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Introduction

A User's Guide to Soils, Climate, and Society

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From their emergence between 3,000 and 8,000 years ago until the Industrial Revolution, agricultural societies were the most culturally complex and advanced societies in the world. Despite the rise of industrial sectors in many countries, agriculture continues to be the primary livelihood for the majority of the global population. Agricultural societies have persisted for nearly a dozen millennia, eventually occupying virtually every tropical and temperate zone in the world. Much remains to be learned about agricultural societies, both past and present, in their seemingly limitless diversity. The chapters in this volume contribute to our understanding of ancient agricultural societies in the New World. All are based on the premise that to understand agricultural societies, you must understand the complex relationship between human populations and the physical environment, in particular the land—the foundation of agricultural production and, by extension, of agricultural peoples.

The emergence of agricultural societies involved much greater transformations than the development of new techniques and strategies for acquiring food. Profound social changes coincided with the emergence of agriculture, including larger sedentary populations, increased population densities, more complex sociopolitical organization, increased material culture, and occupational specialization. Though the causal relationship between agriculture and these social changes continues to be the focus of considerable debate, the fact that they are correlated is clear.

There is no question that pre-agricultural peoples modified the landscape to enhance the production of plant and animal resources, but the magnitude and frequency of this modification increased dramatically with the advent of agriculture. Understanding the relationship between agricultural societies and the environment is a subset of the broader endeavor to understand the relationships between humans and the physical environment.

The studies in this volume straddle the line between processual and postprocessual archaeology. Relationships

between human populations and the physical environment are not unidirectional. On the processual side, humans, like any living organisms, must meet certain biological needs, especially nutritional needs. In agricultural societies, a significant portion of these needs are met through the cultivation of plants. Consequently, the ability of these peoples to meet their biological needs is directly linked to the characteristics of the local environment, including characteristics of soils and climate. On the postprocessual side, it is clear that cultural beliefs and values create needs beyond those of basic nutrition. For example, among the Classic Maya (Wingard, this volume), significant effort and resources were expended on the construction of elaborate temples and palaces. Consequently, it is essential to understand the culture of the peoples living in a particular location or region at a particular time in order to understand their relationship with the local environment and, conversely, to understand the reciprocal impacts of changes in either the sociocultural or physical environment. Consequently, rather than fitting neatly under either label, the studies in this volume demonstrate the complementarity of processual and postprocessual theoretical perspectives.

Methodologically, the chapters in this volume represent innovative attempts to understand and explain the complex social and ecological dynamics that characterized agricultural societies in various parts of the pre-Columbian Americas. These studies build on research dating back to the early decades of the twentieth century (see Cook 1909, 1921; Cooke 1931, 1933; Emerson and Kempton 1935; Steggerda 1941), as well as research from more recent decades.

Archaeologists have not worked in isolation. Expertise from fields as diverse as astronomy and zoology has contributed to our understanding of ancient agriculturalists. Archaeologists have also benefited from technologies and tools initially developed by practitioners in other professions. From surveying, masonry, and dentistry come important components of mapping and excavation. Knowledge from historical and modern textile and ceramic production has provided insight into the nature of artifacts and the processes that created them. Osteology and linguistics have assisted in the reconstruction of ancient lifeways. Remote sensing, from aerial photography to satellite infrared images, has augmented the identification of sites and aided the analysis of relationships among them. Advances in climatology and ecology allow archaeologists to address new questions. New innovations will certainly continue to add to the archaeologist's toolkit.

This volume represents another level of application of "borrowed" analytical tools to archaeological purposes, in this case to interpret the relationships of pre-Columbian populations in the New World with their natural environment, to examine the impact of their environment on the ways people organized their lives and social relationships, and to analyze people's impacts on the environment. The

technologies utilized are varied, from some in common use to others rarely applied in archaeology.

As in present times, people in the past interacted with their environment on many levels, from the household through the village to entire regional ecosystems. Therefore, in studying past populations it is essential to approach each analysis at the appropriate organizational level. In some cases the relationship between humans and their resource base is immediate; they are literally living on the land. Other circumstances, such as wide-ranging climate change, require a broader analytical perspective. Before discussing the sources and uses of the data sets and simulation tools used by the authors of each study in this volume, it should be noted that all of them utilize a common component in their analysis: soil science. There are two branches of soil science, edaphology and pedology. Edaphology studies the influence of soil on organisms, particularly plants. Pedology includes soil chemistry, genesis, morphology, and soil classification. Of these, soil chemistry—which plays a major role in determining the amount of food that can be produced on a given area of a particular soil, how the occupation or cultivation of that particular soil will change it, and the consequences that change may have for future cultivators—is of particular importance to several of the studies in this volume.

Soil science is not merely a technical or chemical process but also requires a knowledge of the history of the human and geologic interactions that have produced the soil being analyzed. Initially, soils were analyzed in efforts to classify them by potential productivity. Pedology has now expanded to examine the origins and modification history of soils. Indeed, archaeology, although a beneficiary of soil science, is now credited as a major contributor to understanding long-term anthropogenic effects.

The role soils play varies in each of these chapters. For Woods and his coauthors the *terra preta* is the end product of human habitation, not only prized by current cultivators for its productivity but also an indicator of the extent of population in Amazonia before the advent of European diseases and depopulation. For Wells and his coauthors, the soil preserves the history of human use and predicts the outcomes of future utilization. Meeks and Anderson, Pool, Hayes, and Wingard use soil to predict food resources; for Dixon, the soil has preserved evidence of the actual crops cultivated at Cerén.

What is particularly notable in Woods's and his coauthors' studies in Amazonia is the degree to which research-based knowledge of the effect of human occupation on soil productivity yields a means for determining the extent of that occupation. Thus, the existence of anthropogenically enriched soils—terra preta—validates the existence of widespread, substantial human populations in a part of the New World once thought to have been sparsely inhabited. The extent of these soils and the degree

of modification are cited as evidence of long-term occupation, refuting models of shifting, transitory cultivation by isolated groups.

Wells and his colleagues, working in eastern Honduras, combine archaeological, geoarchaeological, and pedological approaches to determine whether ancient farming practices caused erosion and other degradation in the soilscape and what implications this will have for the success of economic growth through contemporary cultivation in the study area. Their study of past and persisting patterns of land use in the ecosystem and the consequent transformation of the resource informs interpretations of the impact of the environment on the potential quality of life of today's cultivators.

Meeks and Anderson and Pool separately address a different issue: the interaction of the soil resource and climate in determining changes in occupation in a region. Utilizing dendroclimatological data along with the Palmer Drought Severity Index, which uses temperature and precipitation to predict soil moisture and thus agricultural production, Meeks and Anderson address the issue of population variations in the "Vacant Quarter" and the potential impact of drought on Mississippian chiefdoms. Pool, examining the Mimbres Mogollon area, utilizes dendroclimatological and soil productivity simulations to investigate assertions that the Classic Mimbres period ended as a result of drought, overpopulation, or overexploitation of resources.

Both Hayes and Wingard apply the EPIC simulation program, which combines soil, climate, and cultivation technology to study the interaction between population and the soil resource in Mesoamerica, although in different ways. EPIC is tested at Baking Pot, a data-rich, thoroughly mapped site, to determine whether agricultural productivity simulations can be used to develop credible estimates of sustainable site populations. At the site of Copán, Wingard utilizes EPIC to model productivity and soil erosion impacts of intensifying cultivation and the sociopolitical implications of different intensities of land use.

In the Camaná Valley study, Hayes again utilizes EPIC, applying the simulation program to estimate potential populations that could be sustained by the irrigated agriculture necessary in the extremely arid conditions of south coastal Peru. This illustrates the use of simulations with limited data, which requires testing and modifying known data from other locations, combined with specific local information to reach reasonable conclusions.

Dixon demonstrates that the investigations at Joya de Cerén are a technical tour de force, involving a broad range of approaches to develop important contributions to understanding this archaeological site sealed deep under volcanic ash. The combination of fiber-optic investigation of ash cavities, the injection of dental plaster to preserve plant forms, and the use of ground-penetrating radar to locate features in

the village and surrounding fields has permitted the most precise reconstruction of Mesoamerican lifeways.

Sissel Schroeder raises the most important issue in interpreting the past. No matter the analytical or simulation technique, reliability of the data is paramount. How to determine and adjust for the expectations and biases of those collecting and reporting data so those data can be used to study the past is a crucial question. No sophisticated simulation can compensate for inaccurate data; it is imperative that the investigator understand the limitations for the analysis to succeed.

The studies in this volume clearly show that examination of the complex questions regarding the relationship between ancient peoples and their environments requires an equally complex combination of analytical tools, applied at a scale appropriate to the questions investigated. It is our hope that *Soils, Climate, and Society* will not only provide answers to some readers' questions about the past but will also stimulate further research into those questions that remain to be answered.

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