Journal of Field Archaeology

ISSN: 0093-4690 (Print) 2042-4582 (Online) Journal homepage: https://www.tandfonline.com/loi/yjfa20

Archaeology in the age of the Anthropocene: A critical assessment of its scope and societal contributions

Paul J. Lane

To cite this article: Paul J. Lane (2015) Archaeology in the age of the Anthropocene: A critical assessment of its scope and societal contributions, Journal of Field Archaeology, 40:5, 485-498, DOI: 10.1179/2042458215Y.0000000022

To link to this article: https://doi.org/10.1179/2042458215Y.0000000022

Archaeology in the age of the Anthropocene: A critical assessment of its scope and societal contributions

Paul J. Lane[1,2]

[1]Department of Archaeology & Ancient History, Uppsala University, [2]School of Geography, Archaeology and Environmental Science, Witwatersrand University

Recent decades have witnessed heightened public and governmental awareness of the nature and scale of environmental challenges likely to face the planet over the course of the next fifty to one hundred years. Scholars from across a broad range of disciplines have been drawn into these debates and have begun to reorient their research towards finding solutions to some of the most pressing problems and to devising more sustainable and resilient livelihoods. Archaeologists, with their conventional orientation toward past events and processes have been rather slower to engage with these issues. Recently, however, there has been a steady shift within the discipline so as to incorporate more future-oriented perspectives, and 'the use of the past to plan for a better future' is rapidly becoming a common theme within archaeological research projects and publications. While welcoming some of these developments, this paper offers a critical assessment of the various claims that are now being made of archaeology's potential to help overcome current environmental challenges and its contributions to defining and understanding 'the Anthropocene.'

Keywords: Anthropocene, climate change archaeology, East Africa, historical ecology

Introduction

"The Anthropocene is not just an era of anthropogenic change" (Ogden *et al.* 2013: 345).

We live in an era of heightened environmental awareness. Terms such as 'global warming,' 'greenhouse gasses,' 'carbon foot-prints' and 'climate change' have entered the public sphere and our everyday lexicons; their effects and causes are debated by our politicians and hotly contested in the blogosphere. Anxieties over environmental catastrophe have displaced the fear of a nuclear winter that circulated during the years of the Cold War. Dystopian visions increasingly dominate the entertainment industry's imaginings of the future, and we are all encouraged on a daily basis to recycle, down-scale, be green and think globally while acting locally. That this last notion was first popularized over four decades ago has inevitably prompted many to argue that all this hand wringing is too little too late—the future of our species on this planet is bleak.

Recent extreme weather events serve to heighten such concerns—such as those that in early 2014 left one side of the United States coping with Arctic temperatures and paralyzed under feet of snow, while the farming industry on the other side of the continent was struggling to deal with an acute shortage of water for livestock and irrigation. Or those, also in early 2014, that left up to a quarter of England and Wales inundated by flood waters for weeks, and in some areas months, at a time. In response to such events, our political leaders are often blamed for their lack of foresight and environmental planning while they are simultaneously exhorted to act as if they, unlike King Canute, have the power to control the elements. Individual members of the public are likewise on the one hand castigated for their environmental foolishness, as evinced by their apparent addiction to unbridled consumerism, while they are also praised for their fortitude, public minded actions and 'natural' instinct toward selfless acts of generosity following major 'environmental disasters,' especially those that impact parts of the Global South—such as the typhoons that flattened parts of the Philippines in 2013, or the extended drought across eastern and north-eastern Africa during 2010–11 that devastated livestock herds and pastoralist communities.

Taking a broader view, the heightened environmental concerns of our age, and the cumulative

Correspondence to: Paul J. Lane, Department of Archaeology & Ancient History, Uppsala University, Box 626, 751 26 Uppsala, Sweden. Email: paul.lane@arkeologi.uu.se

DOI 10.1179/2042458215Y.0000000022

events that triggered them, are seen by many in the scientific community as attributable to, or at least symptomatic of, the commencement of a new geological epoch—the Anthropocene (Dryzek 2013; Ellis and Trachtenberg 2014; Wapner 2014), identifiable through distinct stratigraphic indicators including marked increases in percentages of atmospheric carbon dioxide and methane as recorded in polar ice cores alongside broadly coeval changes in biological assemblages. More recent work (e.g., Waters *et al.* 2014), has expanded the number of additional potential stratigraphic markers to include, among others, certain types of anthropogenic soils, the intensification of processes of anthroturbation, changes in reef system ecological functioning and signals, the globalization of biological transfers, and the radiogenic fallout from testing nuclear weapons. As awareness of the concept has grown, and as public and political concern over the future of our planet has stimulated an upscaling in the amount of research funding available for studying the causes, drivers and consequences of climate change, archaeologists have been increasingly drawn into debates over the concept of an Anthropocene and wider human-nature interactions (e.g., Solli 2011; Edgeworth 2014). Of course, climate change research in archaeology is not a new field—there is a long tradition of archaeologists exploring human-environment relationships from different theoretical perspectives and through the study and analysis of a broad range of material, biological and geochemical proxies (for reviews of this intellectual history, see e.g., Sandweiss and Kelley 2012; Davies and M'Mbogori 2013; Van de Noort 2013: 19–43). However, what has changed over the last decade is that this tradition of research is now frequently mobilized in support of the argument that archaeologists have a central role to play in addressing the challenges posed by *future* climate change (see e.g., Hudson *et al.* 2012), rather than solely offering backward-looking perspectives on past climate cycles and human responses and contributions to earlier phases of environmental change. Thus, Marcy Rockman (2012: 194), while acknowledging that "archaeology cannot provide all the answers," has argued:

> *"Without the data, information, ideas and interpretations that the field of archaeology can provide, there is much less of a chance of developing appropriate, workable, and durable means of addressing mitigation and adaptation issues."*

Robert van der Noort (2011: 1046) has put this more explicitly:

> *"By offering long-term perspectives on human interrelationships with climate change, archaeology is well placed to enhance an understanding of the socio-ecological resilience of communities and their adaptive capacity. This would appear to be archaeology's chief contribution to the climate change debate."*

The logical extension of such arguments is that archaeological data, as repository of adaptive pathways, when set within long-term perspectives, offer insights into how past societies responded to earlier phases of climate change, and so have the potential to help build the social resilience of contemporary communities in the face of rapid climate change (e.g., Guttmann-Bond 2010; Brown *et al.* 2011; Van der Noort 2013). The growing use of archaeological data as environmental proxies by climate change researchers also signals this increased prominence of archaeology in current climate change discourse (for discussions of this trend see Sandweiss and Kelley 2012; Brooke 2014).

Welcome though such developments are, there remain several underpinning assumptions and unexamined philosophical questions that need to be addressed before archaeologists can claim that their research on past human-environment interactions, the historical ecology of ancient landscapes, and the resilience of past societies can provide *actual* solutions to the environmental challenges of our time. In what follows I explore these with reference to the concept of the Anthropocene and especially debates over its origins. My perspective is that of someone specializing in the later Holocene archaeology of Africa and with interests in landscape historical ecology and the production of useable pasts aimed at addressing contemporary societal challenges (Lane 2010, 2011). I argue in particular, that while it is important that archaeologists explore the potential contributions their knowledge and data sets may have toward addressing current and predicted future environmental challenges, it remains reasonable to ask: "Just how much contemporary public good can such a deep-time perspective provide?" Put another way, some of the claims that some archaeologists have made in recent years that our discipline can help us navigate the hazards of the Anthropocene—whether this is in terms of providing evidence of the resilience of many non-Western societies or on past responses to climate change, need to be substantiated rather than simply asserted.

The Anthropocene

The notion of 'the Anthropocene' was introduced to the scholarly community in its current guise in 2000, by the Nobel-prize winning atmospheric chemist Paul Crutzen and the ecologist Eugene Stoermer (Crutzen and Stoermer 2000; Crutzen 2002). Their coining of this term was intended to convey the idea that the environmental impacts of human activities since the Industrial Revolution no longer have consequences

solely at the local or regional scale, but do so at a global scale. In this sense, human activities, collectively, are now equivalent to those of geological processes, and for proponents of the concept of an Anthropocene, the term suggests that the Earth is moving, or has already moved, out of the current geological epoch, the Holocene, into a new one. Critically, advocates in favor of this argument also believe that unlike any other point in Earth's history, it is the cumulative effects of human activity that is triggering this exit from the Holocene. In other words, humanity has become a global geological force in its own right (Steffen *et al.* 2007: 614).

Crutzen and Stoermer (2000) acknowledged that humans have long shaped their environments and that their activities have had environmental consequences. They noted that over the entire course of the Holocene there is evidence indicating increasing levels of human influence, including diverse biotic and sedimentary signals, such as pollen of weeds and cultivars following land clearance for agriculture, and sediment pulses from deforested regions. They also recognized that atmospheric lead pollution arising from human activities begins to be registered in polar ice cores and in sediments around the world from Greco-Roman times onward. Nonetheless, they saw the commencement of the Industrial Revolution around A.D. 1750 as initiating a step change in terms of the scale of such impacts. Subsequently, with Will Steffen and John McNeill, Crutzen extended these arguments with reference to a larger body of indices and proxies (Steffen *et al.* 2007), to argue that since A.D. 1800 there had been two broad stages to the Anthropocene. These comprised an initial stage, which they termed 'The Industrial era,' lasting to ca. A.D. 1945, characterized by a dramatic and increasingly global rise in the burning of fossil fuels and associated production of greenhouse gases compared with all pre-Industrial Revolution epochs, and a more recent ongoing phase, which they termed 'The Great Acceleration,' commencing after the end of World War II up to the present day characterized by the almost exponential acceleration of 'the human enterprise' across the globe.

As evidence for these stages, they cited a wide selection of different proxies, of which changes in atmospheric carbon dioxide (CO_2) concentrations were considered to be the most significant benchmark. Based on available data, global carbon dioxide atmospheric concentrations are over a third higher than in pre-industrial times, and higher than they have ever been at any time in the past 0.8 million years, as are those of methane and nitrous oxide (IPCC 2014: SYR-9). In 1850, CO_2 concentrations were still within the range recorded for interglacial periods during the late Quaternary at around 285 ppm. By the end of the 'Industrial Era' stage they had risen by around 25 ppm, beyond any recorded upper limits of 'natural variation,' and by 2005 had reached 379 ppm (Steffen *et al.* 2007: 616). If human population growth, agriculture and industrial activities continue to accelerate at more or less the same pace as witnessed since 1945, the concentration of global greenhouse gases (GHGs) are predicted to double by the end of the twenty-first century (IPCC 2014: SYR-9-11).

Compared with GHGs, the rise in global temperature has been slower, possibly as a result of the effects of industrially derived sulphate aerosols—the so-called "global dimming" effect. Nonetheless, owing to anthropogenic carbon emissions, temperatures in the past 120 years rose by an estimated average of 0.85° C and the rate of increase has accelerated in the past two decades. In some predictions, mean average temperatures are expected to rise by around between 3.0° and 4.0° C by the end of this century (Sherwood *et al.* 2014). Even modest temperature rises are expected to accelerate ice loss in the Arctic and Antarctic and increase ocean heat content, leading to sea-level rise, accentuating the documented rise in global mean sea level (GMSL) since the 1860s of around 250 mm (Church and White 2006), with some scholars suggesting that this could result in an overall rise in GMSL in excess of one meter by 2100, potentially resulting in forced displacement of over 185 million people (Nicholls *et al.* 2011). Additionally, relative to pre-Industrial Revolution oceans, surface ocean waters are now more acidic by a factor of 0.1 pH units, due to anthropogenic carbon release, and the projected effects of future acidification will be both physical and biological, thereby hindering carbonate-secreting organisms in building their skeletons, with potentially severe effects in both benthic (especially coral reef) and planktonic settings.

For proponents of the Anthropocene, it is recent changes in the scale and intensity of a host of human activities that have been the likely drivers of these changes, which in turn have triggered a wide range of environmental consequences from depletion of fisheries to falling aquifers, increased soil erosion, ecosystem fragmentation and biodiversity loss (e.g., Steffen *et al.* 2007; Rockström *et al.* 2009; Ellis *et al.* 2010; Hughes *et al.* 2013). Where debate remains is often over which sedimentary marker, or markers, provide the best "isochronous datum" indicative of "a critical change in the sedimentary sequence (golden spike)" that is also sufficiently universal that it "can be considered the boundary between two epochs (i.e., the Holocene and the Anthropocene)" (Rull 2013: 1198). As Rull (2013)

notes, while agreement on this point is likely essential for formal recognition of the Anthropocene by the International Commission of Stratigraphy (ICS) and its Anthropocene Working Group, the work done by more informal manifestations of the concept is likely to be far more important.

In this regard, it is important to note that concepts similar to that of the Anthropocene have been proposed by previous generations of scholars at times when public concerns over the future of the planet and our species were much less heightened than they are today. In 1778, for example, the French naturalist Georges-Louis Leclerc, Comte de Buffon (1707-1788), observed in his book *Époques de la nature*, that "the entire face of the Earth now bears the imprint of man's power" (cited in Locher and Fressoz 2012: 579). A century later, the Italian Roman Catholic priest and geologist Antonio Stoppani similarly acknowledged the increasing influence of humanity on Earth systems when he used the term 'Anthropozoic' in his 1873 Corso di Geologia (Crutzen 2000). In the 1920s and 1930s, the French philosopher, geologist and Jesuit priest Pierre Teilhard de Chadrin and the Russian mineralogist and naturalist Vladimir I. Vernadsky favoured the term 'Noosphere.' Later in the twentieth century, E.O. Wilson used the 'Eremozoic' and Andrew Revkin that of the 'Anthrocene'—both proposed in 1992—to convey many of the same ideas encapsulated by Crutzen's notion of an Anthropocene (Steffen *et al.* 2011: 843–5). As a scientific idea, the concept of an age when humanity, through collective and cumulative actions, has the power to drive Earth system processes is thus far less revolutionary than the coining of the term 'Anthropocene' might suggest (see also Sayre 2012; Castree 2014).

Likewise, some of the philosophical debates that have been prompted by the popularization of the concept of the Anthropocene also have a distinguished ancestry. John Stuart Mill, for example, in his 1874 essay '*On Nature*' was particularly critical of the doctrine 'follow nature' on the grounds that:

> *"If nature encompasses everything that exists in the natural world and all the laws that govern it, then "follow nature" is vacuous because it tells us to do something we have no way of* not *doing ... On the other hand, if "follow nature" ... means something akin to ... "let nature take its course" independent of our intervention, then ... we have a moral injunction utterly unworthy of our support" (Hourdequin 2013: 116).*

Mill's position finds its modern-day expression in, on the one hand, the public's exhortations for their politicians to do something about the floods, the drought, the snowstorms, coastal erosion and the like, while on the other hand being equally vociferous about the need to protect 'nature' where it is believed to still survive in a 'pristine' state and to restore habitats to their 'natural' state where it is believed they have been damaged by humanity. Concerned as we may be about the consequences of climate change, few of us would feel comfortable if we did let 'nature' completely overwhelm our dwelling spaces, yet we also mourn 'nature's loss' each time news reaches us that yet that another species facing extinction has been placed on the IUCN's Red List. Being in the Anthropocene, in other words, raises some profound moral and ethical questions for us as citizens. It also requires scholars who claim that their research activities can help address today's global environmental challenges also engage with these more philosophical dimensions of the Anthropocene discourse. As Hourdequin (2013: 116) notes:

> *"Debate over the Anthropocene can be separated into two distinct questions. First, is it true that humans are the key drivers of biological, geological, and chemical processes on Earth? And second, if the answer to the first question is affirmative, [and the weight of scientific evidence suggests that this is so] then what should we do about it?"*

Hourdequin argues that the second question is more salient from an ethical perspective, although determining a suitable response depends to a considerable extent on how the first is answered. Put another way, as "an emergent narrative in global environmental politics," the Anthropocene concept requires us to "reimagine how humans make connections between planetary and everyday life in ethical, sustainable, and ecologically just ways" (Houston 2013: 440).

Anthropocene Archaeology

Of the various recent archaeological considerations of archaeology in the age of the Anthropocene, most critical engagements with the concept have concerned themselves with Hourdequin's (2013) first question, rather than the second. In this, they have largely been following the lead of the environmental scientist William Ruddiman (2003), who was among the first group of scholars to propose a counter-thesis to that of Crutzen and Stoermer, citing evidence that important anthropogenic effects on the environment and on global climate began thousands of years ago and were already extensive well before the start of the industrial era. Among other arguments, Ruddiman has pointed out that the observational records and related data sets on which Crutzen and Stoermer developed their case, were spatially incomplete and do not reflect the actual distribution or extent of human activities even at the start of the Industrial Revolution. More recently, Ruddiman (2013) has questioned whether the size of population is a good

proxy indicator of the amount of cultivated land and deforestation (both implicated in the increase in GHGs), *and* that linked increases in population and land-use change have grown in an exponential unidirectional manner. Neither assumption, he argues, is consistent with available historical evidence. Drawing on historical studies of dynastic administrative records concerning land-use trends during the past 2,000 years across the entire agricultural area of east-central China, for example, Ruddiman (2013: 51) notes that whereas the per-capita area cultivated nearly 2,000 years ago was 0.6–0.7 hectares per person it had fallen to 0.15–0.2 hectares by the 1800s. Similarly, in contrast to the claims made by those in favor of a relatively recent origin of the Anthropocene, once evidence from historical, palaeoecological and archaeological is taken into account it is quite possible that as much as three-quarters of the world's forest had been felled by the start of the industrial era (Ruddiman 2013: 52–4).

Historical data from Europe, in particular, reveal more extensive early clearance than reconstructed by Crutzen and Stoermer. Specifically, here, forest clearance seems to have been widespread at a relatively early date when population densities were still quite low, and well before even the Medieval era. Consequently, even though there have been marked increases in population across Europe over the last few thousand years, these had limited effects on deforestation, and the available evidence even suggests that, as in China, per-capita clearance may well have fallen over the last 2,000 years by a factor of three to four (Kaplan *et al.* 2009). In a similar vein, Dorian Fuller and colleagues (2011) have argued that the rapid expansion of irrigated rice agriculture in Asia between 5,000 and 1,000 years ago, as with the spread of herding regimes and domestic livestock across Asia and Africa, led to a significant increase in global methane emissions globally.

Other recent archaeological contributions to this debate make rather similar points concerning the long history of global-scale human impacts on the environment. Leaving aside the question as to whether the ICS, who actually determine how and whether geological epochs can be named by scientists agree to formally recognize the Anthropocene as a new geological epoch (something they will not decide upon until 2016), opinion also seems to be shifting toward a two-phase definition of the Anthropocene. Namely, an early phase that began several thousands of years ago, although opinion differs on exactly how long ago (compare, for instance, Olofsson and Hickler 2008; Certini and Scalenghe 2011; Ellis *et al.* 2013; Smith and Zeder 2013), initially at a fairly small scale but with impacts becoming far more significant by the start of the industrial era; and, a later, very rapid phase of accelerating and widespread impacts from ca. A.D. 1750 (Ruddiman 2013).

To date, archaeology's contribution, while valuable, has been largely constrained to the task of better defining when humans began influencing their environments, the nature of these changes (which may not always have had negative impacts), their spatial and temporal scale and their socio-ecological legacies. This is certainly important and much needed work—we know little about these issues for many parts of the globe and for numerous time periods (Kintigh *et al.* 2014; Seddon *et al.* 2014). However, a common thread in such arguments is the emphasis they place on the need *to disentangle* natural from human processes. While certainly valuable from a heuristic perspective so as to determine the relative weight of different factors as drivers of change and stability at particular moments in the past, the conceptual prioritizing of this need ultimately reinforces a tacit epistemological commitment to evaluating ecological relationships explicitly with regard to an *a priori* baseline. As Nathan Sayre (2012: 61) notes, this belief in "a pristine, original nature untouched by humans" verges on the ideological among many environmentalists and ecologists, since without such a baseline "how is one to define the environment to be protected or preserved?" From such a perspective the challenge becomes, as so aptly illustrated by the divergent opinions on when, if at all, the Anthropocene began, determining which point in time can be said to qualify as a 'pre-human impact' baseline.

To circumvent such dualistic thinking it is important that greater intellectual space is created for a consideration of the mutual, co-construction and production of the world through the ever accumulating processes of human-thing entanglement (Hodder 2011). Likewise, there needs to be more overt recognition that 'environment' must be understood partly as a social and political category that emerges from intimate engagements with its physical realities (Tvedt 2010; Angelo 2013); consideration of the materiality of things in and of the world and the manner in which these shape such intimate relationships (Olsen 2010); and acknowledgement of the agency of non-human entities (Strang 2014), and the 'more-than-human' dimensions of human-animal encounters (Cassidy 2012; Wilkie 2015). In short, what much of the science-driven debates on the Anthropocene lack is recognition of the potential contributions of the post-humanism turn across the social sciences and humanities of the last few decades, which has challenged the privileged place of the modern human subject and sought to animate these disciplines by including those affects, emotions and sensibilities previously excluded from the narrow remit of Enlightenment rationality.

Archaeology of the Anthropocene

Aside from pointing to evidence in support of a deep history to the Anthropocence, the potential threats to livelihoods, food security, and patterns of human settlement posed by accelerating climate change and the anticipated disruption to current social, economic and political orders this may trigger, have encouraged scrutiny of the implications that commencement of the Anthropocene may have for humanity's tangible and intangible heritage. For some (e.g., Murphy *et al.* 2009; Sabbioni *et al.* 2010; Barthel-Bouchier 2012), the issues of concern are how best to protect archaeological sites, monuments, deposits, material remains and other components of the built environment from the threats climate change may pose to their long-term future. For others, the impacts of climate change may manifest themselves in a far "more fundamental, almost existential" manner by changing how heritage is conceptualized and how "scientific narratives about the past" are produced (Solli 2011: 42).

Aspects of these ideas have also been explored in a recent set of short essays (Edgeworth 2014) outlining alternative archaeological approaches to the Anthropocene. Adopting a more critical perspective on the value of creating a new age to add to all the other 'ages' that impose boundaries on archaeological interpretation and compartmentalize the way our discipline approaches its study of the past, most of the contributors still accept the underlying premise that humanity now lives in the Anthropocene. However, unlike those archaeologists who have sought to illustrate the deep-time history of human environmental impacts on Earth systems, several of these authors explore in different ways the 'archaeology' (in the Foucauldian sense, although with a greater emphasis on materiality) of the Anthropocene as a concept. Others are more concerned with 'Anthropocene archaeology,' i.e. the distinctive material traces of this epoch and their referents at both a planetary (e.g., Benjamin 2014; Zarankin and Salerno 2014) and extra-planetary (Gorman 2014) scale. Most of these contributors associate 'the Anthropocene' with modernity, although some view the concept as little more than an over-determined slogan (Clarke 2014: 101). Individually and collectively, these papers work to complicate the idea of the/an Anthropocene. In particular, they underscore the fact that whether we live in a new geological epoch or not, and however we choose to define such a time, humans have always been entangled with their material environments. In this sense, the concept of the Anthropocene, precisely because it subverts older nature/culture binaries, could be said to be ideally suited to describing the entire course of human history and our evolution as a species.

Nonetheless, as already alluded to, discussions in the wider Anthropocene discourse of human manipulations of the environment still tend to reproduce the Enlightenment idea that human action *inherently* acts against nature and so degrades it (see Escobar 1999). This is particularly clear from the emerging conceptualization of fire as "the essential evolutionary trigger for the Anthropocene" (Malm and Hornborg 2014: 63). Thus, according to Michael Raupach and Josep Canadell (2010: 210–211), "long before the industrial era, a particular primate species learned how to tap the energy reserves stored in detrital carbon," while for Steffen and colleagues (2007: 614), "the mastery of fire by our ancestors provided humankind with a powerful monopolistic tool unavailable to other species, that put us firmly on the long path towards the Anthropocene." In their commentary on such observations Andreas Malm and Alf Hornborg (2014) note that there is more than a hint of inevitability in such statements, as if the growth of a fossil-fuel economy was determined in the Early Stone Age in Africa when *Homo Erectus* learned to make and control fire—determined no doubt by their 'natural' human curiosity and propinquity for invention driven in turn by external evolutionary pressures. Yet, as they point out, our reliance on the fossil fuels which have driven the increase in GHGs and the climate changes that have accompanied this, has a specific history allied to the activities of a very narrow social and economic class of British, other European and North American industrialists and entrepreneurs in the eighteenth and nineteenth centuries, whose control over the means of production and economic power owed much to the profits reaped from participation in the Trans-Atlantic slave trade and the exploitation of Europe's urban and rural poor. Zoe Crossland (2014: 125) similarly recognizes this, remarking that:

> *"The Anthropocene is a political project as much as a scientific one, and to embed its origins in the long history of the Holocene is to spread genesis, and the responsibility for it, across many different human societies."*

Indeed, as anthropologists and political ecologists have long pointed out, resource management is based on diverse social, political and cultural features, differing societal and individual perceptions of and physical engagements with the bio-physical world, the choices made by different interest groups and individuals, and their differential power to do so. However, many of the processes of environmental change that are summarized by the concept "The Anthropocene" are not readily observable by the human senses. They act at spatial and temporal scales that are too big or too minute to fall within the range of human perception. Other than for

specialists in earth system processes and atmospheric chemistry, the concept accomplishes little more than an epistemic distancing—as global processes they lose the very properties the concept is intended to emphasize, namely their association with human actions. Erik Swyngedouw (2011) is likewise critical of the manner in which the discourse surrounding climate change works to de-politicize the issues involved, despite all of the political rhetoric and grandstanding that claims otherwise (Wynne 2010). He argues, in particular, that as "the concept of Nature [and the need to protect or restore it] becomes ideology par excellence and functions ideologically ... it forecloses thought, disavows the inherent slippery [aspects] of the concept and ignores the multiplicities, inconsistencies, and incoherencies inscribed in its symbolization" (Swyngedouw 2011: 258). Thus, whereas humanity's responsibility for triggering increases in GHGs, species loss, the homogenization of biodiversity and a host of other 'environmental ills,' may well be recognized, by pushing the origins of these human impacts increasingly further back in time we effectively distance ourselves, i.e. Western society and modernity, from culpability. Once we recognize this, Malm and Hornborg (2014: 65) suggest:

> *"the main paradox of the narrative, if not of the concept as such, becomes visible: Climate change is denaturalised in one moment – relocated from the sphere of natural causes to that of human activities – only to be re-naturalised in the next, when derived from an innate human trait, such as the ability to control fire. Not nature, but human nature – this ... is the Anthropocene displacement."*

Not Nature, but Human Practice

The visibility of the environmental costs that the accumulated consequences of human activities have left as a legacy for all of humanity today is, in itself, a resource which is not evenly spread over the human population of the Earth. Archaeology has an important role in mapping the history of these costs, to increase the visibility of such distributional injustice and draw attention to the need for possible interventions. It is noteworthy, therefore, that an interesting contrast can be drawn between the kinds of globalizing discourse concerning the origins of the Anthropocene discussed above, and more regional scale studies of long-term historical ecologies of specific landscapes. Many of the more effective studies have been those conducted in so-called Lesser Developed Countries in the Global South, where the need to demonstrate the social or public good of academic research is often pronounced—and certainly reinforced by the prevailing conditions of poverty and environmental vulnerability encountered by researchers while in the field and the often limited political power of the local communities with whom they work. Thus, for example, several archaeological projects in different parts of Latin America have had a long tradition of applying archaeological knowledge so as to help create, or recreate, environmentally sustainable farming practices in a manner that also improves local livelihoods (e.g., Erickson 1985; Beach and Dunning 1995; Kendall 1997, 2005; Renard *et al.* 2011; Isendahl *et al.* 2012), although some of these efforts have not been without their critics (e.g., Swartley 2002). In both Latin America and elsewhere, other projects have drawn on archaeological results so as to inform the restoration of particular habitats and to guide wildlife conservation efforts (see Hayashida 2005, and Wolverton and Lyman 2012, respectively, for indicative examples).

To date, nothing precisely comparable to the kind of rehabilitation of former agricultural practices explicitly using archaeological datasets, as undertaken in Bolivia and the Andes, has been attempted in sub-Saharan Africa. This is despite several decades of widespread positive valuation of Traditional Ecological Knowledge (TEK) and 'traditional' farming practices within the community of 'development' specialists (Stigter *et al.* 1995), and numerous efforts to integrate such knowledge in the planning for sustainable futures (e.g., Reij *et al.* 1996; Hart and Vorster 2008; Pretty *et al.* 2011). Several recent and ongoing projects, nonetheless, have sought to employ a 'deep time' perspective on farming and risk management strategies so as to help identify the antecedents and possible drivers of current environmental challenges. These tend to be more place- and problem-focused, and are often oriented toward deconstructing prevailing policy narratives that have directed (some might argue misdirected) environmental interventions at a local level for decades (e.g., French *et al.* 2009; Lane 2009; Sulas 2010). Other projects have sought to better delineate which aspects of contemporary practices can be said to genuinely contribute to socio-ecological and cultural resilience (e.g., Sulas *et al.* 2009; Davies 2012), while also offering critical perspectives on concepts such as 'Indigenous Knowledge' and TEK, and especially the ahistorical manner in which these concepts are currently deployed in rural development projects across the region (Stump 2010, 2013). Although their specific focus has varied, a unifying aspect to all of these studies has been their concern as much with the *limits* of archaeological contributions to the task of devising sustainable and resilient agricultural practices today, as on what can be learned by adopting a deep-time perspective and

how this knowledge might be applied at a local, community level.

Precisely how these archaeologically oriented projects will enhance livelihoods, reduce vulnerability, and contribute to more resilient societies is uncertain as in all the above cases the research and accompanying community engagement are ongoing. Nonetheless, a specific example can help identify what might accrue as benefits. This research is being undertaken as part of a European Union Framework Programme 7 Marie Curie Innovative Training Network, entitled *Resilience in East African Landscapes* (REAL – http://www.real-project.eu/). The overall project focus is on the temporal, spatial and social dynamics of human-landscape interaction in East Africa over the last millennium, with particular reference to Kenya and Tanzania. A core consideration is on how societies, landscapes and ecosystems have responded to climate change both currently and in the past under different conditions, so as to better understand how they may respond to future climate change. It is intended that knowledge generated by REAL can be used to support decision makers working in East Africa when they face critical issues of rural and urban food production and food security. Specifically, REAL aims to illustrate the interplay between past human activity and natural climate variability at different temporal and spatial scales, while demonstrating the importance of considering local perceptions, narratives, and experiences of climate change in the formulation of policy responses. The key value of such data is that they can inform us about how past human societies responded under conditions of intensifying climate change to (a) increased frequency and intensity of extreme climatic change and (b) occurrence and spread of hazards. They can also help determine whether socio-economic vulnerability increased in response to heightened, climate-induced risk, while also offering insights into why particular strategies, and not others, were adopted.

One particular case concerns the historical ecology of the Lake Baringo basin, Kenya (FIG. 1). Perhaps best known among the wider archaeological community as the locus of Ian Hodder's (1982) early post-processual ethnoarchaeological studies, and possibly also as an emerging research landscape for the study of hominin evolution (e.g., Kingston *et al.* 2007), the Lake Baringo basin is considered today as being severely degraded owing to a combination of climatic, environmental, governance, and socio-economic factors. The apparent 'malaise' of this environment has prompted numerous scientific studies from across the environmental and social sciences since the colonial era, and an almost equal number of recommended solutions at both practical

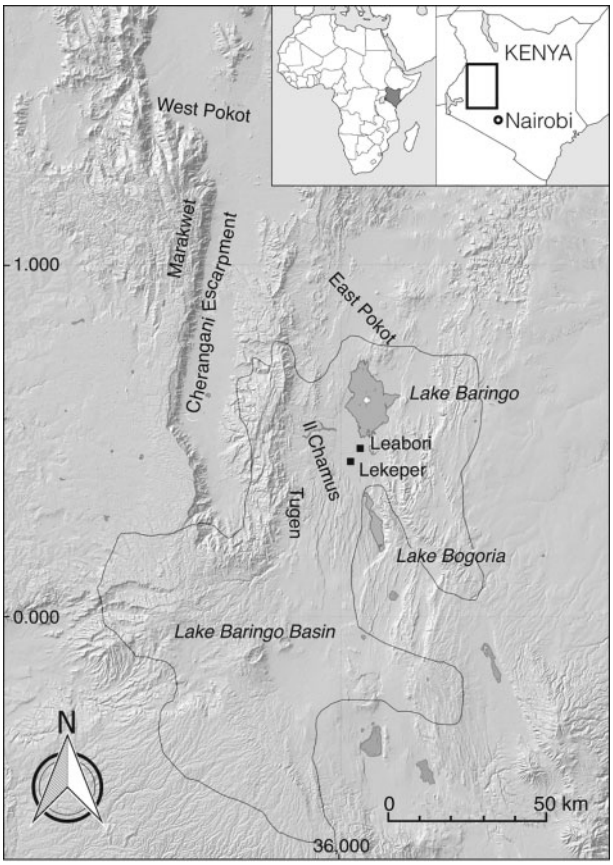

Figure 1 Location of the Baringo Basin and sites, places and ethnic groups mentioned in the text. Figure prepared by Nik Petek, with data provided by Aynalem Degefa, based on Aster DEMs. ASTER GDEM is a product of METI and NASA.

and policy levels. Historical perspectives on these suggest that their implementation, whether during the colonial period or since independence, has only rarely enhanced overall sustainability (Little 1992; Anderson 2002).

Particular concern is currently voiced regarding the accelerating rate of deforestation and accompanying soil erosion as inferred from changes documented on satellite imagery taken since the 1980s (Kiage *et al.* 2007); changes in the sediment load of rivers discharging into the lake and reduction in overall lake depth over the last several decades (Lwenya and Yongo 2010); sub-catchment studies of soil erosion processes and their spatial extent (e.g., Sutherland and Bryan 1990); and palaeoecological signals recovered from lake-bed sediments and adjacent swamp cores recording catchment vegetation and precipitation regimes since ca. A.D. 1650 (Kiage and Liu 2009; Degefa *et al.* in press). Among the consequences of these land cover changes have been the loss of good quality land for crop cultivation and livestock herding, the deterioration of water quality, and the creation of conditions favoring outbreaks of toxic cyanobacteria (algal) blooms, all with obvious knock-on impacts for local populations in terms of public health, food security, quality of nutrition,

and household economies. Efforts to mitigate some of these detrimental environmental problems have created new challenges, especially the widespread planting of *Prosopis juliflora* (a quick growing but alien species) to combat soil erosion (Mwangi and Swallow 2008). Coalescing around these 'environmental problems' are a set of related social, economic and political issues, including recurrent inter-ethnic violence, disputes over access to land and resources, conflicting land uses, constraints on income and livelihood diversification, power imbalances, and gendered labour relations (e.g., Little 1985; Greiner *et al.* 2011; Greiner 2013; Caretta and Börjeson 2014).

What makes this current state of affairs particularly poignant is that at the end of the nineteenth century the Lake Baringo basin had abundant wildlife populations, including sizeable herds of elephants (Von Höhnel 1894) and supported a mosaic of pastoralists, farmers and hunter-gatherers (Little 1992; Anderson 2002: 23–47). These included relatively large, sedentary, populations in the Il Chamus-dominated settlements of Leabori and Lekeper at the southern end of the lake associated with a productive system of intensive irrigated agriculture (Anderson 1989). The surplus generated by this system helped feed sizeable visiting trade caravans, at times numbering over one thousand individuals, drawn to the area because of its important sources of ivory (Håkansson 2004). Pokot dominated the northern and eastern sections of the basin, as they do today, but from at least A.D. 1750 different sections had developed dual economic specialisations, with those occupying the western boundaries along the Cherangani escarpment practicing intensive irrigated agriculture (Davies 2008, 2014) alongside their Marakwet neighbours (Adams *et al.* 1997; Davies, Kipruto and Moore 2014), whereas those occupying territories to the east and north of Lake Baringo engaged in specialised pastoralism (Bollig and Österle 2013). As argued by Davies (2008), this dual specialisation may well have enhanced the resilience of Pokot communities by offering alternative sources of livelihood and subsistence that could be drawn upon, through the mobilisation of kin relations and the bonds created by livestock loans, especially at times of environmental or political stress, such as during the severe regional droughts that occurred during the late eighteenth century (Bessems *et al.* 2008). Looked at more broadly, enabling social flux seems to have been a common mechanism for coping with disaster among Baringo's different communities during the late eighteenth century through to the early twentieth century (e.g., Little 1988; Bollig 1990), and in some settings, as among the Marakwet, remains a key aspect of their social and cultural resilience (Östberg 2014: 210) (FIGS. 2, 3).

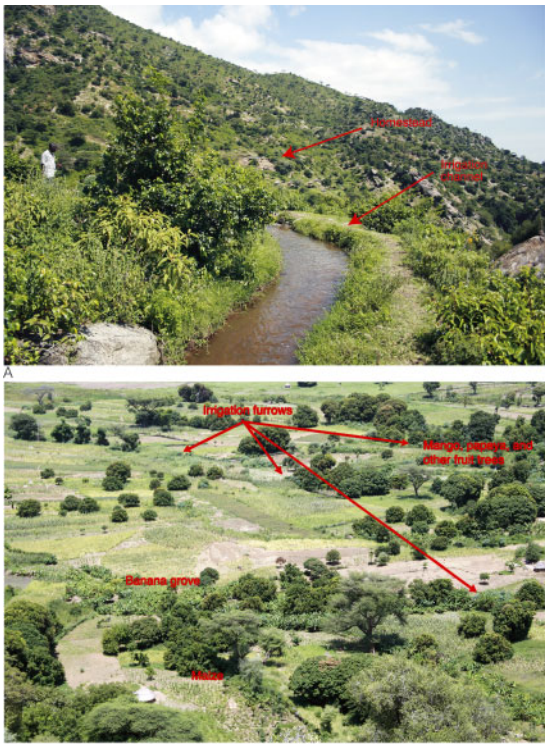

Figure 2 Marakwet Irrigation: A) A typical Marakwet irrigation channel; B) Marakwet irrigated fields of maize, sorghum, millet and other crops at the foot of the Cherangani escarpment, Kenya. Photographs by Paul Lane, 2011.

Figure 3 Lowland Marakwet irrigation channel running through wooded farmland near Tot, Kenya. Photograph by Matthew Davies in 2011, reproduced with permission.

As noted above, detailed historical studies have identified many of the drivers of change over the course of the twentieth century that have contributed to the current state of affairs. However, there is still great uncertainty regarding how different food production systems in the previous centuries were organized, the foodstuffs they produced, and why they were capable of generating surpluses without detrimental effects on the basin's ecosystem services. Exchange networks likely provided one means to reduce or at least offset ecological risk, but details concerning these and the range of products that circulated within and between systems are also poorly documented. Equally uncertain is whether the kind of material signalling of ethnic boundaries between Tugen, Pokot and Il Chamus (Njemps) which in the late twentieth century was related to economic competition (Hodder 1982), was also a feature of these earlier periods, or instead arose in response to widespread landscape degradation. These and comparable questions are all amenable to being answered through archaeological research of the kind being conducted under the auspices of the REAL project (Petek in press) (FIG. 4). The results will not directly benefit local inhabitants. However, by identifying the key components that moderated climate change

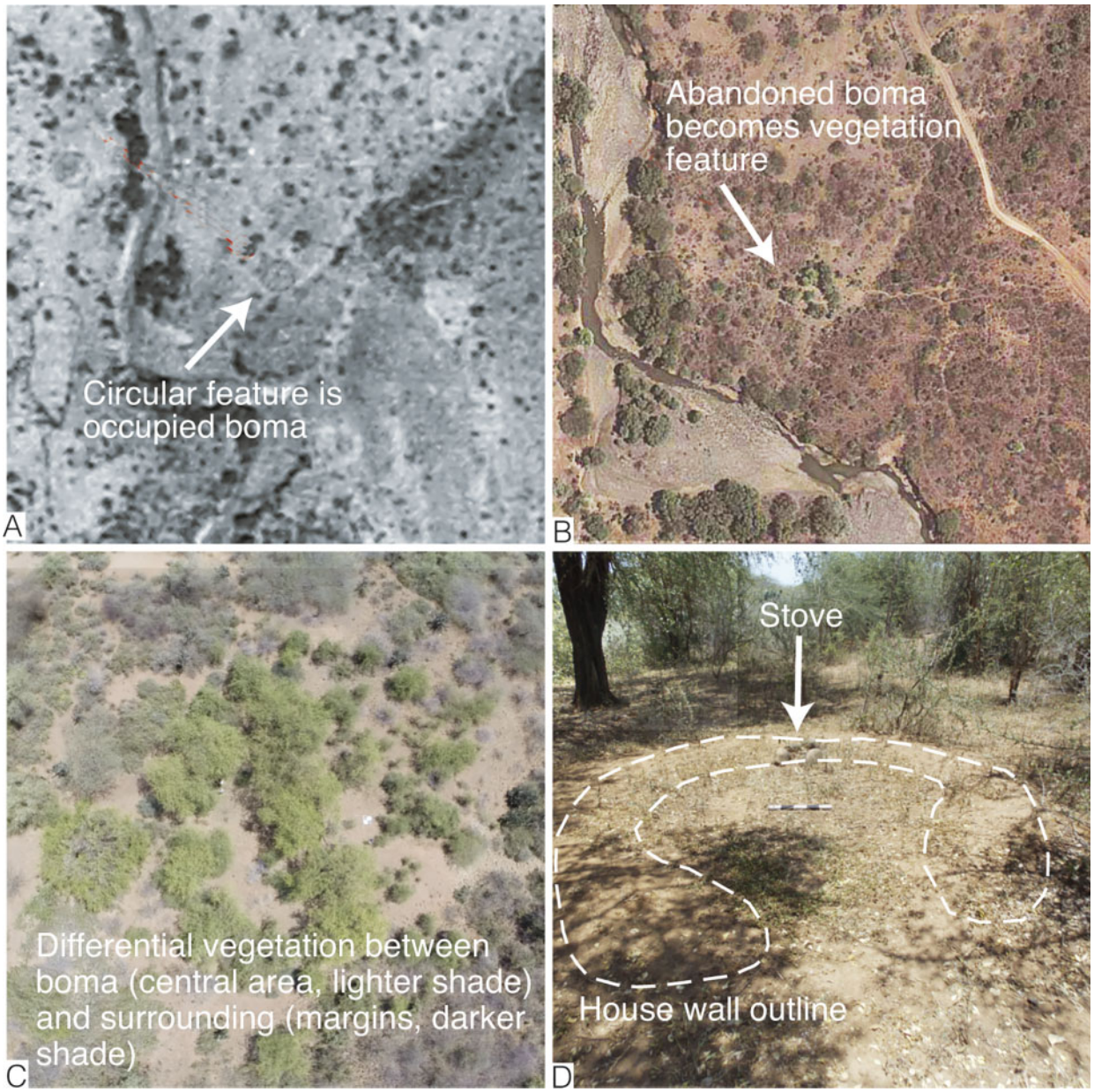

Figure 4 Traces of Il Chamus pastoralist biocultural heritage. Abandoned pastoralist settlements such as these have been shown to enhance local biodiversity and survive for decades, perhaps longer, in the landscape. A) Settlement as occupied in 1950 and visible on an aerial photograph; B) The same settlement after abandonment, as visible on Google Earth ™ in 2014; C) As seen when photographed using a camera attached to a drone, November 2014; D) Surviving traces of house walls and hearth on the ground, November 2014. Figure 4a based on DOS Aerial Photos KENYA 82D / 138 / 2 photo no. 5230, reproduced with permission of the Bodleian Library, University of Oxford, all other images provided by Nik Petek and reproduced with permission.

vulnerability and sustained food production in the past, and by documenting how their earlier integration has been steadily disaggregated by different drivers, it should at least be possible to establish which components might be viably revived or enhanced with beneficial effects under different socio-ecological scenarios. As critically, the very act of drawing attention to past accomplishments and successful human-environment interactions necessarily becomes a political act in a landscape that has been characterized for so long as degraded. The tangible heritage of successful adaptations and the knowledge systems associated with it, however modest this might be in comparison to those of 'grand civilizations', are in themselves importance resources worth protecting, and, increasing public awareness of them such as through innovative uses of social media (see Davies *et al.* 2014a) can contribute to a greater sense of ontological wellbeing and cultural resilience. Alongside more 'practical' measures, these social values have a critical role to play in any society at a time of intensifying environmental pressure of the kind the world is now facing (Adger *et al.* 2013).

Conclusion

Writing from the perspective of their own experiences, Rockman (2012) and Van der Noort (2013) have argued that archaeologists may always have to struggle with the perception that their work is largely irrelevant, at a policy level, for dealing with future climate change. Both also argue that, nonetheless, archaeology has much to contribute if directed more modestly at addressing specific practical challenges. In line with these sentiments, in this paper I have argued that archaeologists hoping their work will help mitigate some of the hazards of the Anthropocene need to engage more fully with the insights offered not just by climate science but also those of political and historical ecology. A logical extension of this argument is the question of environmental justice, of how the results of environmental and climatic change became differently distributed over the human populations of the world and which communities have carried the burden of the "ecological footprints" of commodity consumption. Archaeologists are well versed in exploring how social and economic differences articulate with power, and how these influence control over and access to economic resources. Yet, in most of the recent archaeological discussions of the Anthropocene as both concept and reality, such issues are almost entirely absent. Curiously, there seems to be little interest in whose subsistence opportunities were *most at risk* in the past when temperatures or sea-levels rose and rainfall declined, whose livelihoods became *most vulnerable* or were *most affected* by increased pollution triggered by changes to agricultural and industrial production, patterns of waste disposal or the spread of different disease-bearing vectors in response to the changing contours of local and regional climatic conditions.

To my mind, a climate change archaeology devoid of such considerations, that examines changes in pollen concentrations and the nature of the sedimentary record without a consideration of whose lives these changes impacted; that evokes climatic stress without considering differential patterns of consumption or access to resources; that identifies resilience cycles, and phases of exploitation, collapse and re-structuring without a consideration of relations of social power and authority in these processes, however valuable towards enhancing understanding of the past, does little to advance our understanding of how archaeological studies might make the lives of ordinary people today any better, or help safeguard the future of the planet.

I firmly believe that archaeology has an essential role to play in climate change research in the 21st century—and that it has already made very valuable contributions to scholarly understanding of *past* climatic sequences, their social-ecological effects, and the differential human contributions and responses that entailed. I am not, therefore, trying to single out the work of particular scholars as examples of bad science, but simply wish to caution against making exaggerated claims that our backward looking curiosity really can help us navigate the hazards of the Anthropocene. A little less hubris seems called for, and in conducting our research we need to remind ourselves that people die when their crops fail for yet another year running and when their emaciated livestock can no longer find pasture; when their houses are struck by tidal waves, cyclones and mudslides. They die from air-borne and water-borne pollutants, and when poisonous fertilizers enter the food chain. They also die unnecessarily when resources which should have been made available to assist them during a period of environmental catastrophe or public health crisis are slow in coming or are redirected elsewhere to line someone's pocket. No archaeological study on its own, however elegant, can change that.

Acknowledgments

A previous version of this paper was presented at the Stanford Archaeology Center, Stanford University in March 2014, as part of its Distinguished Lecture Series. I am especially grateful to Professor Lynn Meskell for the invitation and to The Morgan Family Foundation for enabling my visit. I would also like to thank members of the audience on that occasion for their comments and questions, and

Christian Isendahl, Kevin Walsh and three anonymous referees for their comments on a previous draft. Thanks are also due to Nik Petek for sharing Figure 4, and for his work, with Aynalem Degefa on preparing Figure 1, and Matt Davies for permission to reproduce Figure 2. Aspects of the work reported here have been funded under the European Union FP7 programme, as part of the *Resilience in East African Landscapes* Marie Curie ITN (FP7-PEOPLE-2013-ITN project no. 606879). I accept full responsibility for any remaining shortcomings.

Paul Lane (Ph.D. 1986, University of Cambridge) is Professor of Global Archaeology at Uppsala University. An archaeologist with over twenty-five years' research experience in Africa, his main interests are in the historical ecology of African landscapes, the archaeology of colonial encounters, the materialization of memory, the organization and use of space and time in pre-industrial societies, maritime archaeology and the transition to farming in Africa. A former Director of the British Institute in Eastern Africa (1998-2006) and President of the Society of Africanist Archaeologists (2008-10), he currently coordinates the Marie Curie-Skłodowska Resilience in East African Landscapes Innovative Training Network, and is an Honorary Research Fellow in the School of Geography, Archaeology and Environmental Studies, Witwatersrand University, South Africa.

References

Adams, W., E. Watson, and S. Mutiso. 1997. "Water, Rules and Gender: Water Rights in an Indigenous Irrigation System, Marakwet, Kenya," *Development and Change* 28: 707–730.

Adger, W. N., J. Barnett, K. Brown, N. Marshall, and K. O'Brien. 2013. "Cultural Dimensions of Climate Change Impacts and Adaptation," *Nature Climate Change* 3: 112–117.

Anderson, D. 1989. "Agriculture and Irrigation Technology at Lake Baringo in the Nineteenth Century," *Azania* 24: 84–97.

Anderson, D. 2002. *Eroding the Commons*: *The Politics of Ecology in Baringo*, *Kenya 1890-1963*. Oxford: James Currey.

Barthel-Bouchier, D. 2012. *Cultural Heritage and the Challenge of Sustainability*. Walnut Creek, CA: Left Coast Press.

Beach, T., and N. P. Dunning. 1995. "Ancient Maya Terracing and Modern Conservation in the Petén Rain Forest of Guatemala," *Journal of Soil and Water Conservation* 50: 138–145.

Benjamin, J. 2014. "The Industrial Sonifact and the Soundscape of the Anthropocene," *Journal of Contemporary Archaeology* 1: 119–123.

Bessems, I., D. Verschuren, J. M. Russell, J. Hus, F. Mees, and B. F. Cumming. 2008. "Palaeolimnological Evidence for Widespread Late 18th Century Drought across Equatorial East Africa," *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology* 259: 107–120.

Bollig, M. 1990. "Ethnic Conflicts in North-West Kenya: Pokot-Turkana Raiding 1969– 1984," *Zeitschrift für Ethnologie*, 115: 73–90.

Bollig, M., and M. Österle. 2013. "The Political Ecology of Specialisation and Diversification," in M. Bollig, M. Schnegg and H-P. Wotzka, eds., *Pastoralism in Africa*: *Past*, *Present and Future* Oxford: Berghan Books, 289–315.

Brooke, J. L. 2014. *Climate Change and the Course of Global History*: *A Rough Journey*. Cambridge: Cambridge University Press.

Brown, A. G., L. S. Basell, and K. W. Butzer, eds. 2011. *Geoarchaeology*, *Climate Change*, *and Sustainability*. Boulder, CO: Geological Society of America, bmischere Special Paper 476.

Butzer, K. W. 1981. "Rise and Fall of Axum, Ethiopia: A Geo-archaeological Interpretation," *American Antiquity* 46: 471–495.

Caretta, M. A., and L. Börjeson. 2014. "Local Gender Contract and Adaptive Capacity in Smallholder Irrigation Farming: A Case Study from the Kenyan Drylands," *Gender, Place & Culture* 22: 644–661.

Cassidy, R. 2012. "Lives With Others: Climate Change and Human-Animal Relations," *Annual Review of Anthropology* 41: 21–36.

Castree, N. 2014. "Geography and the Anthropocene 1: The Backstory," *Geography Compass* 8: 436–449.

Certini, G., and R. Scalenghe. 2011. "Anthropogenic Soils are the Golden Spikes for the Anthropocene," *The Holocene* 21: 1269–1274.

Church, J. A., and N. J. White. 2006. "A 20th Century Acceleration in Global Sea-Level Rise," *Geophysical Research Letters* 33: L01602, doi:10.1029/2005GL024826.

Clarke, B. 2014. "'The Anthropocene,' or, Gaia Shrugs," *Journal of Contemporary Archaeology* 1: 101–104.

Crossland, Z. 2014. "Anthropocene: Locating Agency, Imagining the Future," *Journal of Contemporary Archaeology* 1: 123–128.

Crutzen, P. J. 2002. "Geology of Mankind," *Nature* 415: 23.

Crutzen, P. J., and E. T. Stoermer. 2000. "The Anthropocene," *Global Change Newsletter* 41: 17–18.

Davies, M. I. J. 2008. "The Irrigation System of the Pokot, Northwest Kenya," *Azania* 43: 50–76.

Davies, M. I. J. 2012. "Some Thoughts on a 'Useable' African Archaeology: Settlement, Population and Intensive Farming among the Pokot of Northwest Kenya,"*African Archaeological Review* 29: 319–353.

Davies, M. I. J. 2014. "The Temporality of Landesque Capital: Farming and the Routines of Pokot Life," in T. Håkansson and M. Widgren, eds., *Landesque Capital*: *The Historical Ecology of Enduring Landscape Modifications*. Walnut Creek, CA: Left Coast Press, 172–196.

Davies, M. I. J., and. F. N. M'Mbogori, eds. 2013. *Humans and the Environment*: *New Archaeological Perspectives for the 21st Century*. Oxford: Oxford University Press.

Davies, M. I. J., A. Dupeyron, and H. L. Moore. 2014. "Mobile Internet Technologies and the Possibilities for Public Archaeology in Africa: Marakwet, Kenya," *Antiquity Project Gallery* 88: 340.

Davies, M. I. J., T. K. Kipruto, and H. L. Moore. 2014. "Revisiting the Irrigated Agricultural Landscape of the Marakwet, Kenya: Tracing Local Technology and Knowledge over the Recent Past," *Azania*: *Archaeological Research in Africa* 49: 486–523.

Degefa, A. Z., I. Bessems, R. Tjallingi, B. Cumming, and D. Verschuren. in press. "200 Years of Anthropogenic Soil Erosion in the Lake Baringo Catchment, Kenya: Exploratory Evidence from Lake Sediments," *Journal of African Earth Sciences*.

Dibley, B. 2012. "'The Shape of Things to Come': Seven Theses on the Anthropocene and Attachment," *Australian Humanities Review* 52: 139–153.

Dryzek, J. S. 2013. *The Politics of the Earth*: *Environmental Discourses* 3rd edition. Oxford: Oxford University Press.

Edgeworth, M., ed. 2014. "Forum: Archaeology the Anthropocene," *Journal of Contemporary Archaeology* 1: 73–132.

Ellis, M. A., and Z. Trachtenberg. 2014. "Which Anthropocene is it to be? Beyond Geology to a Moral and Public Discourse," *Earth's Future* 2: 122–125.

Ellis, E. C., K. K. Goldewijk, S. Siebert, D. Lightman, and N. Ramankutty. 2010. "Anthropogenic transformation of the biomes, 1700 to 2000," *Global Ecology and Biogeography* 19: 589–606.

Ellis, E. C., D. Q. Fuller, J. O. Kaplan, and W. G. Lutters. 2013. "Dating the Anthropocene: Towards an Empirical Global History of Human Transformation of the Terrestrial Biosphere," *Elementa*: *Science of the Anthropocene* 1.

Erickson, C. L. 1985. "Applications of Prehistoric Andean Technology: Experiments in Raised Field Agriculture, Huatta, Lake Titicaca, Peru, 1981–1983," in I. S. Farrington, ed., *Prehistoric Intensive Agriculture in the Tropics*. *BAR International Series* No. 232, Oxford: British Archaeological Reports, 209–232.

Escobar, A. 1999. "After Nature: Steps to an Antiessentialist Political Ecology," *Current Anthropology* 40: 1–30.
French, C. A. I., F. Sulas, and M. Madella. 2009. "New Geoarchaeological investigations of the Valley Systems in the Aksum Area of Northern Ethiopia," *Catena* 78: 218–233.
Fuller, D. Q., J. Van Etten, K. Manning, C. Castillo, E. Kingwell-Banham, A. Weisskopf, L. Qin, Y-I Sato, and R. J. Hijmans. 2011. "The Contribution of Rice Agriculture and Livestock Pastoralism to Prehistoric Methane Levels: An Archaeological Assessment," *The Holocene* 21: 743–759.
Gorman, A. 2014. "The Anthropocene in the Solar System," *Journal of Contemporary Archaeology* 1: 87–91.
Greiner, C. 2013. "Guns, Land, and Votes: Cattle Rustling and the Politics of Boundary (Re) Making in Northern Kenya," *African Affairs* 112: 216–237.
Greiner, C., M. Bollig, and J. T. McCabe. 2011. "Notes on Land-based Conflicts in Kenya's Arid Areas," *Africa Spectrum* 3: 77–81.
Guttmann-Bond, E. 2010. "Sustainability Out of the Past: How Archaeology Can Save the Planet," *World Archaeology* 42: 355–366.
IPCC. 2014. *Climate Change 2014*: *IPCC Fifth Assessment Synthesis Report*. New York: United Nations Intergovernmental Panel on Climate, bmischere November 2014. http://www.ipcc.ch/report/ar5/syr/
Håkansson, N. T. 2004. "The Human Ecology of World Systems in East Africa: The Impact of the Ivory Trade," *Human Ecology* 32: 561–591.
Hayashida, F. M. 2005. "Archaeology, Ecological History, and Conservation," *Annual Review of Anthropology* 34: 43–65.
Hodder, I. 1982. *Symbols in Action*. Cambridge: Cambridge University Press.
Hodder, I. R. 2011. *Entangled*: *An Archaeology of the Relationships between Humans and Things*. Oxford: Wiley-Blackwell.
Hourdequin, M. 2013. "Restoration and History in a Changing World: A Case Study in Ethics for the Anthropocene," *Ethics & the Environment* 2: 115–134.
Hughes, T. P., S. Carpenter, J. Rockström, M. Scheffer, and B. Walker. 2013. "Multiscale Regime Shifts and Planetary Boundaries," *Trends in Ecology & Evolution* 28: 389–395.
Houston, D. 2013. "Crisis Is Where We Live: Environmental Justice for the Anthropocene," *Globalizations* 10: 439–450.
Hudson, M. J., M. Aoyama, K. C. Hoover, and J. Uchiyama. 2012. "Prospects and Challenges for an Archaeology of Global Climate Change," *Wiley Interdisciplinary Reviews*: *Climate Change* 3: 313–328.
Isendahl, C., J. M. Ticona, and S. Calla Maldonado. 2012. "Cultivating the Yungas: Notes on Current Farming at Rasupampa and Tablas Monte," in C. Isendahl, ed., *The Past Ahead*: *Language*, *Culture*, *and Identity in the Neotropics*. Uppsala: Uppsala University 229–259.
Kaplan, J. O., K. M. Krumhardt, and N. Zimmermann. 2009. "The Prehistoric and Preindustrial Deforestation of Europe," *Quaternary Science Reviews* 28: 3016–3034.
Kendall, A. 1997. "Traditional Technology Emphasized in a Model for Andean Rural Development," *Journal of International Development* 9: 739–752.
Kendall, A. 2005. "Applied Archaeology: Revitalising Indigenous Agricultural Technology within an Andean Community," *Public Archaeology* 4: 205–221.
Kiage, L. M., and K. B. Liu. 2009. "Paleoenvironmental Changes in the Lake Baringo Basin, Kenya, East Africa Since AD 1650: Evidence from the Paleorecord," *The Professional Geographer* 61: 438–458.
Kiage, L. M., K. B. Liu, N. D. Walker, N. Lam, and O. K. Huh. 2007. "Recent Land-Cover/Use Change Associated with Land Degradation in the Lake Baringo Catchment, Kenya, East Africa: Evidence from Landsat TM and ETM+," *International Journal of Remote Sensing* 28: 4285–4309.
Kingston, J. D., A. L. Deino, R. K. Edgar, and A. Hill. 2007. "Astronomically Forced Climate Change in the Kenyan Rift Valley 2.7–2.55 Ma: Implications for the Evolution of Early Hominin Ecosystems," *Journal of Human Evolution* 53: 487–503.
Kintigh, K. W., J. H. Altschul, M. C. Beaudry, R. D. Drennan, A. P. Kinzig, T. A. Kohler, W. F. Limp, H. D. G. Maschner, W. K. Michner, T. T. Pauketat, P. Peregrine, J. A. Sabloff, T. J. Wilkinson, H. T. Wright, and M. A. Zeder. 2014. "Grand Challenges for Archaeology," *American Antiquity* 79: 5–24.
Lane, P. J. 2009. "Environmental Narratives and the History of Soil Erosion in Kondoa District, Tanzania: An Archaeological Perspective," *International Journal of African Historical Studies* 42: 457–483.
Lane, P. J. 2010. "Developing Landscape Historical Ecologies in Eastern and Southern Africa: Opportunities and Challenges," *African Studies* 69: 299–322.
Lane, P. J. 2011. "Possibilities for a Post-colonial Archaeology in sub-Saharan Africa: Indigenous and Useable Pasts," *World Archaeology* 43: 7–25.
Little, P. D. 1985 "Social Differentiation and Pastoralist Sedentarization in Northern Kenya," *Africa* 55: 243–261.
Little, P. D. 1988 "Maasai Identity on the Periphery," *American Anthropologist* 100: 444–457.
Little, P. D. 1992. *The Elusive Granary*: *Herder*, *Farmer*, *and State in Norhtern Kenya*. Cambridge: Cambridge University Press.
Locher, F., and J.-B. Fressoz. 2012. "Modernity's Frail Climate: A Climate History of Environmental Reflexivity," *Critical Inquiry* 38: 579–598.
Lwenya, C., and E. Yongo. 2010. "Human Aspects of Siltation of Lake Baringo: Causes, Impacts and Interventions," *Aquatic Ecosystem Health & Management* 13: 437–441.
Malm, A., and A. Hornborg. 2014. "The Geology of Mankind? A Critique of the Anthropocene Narrative," *The Anthropocene Review* 1: 62–69.
Murphy, P., D. Thackray, and E. Wilson. 2009. "Coastal Heritage and Climate Change in England: Assessing Threats and Priorities," *Conservation and Management of Archaeological Sites* 11: 9–15.
Nicholls, R. J., N. Marinova, J. A. Lowe, S. Brown, P. Vellinga, D. de Gusmão, J. Hinkel, and R. S. Tol. 2011. "Sea-level Rise and its Possible Impacts Given a 'Beyond 4 Degrees C World' in the Twenty-First Century," *Philosophical Transactions of the Royal Society* 369: 161–181.
Ogden, L., N. Heynen, U. Oslender, P. West, K. A. Kassam, and P. Robbins. 2013. "Global Assemblages, Resilience, and Earth Stewardship in the Anthropocene," *Frontiers in Ecology and the Environment* 11: 341–347.
Olofsson, J., and T. Hickler. 2008. "Effects of Human Land-use on the Global Carbon Cycle During the Last 6,000 Years," *Vegetation History and Archaeobotany* 17: 605–615.
Olsen, B. 2010. *In Defense of Things*: *Archaeology and the Ontology of Objects*. Lanham, MD: Altamira Press.
Östberg, W. 2014. "Irrigated Fields are Wives: Indigenous Irrigation in Marakwet, Kenya," in T. Håkansson and M. Widgren, eds., *Landesque Capital*: *The Historical Ecology of Enduring Landscape Modifications*. Walnut Creek, CA: Left Coast Press, 197–214.
Petek, N. in press. "An Archaeological Survey of the Lake Baringo Lowlands 2014: Preliminary Results," *Nyame Akuma*.
Pretty, J., C. Toulmin, and S. Williams. 2011. "Sustainable Intensification in African Agriculture," *International Journal of Agricultural Sustainability* 9: 5–24.
Raupach, M., and J. Canadell. 2010. "Carbon and the Anthropocene," *Current Opinion in Environmental Sustainability* 2: 210–218.
Reij, C., I. Scoones, and C. Toulmin, eds. 1996. *Sustaining the Soil*: *Indigenous Soil and Water Conservation in Africa*. Abingdon: Earthscan.
Renard, D., J. Iriarte, J. J. Birk, S. Rostain, B. Glaser, and D. McKey. 2011. "Ecological Engineers Ahead of their Time: The Functioning of pre-Columbian Raised-field Agriculture and its Potential Contributions to Sustainability Today," *Ecological Engineering* 45: 30–44.
Rockman, M. 2012. "The Necessary Roles of Archaeology in Climate Change Mitigation and Adaptation," in M. Rockman and J. Flatman, eds., *Archaeology in Society*: *Its Relevance in the Modern World*. London: Springer, 193–215.
Rockström, J., W. M Steffen, K. Noone, Å. Persson, F. S. Chapin III, E. F. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. J. Schellnhuber, B. Nykvist, C. A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. A. Foley. 2009. "A Safe Operating Space for Humanity," *Nature* 461: 472–475.
Ruddiman, W. F. 2003. "The Anthropogenic Greenhouse Era Began Thousands of Years Ago," *Climatic Change* 61: 261–93.
Ruddiman, W. F. 2013. "The Anthropocene," *Annual Review of Earth and Planetary Sciences* 41: 45–68.

Rull, V. 2013. "A Futurist Perspective on the Anthropocene," *The Holocene* 23: 1198–1201.

Sabbioni, C., P. Brimblecombe, and M. Cassar. eds., 2010. *The Atlas of Climate Change Impact on European Cultural Heritage*: *Scientific Analysis and Management Strategies*. London: Anthem Press.

Sandweiss, D. H., and A. R. Kelley. 2012. "Archaeological Contributions to Climate Change Research: The Archaeological Record as a Paleoclimatic and Paleoenvironmental Archive," *Annual Review of Anthropology* 41: 371–391.

Sayre, N. F. 2012. "The Politics of the Anthropocene," *Annual Review of Anthropology* 41: 57–70.

Seddon, A. W. R., A. W. Mackay, A. G. Baker, H. J. B. Birks, E. Breman, C. E. Buck, E. C. Ellis, C. A. Froyd, J. L. Gill, L. Gillson, E. A. Johnson, V. J. Jones, S. Juggins, M. Macias-Fauria, K. Mills, J. L. Morris, D. Nogúes-Bravo, S. W. Punyasena, T. P. Roland, A. J. Tanentzap, K. J. Willis, M. Aberhan, E. N. van Asperen, W. E. N. Austin, R. W. Battarbee, S. Bhagwat, C. L. Belanger, K. D. Bennett, H. H. Birks, C. Bronk Ramsey, S. J. Brooks, M. de Bruyn, P. G. Butler, F. M. Chambers, S. J. Clarke, A. L. Davies, J. A. Dearing, T. H. G. Ezard, A. Feurdean, R. J. Flower, P. Gell, S. Hausmann, E. J. Hogan, M. J. Hopkins, E. S. Jeffers, A. A. Korhola, R. M. Marchant, T. Kiefer, M. Lamentowicz, I. Larocque-Tobler, L. López-Merino, L. H. Liow, S. McGowan, J. H. Miller, E. Montoya Romo, O. Morton, S. Nogúe, C. Onoufriou, L. P. Boush, F. Rodriguez-Sanchez, N. L. Rose, C. D. Sayer, H. E. Shaw, R. Payne, G. Simpson, K. Sohar, N. J. Whitehouse, J. W. Williams, A. Witkowski, and M. McGlone. 2014. "Looking Forward Through the Past: Identification of 50 Priority Research Questions in Palaeoecology," *Journal of Ecology* 102: 256–267.

Sherwood, S. C., S. Bony, and J. -L. Dufrense. 2014. "Spread in Model Climate Sensitivity Traced to Atmospheric Convective Mixing," *Nature* 505: 37–42.

Smith, B. D., and M. A. Zeder. 2013. "The Onset of the Anthropocene," *Anthropocene* 4: 8–13.

Solli, B. 2011. "Some reflections on heritage and archaeology in the Anthropocene," *Norwegian Archaeological Review* 44: 40–54, 83–88.

Steffen, W, P. Crutzen, and J. McNeill. 2007. "Are Humans Now Overwhelming the Great Forces of Nature?" *Ambio: A Journal of the Human Environment* 36: 614–621.

Steffen, W, J. Grinevald, P. Crutzen, and J. McNeill. 2011. "The Anthropocene: Conceptual and Historical Perspectives," *Philisophical Transactions of the Royal Society* 369: 842–867.

Stigter, K. J., and D. M. Warren. 1995. "Transfer of Indigenous Knowledge and Protection of the Agricultural Environment in Eastern Africa," in K. J. Stigter, D. M. Warren, L. J. Slikkerveer, and D. Brokensha, eds., *The Cultural Dimension of Development*: *Indigenous Knowledge Systems*. London: Intermediate Technology Publications, 419–425.

Strang, V. 2014. "Fluid Consistencies. Material Relationality in Human Engagements with Water," *Archaeological Dialogues* 21: 133–150.

Stump, D. 2010. "'Ancient and Backward or Long-Lived and Sustainable?': The Role of the Past in Debates Concerning Rural Livelihoods and Resource Conservation in Eastern Africa," *World Development* 38: 1251–1262.

Stump, D. 2013. "On Applied Archaeology, Indigenous Knowledge, and the Usable Past," *Current Anthropology* 54: 268–298.

Sulas, F. 2010. *Environmental and Cultural Interplay in Highland Ethiopia*: *Geoarchaeology at Aksum*. Unpublished PhD dissertation, University of Cambridge.

Sulas, F., M. Madella, and C. A. I. French. 2009. "State Formation and Water Resources Management in the Horn of Africa: The Aksumite Kingdom of the Northern Ethiopian Highlands," *World Archaeology* 41: 2–15.

Sutherland, R. A., and K. B. Bryan. 1990. "Runoff and Erosion from a Small Semiarid Catchment, Baringo District, Kenya," *Applied Geography* 10: 91–109.

Swartley, L. 2002. *Inventing Indigenous Knowledge*: *Archaeology*, *Rural Development*, *and the Raised Field Rehabilitation Project in Bolivia*. New York: Routledge.

Swyngedouw, E. 2011. "Depoliticized Environments: The End of Nature, Climate Change and the Post-Political Condition," *Royal Institute of Philosophy Supplement* 69: 253–274.

Tvedt, T. 2010. "'Water Systems', Environmental History and the Deconstruction of Nature," *Environment and History* 16: 143–166.

Van de Noort R. 2011. "Conceptualising Climate Change Archaeology," *Antiquity* 85: 1039–1048.

Van de Noort R. 2013. *Climate Change Archaeology*: *Building Resilience from Research in the World's Coastal Wetlands*. Oxford: Oxford University Press.

Von Höhnel, L. 1894. *Discovery of Lakes Rudolf and Stephanie: A Narrative of Count Samuel Teleki's Exploring and Hunting Expeditions in Eastern Equatorial Africa in 1887 and 1888*. London: Longmans, Green, and Co.

Wapner, P. 2014. "The Changing Nature of Nature: Environmental Politics in the Anthropocene," *Global Environmental Politics* 14: 36–54.

Waters, C. N., J. A. Zalasiewicz, M. Williams, M. A. Ellis, and A. M. Snelling, eds. 2014. *A Stratigraphical Basis for the Anthropocene*. *Geological Society of London Special Publication* 395. London: Geological Society of London.

Wilkie, R. 2015. "Multispecies Scholarship and Encounters: Changing Assumptions at the Human-Animal Nexus," *Sociology* 49: 323–339.

Wolverton, S., and R. L. Lyman, eds. 2012. *Conservation Biology and Applied Zooarchaeology*. Tucson: University of Arizona Press.

Wynne, B. 2010. "Strange Weather, Again: Climate Science as Political Art," *Theory, Culture & Society* 27: 289–305.

Zarankin, A., and M. A. Salerno. 2014. "The 'Wild' Continent? Some Discussions on the Anthropocene in Antartica," *Journal of Contemporary Archaeology* 1: 114–118.