

1 Correlation Is Not Enough

Building Better Arguments in the Archaeology of Human- Environment Interactions

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The impacts of climate change on human societies, and the roles those societies themselves play in altering their environments, appear in headlines more and more as concern over modern global climate change intensifies. Increasingly, archaeologists and paleoenvironmental scientists are looking to evidence from the human past to shed light on the processes which link environmental and cultural change. As they do so, they are emphasizing the complexity of the dynamics underlying both human responses to environmental changes and anthropogenic impacts on environments.

Although archaeology has a long history of interest in human impacts on environments and environmental influences on human activities, construction of detailed arguments about causality in such interactions remains a persistent challenge. Limitations in chronological resolution of archaeological data and paleoenvironmental archives pose a methodological problem, while equifinality remains an interpretative challenge. Establishing clear contemporaneity and correlation, and then moving beyond correlation to causation, remains as much a theoretical task as a methodological one. The contributors to this volume embrace this challenge, and the case studies presented provide a series of snapshots of researchers working, in diverse but related ways, to tease apart the links between human and environmental dynamics around the globe.

The problem that initially brought these authors together was one that for all its apparent simplicity, and in spite of its modern resonance, remains vexing: in what ways did past humans interact with their environments, and how did each affect the other? More particularly, how can we not only generate data about, but also build compelling explanations of, these interactions?

This volume reunites this group, with the addition of a few other like-minded colleagues, to explore these questions through engagement with concrete research problems. As will be evident to the reader, on display throughout is a shared conviction that the questions involved are vital, and a shared recognition that the problems that are endemic to such research need confronting in their own right.

The chapters that follow illustrate this with a variety of case studies, and demonstrate in the accompanying methodological vignettes how some of the

research tactics employed can be generalized in the construction of arguments about past human-environment interactions. These case studies exemplify the ways in which diverse methodologies can be mobilized to address human-environment dynamics. Tools used include alluvial geoarchaeology, geospatial modeling, micromorphological study of anthropogenic and alluvial sediments, various paleobotanical and geochemical analyses, and investigation of on-, near-, and off-site paleoenvironmental archives. The use of these methods sheds light, through the case studies presented here, on human-environment interactions around the globe and spanning the time period from the Last Glacial Maximum through the second millennium C.E. (~500 B.P.).

Rather than rehearse each chapter in detail in this introduction, I provide some broad context and draw out some of the themes shared by the studies that follow. The authors use examples from their own research to explore theoretical and methodological approaches to human-environment dynamics and to address the key task of constructing arguments that can link humans and their environments in concrete and detailed ways. These include ways of operationalizing theoretical frameworks, means of demonstrably relating human activity to environmental conditions, exploration of paleoenvironmental proxies that can be concretely linked to human activity, and foci on particular times and places that lend themselves particularly well to exploring such issues. The contributors include researchers working in a wide variety of regions and time periods; each focuses on the particular, while in aggregate they provide a cross-section of strategies for studying long-term human-environment interactions more generally. The regions explored include Mesoamerica (Borejsza and Joyce), Mongolia (Wright), southwest Asia (Contreras and Makarewicz, Jones and colleagues), the U.S. Southwest (Purdue), the Central Andes (Caramanica and Koons), the Amazon Basin (Browne Ribeiro), California (Coddling and Jones), and the Island Pacific (Baer) (see Figure 1.1).

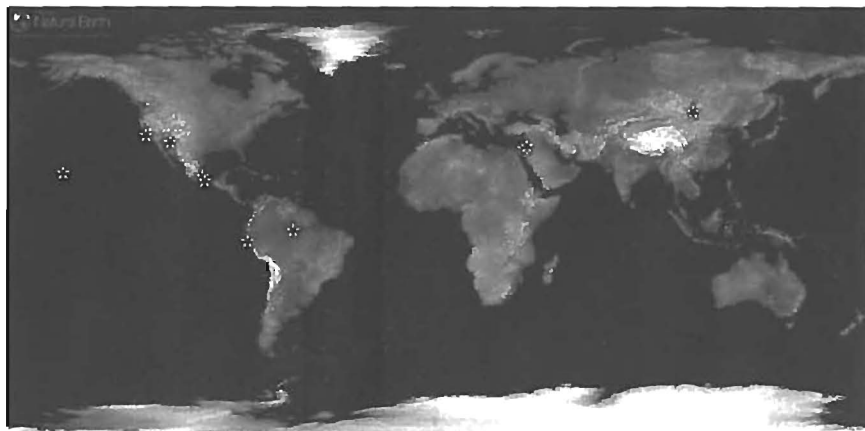


Figure 1.1 Locations of studies included in this volume.

Archaeological Perspectives on Humans and Their Environments

The geographic and temporal breadth of these contributions is testament to how fundamental the theme of human-environment interaction is to anthropological archaeology. This book builds on a distinguished research tradition, and its existence should be taken not as a critique of what has gone before so much as a testament to how difficult—though not, the contributors here would suggest, intractable—the problems of untangling human-environment interactions are. The focus in this collection is on innovation in research tactics—i.e., the ways in which established methods and combinations thereof can be used to approach problems of human-environment interaction.

In theoretical terms, these papers belong to the third of three strands of archaeological literature relating humans to their environments. These comprise (1) investigations of the structuring effects of environments on their human inhabitants, (2) analyses of human impacts on environments, and (3) studies of mutually constitutive human-environment interactions. By focusing particularly on the mechanisms that link human activity and environmental conditions, these papers fall in the latter category, making the directionality of influence a question for research rather than upholding the primacy of either environmental determinism or human agency as points of theoretical principle.

These strands of thought in the archaeology of human-environment interaction both coexist in contemporary archaeology and recapitulate the historical development of archaeological thought. The idea that environmental factors had a structuring effect on the human past was explored nearly from the beginnings of archaeology's development as a field of study; "environmental determinism" and "environmental possibilism" were both based in such a concept (cf. Trigger 1989:Ch.7). This was reinforced in Americanist archaeology in the mid-twentieth century by ecological perspectives (e.g., Butzer 1964; Watson and Watson 1969) and particularly the influence of Julian Steward's cultural ecology (cf. Steward 1972) on such seminal settlement pattern studies as the Virú Valley Survey (Willey 1953) and the Basin of Mexico Survey (Sanders et al. 1979). Although early investigations into human *impacts* on past environments were contemporary with these developments, formative studies like those of George Perkins Marsh (1864) and Walter Lowdermilk (1953) remained relatively isolated from archaeology (see historical overview in Goudie 2013). It was historical geographers like Carl Sauer (e.g., 1941), rather than archaeologists, who developed the ideas about widespread anthropogenic influence that culminated in the 1956 publication of *Man's Role in Changing the Face of the Earth* (Thomas et al. 1956).

These ideas had little apparent impact on archaeology until the final third of the twentieth century, when the discipline really began to embrace study of anthropogenic environmental change as fundamental to understanding the human past (cf. Redman 1999:Ch.2). At approximately the same time,

environmental history also developed as a field during this latter part of the twentieth century (cf. Worster 1990; McNeill 2003). Still today, however, archaeology and its sibling fields of historical geography and environmental history remain surprisingly isolated from one another (see McNeill's (2003) review of environmental history and Williams's (1994) treatment of its attenuated relationship to historical geography; it is perhaps telling that archaeology only barely figures in either discussion). Paleoenvironmental and paleoclimatic scientists, meanwhile, collaborated with social scientists from various disciplines, and at least some have begun to advocate a more integrated approach (O'Sullivan 2008; Caseldine and Turney 2010). I do not attempt to comprehensively review even the intellectual history of archaeology here, but provide below a brief conceptual overview.

Increase in the quantity and quality of paleoenvironmental data has produced a resurgence of interest in studies of environmental influence on past societies since the latter decades of the twentieth century, and paleoclimatologists and paleoenvironmental scientists as well as geographers and archaeologists have produced a broad array of studies claiming to recognize such effects (so many that I am not aware of any single summary, but for overviews of particular regions, see Wright 1993 on the Near East; Roberts et al. 2004 for the Mediterranean; Yaeger and Hodell 2008 for the Maya region; Weninger et al. 2009 for the Eastern Mediterranean; Grosjean et al. 2007 for the South-Central Andes; Contreras 2010 for the Central Andes; and Spriggs 2010 for the Island Pacific).

This has been widely criticized as a revival of discredited environmentally determinist perspectives on the human past. However, the label is not used consistently and encompasses a wide range of approaches with a long history (Coombes and Barber 2005); the "revival" certainly comprised a more restrained vision than the original manifestations, which could be totalizing in their explanatory ambitions. Rather than arguing that culture was *always* the product of environment, salient papers in recent decades focused on the proposed and perhaps inevitable impacts of pronounced climatic changes evident in paleoclimatic proxies (e.g., Brenner et al. 2001; deMenocal 2001; Mayewski et al. 2004; Brooks 2006; Kennett et al. 2012; Kaniewski et al. 2015).

Environmentally determinist perspectives are most commonly manifest in studies relating cultural "collapse" to environmental change in various scenarios (too many to list here, but see useful reviews in Tainter 2006; Butzer 2012; and Middleton 2012), but also are inherent to varying degrees in interpretations that relate cultural trajectories to changing affordances provided by environmental shifts. Although the term "environmental determinist" is one of deprecation within anthropological archaeology, studies so labeled range from truly climatic determinist to more nuanced studies that examine climatic or environmental influence without embracing simple determinism. The latter include analyses of past human reactions to changing climatic conditions that focus on contingency, behavioral diversity, and human adaptation (recent examples include Jones et al. 1999; Anderson

et al. 2007; Costanza et al. 2007; Sandweiss and Quilter 2009; and Cooper and Sheets 2012), perhaps most programmatically laid out in the research program of human behavioral ecology (cf. Bird and O'Connell 2006).

Critiques of environmental determinism have focused on its privileging of environmental drivers of human behavior at the expense of social ones (e.g., Brumfiel 1992), the lack of room for human agency in its narratives (e.g., Erickson 1999 in archaeology; and, more obliquely, Cronon 1990 in environmental history), and its often simplistic accounts of social, political, and cultural change (e.g., McIntosh et al. 2000; Butzer and Endfield 2012; Middleton 2012). A more subtle criticism that highlights how little explored the mechanisms of "determinism" are points to the absence of political ecology in accounts of environmental effects on human societies (e.g., Fisher and Thurston 1999; Ensor et al. 2003). With some interesting exceptions (e.g., van Buren 2001; Billman and Huckleberry 2008), even archaeologists (much less paleoenvironmental scientists) have largely ignored the fairly obvious point that such effects would be felt differentially in any non-egalitarian society and would have complex effects. Meanwhile, a more fundamental deconstruction questions the Cartesian separation of humans from environments implicit in such analyses (e.g., Ingold 2000; Head 2008). The more extreme of these critiques, however, have often sought to redress the balance by disengaging archaeology from *any* focus on past human environments, implicitly or explicitly arguing that human-environment interactions should be secondary to human-human interactions in any analysis of human behavior. Such a reaction risks throwing the environmental baby out with the determinist bathwater, creating an archaeology in which past humans inhabit spaces which are either featureless or limitlessly malleable.

One reaction that has engaged with rather than backgrounded human-environment interaction centered on the unidirectionality of environmentally determinist explanations. Reformulating the prevailing view—which perhaps owes an uncomfortable amount to notions of the Noble Savage living in harmony with his surroundings (cf. Denevan 1992, *inter alia*)—that pre-Modern humans were simultaneously living lightly on the land and at the mercy of their environments, this renewed emphasis on human impacts on past environments has focused on identifying ever-increasing antiquity and the magnitude of anthropogenic influence (cf. Hayashida 2005). That such a human footprint is global and dates back millennia is apparent from the geographic and temporal span of the literature: exemplary studies include work on Central Europe (e.g., Bork and Lang 2003) and the Mediterranean (e.g., Barker 1995; Bintliff 2002; Butzer 1982; 1996), the Island Pacific (e.g. Kirch 1997; 2005), Mesoamerica (e.g., Denevan 1992; Fisher et al. 2003; Heine 2003; Beach et al. 2015), and Amazonia (e.g., Heckenberger et al. 2003; Erickson 2008), and span the Holocene. They have continued to proliferate since Redman's syntheses (e.g. 1999; Redman et al. 2004), and have been argued to comprise evidence of human impact on global processes (e.g., Ruddiman 2003; Ruddiman et al. 2016). This has dovetailed

with the embrace of niche construction perspectives that focus particularly on the potential evolutionary significance of anthropogenic effects on the environments to which humans have adapted (e.g., Smith 2007; Laland and O'Brien 2010), as well as the application of such perspectives to discussions of the antiquity of the Anthropocene (e.g., Braje and Erlandson 2013; Smith and Zeder 2013). Moreover, while environmental determinist perspectives have been salient in popular science literature, notably in the form of Jared Diamond's (1998) *Guns, Germs, and Steel*, discussion of the surprising antiquity and ubiquity of human impact is ably represented by Charles Mann's (2005) *1491*.

Studies of environmental influence and anthropogenic impact have also recently been complemented by perspectives that focus on the ways in which humans and their environments mutually constitute one another, characterizing bidirectional influences rather than unidirectional causality. This development has been explicit and programmatic in historical ecology (cf. Crumley 1994; Balée 2006; Balée and Erickson 2006; Thompson and Waggoner 2013), but is also evident in literature addressing "socio-natural" or "socioecological" aspects of the human past (e.g., van der Leeuw and Redman 2002; de Vries and Goudsblom 2002; Hornborg and Crumley 2007; Fisher et al. 2009; Barton et al. 2012; Giosan et al. 2012; Mayle and Iriarte 2014) and "human ecodynamics" (e.g., McGlade 1995; Kirch 2007; Kohler et al. 2007; Varien et al. 2007; Barton et al. 2011). A focus on mutual influence is also evident in attempts to integrate archaeological data and perspectives into discussions of sustainability and resilience (e.g., Minnis 1999; Redman and Kinzig 2003; Redman 2005; Costanza et al. 2007; de Vries 2006; Dean 2010; Morrison 2015; van de Noort 2011; Turner and Sabloff 2012; Kidder and Liu 2014).

The Temptation of Correlation (and What to Do About It)

In spite of this diversity of perspectives, and interest in human-environment interactions that stretches back to the early years of archaeology as a discipline, the articulation of specific linkages between paleoenvironmental and cultural change remains a rarely realized and tantalizing goal. It offers a means of better explicating cultural trajectories, a tool for examining human ecological footprints, and a strategy for untangling intertwined human and environmental histories in the long term. So central is the theme of human-environment interaction to anthropological archaeology that it comprises one of the five pillars of the recently articulated "Grand Challenges for Archaeology" (Kintigh et al. 2014). It also animates current trans-disciplinary debates over the character and timespan of the "Anthropocene," defined roughly as the time period during which human influence on the globe has been significant (e.g., Crutzen and Steffen 2003; Erlandson and Braje 2013; Ruddiman 2013; Smith and Zeder 2013; Zalasiewicz et al. 2015).

The debates over the definition of the Anthropocene are revealing about both interdisciplinary discourse about past human-environment interactions and archaeology's interaction with its sibling disciplines. They turn fundamentally on the establishment of correlation: the debate is global in scale and coarse synchronicity of human activity and environmental effect is considered argument enough to fix the period's origins in time. Studies focused on the antiquity of anthropogenic impact are in this sense analogous to claims of environmentally driven collapse: both take as their points of departure the identification of suggestive correlations at large scales. Where investigations of human impact identify particular environmental shifts that may be broadly coincident with shifts in human population or behavior and argue that the latter brought about the former (e.g., Doughty et al. 2010; Ellis et al. 2013; Erlandson 2014), the more abundant studies of environmental influence maintain that similar correlations are evidence of environmental impact on human societies (e.g., Binford et al. 1997; Brenner et al. 2001; Sandweiss et al. 2009; Weninger et al. 2009; Clare and Weninger 2010; Medina-Elizalde and Rohling 2012; Lachniet et al. 2012, among many). Of course either process might in principle operate; the shortcomings of these arguments are not in their logic, but their evidentiary sufficiency and chronological precision. Nevertheless, their critics notwithstanding, such papers should not necessarily be read as arguments that correlation should be understood to be causation; rather the identification of correlation is at once a statement of hope and an admission of defeat. It is a statement of hope in that reportage of climate-culture correlation is driven by a conviction that it *should* be possible to develop the putative links further, and an admission of defeat in that it remains unclear *how* those links can be developed.

Two primary factors contribute to this difficulty: problems of spatial and temporal scale and resolution, and problems of articulation of mechanism. The former make it difficult to relate archaeological and paleo-climatic/environmental data more than generally, while in the absence of the latter, influence must remain inchoate, causality vague, and effects linked to causes only by commonsensical assertion.

The juxtaposition of archaeology and paleoenvironmental science highlights just how fundamental questions of scale and resolution are. Environmental parameters are generally discussed in the terms of paleoclimate reconstructions and environmental modeling—that is, spatial scales that are regional and temporal scales that are generally at best centennial. Of course, remarkable paleoenvironmental archives like long dendroecological sequences or varved lacustrine deposits can provide temporal resolution that reaches sub-annual, and deposits from small catchments can offer very local signals, but the bulk of the effort in paleoenvironmental science has been to achieve regional and long-term relevance, pushing the focus towards coarser scales of analysis. In contrast, archaeological explanation relies fundamentally on anthropological models of behavior—i.e., understandings of human activity that are grounded in decision-making at local and annual or decadal

scales and catchments generally defined by distances reasonable for pedestrian travel. Articulating analyses that focus on distinct scales, with varying resolutions, is vital to characterization of relationships between local and regional data, fundamental to understanding relationships between samples and populations, and often central to relating archaeological and paleoclimatic and paleoenvironmental data. As a result, it has been the focus of both practical and theoretical consideration in archaeology (e.g., Stein 1993; Lock and Molyneaux 2006; Robb and Pauketat 2013). One of the chief challenges of the multi-scalar analyses that necessarily result is that of articulating particular mechanisms of human-environment interaction in order to provide a means of moving between scales.

The contributors to this volume use their research to address these problems of scale, resolution, and mechanism. For instance, they ask how (and if) regional paleoclimatic shifts affected everyday life in particular locales, whether distinct groups responded in similar ways to environmental phenomena, what other imperatives than agricultural ones might drive anthropogenic landscape modifications, and what widespread environmental effects are created by small-scale human activities. As importantly, they ask *how*—how can we identify changes, link scales of analysis, understand which environmental parameters were significant to a landscape's inhabitants, differentiate intentional and incidental human impacts, and address challenges of equifinality. The methodological strategies are diverse, illustrating the manifold nature of the subject and suggesting a wide variety of strategies for approaching it.

With regard to temporal scale and resolution, many of the chapters that follow return to basic questions: how reliable are putative correlations, and how can causal relationships be established if correlation is logically insufficient? Even as they seek more robust means of identifying and characterizing links between environmental and human trajectories, they return to the fundamental archaeological problem of establishing precise chronologies. For instance, the limits of regional periodization schemes that imply rigid and precisely dated divides have been recognized for decades (e.g., Rowe 1962)—but they continue in widespread use due to their convenience. As several of the contributors here emphasize, however, the abundance of such schemes in no way means that they are an adequate basis on which to build arguments *even for correlation*, much less causation. Conversely, paleoenvironmental chronologies—generally based, when regular laminations like varves, growth layers, etc. are not available, on age-depth models anchored with ^{14}C dates—themselves are often chronologically imprecise. Moreover, the interpretations of proxies themselves may be subject to critique, with potentially catastrophic consequences for archaeological interpretations (for cautionary examples of both chronological and interpretive problems see, e.g., Calaway 2005; Meadows 2005; and Maher et al. 2011).

As Jones and colleagues demonstrate in Chapter 5 with their from-the-ground-up approach to the chronology of the Azraq Basin in the Late Pleistocene, it can be necessary to revisit the basic building blocks of chronology,

thinking hard about radiocarbon dates and how probabilities distributed over ranges of time relate to one another. This highlights one relatively recent development that none of the chapters in this volume have the data to address: the increasing use of Bayesian chronological modeling in developing both paleoenvironmental and archaeological chronologies (cf. Bayliss 2009; Bronk Ramsey 2009). The resulting improved archaeological chronologies hold significant promise for the elaboration of human-environment interaction, but need to be matched by (or perhaps directly integrated with) paleoenvironmental chronologies of relevant archives.

Building such chronologies for archaeological and paleoenvironmental records is fundamental to any understanding of human-environment interactions. That the resulting correlation-based narratives are challenged as inadequate does not diminish the significance of correlation, but rather highlights its epistemological fragility and its logical insufficiency. These limitations point to the need to use correlation as a prompt rather than an answer, one which demands further investigation of chronology and relationships between humans and the environments they inhabit, as well as construction of robust arguments that can link humans and environments through mechanisms that can be specifically articulated and investigated.

In addition to working with chronology-building, several of the contributing authors focus particularly on more direct means of linking archaeological and paleoenvironmental data. Jones and colleagues in Chapter 5, Contreras and Makarewicz in Chapter 4, and Caramanica and Koons in Chapter 6 all explore the analysis of on-, near-, and off-site paleoenvironmental archives as a means of directly articulating archaeological and paleoenvironmental data. While this by no means obviates the need for chronological control, the potential for identifying markers that can link distinct archives by means other than chronological correlation is tantalizing. Purdue's use, in Chapter 3, of micromorphological markers of distinct climatic regimes, in which she uses source-to-sink sediment analysis to identify not just the sources of sediment but the processes implicated in its transport, illustrates the rich potential for cross-scale links that rest on more than correlation.

Borejsza and Joyce's focus in Chapter 2 on alluvial geoarchaeology shifts the axis of site and off-site, making it temporal as well as spatial. Following Schumm (1991), they describe interpretive problems of convergence and divergence—that is, difficulties of what kind of processes to infer from palimpsests of landscape evidence of human-environment interaction. They suggest—and have elaborated elsewhere (Borejsza et al. 2014)—that alluvial geoarchaeology is a particularly promising source of evidence and argument. Inasmuch as it focuses on archives that juxtapose archaeological and paleoenvironmental data directly, alluvial geoarchaeology might appear to transcend problems of scale, resolution, and linkage. As Borejsza and Joyce emphasize, however, even as alluvial stratigraphic archives may provide both archaeological and paleoenvironmental evidence, the scales of the processes reflected in these archives may vary both spatially and temporally, and must be assessed on a case-by-case basis.

Multi-scalar concerns also explicitly motivate Browne Ribeiro's argument in Chapter 7 that regional questions about anthropogenic dark earth in Amazonia (e.g., is it a marker of a *particular* and relatively synchronous cultural phenomenon?) can only be answered by addressing local questions (e.g., how were particular deposits of *terra preta* formed?). In parallel, on the other side of tropical South America, Caramanica, and Koons argue that regional-scale geographic typologies, not only coarse in scale but also projecting present observed conditions relentlessly into the past, can obscure as much about past human-environment interaction as they reveal. While the Pampa de Mocán on Peru's North Coast is classified as desert and has been archaeologically interpreted as such, their direct investigation suggests that this characterization is inaccurate for at least some past periods, and interpretations derived from it are misleading about the scope and character of past human occupation of the area.

Related issues of scale—the differentiation of environments at micro- or meso-scales within a regional environmental mosaic that might be glossed as uniform by coarse-grained mapping—are apparent in Contreras and Makarewicz' and Jones and colleagues' investigations of the local manifestations of regional environmental patterns in the Levant, and underlie Codding and Jones's assertion in Chapter 8 that complex behavioral patterns may be explained by examining the interaction of environmental diversity and dynamism with hypotheses about human-environmental interaction derived from human behavioral ecology.

These are complemented by more inductive approaches like the ethno-crogeography that Wright proposes in Chapter 9, which uses an analysis of patterning in the environmental characteristics of Mongolian pastoralist camps as a tool for archaeological interpretation. The soil geochemical analyses that Baer highlights in Chapter 10, similarly, provide a means of assessing which characteristics of the agricultural landscape were important to the early state on Maui, demonstrating that particular elite decisions were apparently responsive simultaneously to political imperatives (state expansion) and environmental assessments (land was chosen for productive potential rather than because of proximity, cosmological significance, etc.). These studies use systematic characterizations of environments and distributions of archaeological sites as a means to attack the problem of mechanism: by examining in aggregate the factors influential in past human decisions about interaction with environments (i.e., where to establish camps or intensify agricultural production), they approach emic systems of environmental classification, identifying some of the ways in which environments were understood by their inhabitants.

Learning How to Study Past Human-Environment Interaction

These cases illustrate several prominent themes that are coming to the fore in the study of human-environment interactions, including most saliently

the importance of research that sets out specifically to address questions of scale and resolution and examine linking mechanisms. The research reported here is *designed* to link environmental and cultural change, rather than simply identifying broad correlations and speculating about potential links. As such, it is interdisciplinary even in conception, rather than an attempt to marry distinct archaeological and paleoenvironmental data. However, if there is any indisputable lesson to be taken from the history of research on past human-environment interactions described above, it is that the topic is as theoretically and methodologically challenging as it is important. It would clearly be a mistake to think of even the most exemplary study as prescriptive; both humans and environments are diverse enough that their study cannot be formulaic, and the right questions and methods for any particular context are rarely if ever obvious. The studies included here are illustrations of archaeologists grappling with those problems and wanting their readers to learn both from their successes and the difficulties encountered.

The authors provide a variety of examples of how to frame questions in ways that make them answerable, of ways of thinking about what data may hold answers, and of means of acquiring that data.

Three approaches to addressing problems of human-environment interaction stand out:

- 1 A focus on interaction: Rather than embracing the convenience of environmental determinism or fetishizing human agency, the authors in this volume set out to detail human-environment relationships that are conceptualized as complex, dynamic, multivalent, and at least potentially mutually influential.
- 2 A shift in the questions asked: Rather than asking *whether* environments affected their inhabitants, or *whether* inhabitants impacted their environments, the authors ask instead *how* humans and their environments interacted.
- 3 The mobilization of diverse data at temporal and spatial scales that are theoretically appropriate for explanation of human behavior.

To help make these strategies clear and accessible, the contributors each accompany their chapter with a methodological vignette, outlining one of the principal methods they've employed and why. Of course this is not a methodological handbook and cannot be comprehensive. Various substantial volumes attempt this for environmentally oriented archaeology generally (e.g., Evans and O'Connor 1999; Dincauze 2000; Branch et al. 2005; Reitz and Shackley 2012), and a profusion of specialist literature for particular methods. Amongst the missing here are both methods long standard as means of investigating human-environment interaction and more recently developed methods that provide new tools for addressing the issue. The former include zooarchaeology, archaeo- and pedo-anthracology, dendroecology, and study of a wide variety of organic and inorganic environmental

proxies from diverse paleoenvironmental archives (e.g., diatoms, ostracods, organic C, $\delta^{18}\text{O}$, mineral inputs), while the latter include stable isotope studies of human and faunal remains, faunal and soil/sediment aDNA, further environmental proxies (particularly geochemical ratios and biomolecules), Bayesian chronological modeling (discussed above), and agent-based modeling. Of course both of those lists could be expanded. More methods are developed or adapted to archaeological and paleoenvironmental purposes regularly, though their utility in many ways remains a function of a basic archaeological challenge: it is fundamentally dependent on the quality of understanding of the contexts from which samples are derived, or—in the case of paleoenvironmental data—of understanding how those contexts relate to human activity.

In any case, their omission here is by no means a slight on their utility. Rather, this collection focuses not on breadth of coverage of methodology *per se*, but on the application of methods to a particular problem of anthropological archaeology: the interactions between humans and their environments at multiple spatial and temporal scales. It highlights research tactics, and the methodological vignettes are designed to delineate the appeal and utility of various methods for those interested in questions of human-environment interaction, and direct interested readers to the relevant literature if they wish to learn more. If the chapters do not neatly demonstrate simple applications of single methods, that reflects the ambition of the questions they address: the mobilization of diverse methodologies in the service of difficult questions is the norm. At the same time, the authors provide capsule introductions to some of the methods that they find contribute significantly to their research into human-environment interactions. Which methods may be productively employed in other research contexts is more a function of the evidence available and the particular questions of interest than it is of any inherent suitability of methods to problem; it is hoped that readers will take inspiration from the research approaches herein, while applying whichever methods are best suited to their own contexts.

The studies included in this volume also point towards a next step that remains beyond their scope: they suggest the need for an iterative process of tacking between local and regional, and perhaps also *etic* and *emic*, in exploring past human-environment interactions. Browne Ribeiro explicitly advocates a return to the local *in order to* address the regional, while Contreras and Makarewicz, Jones and colleagues, and Caramanica and Koons, by demonstrating that regional data can produce locally misleading results, argue that the regional may not always be directly applicable to the local. These chapters highlight the way in which problems of scale are problems of sampling; we must confront the twin questions of how representative the local/small-scale may be, on the one hand, and of how much diversity the regional/large-scale encompasses, on the other.

The scale of analysis in much of the work that seeks to relate humans to their environments is regional, especially where evidence of past climate is

concerned (in fact many climate studies *strive* for regional relevance). In contrast, the chapters that follow emphasize the local because that is the scale of human consequences of climate change, human perception and experience, and human response. They should not be understood, however, as constituting a call for a (re)turn to the local. One of the cogent critiques of the impact of postmodern thought in archaeology has been that its attack on the validity of generalization produced a retreat to the particular. Here, rather, the local is not so much a refuge as a necessary waystation, a *means* to understanding the more general. In order to understand both local/human and regional/environmental processes, and the feedbacks between them, it is necessary to (a) work *across* scales, incorporating various disciplinary specialties, and (b) work *between* scales, exploring mechanisms through which various human and environmental processes articulate.

As the chapters here suggest, amongst the most salient of those mechanisms are various subsistence practices, through which humans interface directly with the particularity and variability of environmental productivity (Coddington and Jones, Contreras and Makarewicz, Jones et al.) and which may involve substantial anthropogenic modifications to environments, both deliberate and strategic and unintended (Baer, Borejsza and Joyce, Browne Ribeiro, Caramanica and Koons, Purdue). At the same time, as Hayashida emphasizes in her concluding comments, it would be reductive to presume that human motivations and activities were confined to the direct and relatively visible interface of subsistence production. Here, too, multi- or trans-scalar perspectives are necessary, as social, political, and economic networks in which local populations are embedded may effect human-environment interactions in tandem with local processes.

Whether much of this literature whose surface I have skimmed here—or indeed the studies included in this volume—escapes nature/culture binarism is perhaps debatable. However, the focus on more complex *interactions* that Head (2008) advocates can only be pursued by simultaneously investigating both archaeological and paleoenvironmental data (in spite of traditional disciplinary divisions of labor and attention) and seeking to elucidate specific mechanisms of interaction while remaining open-minded about their character. As such, the chapters that follow not only tackle complex problems, but also point the way towards how we may attempt to generate understandings of past human-environment interactions in which sociopolitically embedded humans strive to meet their subsistence and social goals in settings comprising dynamic environmental mosaics. This may have surprising repercussions: environmental historian Ted Steinberg has argued (2002) that considering environment more fully will enhance understanding of agency/structure dynamics, and may in fact be necessary to their analysis. The archaeology of human-environment interactions, in other words, may be vital to understanding past sociopolitical dynamics as well as socioenvironmental ones.

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