Climate Change documents a 25 percent increase in global drought during the 1990s, which produced well-documented population losses. The Hadley’s computer models of future aridity resulting from the impacts of greenhouse gas emissions are truly frightening. At present, extreme drought affects 3 percent of the earth’s surface. The figure could rise as high as 30 percent if warming continues, with 40 percent suffering from severe droughts, up from the current figure of 8 percent. Fifty percent of the world’s land would experience moderate drought, up from the present 25 percent. Then the center ran the model without factoring in the impact of greenhouse gases, which they assumed were the temperature change villains. The results implied that future changes in drought without anthropogenic warming would be very small indeed.

In human terms, the United Nations Environment Program reports that 450 million people in twenty-nine countries currently suffer from water shortages. By 2025, an estimated 2.8 billion of us will live in areas with increasingly scarce water resources. Twenty percent of the world’s population currently lacks access to safe, clean drinking water.
Contaminated water supplies are a worse killer than AIDS in tropical Africa. If the projected drought conditions transpire, future casualties will rise dramatically. The greatest impact of intensifying drought would be on people already living in arid and semiarid lands—about a billion of us in more than 110 countries around the world. And those who would be hit hardest are subsistence farmers, especially in tropical Africa. Seventy percent of all employment in Africa is in small-scale farming, and completely dependent on rainfall.

The number of food emergencies in Africa each year has already almost tripled since the 1980s, with one in three people across sub-Saharan Africa being malnourished. The Nigerian institute's projection for 2020 is just the beginning. Future drought-related catastrophes will make these preliminaries seem trivial and could affect more than half of tropical Africa's population.

Peru offers another frightening example. The Cordillera Blanca, the largest glacier chain in the tropics, is melting fast because of rising temperatures. The Quelccaya ice cap in southern Peru, a crown jewel of climatic data, is retreating about 197 feet (60 meters) a year, three times faster than in the 1960s. Taken as a whole, the Peruvian Andes have lost at least 22 percent of their glacier area since 1970. Two thirds of Peru's 27 million people live on the coast, where only 2 percent of the country's water supply is to be found. A thousand years ago, with many fewer people to feed, the lords of Chimor could adapt their irrigation strategies to prolonged droughts. Their modern successors, living in crowded cities, shantytowns, and an increasingly congested rural landscape hemmed in by desert, cannot do so.

Droughts are expensive in human terms and also carry a high economic price. The notorious Dust Bowl droughts of 1934-40 over the Great Plains scarred an entire generation. Three and a half million people fled the land. Many suffered from typhoid and other diseases, also long-term health effects like higher risks of cancer and heart disease, but exact casualty figures are not available. The midwestern drought of 1950 to 1956 brought extreme heat, ruined numerous farmers, and reduced crop yields in some areas by as much as 50 percent. The 1987-89 drought covered 36 percent of the United States, less than 70 percent of the area affected by the Dust Bowl, but with an estimated cost of $39 billion, which makes it one of the most expensive natural disasters in American history. The dry conditions fanned huge wildfires in the West and caused serious navigational problems due to drought-related shoaling in the upper Mississippi basin. As a comparison, and to give some insight into the potential costs of really huge future climatic disasters, 2005's Hurricane Katrina has cost $81 billion so far, and that figure is rising.

History tells us that droughts have long wreaked havoc, especially in the tropics. At desert margins and in semiarid environments, the pump effect comes into play as faltering rainfall pushes animals and people out to better-watered margins. In a telling analysis of nineteenth-century droughts, the historian Mike Davis has estimated, conservatively, that at least 20 million to 30 million people, and probably many more, most of them tropical farmers, perished from the consequences of harsh droughts caused by El Niños and monsoon failures during the nineteenth century, more people than in virtually all the wars of the century.
The Victorian famines are relatively well documented, although, as Davis points out, his fellow historians often ignore them, for the victims who perished were mostly unlettered and their lives unrecorded.

The mortalities for earlier famines, like those that must have occurred during the Medieval Warm Period, are lost to history. An estimated 1.5 million medieval Europeans perished as a result of famine and famine-related diseases during the great rains of 1315–21, which ushered in the Little Ice Age. The casualties among Chinese peasants in the Huang He Valley, among farmers in the coastal river valleys of the Andes, and in the American Southwest must have been significant, especially since many people lived in crowded villages, towns, and pueblos with but rudimentary sanitation. Twentieth-century experience provides a point of comparison. The Chinese famine of 1907 killed an estimated 24 million people. Over 3 million perished in the drought of 1941–42. One and a half million Indians died in the famine of 1965–67, as a result of monsoon failure. Between a quarter of a million and 5 million Russians were victims of a drought in the Ukraine and Volga regions in 1921–22. All of these disasters occurred when global populations were much smaller than today. When one realizes that droughts in the sparsely inhabited Saharan Sahel claimed over 600,000 lives in the droughts of 1972–75 and again in 1984–85, one can only imagine what the magnitudes of these disasters would have been had farming populations been at today's levels.

I hadn't realized until I researched this book just how remarkably flexible human societies were in much of the world a thousand years ago. During the Medieval Warm Period, a high proportion of the earth's population lived in drier environments like those that had nurtured the first civilizations some five thousand years ago. Cities were much smaller, with populations numbering in the tens of thousands, not the millions, which made it easier to adopt strategies for riding out climatic shifts. Every society living in marginal environments for farming developed coping mechanisms. The Ancestral Pueblo of the American Southwest maintained kin ties with distant communities and were prepared to move when droughts came. The Maya stored water at the village and city level. Chimu lords in coastal Peru built elaborate canals and distributed irrigation water with sedulous care. Mande farmers in West Africa's Niger basin developed complex social mechanisms that handled the realities of sudden climatic change, while California Indians stored acorns and depended on their neighbors to make up for food shortfalls.

All of these societies, and others we've described in these pages, were vulnerable to drought. For the most part, with the notable exception of monsoon India and China, they rolled with the climatic punches like trees buffeted by a strong wind. Some environments, like the loess lands of northern China, were so unpredictable that famine was chronic even in years of good rainfall, when floods inundated and saturated thousands of acres of arable land. But in general the human societies of a millennium ago were less vulnerable than we are. There came a point, however, when a society reached a critical mass, a density of urban population and nonfarmers that was unsustainab e in drought cycles, or an agricultural economy that had exhausted the land and all opportunities for diversification. The Maya of the southern lowlands of Mexico and Guatemala are a dramatic case in point, where a combination of endemic warfare, rigid governance, environmental degradation, and drought dealt a crippling blow to dozens of towns and great centers. The great lords and the mechanism of state disintegrated and the people dispersed into the subsistence farming villages of a thousand years before. We're dazzled by the splendors of Angkor Wat and Angkor Thom in Cambodia, but, like the Maya, the Khmer lived on the edge of the slippery slope that led downward from self-sustainability.

Fast-forward to the nineteenth century, to the height of Victorian imperial power, where threats to send a gunboat were a powerful diplomatic tool and the technologies of communication and transport—telegraph, steam, rail—ininitely more effective than those of medieval times. A global economy was emerging, founded in great part on grain prices. Yet the nascent vulnerability of the Medieval Warm Period increased a thousandfold. Mike Davis's conservative estimate of twenty million to thirty million casualties sustained, for the most part on the
dark, unwritten side of history, beggars the imagination. His figures are from a time when the proportion of the world’s population living in semiarid and monsoon lands was a fraction of what it is today.

In the early twenty-first century, some 250 million people live on agriculturally marginal lands, at direct risk from droughts caused by ENSO events, by arbitrary swings of the Southern Oscillation. There are far more instances than those mentioned in earlier chapters. Northeastern Brazil has suffered from major droughts repeatedly, many of them caused by El Niños; Indonesia and Australia are at the mercy of ENSO droughts, to mention only three examples.

Today, the number of people in the world who are highly vulnerable to drought is enormous and growing rapidly, not only in the developing world but also in densely populated areas such as Arizona, California, and southwestern Asia. Judging from the arid cycles of a thousand years ago, the droughts of a warmer future will become more prolonged and harsher. Even without greenhouse gases, the effects of prolonged droughts would be far more catastrophic today than they were even a century ago.

Droughts nurture crop failure and allow pastureland to dry out. The same droughts cause rivers to dry up and turn small streams into dry watercourses. Water is the lifeblood of humanity—for agriculture, for herds, for the animals people once hunted, and for drinking. The Chumash Indians of southern California suffered greatly during droughts, not because they lacked food, for they had plenty of fish, but because of a lack of clean water. Crowded into fishing camps and densely inhabited villages near increasingly scarce water supplies, they relied on polluted drinking water, with the inevitable onslaught of disease caused by poor sanitation. The same was true of the British Raj’s Indian famine camps in the late nineteenth century, also of ancient eastern Mediterranean cities.

Now, with warming accelerating, the stakes for humanity are much higher. Today, we harvest water on an industrial scale—from rainfall, from rivers and lakes, and from rapidly shrinking water tables. Many of us live off looted supplies, brought by aqueduct from the Owens watershed, culled from the Colorado River, and taken from artesian wells, aquifers that will one day run dry. With respect to California, it’s sobering to remember that the past seven hundred years were the wettest since the Ice Age. We have experienced droughts, but none of them have endured like those that descended on the Sierra Nevada a millennium ago.

Today, we are experiencing sustained warming of a kind unknown since the Ice Age. And this warming is certain to bring drought—sustained drought and water shortages on a scale that will challenge even small cities, to say nothing of thirsty metropolises like Los Angeles, Phoenix, and Tucson. The Ogallala aquifer, an enormous underground reserve that supplies eight states from Nebraska to Texas, is being depleted at a rate of 42 billion gallons a year. When one hears that an expanding Las Vegas is trying to buy up water supplies from outlying Nevada ranches, one wonders what the future will hold. Will a day come when the hotels on the Strip run out of water because the aquifers have run dry? In terms of water, if the lengthy droughts of a millennium ago were to return, much of the western United States is living on borrowed time.

According to UNESCO, the world has plenty of fresh water, albeit unevenly distributed. But if you look more closely you’ll see that, owing to mismanagement, limited resources, and environmental change, almost one fifth of the world’s population still lacks access to safe drinking water. Forty percent do not enjoy basic sanitation. In raw figures, UNESCO estimates that 1.1 billion people do not have drinking water supplies, and about 2.6 billion lack basic sanitation. 9 Over half of these people live in China and India, millions more in tropical Africa. These figures come at a time when natural disasters involving water, or its lack, are on the rise. By 2030, UNESCO also estimates, the world will need 55 percent more food, which translates into a growing demand for irrigation, which already claims 70 percent of all fresh water consumed by humans. Then there is the huge increase in urban populations. UNESCO researchers estimate that two thirds of humanity will be urban dwellers by 2030, an estimated 2 billion of them in squatter
settlements and slums. The urban poor suffer the most from lack of clean water and sanitation.

The lesson of the Medieval Warm Period for our time is subtle yet alarming. Our journey through the warm and drought-ridden world of a thousand years ago revealed a great diversity of human societies, many of them interconnected by ever-changing economic and sociopolitical ties.

Our travels have taken us down the highways and seaways of a nascent global economy, through a world where interconnectedness and interdependency were beginning to become sustained political realities. We traveled through a time when, on the whole, people lived conservatively, with a good weather eye for risk. Now we confront a future in which most of us live in large and rapidly growing cities, many of them adjacent to rising oceans and waters where Category 5 hurricanes or massive El Niños can cause billions of dollars of damage within a few hours. We’re now at a point where there are too many of us to evacuate, where the costs of vulnerability are almost beyond the capacity of even the wealthiest governments to handle. The sheer scale of industrialized societies renders them far more vulnerable to such long-term changes as climbing temperatures and rising sea levels.

This is the immediate crisis of global warming in human terms and it requires not a short-term response but massive intervention on a truly international, and long-term, scale.

We’re not good at planning for our great-grandchildren, yet this is what is required of our generation and of those who follow us. There’s a political temptation to announce some short-term palliatives and then to claim that we have made a significant contribution to the battle against global warming. Unfortunately, we are past the moment when we can rely on short-term thinking. Drought and water are probably the overwhelmingly important issues for this and future centuries, times when we will have to become accustomed to making altruistic decisions that will benefit not necessarily ourselves but generations yet unborn. This requires political and social thinking of a kind that barely exists today, where instant gratification and the next election seem more important than acting with a view to the long-term future. And a great deal of long-term thinking will have to involve massive investments in the developing world, for those most at risk.

We can’t afford to think in provincial terms, of only the drought problems in our own backyards. The warm centuries of a thousand years ago show us that drought is a global problem. Today, we’re all interconnected. The experience of the Medieval Warm Period shows how drought can destabilize a society and lead to its collapse. Today, destabilizing forces can jump local boundaries. If we look at how the chance to earn a better living has drawn millions from Latin America across U.S. borders, imagine how many people might uproot themselves if the choice were between famine and food. Many futurists believe the wars of coming centuries will not be fought over petty nationalisms, religion, or democratic principles, but over water, for this most precious of all commodities may become even more valuable than oil. They are probably correct.

How much longer can we remain detached? What will today’s casualty figures be like if the droughts projected by the Hadley meteorologists come to pass? They’ll be catastrophic, far more so than nineteenth-century fatalities revealed by Mike Davis, and could produce frightening scenarios. Are we looking, for example, at a time when enormous, uncontrollable mass migrations of people fleeing hunger and drought will burst across territorial boundaries? Such population movements are not beyond the realm of possibility.

It’s been easy for us to forget that millions of people still live at the subsistence level and use basically medieval technologies to wrest a living from the soil. We can no longer afford benign ignorance, for the long-term perils of chronic drought connect all humankind in ways that we are only just beginning to understand. In an earlier book, I described industrial society as a huge supertanker that takes many miles to stop and maneuvers slowly.10 I accused our society of being oblivious and inattentive, of ignoring the climatic danger signals that lie ahead.

Thanks to a new generation of science and thanks to activists ranging from Al Gore to university students, global warming has become a political issue and a topic of fascination for the chatterers. Yet, it's
striking, and very frightening, that the elephant of drought is still so widely ignored.

History is always around us, threatening, offering encouragement sometimes showing us precedents. The warm centuries of a thousand years ago remind us that we have never been masters of the natural world; at our best, we have accommodated ourselves to its fickle realities. As the Khmer and the Maya show us, the harder we try to master it, the greater our risk of sliding down the hazardous slope of unsustainability. We should accept this reality and not be frightened by a future where we are not the masters; we must cease trying to assume that role. The people of a thousand years ago remind us that our greatest asset is our opportunism and endless capacity to adapt to new circumstances. Let us think of ourselves as partners with rather than potential masters of the changing natural world around us.

Acknowledgments

The Great Warming is the culmination of over a decade of thinking and writing about ancient climate change. It treats of a subject that is still little known, information about which is scattered in obscure academic literatures in dozens of languages. I’ve attempted to produce a synthesis that is very much my own take on a confusing jigsaw puzzle of archaeology, history, and paleoclimatology. I am, of course, responsible for the conclusions and accuracy of this book, and, no doubt, will hear in short order from those kind, often anonymous individuals who delight in pointing out errors large and small. Let me thank them in advance.

The research for this book involved consulting a large number of busy specialists, who were invariably courteous and often startlingly prompt in their replies. I am deeply grateful to them for taking my importunings seriously. It’s impossible to name everyone, but my long list of indebtedness includes Reid Bryson, Roseanne D’Arrigo, Carole Crumley, Ronald Fletcher, Michael Glantz, Michael Glassow, John Johnson, Doug Kennett, Ian Lindsay, Roderick McIntosh, George Michaels, Dan Penny, Mark Rose, Vernon Scarborough, Chris Scarre, Scott Stine, and Stan Wolpert.

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Finally, and as always, my thanks to Lesley, Ana, and our menagerie, who have suffered through the pains of writing with amused tolerance. In fact, I've just been delayed for five minutes by a cat sitting on the keyboard demanding attention. Life is always interesting around here.

Brian Fagan
Santa Barbara, California

Notes

The literature on the societies described in these pages is enormous and growing rapidly, but is dwarfed by the current tidal wave of publications on ancient and modern climate change. New journals and books appear daily. Many of them are, of course, highly specialized and of little relevance to these pages. The references that appear below provide a good cross-section of the literature as of mid-2007 and contain useful bibliographies for those wishing to probe deeper.

Preface

1. For the benefit of those confused by the terms “climate” and “weather,” climate is the accumulation of daily and seasonal weather events over a long period of time. Weather is the state of the atmosphere in terms of such variables as temperature, cloudiness, rainfall, and radiation at a moment in time. In other words, climate is cumulative experience, weather is what you get.

2. Lamb's “Medieval Warm Period” is the most commonly used term to describe what he perceived as a period of medieval warming. Many climatologists rightly question whether the term has global validity, on the grounds that it is not well defined and was, in fact, a period of highly variable climatic conditions. Others use the term “Medieval Climatic Anomaly.” In the interest of clarity, I have used “Medieval Warm Period” to the exclusion of other terms, although I occasionally refer to “the warm centuries” as a generic term, even if the centuries weren't all warm. Experts may cavil, but, after all, “Medieval Warm Period” is convenient, in common use, and widely known. And most serious students of the subject know that the term is something of a misnomer.


CHAPTER 4

The Golden Trade of the Moors

They start from a town called Sijilmassa . . . and travel in the desert as it were upon the sea, having guides to pilot them by the stars and rocks in the deserts.

—Anonymous, Toffut-al-Alabi (twelfth century).1

In July 1324, the sultan of Egypt welcomed a truly exotic visitor. Mansa Musa, ruler of the West African kingdom of Mali, was on a pilgrimage to Mecca. Hundreds of camels and slaves carried gold staffs and lavish gifts across the desert. Mansa Musa held court in Cairo for three months. To the Egyptians’ astonishment, his subjects prostrated themselves before him and poured dust on their heads. The Malians injected so much gold into the Egyptian economy that the value of this most precious of metals decreased between 10 and 25 percent for some years. Tales of the African kingdom and its fabulous wealth reverberated through the Christian and Muslim worlds. By the end of the fourteenth century, two thirds of Europe’s gold came from Mali, transported by camel across the Sahara. This “Golden Trade of the Moors” linked two very different worlds, those of the Mediterranean and of the western Sudan in West Africa, Bilad es-Soudan, what Islamic geographers called “the Land of the Blacks.”
sand years ago, Lake Chad, on the southern boundaries of the desert, covered a larger area than Eurasia's Caspian Sea. Today, Chad is drying up rapidly. During good rainfall years, the desert absorbs animals and people, often far north of Lake Chad. When drought years descend on the Sahara, water sources and grazing dry out, and the sparse desert populations move out to better-watered areas. The Saharan pump is never still; it is sometimes quiescent for a few years, then gyrates wildly during periods of highly variable rainfall from one year to the next. This is the story of the gold trade of a thousand years ago between the Islamic world and West Africa. The trade thrived through the warm centuries thanks to the highly adaptable camel and because those who handled the gold at the African end engineered their society to accommodate the sudden climatic extremes that marked the Medieval Warm Period.

The climatic history of the Sahara and the Sahel, the semiarid grasslands that border the southern margins of the desert, is a relentless chronicle of chaotic shifts, well documented from both modern instrument records and proxy measures from deep-sea cores drilled off Mauritania. We can even link some of these records to the deep-sea cores from the all-important Cariaco basin off Venezuela, described in chapter 8.

The Mauretanian sea cores reveal recent, abrupt changes of 1.0 degree F or more (2.16 degrees C) in the sea surface temperatures of the eastern North Atlantic. At the same time, changes in the salinity of the ocean at different levels can affect the workings of the ocean conveyor belt that is a fundamental driver of global climate, transferring heat as it does from the tropics to northern latitudes. The sea surface temperature in the eastern North Atlantic has a strong effect on the dry winds that blow across the Sahara. If sea surface temperatures are lower in the eastern Atlantic between 10 degrees north and 25 degrees north, and higher in the Gulf of Guinea, the monsoon winds are displaced southward, causing drought in the Sahel and Sahara. We know this because between A.D. 1300 and 1900, cooling documented in the Mauretanian sea cores caused dry conditions in the Sahel, including droughts that may have been worse than the disastrous megadrought of the 1960s. The cores allow us to make a tentative reconstruction of climatic conditions over the past two thousand years, and through the Medieval Warm Period, that goes something like this:

- Between 300 B.C. and about A.D. 300, conditions in West Africa were stable and dry—as they were in both Southeast Asia and the Amazon basin—with rainfall somewhat below modern levels. People moved into better-watered areas like the middle Niger, where towns appeared.

- After A.D. 300, rainfall increased to perhaps 125 percent to 150 percent of today’s level until A.D. 700, a time when a formerly shrunken Lake Chad expanded dramatically (There is no evidence of intervening dry periods, but they may yet be undetected.) Then, between A.D. 900 and 1100, there was an abrupt transition to much more unstable conditions, mirrored by increased monsoon variability in the Cariaco basin on the other side of the Atlantic. At some times there was high, stable rainfall; at others, drought. The Sahara’s margins were constantly on the move.

In an attempt to understand these changes, the climatologist Sharon Nicholson has analyzed colonial meteorological records throughout tropical Africa and identified six different rainfall patterns, or climatic modes, through which African climate has cycled over and over again since the nineteenth century. These modes alternate at random from extreme aridity at one end of the spectrum, characteristic of the Sahel in the 1890s and in the 1960s, through various intermediate and related stages, to disastrous wet shifts, when herds multiplied and overgrazed a new green landscape on the margins of the desert. Today, climate in the Sahel leaps abruptly and without warning from one mode to another in a completely unpredictable manner. It is likely that exactly the same kinds of abrupt shifts occurred during the Medieval Warm Period, creating extraordinary challenges for people engaged in cattle herding, subsistence agriculture, and long-distance trade.

Looking at these changes on a more global scale, we know that a dry year in the Sahel coincides with high pressure over the Azores and low pressure over Iceland. The northeast trades speed up and the Intertropical Convergence Zone stays well south. Southwesterly winds bring less moisture to West Africa. When the sea surface temperature between 10
The Intertropical Convergence Zone (ITCZ)

The northeast and southeast trade winds meet near the equator, forming an area of low pressure. The winds converge and force moister air upward. As the air rises and cools, the water vapor condenses. A band of heavy rain forms, which moves seasonally toward areas where solar heating is most intense, places with the warmest surface temperatures. From September to February, the ITCZ moves toward the southern hemisphere, reversing direction for the northern summer. While the ITCZ moves over land, it shifts much less than over open water, maintaining a near-stationary position just north of the equator. Here rainfall intensifies as solar heating increases, diminishing as the sun moves away. As temperatures warm up, so rainfall increases, diminishing with cooling. El Niño events (see chapter 9 sidebar) have a major effect on the ITCZ, deflecting it toward unusually warm sea surface temperatures in the tropical Pacific and bringing less rainfall to the Atlantic and to the Sahara Desert’s margins.

and 25 degrees north is 3.6 to 7.2 degrees F (2 to 4 degrees C) colder, and the Gulf of Guinea’s waters are unusually warm, then the effect of the Intertropical Convergence Zone weakens. The deep-sea cores also show that the thresholds of many of the mode shifts are marked by very violent transitions in the interior, some of them preceded by extreme cooling spikes. One of these occurred in about A.D. 900, with another at the beginning of the eleventh century. Such unstable phases, with often prolonged droughts—and one stresses the word “prolonged”—would have been periods of remarkable difficulty and change for the Sahelians who experienced them.

What effects, then, did the warmer temperatures and droughts of the Medieval Warm Period have on the Saharan gold trade and on the peoples of the Sahel? As far as the Saharan caravans were concerned, the effects were remarkably small because of the camel, or, more accurately, because of the saddles on camels’ backs.

On the Eurasian steppes, life depended on cattle and horses, on good pastureland. When higher temperatures and drought descended on the grasslands, the nomads moved out in search of pastureland and water. The desolate plains and highlands of the Sahara were not a place where cattle and horses could thrive a thousand years ago, even if the rainfall increased slightly. In classical times, the desert was a fearful wilderness. Herodotus remarked that Libya on the Mediterranean coast was “infested by wild animals. Further inland from the part full of animals Libya is sandy desert, totally waterless, and completely uninhabited by anyone or anything.” Only a scattering of pastoral nomads survived near oases, and for them the margin between survival and starvation was always razor thin. Anyone who lived here was tough, resourceful, and constantly on the move.

The Romans turned North Africa into a prosperous granary, but never crossed the desert to the tropical lands to the south. They lacked the pack animals that would allow them to travel for days at a time without water. To cross the Sahara with laden beasts on a regular basis meant combining highly adaptable behavior with an animal capable of going for up to ten days without water. That animal was the camel. And the camel was remarkably immune to severe drought.

The Golden Trade would never have thrived without the camel, but it was the development of a load-carrying saddle that made the camel the “ship of the desert.” Camels store fat in their humps; their long necks allow them to browse in trees and brush; and their padded feet allow them to walk on soft sand. They conserve water through an efficient
kidney system and they absorb heat by allowing their body temperature to rise significantly without perspiring. The Romans knew all about camels. They used them in North Africa to pull carts, and even as defensive barriers to protect soldiers. They knew that these curious, only beasts thrived in desert conditions. But these advantages were of limited value without an effective load-carrying saddle, which the Romans lacked.

The Saharan camel saddle came into use during the early Christian era, perhaps around the Nile Valley in what is now the modern Sudan, not for fighting, but for cargo. The saddle lies on the beast's shoulders forward of the hump, and so positioned it maximizes load-carrying capacity, endurance, and control. A Saharan camel driver steered his charge with a stick or with his toes. For the first time, camel caravans could now carry sufficient water and provisions (for the humans in the party) to cross long distances between oases from North Africa to the western Sudan.

No one knows when the first camel caravans traversed the western Sahara, but it was well before Islamic armies conquered North Africa in the seventh century. They followed obscure tracks that soon became well-established trade routes controlled by Muslim traders who came from a culture with a far broader outlook on the world than their predecessors from North Africa.

Saharan caravans followed a well-established routine. Heavily laden camels plodded southward from Sijilmassa each fall, south to Taghaza, where they picked up cake salt from nearby mines. Salt is a precious commodity for African farmers to this day, for they lack local supplies. From Taghaza they followed well-trodden paths to Walata, Ghana, and Jenne, on the middle Niger River. The journey was hazardous under the most favorable circumstances. The desert was always hostile, even in times of slightly greater rainfall. Heat and dehydration were a constant threat. So were desert nomads, robed in blue burnooses, armed with gazelle-hide shields and spears, who would launch pitiless attacks without warning. Most caravan organizers negotiated agreements with nomad chiefs allowing them safe passage through the oases they controlled. The nomads also provided guides, who used rocky outcrops and the stars to navigate. They also provided camels to the merchants, who sold them back at the end of the journey.

The caravans were well-organized convoys. The camels laden with merchandise were supported by numerous others carrying water and provisions, or serving as mounts. Safety came in numbers—safety from raiding nomads, in a larger number of beasts who carried water and food, in the ability to transport larger loads and to make a great profit. During the twelfth century, some caravans numbered as many as twelve hundred to two thousand beasts. The journey itself lasted between six weeks and two months, with departure in the autumn. Writes the contemporary Muslim geographer al-Idrisi: “The camels are loaded at a very early hour and one travels until the moment when the sun appears on the horizon and the heat generated on the earth is unsupportable.”

The caravans would rest until late afternoon, then proceed silently through the night, guided by the stars, just as they still do today.

Camel caravans made the long journey across the Sahara even during the driest years of the Medieval Warm Period. Those who traversed the desert spent a great deal of time acquiring intelligence about water supplies, for wells and oases were vital to a safe journey. Conditions were never the same from one year to the next. The cycles of wetter and drier conditions affected the patterns of the trade. When conditions were wetter, large numbers of wells were dug in the aqueous gravels of the central Sahara, around the highlands of the Ahaggar and Adrar des Iforas. Many caravans then followed direct routes over the dunes of the central Sahara to Taghaza and the town of Awdaghust (in modern-day Mauretania) on the borders of the desert, an important salt-trading center. During dry cycles, the caravans would follow more roundabout routes far to the west, or, passing eastward and northward from the Bilad es-Soudan, they traveled to the Adrar des Iforas, then west, ending up ultimately in Sijilmassa. The versatility of the camel provided sufficient flexibility to ride the gyrations of the desert pump. The numbers of dead and exhausted beasts could be enormous; casualties were often in the hundreds from one caravan alone. The bleached skeletons of
camels and their drivers littered the routes, but the Golden Trade never ceased. The camel and its load-carrying saddle proved an effective weapon against heat and drought even in the worst years, when extreme aridity affected cattle people living far south of the desert.

We know enough about climate change during the warm centuries to be virtually certain that they were a time of abrupt and sudden rainfall shifts. The Saharan pump would have moved into frenzied activity as the desert margins advanced and retreated even on a yearly basis. The Islamic discovery of the West African gold trade seems to have coincided with the end of a period of relatively stable conditions, with at least some more rainfall than today. Water holes would have been more plentiful, and desert travel by camels, while yet perilous, could be organized on a relatively large scale. Fortunately for the outside world, the adaptability of the camel and the skill of those who lived in the desert and on its edges gave the Saharan gold trade a considerable degree of immunity from climatic shifts.

The human bridge was as important as the camel. Much of the trade depended on the nomadic Berbers, ancient inhabitants of the desert, who bred camels and also accompanied many of the caravans. They lived at both ends of the trade routes and served as the human link between north and south. The other connection was Islam, which was eventually to become the common religion of the North African merchants, Saharan nomads, and many African rulers and traders south of the desert.

Gold was of profound importance in the Muslim world, which was a strong incentive for the trade to overcome the hazards of desert travel. The golden dinars minted by the caliph in Baghdad, and by the caliph alone, circulated throughout the Maghreb (northwestern Africa) and Spain. At first, gold supplies came from booty taken in Syria and Egypt, also from Christian treasuries and sources in upper Egypt and farther up the Nile. But by the eighth century, West African gold was already well known. The metal itself arrived as dust, traded from miners in the Bambuk region of the Senegal River, twenty days' journey south of the kingdom of Ghana in the Sahel, then a major staging post for the gold trade. Enterprising merchants tried to gain control of the gold sources, but to no avail. The miners firmly maintained their independence and little was known about their operations. They extracted the ore from auriferous river gravels by digging numerous small pits. But the yield from these simple workings was enormous. The Baghdad astronomer al-Fazari, writing late in the eighth century, called Ghana the "land of gold."

In A.D. 804, the rulers of the Maghreb began using Sudanese gold to mint their own dinars. Sudanese gold financed wars of conquest and brought immense wealth to Islam. Until the twelfth century, most West African gold remained in the Muslim world. Western Europe had abandoned gold-based currency, partly because an adverse balance of trade with the east had drained its supplies with few means of replenishment. As Europe's economies recovered and the Italian cities built powerful fleets to combat Arab piracy, a growing volume of trade in cloth and other commodities attracted increasing quantities of gold. By the end of the thirteenth century, European mints were making gold coins. Country after country returned to the gold standard. The demand for gold increased; prices rose, then stabilized. Most of late-fourteenth-century Europe's gold came from the western Sudan. The relative immunity of the camel to the ravages of the desert pump ensured that the trade continued to help change history.

No one knows exactly how much gold passed into the trans-Saharan trade from West Africa. Tax records levied on caravans at Sijilmassa during the tenth century and quoted by the author Ibn Haukal cover imports of some 9.4 tons (8.5 metric tons) of gold annually, perhaps half of an annual total of some 16.5 to 18.7 tons (15 to 17 metric tons), carried northward from West Africa. In 952, Ibn Haukal saw a promise note for 42,000 dinars drawn on a merchant in the north, a measure of the staggering wealth of the trade in its heyday.10

Where, then, did the gold come from? Before traveling farther south, the caravans stopped at Awdaghust at desert's edge, a large and populous Berber town of flat-roofed mudbrick and stone houses overlooked
by a high outcrop. In Awdaghust's always crowded market, one could buy salt, sheep, honey from the Sahel, and food of all kinds—provided one paid in gold. The prosperous oasis town had good water and was home to merchants with a monopoly over the trans-Saharan trade. They organized their caravans under the auspices of the Sanhaja nomads of the desert. The Muslim geographer al-Bakri tells us that the nomadic Sanhaja ruler of the town's domains extended over a distance of two months' traveling. He was said to be able to field one hundred thousand camels. Gold and salt flowed through the town, whose leaders were careful to maintain good relations with powerful chiefs to the south, especially those presiding over a gold-rich kingdom named Ghana.

The King adorns himself like a woman wearing necklaces round his neck and bracelets on his forearms and he puts on a high cap decorated with gold and wrapped in a turban of fine cotton. He holds an audience in a domed pavilion around which stand ten horses covered with gold-embroidered materials... and on his right, are the sons of the vassal kings of his country, wearing splendid garments and their hair plaited with gold.

At the door of the pavilion are dogs of excellent pedigree. Round their necks they wear collars of gold and silver, studded with a number of balls of the same metals.¹¹

Al-Bakri's description of Ghana was the stuff of legend. He never visited the Sahel, but drew his account from sources in the Córdoba archives. His Ghana was a Mediterranean-style court deep in Africa, a capital with two towns, one with twelve mosques where Muslim merchants dwelled, the other the ruler's compound, with sacred groves and royal tombs, nearly ten kilometers away. The royal treasure included a gold ingot said to weigh nearly 30 pounds (13.6 kilograms), so large that it became famous through the Christian and Muslim worlds.¹²

This seemingly imposing capital, Koumbi Saleh, is commonly thought to have lain about 300 miles (480 kilometers) west-southwest of Timbuktu and the Niger River bend. There are indeed extensive stone ruins here, also Arabic inscriptions, but no traces of the royal quarter nor of the burial mounds said by Muslim travelers to lie close by. The ruins lie at the extreme northern limits of the Sahel, where agriculture would have been near impossible even in periods of higher rainfall.¹³ Maybe Koumbi was not Ghana's capital at all, but a small trading community, part of an entirely different, more decentralized kingdom. For the moment, the kingdom of Ghana remains elusive, its capital peripatetic. Our only certainty is that it was not an Islamic polity, but an indigenous African domain, something very different from al-Bakri's portrait, with roots deeper in West Africa, where the gold came from.

For a long time, the gold sources were a mystery. Writing in A.D. 872, the historian al-Yaqubi repeated an oft-told tale about gold sprouting from the ground like carrots. As always happens with gold, the fables grew with the telling, until they produced an "Island of Gold" where gold was to be had for the taking.¹⁴ The miners were well aware of gold's value and kept the locations of their ore deposits a close secret, lest outsiders try to take control of the supply. For this reason, they refused to trade face to face: the merchants piled their goods, mostly cake salt, on the riverbank and passed out of sight while the local people placed heaps of gold alongside each pile. If the visitors were satisfied, they would take the gold and retreat, beating drums to signify the end of the transaction. On one occasion, they captured a miner in an attempt to find the source of the gold. He pined to death without revealing anything. The trade ceased altogether for three years before resuming.

The miners of Bambuk and Buré, another area to the east, were timid, private people who jealously guarded their gold-mining activities, which is why they engaged in silent trade. No Berber merchant from the Sahara ever visited the goldfields, so the Island of Gold remained a mystery. It remains a geographical conundrum today. During the twelfth century, al-Idrisi described the island as an area nearly 300 miles long and 155 miles wide (500 by 250 kilometers) that flooded each year, where the local people "collected gold." The position of the island on his map coincides with that of the seasonally flooded middle Niger delta, inhabited by Mande-speaking farmers and fisherfolk.
The Niger is one of Africa’s great rivers, rising in the mountains of Guinea near the Sierra Leone border, then flowing northeastward into a great inland delta, a patchwork of tributaries, channels, swamps and lakes. This interior floodplain is what the archaeologist Roderick McIntosh calls “a vast alluvial garden abutting the bleak Sahara.” Here, the desert caravan networks came in contact with much older riverine trade routes. The middle Niger floodplain was rich in grain and other basic commodities, including potting clay, but, like Mesopotamia, lacked stone, metal ores, and salt. Over many centuries the Mande farmers and fishers of the region developed a lattice of contacts with other peoples near and far to supply their needs. They were also active players in the Saharan gold trade.

The Mande (the term refers to a language common to many groups) are descended from Saharan peoples, and settled in the Sahel during a series of dry spells that affected the region about two thousand years ago, perhaps earlier. Today, Mande speakers flourish over a large area of West Africa from Gambia to Côte d’Ivoire. They were millet farmers and cattle herders, also traders, who exchanged copper, salt, and semiprecious stones with contacts in the desert. As they moved southward, many of them colonized the fertile basins of the Niger River.

Today, the annual flood inundates some 21,000 square miles (55,000 square kilometers) of swamps and lakes, but covered a much larger area at wetter times in the past. The floodplain environment is diverse, unpredictable, and made up of radically different landforms and soils packed closely together. The Mande who live there are the Bozo, who are fisherfolk, and the Marka, who cultivate many varieties of African rice (Oryza glaberrima). The Bozo are constantly on the move, their lives dictated by the breeding cycles of both small fish and the enormous Nile perch. Sometimes as many as 150 canoes will gather around artificial barrages where they harvest enormous catches. The Marka help with the major fish runs. In return, the Bozo assist the Marka, for the rice harvest comes during high flood, when fishing is poor.

The societies that flourished in the middle Niger a thousand years ago thrived on constant change in a place where different cultures lived in an exceptionally heterogeneous environment. They thrived not only by cultivating a wide variety of crops, but also by making extensive use of social memory. Roderick McIntosh calls the middle Niger basin a “symbolic reservoir,” a place where a shared body of social values that originated in deep time survived over thousands of years to define history and society. This was not a world where highly centralized, authoritarian kingdoms flourished, with all power flowing to the center, as once was the case in ancient Mesopotamia with its competing city-states. There was no hierarchy of power, as there was among the ancient Maya or in medieval Europe. Here, powerful kin groups and people engaged in activities of all kinds, living together under a system of unspoken checks and balances that gave everyone considerable autonomy, mutual support, and enhanced chances of survival in the unpredictable desert-margin climate.
The Great Warming

town of Jenne in the upper Niger basin. The site lies at a strategic location near basins where one could grow climatically tolerant *Oryza glaberrima*, close to pastureland and open plains, with access by boat to the Niger. Jenne-jeno probably came into being as the drying Sahara expelled people to its margins after 300 B.C. People continued to live there for over sixteen hundred years, at a location that remained dry even in the highest flood years. Few places anywhere, let alone in West Africa, have such a long history. The settlement expanded vertically and horizontally, from about 49 acres (20 hectares) in A.D. 300 to nearly double that size three centuries later. Jenne-jeno’s people lived off agriculture, hunting, plant gathering, and fishing; this generalized subsistence economy changed little over the centuries despite major population increases and rapidly changing climatic conditions. Through the town’s long history, its inhabitants resolutely maintained a highly diverse economy, exploiting numerous microenvironments rather than seeking to increase food supplies with irrigation works or raised fields, as was the case with the Maya, for example.

At one point in Jenne-jeno’s later history, no fewer than sixty-nine settlements lay within 2.4 miles (4 kilometers) of the main settlement. But why did the people here and elsewhere choose to live in clusters of villages instead of in densely inhabited cities like those of the Islamic world? The reason was climatic. The Mande lived with a constant backdrop of sudden, potentially disastrous climate change and they engineered their society around this reality.

For centuries, so excavations tell us, the Jenne-jeno people maintained a way of life that involved agriculture, fishing, gathering, and moving within the local environment when necessary. But they were far from being stationary pawns affected by short-term climatic cycles. McIntosh believes the Mande were far more proactive, combating unpredictability by linking together farmers and specialized artisans such as metal smiths into a generalized economy. People lived at separate, clustered locations, linked by ties of kin as well as by powerful myths and legends that provided rationales for decision making. No charismatic leaders, no cities or powerful elites, no armies to enforce law and order held this system together. Instead a “weather machine” of belief and ritual provided a framework for predicting rainfall and drought. Social memory, carefully preserved by select people, is the core of the Mande weather machine.

How can we know how ancient communities responded to climate change, to perceived changes in their environment? We cannot reconstruct ancient minds. But we can examine Mande social memory, which couples their existence to the real world in complex ways. People surely had social memory of climate change, of catastrophic droughts and floods, perhaps, like today, associated in their minds with the names of individuals who were victims of the disaster and even named after them, or with a group of people, such as ironworkers, who are perceived to have occult powers. They preserve generations of knowledge about climatic shifts and environmental conditions, and often predict impending changes and offer strategies to combat them. At issue here is the question of authority to make decisions for the future, where climatic and other hazards wait unseen. Who can handle such matters? Who can be trusted not to abuse the dangerous knowledge of climate change and appropriate social responses for personal gain? In Mande society, climatic prediction is not the disinterested, scientific forecast of a climatologist. Every predictor also has responsibilities in the domain of social action, so his or her predictions are a critical link between climate change in the objective world and the perceived world on which people are going to act.

The dynamics behind the Mande weather machine are based on a set of familiar cultural values enshrined in many layers of legends and symbols. Numerous interest groups make up Mande society, all negotiating with one another constantly over land and the events of history, as they have done for centuries. The result is a powerful landscape of what one might call social memory, defined both by oral traditions and by recollections of climatic and other events. The fluid adaptability of their society has always depended on this familiar and ever-changing social landscape. The Mande had to be watchful and flexible in their responses
The Great Warming

to the very complex, variable, and unpredictable Sahel climate. Violent shifts from ample rainfall to drought, or modes in between, were part of the ecological and social crises that shaped core values and transformed authority. This is why the people of Jenne-jeno and other Mande towns lived in clusters, in a heterarchical society that created flexible and changing social landscapes more responsive to climate change than highly centralized contemporary societies such as the ancient Maya or the Chimú of northern coastal Peru.

The men and women who exercised the greatest influence in Mande society were members of secret societies. The kamo remains a pervasive form of secret society, led by the komotigi, today often a blacksmith. The original secret societies were for hunters, long before metallurgy arrived in the Niger basin. A komotigi had the ability to see into the future; he was a curer and a protector against malevolent spells. An astrologer and weather forecaster, he studied the heavens and the most visible celestial bodies. A komotigi was expert in the behavior of animals and plants, which he used to predict whether rain would come when needed at planting time. The kamo persists, as do extremely secretive hunters’ societies. Today, there are at least seven major secret societies in the middle Niger.

The earliest specialists in Mande country were hunters with occult powers and social authority. From very ancient times, such individuals traveled to special places that were imbued with spirits, and as such were powerful and dangerous. Here they harvested power, the ability to control weather and other aspects of life. Over two thousand years ago, with the coming of agriculture and ironworking, metalsmiths became important nyama holders. (Nyama can be loosely defined as the earth’s force.) The smiths were members of the first secret societies, the central actors in centuries of Mande resistance to hierarchy and centralization, armed with a symbolic and mythic repertoire that confronted environmental and social stresses. For centuries, Mande secret societies dispersed knowledge about the landscape over enormous areas.

The great Mande folk heroes harvested the power of nyama to navigate safely through a dangerous world. For instance, the smith-sorcerer Fakoli undertook quests to acquire the medicine items such as birds’ and snakes’ heads that hang from his sorcerer’s bonnet. Fakoli’s quest was also a knowledge journey, which took him on an expedition through a spiritual and symbolic landscape. Another mythic hero, Fanta Maa, a Bozo culture hero, learned how to become a proficient hunter while still in his infancy. Under threat of extinction, the animals came together and selected a gazelle to take the form of a young woman and seduce Fanta Maa, then lure him into the wilderness and to his death. But Fanta Maa used hunters’ paraphernalia to unravel the plot.

Nyama is malign, if controlled, energy that flows through all animate and inanimate beings. As the Mande perceived climate change, it was because of perturbations in nyama within the landscape. Generations of understanding how nyama perturbations affect the environment allowed Mande heroes and komotigi to predict climate change. The most powerful among them had the spiritual authority to manipulate the forces that bring on rains or drought—or to kill someone at a distance with merely a thought. Thus, charismatic individuals moved through a symbolic landscape in which they harvested power, authority, and knowledge. Hunters moved into the wilderness on tours of spiritually powerful locations. There they killed spirit animals. The killing released vast amounts of nyama that only the best hunters could control, and ensured well-watered lands for stressed communities.

Hunting lodges are still revered places where the accumulated climatic lore of generations, about resources within local areas, resides. Even famous hunters still go to such lodges to acquire more and increasingly obscure knowledge. Underground watercourses may also mark former north–south migration routes used in better-watered times. To Mande farmers, the landscape was, and still is, a catalog of names and places, a predictor of human occupations and climatic shifts that was very successful in combating drought and flood over many centuries.

The Mande weather machine worked well. By A.D. 800 to 900, Jenne-jeno was 0.6 mile (1 kilometer) long, with, by conservative estimate, as many as 27,000 people living in the town and in the sixty-nine satellite communities within a 2.5-mile (4-kilometer) radius. Between A.D. 900
Mande oral traditions tell of a great hero, Dinga, grandfather of the Ghanaian chiefs, a brilliant hunter, an extractor of nyama. Ancient tales describe his movements across the landscape, the power places where he triumphed over guardian and knowledge animals. Dinga settled at Jenne for twenty-seven years and took a wife, but had no children. Perhaps this was a time of forging solid alliances with Jenne, which was not under Ghanaian rule, but always friendly to its neighbor. Dinga moved on and settled to the northwest, vanquished a female protector spirit at Dalangoubé, and patched together the kingdom of Ghana, probably through a long process of alliance building, of constructing agglomerations of social groups. The same thing happened again and again in the Sahel, the creation of loosely consolidated groups of chiefdoms that paid tribute to the core. Thus it was that the chief of Ghana was able to tax the trade in gold and other commodities from the south. At the same time, he maintained a standing cavalry to deal with hostile camel nomads and uncooperative chiefs.

Geographer al-Bakri’s descriptions of Ghana appear during a few centuries of stable and relatively favorable climate. The Ghana he described was a fluid kingdom, marked by its heterogeneous organization and by its flexibility, forged partly by conquest but more importantly by the constant checks and balances that had always been a part of Mande existence. Ghana indeed possessed great wealth, but its greatest riches came not from gold and material things, but from the rich practices and traditions of its native culture that enabled its members to thrive in a climate of pitiless and violent extremes.

At the end of his life, the traditions tell us, Dinga passed on his accumulated nyama to his son, the water snake Bida, twin of the Ghanaian founder chief Diabé Sissé. Bida agreed to provide sufficient rain and gold from Bambuk, several days to the southwest, if he was given the kingdom’s most beautiful virgin each year. One year, the virgin’s suitor killed the snake. The lopped-off head bounced seven times and landed in gold-rich Bure, much closer to Mali. Gold production moved away from Bambuk and toward Mali. Seven years of drought and famine devastated Ghana. The kingdom fell apart. Once the spirit animal died,

and 700, local rainfall was about 20 percent higher than that between 1930 and 1960. After 1000, the climate was much more volatile and the town went into decline. The people abandoned low-lying rice-growing regions, then higher and lighter floodplain soils, and switched from rice to drought-resistant millet, displacements caused in part by changes in the river flood regime, at a time when drier conditions were setting in. In nearby Méma, large, clustered mounds near channels and water-filled depressions give way to smaller, more isolated settlements, often on sand dunes. Everywhere in the middle Niger, communities large and small adapted to new circumstances, not necessarily without suffering, but just as their ancestors had.

This, then, was the cultural environment from which Ghana emerged around A.D. 700, at the end of a period of relative climatic stability.
malevolent nyama intervened. It was no coincidence that Ghana ran into problems with its desert neighbors just as the period of relative climatic stability ended.

Oral traditions are history filtered through fickle human memory.
Perhaps the tale of Bida's demise and the droughts that followed constitute a dim recollection of violent climatic swings, perhaps an epochal drought that caused an always flexible kingdom to evaporate. At a time of rising Muslim influence and conquest, Ghana remained pagan until 1076, when the Almoravid chieftain Abu Bakr captured Koumbi and imposed Islam on its inhabitants.19 A century and a half later, in the east, the kingdom of Mali rose to prominence, the golden empire made world famous by Mansa Musa's hajj in 1324.
Again there comes a humiliation, destruction, and demolition. The manikins, woodcarvings were killed when the Heart of Sky devised a flood for them. A great flood was made: it came down on the heads of the manikins, woodcarvings.

—Popul Vuh, the Maya book of dawn of life

Hunting bands in North America’s Great Basin stayed close to shrinking water supplies and moved to higher ground. The Ancestral Pueblo abandoned Pueblo Bonito and the other great houses in Chaco Canyon, for centuries the sacred hub of their world, in the face of intense drought. Chumash Indian groups along the southern California coast fought each other over water and precious acorn crops devastated by persistent drought. All these peoples lived in semiarid landscapes, where flexibility and movement were automatic reactions to drought.

Deep traditions of mutual obligation, of reciprocity, were a fundamental part of life in the American West, where the endlessly cycling pumps of deserts sucked in and pushed out people as rainfall came and went. Far to the south, in Central America, ancient Maya civilization was at its apogee when the droughts of the warm centuries arrived, bringing catastrophic disruption that killed thousands and depopulated much of the southern Maya lowlands.

Just as, in the 1970s, the decipherment of their script revolutionized our knowledge of the ancient Maya, so in the last few decades have deep-sea and lake borings provided insights into the climatic changes that rippled across their rainforest homeland a thousand years ago. The evidence for repeated, and often severe, drought mirrors that from western North America.

The Carriaco basin, off Venezuela in the southeastern Caribbean, is the source of the most influential of all deep-sea cores, because it records climatic shifts resulting from the northward and southward movement of
the Intertropical Convergence Zone (see sidebar in chapter 4). The ITCZ had a profound effect on rainfall in the Maya lowlands and across the ocean, on the Saharan Sahel. We can, in general terms, link climatic changes on either side of the Atlantic. As we shall see in chapter 11, there may even be connections across the Pacific to Asia. The Cariaco core is remarkable for its layers of fine sediment deposited annually by rivers flowing into the ocean. The deposits are unusual, for they are exceptionally well defined, with about 1.8 inches (30 centimeters) representing every millennium. The laminated sediments reflect fluctuations in river output caused by changing rainfall amounts. The changes result from seasonal shifts in the Intertropical Convergence Zone, dark laminae reflecting rainfall during the summer and fall rainy season, light-colored ones in the dry winter and spring, when the Convergence Zone is at its southernmost position and trade winds blow strongly along the Venezuelan coast. The bulk titanium content in the laminae records the amount of land-based sediment brought to the basin from surrounding watersheds. The higher the titanium content, the greater the rainfall.

Among sediments deposited over the past two thousand years, titanium concentrations were lowest between about five hundred and two hundred years ago, during the dry centuries of the Little Ice Age. Higher titanium concentrations arrived in the basin between A.D. 880 and 1100, the heart of the Medieval Warm Period. But the titanium levels were far from constant. There were pronounced minima in about A.D. 200, 500, and 750. Fortunately for climatologists, the Cariaco basin lies within the same climatic regimen as the Maya lowlands, where most rain falls during the summer, when the Intertropical Convergence Zone is at its north point over the Yucatán. If the Convergence Zone remains at its southernmost position for any length of time, drought hits both the Cariaco region and the Maya homeland.

Maya civilization flourished before about A.D. 150, when cities like El Mirador reached enormous size. El Mirador was abandoned rapidly during the early first millennium A.D., at a time when the Cariaco sea cores tell of drought in the area. But the Maya recovered, new cities arose, and new water management strategies came into use. Relatively wet times between A.D. 550 and 750 saw growing populations. Many Maya communities were soon operating at the limits of the carrying capacities of their lands. By this time, Maya settlements large and small were far more vulnerable to multiyear droughts, which would descend without warning but so infrequently that they lay outside the short generational memory of the day.

The Cariaco core documents a low-titanium interval centered on the ninth century, at the beginning of the Medieval Warm Period, a severe drought also found in a core bored in Lake Chichancanab in the Yucatán itself. The two records chronicle multiyear droughts that began as early as A.D. 760, and reoccurred at about fifty-year intervals: 760, 820, 860, and 910. The first drought was a slight long-term drying trend, followed by a severe drought of about three years beginning in 810, and another drought beginning in about 910 and lasting for about six years. It was during this period that Maya civilization in the southern and central Yucatán lowlands collapsed.

The Lake Chichancanab core not only mirrors that from Cariaco, though it can be dated somewhat less accurately (plus or minus twenty years), but also documents drought conditions lasting until A.D. 1075. The climate record is now unequivocal. Drought cycles during the early Medieval Warm Period settled over the Maya lowlands at about fifty-year intervals, at the same time as profound aridity affected western North America.

The Maya were obsessed with water, and with good reason, for they lived in an environment of uncertain rainfall. They believed that civilization began in the dark primordial waters of Xibalba, the Otherworld. The waters were calm and dark, the world nothing but water. “There is not yet one person, one animal, bird, fish, crab, tree, rock, hollow gully, meadow, forest. Only the sky alone is there; the face of the earth is not clear. Only the sea alone is pooled all under the sky; there is nothing whatever gathered together. It is all at rest.” Xibalba was a calm, dark pool. But there were signs of movement in the water, “murmurs,
ripples, in the dark, in the night.” The creators were in the waters, “a glittering light. They are there, they are enclosed in quetzal feathers, in blue-green.” Here the gods created humanity. Once they had done so, they caused water to well out of the entrances to the nether regions, the most sacred places in the Maya landscape, to nourish crops and nurture human life. Water defined this most flamboyant of native American civilizations in subtle ways, and became an instrument of political power and social control. The cycle of Maya life ended when great lords descended in death to Xibalba’s inky waters. And when the rains failed and drought descended on the Maya world, the foundations of civilization quivered.

Like the ancient Egyptians, the Maya were village farmers for many centuries before they transformed their homeland into a landscape of great cities ruled by powerful lords. There the resemblance ends. No annual inundation or fertile river floodplain provided a safety net for Maya civilization. Nor did any great rivers link cities, towns, and villages into a large, unified state like that of the pharaohs. The Maya farmed the Petén-Yucatán peninsula, which juts into the Gulf of Mexico; it is a vast limestone shelf lifted from the depths of the ocean over an immense length of time. They lived in a densely forested world where huge mahogany trees towered as much as 150 feet (45 meters) above the ground, where sapodilla and breadnut abounded. The forest gave way to patches of open savanna covered with coarse grass and stunted trees. Hot, humid, and generally poorly drained, the Maya lowlands were a fragile, water-stressed environment even at the best of times. The porous limestone bedrock absorbed water to the point where fluctuations in the water table were unpredictable. It’s hard to imagine a less likely place for a great civilization.

Fly over the homeland of Classic Maya civilization (A.D. 250-900) in the lower Yucatán and you pass over a featureless green carpet. But the seeming uniformity is an illusion. The dense tree cover masks an astonishing diversity of local habitats, all of which presented special challenges to ancient Maya farmers. Between 53 and 78 inches (1,350 and 2,000 millimeters) of rain fell each year, but precipitation was less abundant and predictable than one might expect. Most rain arrived between May and October, after a dry season that lasted between four and six months. Lakes, springs, and perennial streams were priceless rarities. Even small-scale village farming required creative ways of collecting, storing, and managing water for the long dry months.

To understand why, we must journey back to the beginnings of the Maya. In about 1000 B.C., only the coastal plain and a few small, perennial drainages could support permanent farming communities for the long term. Many of these communities were also involved in fishing. As local populations increased, so small groups moved inland along streams and the swamps that bordered them. Within six centuries, a patchwork of tiny villages had become a rapidly growing civilization.

By the third century B.C., thousands of people lived in scattered communities across the lowlands. They were adept, patient farmers, who developed many ways of managing water and modifying the environment for maximum productivity. Generations of trial and error, of hunger and plenty, led people to settle at strategic locations—for example, they could live near the base of shallow natural depressions that received surface runoff during the rainy season. These they constructed reservoirs to store rainwater, close to places where the first great ceremonial centers rose with remarkable speed. By any standards, these were imposing structures. For instance, between 150 B.C. and A.D. 50, a mere two centuries, El Mirador in Guatemala’s Petén grew to cover 6 square miles (16 square kilometers), dominated by the Danta Pyramid, built on a natural hill more than 230 feet (70 meters) high. The city lay amidst an undulating landscape, where water collected in a large, basically natural watershed during the rainy season. Causeways traversed low-lying swamps or shallow lakes near the central area. El Mirador thrived thanks to a simple form of water management, by which large natural depressions, extended into reservoirs, served as water storage facilities. The same reservoir system was also an integral part of an extensive agricultural landscape.
Some of these systems reached considerable size. The people of Edzna in Campeche, occupied between 400 B.C. and A.D. 150, excavated huge canal basins and removed nearly 62 million cubic feet (1.75 million cubic meters) of fill to build them—more than the volume of Teotihuacán's vast Pyramid of the Sun far away in the Mexican highlands. Then, suddenly, during the first and second centuries, El Mirador, Edzna, and the other growing centers collapsed. Their pyramids and temples were abandoned to the forest; the people dispersed into small villages scattered across the landscape. Many experts believe this was because of a severe drought that rendered their reservoirs and simple water systems virtually useless.

After A.D. 250, the start of the Classic period of Maya civilization, water management strategies changed. For the first time, Maya lords built palaces, pyramids, and temples on elevated ridges and hillocks. They moved their centers away from natural water sources and chose to build large reservoirs close to their ceremonial precincts. The largest cities, among them Calakmul, Copán, and Tikal, developed elaborate water management systems, built as part of the process of erecting the plazas and pyramids that were symbolic replicas of the Maya world. The pyramids became "water mountains." Thousands of villagers labored over the great centers. The first order of business was to quarry stone, to create the artificial depressions that would become reservoirs and tanks. Without a viable water system, the builders had no drinking supplies for work gangs or for mixing the limestone mortar used for floors and walls. The labor investment was enormous, but no urban center could survive without far larger-scale water supplies than those required by a small farming village.

Every Maya lord built his largest reservoirs and tanks close to his most imposing civic architecture. Here he appeared before the assembled populace in elaborate public ceremonies. Here dancers would perform in open plazas dwarfed by high temples. Here chants would resonate from pyramid stairways, torches flickering and flaring in the night breeze as incense wafted among the crowd. The ruler himself would emerge from a dark opening in the temple, the symbolic entryway to Xibalba, and appear before the people in a state of trance induced by hallucinogenic drugs. He performed ritual bloodletting on himself, then vanished abruptly, embarking on a journey into the supernatural world. The great rituals revolved around the complex relationships between the living, the deities, and the ancestors, between the rulers and the ruled. The same ceremonies recognized the central place of water in Maya life—and in the complex equations of political power. From earliest times, Maya society had thrived on kin ties that linked community to community with vital ties of reciprocity—the obligation to provide food, assistance, or labor to kin in times of need. As Maya civilization emerged from its village roots and new leaders came into prominence, ancient kin ties still provided at least a theoretical link between lords and commoners. But the nature of the ties between them changed from simple reciprocity to a more elaborate social contract. Maya rulers proclaimed themselves divine lords, with exceptional supernatural powers. They became like shamans, capable of passing freely into the supernatural world, where they served as intermediaries between the living Maya, their ancestors, and the forces of the spiritual world. The lords provided supernatural protection, fostering rain and good crops. In exchange, the people paid tribute and taxes in food and labor. They worked when called upon for the nobility, for the public good, in an unwritten alliance that justified social inequality. As long as there was ample rainfall, the tacit contract survived. But once the fallibility of the lords became apparent, social disorder ensued.

Tikal, the greatest of the Maya cities, was dominated by the most imposing of all water mountains, founded during the first century A.D. Thirty-one rulers, the earliest dating to A.D. 292, the latest to A.D. 869, left nearly 600 years of recorded history here. By a combination of judicious political marriages and warfare, Tikal's lords extended their sway over neighboring centers, ruling at one point over between 200,000 and 300,000 people. No one knows how many people lived in the center, surrounded as it was by a hinterland of villages and larger communities.
But we do know that the city depended entirely on seasonal rainfall for its water supplies.

The amount of water collected at Tikal was truly astounding. Six catchment areas surrounded the major hillock where the city lay. One central-precinct catchment alone covered 756 acres (63 hectares) and could collect more than 31.7 million cubic feet (900,000 cubic meters) of water in a year when 59 inches (1500 millimeters) of rain fell—an amount typical of a nondrought period. Slightly cantilevered pavements and subtly diverted weirs directed rainfall into the central-precinct reservoirs, which were sealed with stones and imported clay. The combined reservoirs could hold between 3.5 million and 7 million cubic feet (100,000 and 200,000 cubic meters) of water, enough to allow controlled release of water during the dry season, using carefully placed sluice gates under the city’s causeways. Small domestic tanks for the houses immediately below the summit were probably recharged from the central system. Four large reservoirs lay near the foot of the central hillock and around the swampy margins of Tikal, designed to recapture gray and reused water from upslope residential areas. The 1.76 to 6.1 million cubic feet (50,000 to 175,000 cubic meters) of runoff served to irrigate about 210 acres (85 hectares) of swamp-margin plots around the city. With water available year-round, local farmers could potentially raise two crops a year.

Tikal’s water system was huge and complex, a startling contrast to the much less elaborate water systems that sustained small communities. Most villages survived the dry season by using shallow water tanks close to the settlement that held enough water to carry the farmers through one dry season, perhaps a few months more. But Tikal’s vast reservoirs held enough water to reduce the vulnerability of its residents in dramatic ways. Two or three years of little or no rain would not cause problems for Tikal’s water managers, though such a long drought would have drastic consequences for the small villages that held most of the dispersed Maya population. But even Tikal’s water system was inadequate for sustained, multiyear droughts.

The hushed crowd in the plaza gazes upward to the temple at the summit of the pyramid. Flickering torches cast deep shadows in the gloom of dawn. Incense smoke drifts across the slopes of the sacred mountain. High above the mob, serried rows of white-clad nobles surround the dark entrance to the shrine. Suddenly, the great lord appears, his hair long, tied above his head with brightly colored feathers that cascade down his back. He is bare-chested, wearing a brilliantly white loincloth, his legs and wrists adorned with deep, blue-green jade beads. A noble in a white cape lays a broad clay bowl holding unmarked paper and a stingray spine before him. The lord squats, pierces the loose flesh of his penis three times, and threads paper strips through the wounds. The tan paper turns bright red as the lord dances himself into a frenzied trance, holding a symbol of the double-headed serpent that symbolizes the path of communication with the gods. Conch shell trumpets sound; a god has been summoned from the Otherworld. The crowds milling in the plaza sway in ecstasy as the drums beat. Brightly dressed nobles dance on a terrace below the lord. The devout gash themselves and spill blood onto cloth bands on their arms and legs.

Great Maya lords proclaimed themselves divine rulers, related by carefully crafted genealogies to prominent ancestors and the gods themselves. Kingship and the world that defined Maya civilization were closely tied to the experience of the humble villager. Rulers molded their power, and the symbols of that power, from the plants and animals of the forest, from the ancient rhythms of planting and harvest, from the alternation of the dry and rainy seasons. Like their subjects, they looked at the world in the context of things both spiritual and human, ancestral and contemporary, and in the context of realms that were those of lords or of commoners. The bloodletting, the trances, the elaborate ceremonies that surrounded the accession and death of kings, were an integral part of a society that gave lords the right to control the water supplies that came from heaven. And water mountains were the conduits that brought water from the spiritual realm to the earth.

The Tikal water mountain with its reservoirs and tanks allowed its
rulers to control water supplies for large numbers of people at lower elevations. Maya lords promoted themselves as divine leaders with powerful supernatural abilities. But their real power came from their control of key resources such as water, and from the reality that many of their subjects lived in engineered landscapes. Maya life revolved around the seasons of planting, growth, and harvest, each with its ceremonial associations, so water rituals were an essential part of the fabric of daily Maya existence. At Tikal and other cities, the lords manipulated water not through authoritarian rule, but by using ritual to direct and appropriate the labor needed to excavate and operate the system. It was no coincidence that their water mountains were settings for elaborate public ceremonies.

We know little of these rituals, but we do know that two metaphors defined death for the Maya nobility. One was a fall into a watery underworld, often into the open jaw of an earth monster—a chasm in the surface of the earth. Another was a journey by canoe into the endless waters below the earth. Both metaphors linked lords to water, to the mirrorlike surfaces of the teeming reservoirs that lay close to their pyramidal burial places. Whether one lived near a major center or in a remote village with its own water tanks, survival ultimately depended on the sustainability of the large cities—the water mountains. During periods of prolonged drought, farmers from outlying areas would migrate to the edges of the great cities, to the feet of the artificial mountains that were the anchors of Maya water supplies.

As Maya lords developed their enormous reservoirs, so the predictability of water supplies increased—up to a point. But the only source of their water was rainfall. Unlike societies that could draw a relatively constant supply of water from rivers or subterranean aquifers, the Maya, for all their engineering prowess, were highly vulnerable to short-term discontinuities of climate.

They lived in an environment of constant disruptions—years of drought and crop failure, torrential rains and soil erosion, unexpected storms that drowned their crops. They farmed with the simplest of methods, but with a comprehensive knowledge of their forest environment. Like other tropical farmers, they used slash-and-burn methods, cutting down a patch of forest, burning the wood and brush, then working the natural fertilizers of ash and charcoal into the soil. They would plant with the first rains, use the garden for two years, then abandon it, as the soil lost its fertility rapidly. These milpa plots were a patchwork of newly cleared and regenerating land, surrounded by thick forest that vanished progressively in the face of rising populations over the centuries. Cultivating these lands required great experience and infinite patience, for pelting rain and intense tropical sunlight soon hardened the soil. But the lowlands are far from uniform. Fortunately, the Maya lived in a diverse environment, where they could also practice other forms of agriculture. In swampland areas, they built raised-field systems, with narrow rectangular plots raised above swamps or seasonally inundated lands bordering rivers. These productive fields could yield several crops of beans and maize a year. The farmers also terraced steep hillsides, the stone-faced terraces trapping silt that would cascade downslope during torrential downpours.

Whatever farming methods they used, the Maya were brilliant agriculturalists. They grew a wide variety of crops, suited to a wide diversity of microenvironments, and selected arable land with the utmost care. Everything was a mosaic—of highly productive swamps and raised fields, milpa plots, and terraced hillsides. The Maya managed and manipulated their environment over the centuries, always living in dispersed communities, even close to major centers, for the realities of their homelands would never support large concentrations of people living in one spot. But the population was denser than it appeared. In parts of the southern lowlands, population densities rose as high as 600 per square mile (2.6 square kilometers) over an area so large that people could not move away from their local environments if drought or other disasters came along. The landscape filled up. As urban populations rose, so the Maya ate up their land, at a time when the farmers were supporting a growing nobility and increasing numbers of nonfarmers.
Maya civilization was never a centralized state like that of the pharaohs or the Babylonians. The decipherment of Maya glyphs during the 1970s, one of the great scientific triumphs of the twentieth century, revealed a landscape of frantically competing city-states governed by ambitious and rapacious lords obsessed with genealogy, warfare, and personal advancement. Tikal, for example, rose to prominence in the first century B.C. By A.D. 219, the lord Xac-Moch-Xoc had founded a brilliant ruling dynasty that conquered its nearest neighbor, Uaxactún. Three centuries later, the dynasty presided over a territory of 965 square miles (2,500 square kilometers). The city was but one of many centers vying for power in a volatile, ever-changing world. Alliances were forged and would then fall apart as a lordly partner died. Rulers would conquer their neighbors, sacrifice their leaders, and cement a new relationship with a timely diplomatic marriage. But, ultimately, this entire landscape of political wheeling and dealing, of warfare, elaborate ritual, and kingship, depended on water from the heavens. When the now well-documented Medieval Warm Period droughts descended on the lowlands, they eroded the foundation of Maya civilization.

Were the droughts enough to cause the collapse of Maya civilization? Each planting season, the farmers gambled with their crops, setting seed in the ground with the first rains, then waiting for later storms to moisten the drying soil. Some years the rain would fall. In others, weeks would pass with mounting clouds on the horizon, but no showers except for a few heavy drops. Rain would fall a few miles away, but the dark cloud would bypass other villages. In hundreds of small hamlets and tiny farming communities, people lived from harvest to harvest, just as they did in distant medieval Europe. Everyone experienced episodes of hunger during their lifetimes. To what extent the lords redistributed food to hungry communities as part of their rituals, we do not know.

In the early centuries of Maya civilization, there was a natural cushion of wild foods that one could rely upon in dry years. But rural populations rose inexorably, and in many places stressed the carrying capacity of the forest, now people ate up the land as they cleared more brush and trees, exposing fragile soils to the harsh sun. The primordial forest vanished, replaced by regenerated growth. Fewer and fewer wild resources remained as famine foods in dry years. The margin between plenty and hunger, between good harvest and poor, narrowed significantly between the seventh and ninth centuries.

The population growth came during generations when the number of nonfarmers increased, when more and more people aspired to the nobility. Increasing numbers of high officials, traders, and priests now claimed ancestry from noble lineages. Maya society became top-heavy with nobility, with non–food producers, with people keenly aware of the privileges that came with rank. The demands on commoners, on rural farmers, in terms of food and tribute, increased steadily from generation to generation. As the rural population ate up the land, deforestation accelerated and agricultural yields reached their limits. Meanwhile, the elite were largely divorced from the harsh realities of aridity and hunger that would descend on their homeland during multiyear droughts.

Even at the distance of more than a millennium, we can see the demise of Maya civilization in the southern lowlands playing out like a Greek tragedy. The droughts begin in the early ninth century, at the beginning of the Medieval Warm Period. After a year or two, villagers are hungry, but still subject to inexorable demands for food and tribute. The water mountains, for example Tikal and another great city, Copán, with its nearby river, still have adequate water reserves, but these reserves are diminishing. The public ceremonies linking great rulers to the smooth mirror of primordial waters still unfold. In this sense, the lords are active participants in the shaping of history, for they bring their own historical consciousness to bear and respond to drought as they always have, by distributing food and appeasing the forces of evil, by ritual, strategic alliances with former enemies, and by warfare. But the drought continues: the reservoirs begin to run dry.
For generations, the people have considered their lords, the descendants of divine ancestors, to be infallible guardians of the harvest, of Maya life. But now they have feet of clay, are powerless in the face of mocking, cloudless skies, and unrelenting heat. Tikal and Copán and the other cities like them fall apart. Social disorder erupts in the face of persistent hunger and water shortages. The commoners rise in protest against the bloated nobility; they desert their leaders and scatter through the countryside, leaving mere handfuls of survivors, some the descendants of great lords, still squatting among the ruins.

An apocalyptic scenario, perhaps, but entirely plausible, given the vulnerability of Maya civilization to multiyear droughts, of the kind now known from climatological records. The droughts themselves did not destroy Maya civilization, but the economic, political, and social consequences of arid years certainly did. By the late tenth century, the great cities of the Petén and southern Yucatán had imploded as their inhabitants scattered in the face of hunger and chronic water shortages. As had happened thousands of years before in Mesopotamia and along the Nile, drought and famine brought social unrest, rebellion, and the collapse of rigid social orders that were based on doctrines of lordly infallibility.

Of course the fall of Maya civilization was more complicated than this, for intricate political and social factors came into play. In some places, the elite continued to wage war as they had always done, even at a time when civilization was collapsing around them. The archaeologist Arthur Demarest has spent five years excavating six Maya sites, among them a heavily fortified center, Dos Pilas in the Petexbatun area of northern Guatemala. He believes that the raiding form of warfare favored by Maya lords in earlier times gave way to all-out civil war in this area during the eighth century. The center’s rulers became ever more aggressive and conquered their neighbors. Eventually the kingdom became so large that it fragmented into smaller warring chiefdoms, each with its own fortified center. Inevitably, this activity and endemic warfare had adverse effects on the delicate jungle ecology. Dos Pilas has miles of trenches and moats. Demarest’s excavators have found numerous spearheads at the foot of the walls, caches of decapitated skulls, and postholes that mark now vanished palisades and towers. He believes that the effects of all-out war were disastrous, as the violence forced changes in farming methods, causing soil depletion and then widespread crop failure. Concentrated agriculture in strategic locales simply did not work in the Maya environment, especially at a time when multiyear droughts were stressing the already overtaxed water systems. In the end, a nobility obsessed with warfare hastened the demise of one of the Americas’ most dynamic and innovative civilizations.

After about 1100, climatic conditions became more humid, but Maya civilization in the southern lowlands never recovered. In the northern Yucatán, large cities and centers continued to flourish, thanks, in large part, to natural sinkholes, cenotes, in the limestone that allowed people to reach the water table. Maya civilization endured, albeit on a reduced scale, until Hernan Cortés and his Spanish conquistadors arrived over the eastern horizon in 1529. But what would have happened if more cyclical, multiyear droughts had afflicted the Maya lowlands? What if warming had continued and the water table had dropped so that the cenotes dried up? Inevitably, there would have been another implosion, this time of cities and kingdoms in the northern parts of the Maya world, where people, once again, would have adopted the only defense available to them: dispersal into small, largely self-sufficient communities. Would, then, have Cortés and his motley band of adventurers ever marched to the heart of Aztec civilization in the highlands? In a different, semiarid environment, would Aztec civilization ever have come into being, founded as it was on conquest, tribute, and an agricultural base of swamp gardens that depended on the swampy lands of the Basin of Mexico? The historical possibilities are intriguing.

The implosion of lowland Maya civilization is a sobering reminder of what can happen when human societies subsist off unpredictable water sources, and, through their efforts, put more demands on the water supply than it can sustain. They may build water mountains or hundreds of
acres of irrigation canals, but, in the final analysis, they are powerless against the forces of drought, flood, and El Niños, especially when their rulers are oblivious or indifferent to the suffering of those who feed them. The analogies to modern-day California, with its aqueducts for water-hungry Los Angeles, or to cities such as Tucson, Arizona, with its shrinking aquifers and falling water table, are irresistible.

Below the equator, the warm centuries and their epochal droughts also brought powerful climatic shocks.

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**CHAPTER 9**

The Lords of Chimor

The bodies of the kings and lords were venerated by the people as a whole, and not just by their descendants, because they were convinced that in heaven their souls played a great role in helping the people and looking after their needs.

—Father Bernabé Cobo, *Historia general de las Indias* (1653)

Moche Valley, Coastal Peru, A.D. 1200. The gloom hovers low over the cliffs, the Pacific calm and oily smooth in the early morning. Fog has lingered for weeks, ebbing and flowing with the daylight. Just the regular beat of the ocean surf resonates over the low-lying shore, where the reed-matting shelters of the fisherfolk huddle close to the sand. Campfires flicker in the gray; cloaked figures move in and out of the shadows. Piles of reed canoes lie along the beach, well clear of high tide, drying after a few days of use. At the edge of the breakers, young men launch one of the canoes through the crashing swell, leaping nimbly aboard as the curved bows rise to a steep wave. They laugh as they paddle close offshore, watching the seabirds soar and weave overhead. Soon they bear to the left, toward a spot where gulls dive steeply into rippling water alive with hundreds of small fish. The birds shriek and move elsewhere as the