

The Archaeology of Climate Change: Perspectives and Challenges

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The archaeology of climate change and environmental archaeology—each of which, in many respects, embraces the other—reflect our own times as much as they reflect both scientific advances and intellectual curiosity [1]. Over the course of the last two to three decades, archaeological research and interpretation has become increasingly integrated into a broader group of natural as well as social scientific disciplines, many of which are designed to address the ways in which shifts in climate conditions have impacted human societies in the past and with what effects and outcomes. Historians similarly have begun, somewhat more recently, to join these efforts and use historical archives in combination with data from other disciplines to think about how climate change has impacted past societies, state systems, and social, cultural, and economic relationships and processes. This has not been an easy path nor was the outcome we see today predictable, with respect to transdisciplinary research and research funding. Research frameworks that integrate environmental and human systems have become the norm. Human interventions in landscape evolution are better understood, and differences in scale with respect to chronology across the various contributing sciences are recognised as significant aspects in interpreting both longer- and shorter-term socio-ecological dynamics. While an overly simplistic opposition between “external” and “internal” causal relationships has been largely abandoned, as concepts such as “socio-ecology” indicate, the interaction between human systems and the environment is seen as dialectical rather than simply two-directional. Much of the debate surrounding this topic will be familiar to most readers of this volume, and we do not need to repeat what is already either well-known or easily accessible in the literature [2–6].

Clearly, there now exists a widespread and actionable consensus to the effect that an approach which balances agency, structure, context, and cultural dynamics is the most productive way forward within archaeology and that scientists and archaeologists/historians need to work collaboratively and in an integrated way to make sense of past societal evolution [7–9]. As the title of a recent article expressed, the archaeology of climate change is “a blueprint for integrating environmental and cultural systems” [10]. Integrating climate and palaeoecological science with archaeological and historical data has significantly enhanced our ability to understand how past human societies responded to challenges instigated by shifts in their environmental and climatic conditions of existence. This permits the application of mass quantitative data analysis to isolate long-term evolutionary responses in human populations to significant shifts in their environment and climate, e.g., [11,12]. Computational modelling has been a major contributor in this respect, allowing for a more refined approach to analysing correlations between archaeologically indicated changes in social–ecological systems (embracing demographics, land use, and settlement distribution and density, for example) and in climate. Simultaneously, such computational archaeological approaches make it possible to model the impacts of a range



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of climatic or ecological phenomena on human systems at different scales and to test hypotheses about societal responses [13]. Clare's contribution to this collection, which examines the impact of rapid climate change through the framework of the adaptive cycle model and vulnerability studies and highlights the potential impacts and influence of climate change and climate instability on early agricultural communities, illustrates some of the potential of this. The availability of high-resolution reconstructions of past climatic and ecological/environmental conditions permits a more granular understanding of premodern socio-ecological systems and of societal transformations at the highly local scale of an individual settlement and its evolution over decades, centuries, and sometimes millennia [14], as can be seen in the chapters by Koch, Haldon, and Steadman et al. It also provides better insight into how, in what forms, and at what levels a society demonstrated resilience or fragility, asking questions about which elements of a cultural system bore the costs of resilience, the extent to which a system was able to maintain a sustainable local ecosystem, and what threats to this may have existed, as well as how such threats may have been realised, mitigated, or obviated at different scales of societal life—and, as the chapters by Kearns and Rosen in this volume show—the awareness of scale and an appreciation of the causal role of culturally determined agency, belief, and social praxis are especially important in efforts to understand these aspects.

However, many challenges remain, most obviously that of determining what were the causal mechanisms underlying the relationship between society, climate, and environment, a key aspect in S. Manning's discussion but present in several of the contributions in this collection. Monocausal explanations still appear from time to time, but it is increasingly accepted that significant socio-ecological transformations were the product of multiple factors that combined and recombined in different ways and contributed to both systemic continuity and discontinuity or system collapse. Complex adaptive systems thinking, evolved first in ecological science and increasingly adopted in the social sciences, offers a valuable practical framework for thinking about the dialectics of multicausal relationships. In conjunction with the explanatory framework provided in resilience-theoretical approaches, this further enhances the potential for identifying cross-scalar connections and the forms through which socio-ecological systems respond to tipping points—as in the contribution by Newhard et al. This includes methods for evaluating the adaptive capacity of human systems, for example, by simulating the effects of changing decision rules about land use, crops grown, reproduction, or mobility in response to environmental change. In a crucial intervention, Jacob Damm's chapter in this volume examines in detail the specific ways through which archaeobotanical data—in this case, from legumes—provide a valuable means of approaching regional and local impacts of climate change through a close investigation of the agricultural strategies employed to mitigate risk and/or uncertainty. Coupled with the potential offered by creating a computational model of past climatic conditions and their impacts on societies and their responses, both extremely long as well as relatively short timescales can be analysed by integrating many types of data. Integrating instrumental, palaeoenvironmental, archaeological, archaeobotanical, archaeozoological, and documentary data permits the construction of “socio-ecological profiles” [15–17]. Through these, path dependencies and processes can be identified through which the competitive selection of social practices [18] leads to socio-cultural success as well as to maladaptations [19], as the chapter by Dugmore and Jackson in this volume illustrates using a different perspective. We can thus build causal complexity into our understanding of transformations in practice and deepen our socio-ecological and holistic understanding of cause-and-effect relationships.

Archaeological evidence contributes not only to studying the past in its own right but has also increasingly been called upon to inform contemporary debates about environmental policy and questions of ecological as well as societal sustainability [20–25], points illustrated in the chapters by Lane et al. and Miller and Fitzhugh, for example. As the chapter by Jaffé et al. shows, this debate also overlaps into examinations of political evolution and contemporary political–cultural identities, with implications for national education policy, conservation, and heritage management. Archaeological models can be deployed predictively to consider climate change impacts on contemporary societies in the long term [26,27]. Humans have been an integral element in ecosystems worldwide since the early Holocene (ca. 9000–7000 BCE); as such, much of environmental history is also cultural history [28], and long before the Common Era, most ecosystems owed their particular characteristics to centuries of human activity. While premodern cultures learned how to manage the landscapes they inhabited, they could still face problems of over-exploitation, surface erosion, and deforestation [29], and anthropogenic environmental damage could be a significant problem [30,31]. Nevertheless, there is no doubt that premodern societies or cultural systems, as with contemporary societies, generally understood the need to maintain the resources to sustain their livelihoods at an appropriate level and to protect those resources from depletion, although they would rarely have expressed it in such terms. Humans, in general terms, have proven to be uniquely adapted to coping with climate variability [32–37]. We have possessed many ways of combating predictable or potential climatic events, such as unusually severe seasonal weather, flooding, and drought, and we have evolved a range of responses to deal with or mitigate threats to agriculture, settlements, and administrative infrastructure. Many cultures maintained a sustainable existence not just across several centuries but millennia [38–40]. Because we can reveal some of the ways in which past societies responded to environmental challenges and adapted to maintain a sustainable existence—or failed to do so—we can exploit some of these examples to inform discussions of how we might address the climatic and environmental challenges that confront us today [13,41,42]. One conclusion that we may draw from integrated palaeoecological/archaeological research is that the culture and vulnerabilities of a society are as significant as the magnitude of the hazards a society may have faced, just as the ways through which a society could respond were determined by culturally moulded social praxis and belief systems, points illustrated in J. Manning’s chapter on ancient and Hellenistic Egyptian management—or failure to manage—the annual Nile flood.

Many past adaptations to environmental change were not only successful in their own time but could suggest approaches for policy responses relevant to modern challenges [43,44]. The rapid increase in interest among the wider public as well as in engagement with the relationship between archaeology and climate change reflects many of these themes, and several of the chapters in this SI reflect that trend. It is also reflected in the 2010 launch of a dedicated journal, *AP: Online Journal in Public Archaeology*, and in numerous articles as well as community engagement projects, e.g., [45–47]. The larger role of archaeology in the broader framework of policy and environmental politics has thus grown rapidly in the last few decades, particularly in connection with contemporary and predicted climatic threats to heritage and community identities [17,48–51]. We hope that the chapters in this collection will both add to the existing and growing body of research in the field of the archaeology of climate change as well as further enhance efforts to broadcast the value of understanding the past in responding to modern challenges and in planning for the future.

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