Climate Change and Cultural Dynamics: Lessons from the Past for the Future

David G. Anderson, Kirk A. Maasch, and Daniel H. Sandweiss

INTRODUCTION

As the twenty-first century winds onward, it is becoming increasingly clear that understanding how climate affects human cultural systems is critically important. Indeed, it has been argued by many researchers that how we respond to changing global climate is one of the greatest scientific and political challenges facing our planetary technological civilization, comparable and closely intertwined with concerns about biological or nuclear warfare, famine, disease, overpopulation, or environmental degradation. By any reasonable evaluation of the evidence, this century, and likely the several centuries that follow it, will be characterized by dramatic climate change, perhaps as significant in terms of its impact on our species as any climatic episodes that have occurred in the past.

What we don’t know with much certainty is how these environmental changes will play out across the planet, and how individuals as well as nation states will respond to them. Archaeology has a major role to play in helping us move through this period of crisis, however, by showing us how human cultures in the past responded to dramatic changes in climate. As the work of many archaeological scholars has shown, climate change has not invariably proven to be a bad thing: it is how people respond to it that is critical (e.g. Anderson et al. 2007b; Cooper and Sheets 2012; Crumley 2000, 2006, 2007).

1 This chapter has been based, in part, on work presented in an earlier paper on the subject (Anderson et al. 2007a), although the text here is original. The chapters in the book Climate Change and Cultural Dynamics: A Global Perspective on Mid-Holocene Transitions (Anderson et al. 2007b) cited throughout this chapter, it should be noted, are summaries of extensive prior work by paleoclimatologists and archaeologists, and provide a much more comprehensive bibliography and discussion for the interested reader.
Hardesty 2007; McAnany and Yoffee 2010; McIntosh et al. 2000; Redman 2004a; Sandweiss and Quilter 2008; Sassaman and Anderson 1996; Tainter 2000). Archaeology working in tandem with a host of palaeoenvironmental and historical disciplines has lessons for our modern world and, as this volume demonstrates, we as a profession are making great strides in getting our message out. Perhaps the most important lesson from the past is that people, through their actions, are the drivers of cultural change, including response to climate change. Societies are not, however, monolithic entities that ‘choose’ to succeed or fail; people as individuals, groups, or factions through their actions generate outcomes, and often some demonstrate remarkable flexibility and resilience (Cooper and Sheets 2012; Diamond 2005; McAnany and Yoffee 2010). This is not to say optimal or happy endings are inevitable, only that they are possible. Likewise, change and diversification typify human response to climate change, not stasis or uniformity. Human response to climate change has varied, with some cultures striving to maintain the status quo in their current setting, sometimes unsuccessfully, others adapting their technology or organization to meet new conditions, and still others relocating to new areas.

This chapter was prepared during a period of record sustained low and then high temperatures in eastern North America in the winter, spring, and summer of 2010. The reasons for these unusual seasonal conditions were the subject of extensive informed and not so well informed public discourse, illustrating how varied humans’ responses can be to conditions occurring right before their eyes. Interest in climate and climate change has attracted increasing attention in recent years among the scientific community as well as the general public, and research and publication on the subject as well as political debate about what to do about it has grown markedly. There is an old adage attributed to Mark Twain, but perhaps more appropriately to his collaborator Charles Dudley Warner, that everyone talks about the weather, but nobody does anything about it. Unquestionably a lot of people are now talking about the weather, and a great many scientists are researching the subject. Doing something about the weather, either directly by attempting to change it, perhaps through reducing greenhouse gases, or indirectly by learning how to cope with the conditions, is now something everyone, and something that many people and nations are attempting to address.

Children being born today in developed nations are likely, given current life expectancy, to live until near the end of the century, and as a result will witness significant changes in many areas in temperature, sea level, glacier and ice sheet extent, and snow and rainfall patterns, mandating the relocation of and changes in plant and animal communities, including human populations (IPCC, 2007: 8, 16). Indeed, the well known migrations of peoples in the late prehistoric and early historic eras, like those of the Angles and Saxons in north-western Europe, the Huns or Mongols in Asia, or the Bantu-speaking peoples in Africa, may pale in comparison to the movements that may occur
in the years to come, at least in terms of the sheer numbers of people involved and the geographic areas covered (see Stipp 2004). The occupation and use of whole regions will likely change markedly, particularly as rising sea levels or changing rainfall patterns affect settlement. To cite one example, as the Arctic Ocean becomes ice-free in the summer, it will likely come to serve as a new shipping route as well as become an area increasingly favourable for the exploitation of minerals, oil, and biota, mandating increased settlement along its margins (e.g., Schiermeier 2007; Stott and Simmonds 2010). The concomitant thawing of the permafrost will undoubtedly change the accessibility and utility of this terrain, as well as threaten an archaeological and palaeoecological record currently preserved in a deep freeze. In a like fashion, around the world, areas now thinly settled may become attractive, while regions of dense population, particularly in low-lying coastal areas, may have to be abandoned, all of which will create new archaeological sites or threaten existing ones.

The question is then not will the climate change, for it always does, but what will we do about it. The record from the human past gives us numerous examples from which to work and to offer guidance. When presenting our archaeological narratives, however, we must be careful about what we say and how we say it. That is, we should avoid over dramatizing the positive or the negative, but instead document what happened, and why, and what would be the likely parallels in the modern world. Fortunately, archaeology is but one of a wide range of disciplines exploring the impact of climate change past and present. Indeed, modern archaeological research is first and foremost multi-disciplinary research, and its successful practice mandates consideration of a wide range of data and, ideally, a wide range of approaches. To cite a few examples, archaeologists having been working with palaeoclimatologists to determine the effects of past climate change on human societies, examining topics as diverse as the impacts of El Niño-induced rainfall and erosion in the Americas (e.g., Richardson and Sandweiss 2008; Sandweiss and Quijler 2008; Sandweiss et al. 1996, 2001, 2007); how variation in rainfall or temperature can affect agricultural productivity and surplus mobilization in the prehistoric American southeast and the Mayan area of Central America (Anderson et al. 1995; Fiedel and Shaw 2000; Yaeger and Hodell 2008); and how changes in the ranges of floral and faunal resources in the Late Pleistocene Old and New Worlds. Examining using procedures such as ecological niche modelling, can help determine where on the landscape prehistoric human populations might have occurred (Banks et al. 2006); this procedure is especially effective at documenting where new biotic ranges might be located given changing climate. The successful reconstruction of climate and culture change in the past involves working with information from multiple sources, and it is clear that multiple independent lines of evidence and argument yield greater insight than individual scholars or disciplines working alone (see Crumley, Chapter 17 this
LESSONS FROM PAST EPISODES OF UNUSUALLY WARM GLOBAL CLIMATE

At present most researchers examining climate change are thinking about developments no more than a century or so into the future, although there are important and somewhat under-appreciated exceptions looking ahead hundreds and in some cases thousands of years (Berger and Loutre 2002; Loutre and Berger 2000; Zickfeld et al. 2010). Most projections, however, focus on change in the twenty-first century, within the lifetimes of people currently alive or their immediate descendants. Global surface temperatures in AD 2100 are assumed to be between 2° and 4.5°C warmer than at present, and sea level perhaps no more than a metre higher (IPCC 2007: 12). Archaeologists and palaeoclimatologists use comparisons with warm periods in the past to suggest possible outcomes of current trends. During the Eemian, the penultimate interglacial period c. 120,000 years ago, for example, high latitude temperatures were some 3°–5°C above those at present and sea level was perhaps 4 to 6 m above current level (IPCC 2007:9). Unfortunately, the Eemian lies in the fairly remote past, and since it has not received anywhere near as much research attention as the current interglacial, it is difficult to draw detailed lessons for the modern world from it. The fact that sea level was several metres higher during that interglacial, in a period when climate was not being influenced by anthropogenic effects (greenhouse gas emissions), however, should give anyone pause, considering that much of the archaeological record of humanity’s past as well as an appreciable portion of its current population is found on or near the coast.

Another episode of warmer global climate that is used to explore change in cultural systems in the near term is the Medieval Warm Period between about AD 800 and AD 1200. Only a millennium in the past, our climate and cultural records for this period are much better, and one clear lesson from archaeology and history is that climate conditions as well as cultural responses were highly varied, with conditions favourable for human population growth in some areas, such as among the agricultural Mississippian societies of the southeastern United States, and less favourable in other areas, such as among the coastal hunter-gatherers of California (Anderson 2001; Fagan 2008; Jones et al. 1999; Milner 2004). The period was only a few hundred years long, however, and global climate was similar to that at present, making it a useful analogue for a world in which climate conditions stabilize as they are at
present. Unfortunately, stable climate does not seem likely in either the short or the longer term, barring a major and sudden change in human behaviour.

The Mid-Holocene warm period from about 9,000 to about 5,000 years ago offers (we argue) perhaps the best parallel from the past through which to explore the impacts of sustained global temperatures higher than those at present, something long noted in the technical and popular literature (e.g., Anderson et al. 2007a; deMenocal et al. 2000; Mitchell 1999). The Mid-Holocene period is not an exact parallel to modern circumstances, however, since the observed warming was due to orbital parameters resulting in greater solar radiation (insolation), and not to anthropogenic effects such as greenhouse gas production. For exploring changes in climate, biota, and human culture due to prolonged warmer temperatures, however, the period is the best we have, and a close parallel with what is likely to occur in the coming decades (e.g., Anderson et al. 2007a, 2007b; Ganopolski et al. 1998; Mitchell 1990; 1180–3). The remainder of this chapter briefly explores what happened during the Mid-Holocene, and how study of this period can help us prepare for the changes likely to occur in the decades and centuries to come.

THE MID-HOLOCENE AS A PROXY FOR THE CLIMATE AND CULTURE CHANGE IN THE COMING MILLENNIUM

Studying what happened during the Mid-Holocene in specific regions illustrates the kind and extent of changes in climate and biota in these areas, and how they could have influenced the human societies present. Correlation of climate and cultural phenomena does not equate with a causal linkage, of course, and relationships must be demonstrated rather than assumed to exist. To cite perhaps the most critical variable of interest to past and present human populations, Mid-Holocene precipitation conditions were of particular importance to agricultural populations then emerging or present in many areas, and having ready access to potable water was critical for human survival anywhere. Observed patterns in precipitation and in the availability of fresh water during the Mid-Holocene (e.g. Mitchell 1990; Ganopolski et al. 1998) are similar to those predicted for the future, when it is likely that there will be significantly increased precipitation in eastern parts of North and South America, northern Europe, and northern and central Asia [and drying] . . . in the Sahel, the Mediterranean, southern Africa, and parts of southern Asia (IPCC 2007: 7). Parts of the Sahel were grassland during the Mid-Holocene, and here and in other parts of the world, such as the Atacama Desert of coastal Peru and Chile, more changes in rainfall and temperature had a major impact on the occurrence of resource important to human populations living in these
areas. The origins of Egyptian as well as western South American civilizations have been attributed in some scenarios to peoples coalescing in river valleys like the Nile as deserts expanded and the ranges of flora and fauna shifted, resulting in the adoption of new forms of social organization to deal with higher population densities, as well as of new food sources such as agriculture and riverine or maritime fisheries (e.g. Grosjean et al. 2007; Mosley and Keefer 2008; Sandweiss et al. 2007; Wendorf et al. 2007). Small changes in climate appear to have had a far greater effect on biota and culture in desert and grassland regions than in areas with much greater vegetation cover. While the Sahara was green in the Mid-Holocene (Kuper and Krügel 2006; Wendorf et al. 2007), they were also regional trends toward greater aridity, particularly in southern Mesopotamia from about 5,000 years ago, after state-level societies had become widespread (Kennett and Kennett 2007; Rosen 2007). In the Atacama Desert, millennial-scale changes in water availability may have led to new religious practices built around artificial mumification (Marquè et al. 2012). Some classic cases of societal collapse, such as the end of the Old Kingdom in Egypt and the Akkadian empire in Mesopotamia, both events occurring about 4,200 years ago, may have been caused by climate change, and specifically by regional drying and changes in the flow of major drainages like the Nile, Tigris, and Euphrates (deMenocal 2001; Stanley et al. 2003; Weiss et al. 1995; but see Yoffe 2005:143; Zentler 2003:17–29).

As is happening again at present, extensive and sometimes fairly large changes in the ranges of plants and animals, both altitudinally and latitudinally, occurred worldwide during the Mid-Holocene (e.g. Delcourt and Delcourt 2004; Parmesan 2006; Watler et al. 2002). For example, the boundary between taiga and tundra (the furthest point at which trees occur) moved as much as 250 km in many areas, and many cold-tolerant species moved to higher elevations (e.g. Delcourt and Delcourt 2004; Ganopolski et al. 1998; 1998). These changes in distribution occurred over large areas and were the result of comparatively minor temperature changes—typically no more than one or two degrees Celsius—a lesson modern planners concerned with the effects of a changing climate would do well to remember. Major declines and range shifts in northern European elm (Ulmus spp.) and eastern North American hemlock (Tsuga canadensis) occurred during the Mid-Holocene: warmer conditions, drought and insect and pathogen infestations are implicated, illustrating how changing climate can produce a range of effects, including the introduction of diseases formerly foreign to a given area (e.g. Bennett and Fuller 2002; Digerfeldt 1997; Dincauze 2000:88–91; Foster et al. 2006; Parker et al. 2002). These broad changes in tree cover are associated with major changes in the human societies in these regions, with increased hunting-gathering activities observed in portions of northeastern North America and the initial adoption of agriculture in northern Europe (Dincauze 2000; Karlén and Larsson 2007; Sanger et al. 2007).
Other major changes in forest community composition and range that occurred during the Mid-Holocene include the expansion of western red cedar (Thuja plicata) in the Pacific northwest and coniferous longleaf pine (Pinus palustris) in the southeastern United States (Anderson et al. 2007b; Delcourt and Delcourt 2004; Fedje and Mathewes 2005: 57; Moss et al. 2007; Watts et al. 1996). The increase in red cedar is thought to have led to the classic northwest coastal adaptation characterized by the use of the wood in plank houses and boats and in totem poles. In the southeast, the pine forests replaced a formerly more mesic community across much of the coastal plain, leading to a reduction in mast for game and an apparent relocation of human populations to the margins of major rivers or well into the interior, where deciduous forests continued to occur. Shellfish began to be intensively used in both regions, and monumental architecture appeared in the southeast in some areas, indicating the emergence of more elaborate forms of social organization. The greater use of shellfish is attributed, in part, to a stabilization of sea level as well as a need to exploit a wider range of resources as human populations grew. Not long after the intensive use of shellfish became widespread in the southeast a number of local plants were domesticated. Changing conditions led to changes in technology, particularly related to food production, and the same is likely to happen in the twenty-first century and after. Palaeoecological evidence from archaeological sites worldwide provides useful data on changes in the abundance of species that appear related to changes in climate; molluscan fauna are particularly sensitive to small changes in temperature and salinity, and are thus especially useful climate markers (Lutzenko et al. 2007; Sandweiss et al. 2007). Just as ecological and cultural refuges were critical to the survival of species and societies during periods of climate change in the past, comparable 'arks' are likely to be needed in the years to come.

Climate-based changes in range and productivity apply to domesticated plants and animals as well as to wild species like molluscs or anadromous fish. Variation in the number of frost-free days, the occurrence and amount of rainfall, and the intensity of wind or hail storms can profoundly affect the productivity of certain plant species. Agricultural populations past and present have been dependent upon their ability to create and store surplus production, and crop failures lasting more than a year or two in succession are frequently catastrophic (Fagan 2000; Le Roy Ladurie 1971). Our own diet will be affected by changes in climate and related changes in the ranges of plant and animal species, and consideration must be given to assessing the reliability of food sources, not just their location. Cold-adapted species will not only relocate toward higher latitudes but also to higher elevations, at least as long as such locations where they can thrive exist: a pattern of vertical movement of biota is already under way in the Appalachian (e.g. Delcourt and Delcourt 2004). Depending on local conditions there were sometimes lags between climate change and biotic response, in some cases with responses taking centuries to
play out (Davies and Bothk 1985). This need to be borne in mind when pollen and charcoal particle date are considered, since changes may not correspond temporarily to changes in climate (e.g., Anderson and Smith 1997).

When it comes to climate change we must think globally, but also focus on how matters played out locally, since they may not correspond to expectations derived from proxy measurements based on conditions over broad areas. Oxygen isotope ratios in ice or ocean sediment cores (e.g. Kirch 2001; Maasch 2008; Mayewski 2008). Research focusing on the Mid-Holocene in particular regions indicates that climate change was not uniform or identical everywhere, in the sense that it was not characterized by directional trends toward warmer and/or dryer or cooler and wetter conditions. Within particular regions, such as the Amazon basin, the Mayan area, and southeastern North America, rainfall regimes differed appreciably in different areas over the course of the Mid-Holocene (Anderson et al. 2007b; Meggers 2007; Vrba and McCal 2007).

Climate change must always be considered in terms of its effects at the local scale, both spatially within small areas and at intra-annual, inter-annual, and decadal temporal scales. Such variation can be as important as longer-term climate trends.

Perhaps the most intensively studied example of relatively short-term climate change and its effect on human society is the El Niño-Southern Oscillation, or ENSO, whose effects are observed widely, with variation on an inter-annual to decadal scale but with changes also observed on much longer intervals. El Niño frequency and intensity increased over several centuries in the Mid-Holocene after about 6,000 years ago and again in the Late Holocene after about 3,000 years ago. The changes in precipitation regimes and biota led to increased runoff and erosion that created problems for complex societies in western South America but also occasionally led to new adaptations (Moseley and Keeler 2008; Richardson and Sandweiss 2008; Sanweis and Quitter 2008; Sandweiss et al. 1996, 2001, 2007).

In the southeastern United States a similar pattern is observed during these two intervals, around 6,000 and 3,000 years ago, which are characterized, respectively, the emergence of monumental architecture of shell or earth in several areas and the end of a number of complex Late Archaic societies, including Poverty Point, which had the largest monumental architecture found during the Archaic period in eastern North America (Kidder 2006, 2010; Thomas and Sanger 2010). Changes in precipitation regimes, flooding patterns, and fluctuations in sea level that affected the availability of subsistence resources are thought have played a role in bringing about the observed changes in culture (e.g. Kidder 2006, 2010), although many other factors are also implicated, such as regional population density, established traditions of behaviour, intensity of land use, and patterns of regional interaction (Anderson 2002, 2004, 2010; Gibbons 2010; Hamilton 1999; Sanger 2010; Sasaaman 2010a, 2010b; Thompson 2010). In both western South America and the
Climate Change and Cultural Dynamics

Southeastern United States, moreover, diversity characterized local adaptations during the Middle and Late Holocene as well as the responses to changing climatic conditions. Evidence for warfare is observed during the Mid-Holocene for the first time in many areas, although whether climate change has much to do with it is uncertain. Some view warfare as a phenomenon dependent on population density, although it is also a means by which individuals and societies can obtain status and resources at the expense of others. That climate change has the potential to lead to major conflict is something politicians and military planners are taking seriously at the highest levels. As the US Department of Defense noted in its most recent Quadrennial Defense Report:

The U.S. Global Change Research Program, composed of 15 federal agencies, reported in 2009 that climate-related changes are already being observed in every region of the world, including the United States and its coastal waters. Among these physical changes are increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the oceans and on lakes and rivers, earlier snowmelt, and alterations in river flows. Assessments conducted by the intelligence community indicate that climate change could have significant geopolitical impacts around the world, contributing to poverty, environmental degradation, and the further weakening of fragile governments. Climate change will contribute to food and water scarcity, will increase the spread of disease, and may spur or exacerbate mass migration.

While climate change alone does not cause conflict, it may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world (DoD 2010: 84–3).

While it is hoped that conflict will be avoided, climate change will affect critical areas such as freshwater supplies and crop yields. It will also result in the opening of new areas as ice caps melt, and cause other regions to be abandoned as agriculture becomes impractical or as sea levels rise. Changes in wind patterns and ocean currents will influence maritime traffic, much as it did earlier in the Holocene (A. Anderson et al. 2007).

Human populations have been shaped by climate change through changes in organization or technology, or through migration, the relocation from one area to another. They have also exploited new resources. Beginning in the Mid-Holocene, and especially from about 6,000 years ago, human use of shellfish and agriculture began to intensify in many areas and helped to make possible the development of complex societies in many parts of the world. Complex hunting-gathering cultures that emerged at this time include the Jomon culture in Japan and the Russian Far East (Lutzenko et al. 2007), the Shell Mound and coastal Archaic cultures of the southeastern United States (Anderson et al. 2007b; Sassaman 2010b; Thomas and Sanger 2010), and various societies along the western coast of North America (Jones 2010;
Kennett 2005; Moss et al. 2007). That minor fluctuations in sea level can have profound effects on the location of settlements is a lesson archaeology teaches well, in the southeastern United States, for example, coastal Archaic shell middens sites were often abandoned and their peoples displaced kilometres away by rises and falls encompassing no more than a metre or two (e.g. Sanger 2010). These relocations only affected a few hundreds of people, however, while similar shifts occurring today would affect millions of people in the southeast alone, and tens of millions worldwide. Minor changes in sea level in the area of the Persian Gulf appear to have played a role in the emergence of civilization in ancient Mesopotamia: cities fabled in history such as Eridu and Ur were apparently much closer to the sea when they first appear in the historical record (Kennett and Kennett 2006: 74, 78; 2007). Sea level rise is regarded with such interest that on Google Earth it is possible to find the area that each one metre increment would flood. The changes in sea level that will likely occur in the centuries to come will prove to be a major challenge for our civilization and in the process will damage or destroy countless archaeological and historic sites. Many archaeologists in the twenty-first century worker in reservoir areas that were about to be flooded; in the twenty-first century and after, our profession may be focusing more on coastal areas.

THE FUTURE IS NOT FIXED, BUT IS UP TO US

How does studying climate and culture change during the Holocene help us in the modern world? In many ways. Lessons range from revealing large-scale changes over time and space that can occur in vegetation and precipitation, and how humans have responded to them, to developing new ways of thinking about how we can best deal with similar changes that are likely to come. Climate change during the Mid-Holocene helped shape the development of complex societies in several parts of the world, not only when conditions favoured the aggregation of larger numbers of people but also when less favourable conditions required new social strategies to maintain existing populations. The Mid-Holocene record also shows how environmental change can trigger a range of cultural responses, from collapse to reorganization to expansion. It appears to have forced or necessitated culture change in some areas; deliberate efforts to maintain the status quo in others, and no obvious impact in yet others. The demonstration of spatial-temporal correlation between climate and culture change, of course, does not prove they are related. It does, however, mandate consideration of possible linkages.

To conclude, Holocene climate has been variable at spatial and temporal scales, a record receiving ever increasing attention by paleoclimatologists and archaeologists alike. Climate cycles roughly 1,500 years in extent are well
The Holocene help us in revealing the large-scale pattern and precipitation, indicating new ways of thinking that are likely to come. The development of not only when conditions are met but also when less favorable conditions exist is evident in the reorganization of culture change in some areas, and no obvious temporal correlation between these processes is related. It indicates that spatial and temporal palaeoclimatologists and years in extent are well documented (e.g., Bond et al. 1997) and it is clear from archaeological, historical, and palaeoclimatic proxy records that climate change has had a significant impact on human culture as well as on natural ecosystems. Climate change since the Late Pleistocene has sometimes occurred rapidly, over decades and even within a few years, and, if the past is any guide, we can expect similar episodes of rapid change in the future (NRC 2002). The Middle Holocene was a time of major change in human societies in many parts of the world, and included the rise of civilization in some areas, continuity with minimal change in other areas, and large scale movements of peoples in still others. The lessons are both sobering and comforting. When faced with significant environmental change, what was critical was how human societies reacted (McAnany and Yoffee 2010; Skinner 2008). Almost invariably, people responded as best they could to the changes occurring; we are a resilient species. While societal collapse or abandonment occurred in some areas, people typically relocated rather than died out, or reorganized their social systems. In some cases, environmental change led to growth and expansion occurred. We as individuals and as nations in the twenty-first century face dramatic changes in the world around us, and unlike earlier societies we have a pretty good idea how to address them. Whether we will not merely endure but prevail, as William Faulkner stated in his Nobel acceptance speech (see Frenz 1969), is up to us, and will depend on how we exercise our ability for perseverance, compassion, and sacrifice.

ACKNOWLEDGEMENTS

This chapter was initially presented as a paper in the session 'Human Responses to Mid-late Holocene Climate Change' organized by Val Attenbrow and John Grattan, at the Sixth World Archaeological Congress, Dublin, Ireland, 1 July 2008. The authors wish to thank Matthew Davies and Freda Nikroo M'Mboigori for inviting us to participate in this volume, and for helpful suggestions with the manuscript.
References


national Monographs in Prehistory), pp. 246-77.


ademic Press).


References


— and Busse, M., eds (2002), Proceedings of APN Workshop on Local Perspectives on Climate Change and Variability in the Pacific Islands (Christchurch: Macmillan Brown Centre for Pacific Studies).


References


Boulogne, N. A. (1766), L’antiquité dévoilée par ses osseaux (Amsterdam, Marc-Michiel Rey).


References


Dalti, R. (1833), 'Mr. Dale’s journal of an expedition from Xiang George’s Sound to the Kolymenuruff Range of magotains', in J. Croft, ed., Journals of several expeditions made in Western Australia, during the years 1829, 1830, 1831, and 1832, under the sanction of the governors, Sir James Stirling, containing the latest authentic information relative to that country', London: J. Croft.


David, B. and Thomas, J., eds (2008a), Handbook of Landscape Archaeology (Walnut Creek, CA: Left Coast Press).


References


Despretz, A. (1833), 'Troisieme Eruption de Volcan de 1789' (Lithograph). La Caricature, no. 135, 6 June 1833.


---(2005), Collapse: How Societies Choose to Fail or Succeed (New York: Viking).

Dickens, C. (1846), Pictures from Italy (Pietas. A. and W. Galignani).


References


--- (2008), The Great Warming: Climate Change and the Rise and Fall of Civilizations (New York: Bloomsbury Press).
--- (2011), The Historical Bolivian Amazon, Diversified Landscape in Bolivia, xity in Historical Ecology,}

References

299
References


References


References


Godleer, M. (1976), Antropología y economía (Barcelona: Anagrama).


Hakanen, N. T. (1995), "Irrigation, Population Pressure, and Exchange in Preclo-

cial Peru, Tanzania", in J. J. M. L. Aral and E. E. Aral, eds, McDonald nei-

J. Duwe, The Long-Term J. R. Torell, eds, Living
References


——— (2003), *'Andean Luxury Goods': Special food for the Ancestors, Deities and the Elite* *Antiquity* 77(297): 45-54.


References

Head, L. (2008), "Is the Concept of Human Impacts Past its Use-by Date?", Hecate 18(3): 373–7.


References


Irwin, P. C. (1855), The State and Position of Western Australia; Commonly Called the Swan River Settlement (London: Simpkin, Marshall).

Isbell, B. J. (1978), To Defend Ourselves: Ecology and Ritual in an Australian Village (Austin, TX: Institute of Latin American Studies, University of Texas).


References

(2004). Las Lagunas. Arqueología y Mythe National (Lausanne: Presses Polytech-
niques et Universitaires Romandes).


(forthcoming). "Collective Representations and Identity Construction: The Mater-
ial Constraints of Archaeology", in A. Coudart, ed. Constructing Identity: the Role of
the Historic and Social Sciences (Cambridge: Cambridge University Press).

Karley, W. and Larsson, L. (2007), Mid-Holocene Climatic and Cultural Dynamics in
Northern Europe in D. G. Anderson, K. A. Munch and D. H. Sandweiss, eds., Climate Change and Cultural Dynamics: A Global Perspective on Mid-Holocene


Keller, F. (1854), "Die leitlichen Phlibbauten in den Schweizer". Mitteilungen der

(1866), Lake Dwellings of Switzerland and other Parts of Europe, 1st edn (London:
Longmans, Green).


nary International 158: 13–22.

Kendall, A. (1991), Los patrones de asentamiento y desarrollo rural prehispánico entre
Ollantaytambo y Machu Picchu (Cusco): Proyecto Cusichaca and Editorial Universi-
aria of the Universidad Nacional San Antonio Abad de Cusco (UNISAC).

(ed. (1997a), Restauración de sistemas agropecuarios prehispánicos en la sierra sur,
Perú: Arqueología y tecnología ñandina en desarrollo rural (Cusco: Cusichaca Trust).

(ed. (1997b), Reconstruction and Rehabilitation of Pre-Hispanic Agricultural Systems
in the Southern Highlands of Peru (Wellbornham, UK: Cusichaca Trust).

(2005), 'Applying Archaeology: Revitalising Indigenous Agricultural Technology:
Within an Andean Community', Public Archaeology 4: 205–21.


Miguel, R., Adrián, R., and Amanbou, J. D. (2008), Tecnología Tradicional Andina: Rehabilitación agrícola y ambiental para el desarrollo rural del sector
comunal. (Lima: Cusichaca Trust).

—and Rodríguez, A. (2009), Desarrollo y perspectivas de los sistemas de aridesenias en los Andes Centrales del Perú (Cusco: Centro Balsasur de las Casas).

References


References

Lubbock, J. (1865), Pre-Historic Times, as Illustrated by Ancient Remains and the Manners and Customs of Modern Savages (London: Williams and Norgate).
References


Malinowski, B. (1922), *Argonauts of the Western Pacific* (New York: Doubt)


— and Ping, H. (1991), 'La culture itinerante et reconstitution de la vegeta-
References


— (2010b), The Eastern Archaic Historianized (Lanham, MD: AltaMira Press).
References


ture (Cambridge: Cambridge University Press).


and Tagg, J. M. (2000), 'The History of Precolonial and Early Colonial Agriculture in Klimansjaro: a Review', in T. Chiek, ed., Culture, History and Identity: Human-Environmental Relations in the Mount Kilimanjaro Area, Tanzania (Cam-


Sutter, B. (2000), 'Prehistoric Genetic and Culture Change: a Bioarchaeological Search for Pre-Inka Altiplano Cultures in the Coastal Valleys of Moquegua, Peru, and Arapa, Chile', Latin American Antiquity 11: 43–70.


References

References


References


Walker, R. J. and Sorge, D. forthcoming. 'Late Holocene climate change and human response in the Calusa region of coastal southwest Florida developing geochemical proxies from archaeological sources'. Quaternary International.


References

Ancestry of a Late Prehistoric Burial from Kwaiane Atoll, Marshall Islands',
Micronesica 32: 191-228.

Weiss, H., Courto, M. A., Wettstrom, W., Senior, L., Meadow, R., Guichard, F., and
Curnow, A. (1993), 'The Genesis and Collapse of Third Millennium North Mesopota-

Wendorf, F., Karlén, W., and Schöler, B. (2007), 'Middle Holocene Environments of
North and East Africa, with Special Emphasis on the African Sahara', pp. 189-227,
in D. G. Anderson, K. M. Maasch, and D. H. Sandweiss, eds. Climate Change and
Cultural Dynamics: A Global Perspective on Middle Holocene Transitions (Ames: Iowa

Wengrow, D. (2006), The Archaeology of Early Egypt: Social Transformations in
North East Africa, 10,000 to 2650 BC (Cambridge: Cambridge University Press).

(Leden: E. I. Brill).

White, L. (1948), The Science of Culture: a Study of Man and Civilization (New York:
Farrar, Stras and Giroux).

White, L. (1959), The Evolution of Culture: the Development of Civilization to the Fall of

Conservation: an Interdisciplinary Perspective (New Haven, CT: Yale University Press),
pp. 3-29.

Conservation: an Interdisciplinary Perspective (New Haven, CT: Yale University Press),
pp. 3-29.

Whittle, A. (2003), The Archaeology of People: Dimensions of Neolithic Life (London:
Routledge).

Widgren, M. (2000), 'Islands of Intensive Agriculture in African Drylands: Towards an
Explanatory Framework', in G. Barker and D. Gilbertson, eds. The Archaeology of

Widgren, M. (2000), 'Towards a Historical Geography of Intensive Farming in Eastern Africa',
in M. Widgren and J. E. G. Sutton, eds. Islands of Intensive Agriculture in Eastern

Widgren, M. (2000), 'Towards a Historical Geography of Intensive Farming in Eastern Africa',
in M. Widgren and J. E. G. Sutton, eds. Islands of Intensive Agriculture in Eastern

Wiley, G. (1953), Prehistoric Settlement Patterns in the Viru Valley, Peru, Bureau of

Williams, E. J. (1985), 'A scheme for the early monumental architecture of the Central

Williams, P. R. (1997), 'The role of disaster in the development of agriculture and the

References


— (2009a), Historia Evolutiva y Subsistencia de Cosadore-Recoletores Marineros de Tierra del Fuego (Buenos Aires: Sociedad Argentina de Antropologia).
References


Бор К. Э. (1848). О влиянии внешней природы на социальное этноношение отдельных народов и истории человечества/Картинная книжка для любительской чтения, отделенная от русского естествознания, за 1848, 2 изд., СПб, 1849 [Bor, K. E. von (1848), 'On the influence of external nature on social relations of certain peoples and on history of human kind', in Pocket book for amateurs of physical geography, published by Russian geographic society, for 1848, 2nd edn (St Petersburg: Russian Geographic Society)] [in Russian].


