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Rediscovering lessons of adaptation from the past

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ABSTRACT

We argue that the deep time perspectives offered by historical disciplines, such as archaeology and history, provide important human-scale data about climate-adaptation over long timescales, and that these insights are currently lacking in global change research and Intergovernmental Panel on Climate Change reports. Pre-modern societies are not comparable with contemporary societies, but the completed experiments they represent can offer evidence of the consequences of climate change, the challenges of uncertainty and socio-cultural limits to adaptation. The limited visibility of data on long-term human interactions with climate change in global change research could be overcome through a 'new social contract', a two-way movement between global change and historical disciplines to, 1) make use of, and apply, historical data to contemporary climate-related challenges, 2) design robust interdisciplinary, and transdisciplinary research, 3) publish synthesised research in high-impact climate-adaptation journals, and 4) communicate research to the public in cultural history museums.

1. Introduction

Anthropogenic climate change is having profound impacts on social and cultural practices, requiring novel approaches to understand the interaction between culture and climate (Hulme, 2009, 2016). In the last decade, numerous authors have highlighted the need for a critical integration of the social sciences and humanities into Global Change Research (GCR) and associated institutional bodies, such as the Intergovernmental Panel on Climate Change (IPCC; see Hulme, 2011; Castree et al., 2014). Archaeology and history, however, have received little attention in mainstream the climate-adaptation literature and institutional reports despite significant research at the interface between human and natural systems (Riede, 2014a; Hudson et al., 2012; Hambrecht and Rockman, 2017). In this paper, we address this lack by proposing a new social contract; a two-way movement by GCR and historical disciplines to make use of and apply historical data to contemporary climate-related challenges.

2. Global change research

GCR examines the impacts of human activities on bio-geo-physical processes (IPCC, 2014). Integrated monitoring efforts have recorded significant changes to these processes, and the crossing of environmental thresholds that define safe operating spaces for humanity (Rockström et al., 2009). While substantial progress has been made towards understanding physical changes to Earth system processes since Assessment Report (AR) 1 (1990) of the IPCC, until IPCC AR4 the social sciences and humanities had limited influence over the consideration of human dimensions within GCR (Corbera et al., 2016). It is now recognised that successful responses to climate change need to overcome socio-cultural limits and barriers (Moser and Ekstrom, 2010; Barnett et al., 2015). This highlights crucial issues that include how to adjust social practices to avoid dangerous climate change and to understand cultural capacities to adapt to change (Adger et al., 2013a).

The limited visibility of archaeology and history in GCR is perhaps unsurprising because recognisable changes to climate, driven by human activities, are a modern phenomenon and societies of the past differ from those of the present in terms of world views, technology, demography and governance structures. Hence, climate change adaptation might be considered solely a challenge for modern societies and thus modern science. Indeed, global production, economic systems, demographic and population trends, and—critically—modes of knowledge

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have changed dramatically since the Enlightenment (Withers, 2005) and industrial revolutions (Urry, 2014). This development has been so profound that, in the case of Western societies, Hannah Arendt (1998) has characterised a new *human condition* capable of ever-greater destruction. Linked to this, the 'Anthropocene' concept has sought to define humanity's transformed relationship with the Earth system (Crutzen, 2006). The industrial revolution's influence on global atmospheric composition (c. 1750–1800 AD), socio-economic trends of the post-1950 'great acceleration' (Steffen et al., 2015) and the creation of an artificial global radionuclide marker horizon from atomic detonations (Zalasiewicz et al., 2008) are used as evidence for a post-industrial global environmental threshold. But defining this threshold potentially shifts attention from antecedent processes of cultural-ecological change (Erlandson and Braje, 2013) and past human resource-use and decision-making in response to climate stimuli. As argued by Hartman et al. (2017), the notion of the new human condition is in need of updating in light of past human-environment interactions, and how these impinge on the present and future of human planetary stewardship.

Anthropologists Smith and Zeder (2013) have challenged the post-industrial designation of Anthropocene, arguing "focus should be on cause rather than [a measurable] effect" (p.11), such as a 'golden spike'. The cause in question is, for Smith and Zeder (2013), the 'agricultural revolution' of ~11,000–9000 yr BP. This period marked a significant transition in human impacts, from those of hunter-gatherers to the domesticators of plants and animals (Zeder, 2015). The social and ecological consequences of agriculture are significant, and their imprint is discernible today. The adoption of agriculture increased and expanded human population and human-favoured taxa across the globe —primarily the newly domesticated plant and animal species common to modern diets (Boivin et al., 2016). Major environmental impacts from Holocene agricultural expansion, such as the transformation of central Eurasian forests and grasslands through grazing, are responsible for engineering the familiar cultural landscapes of today (Miehe et al., 2009).

The spread of agriculture is significant to modern GCR because it fundamentally altered human adaptive responses to climate variability. Whereas hunter-gatherer societies used mobility to respond to climate-induced shifts in wild resource distribution, agriculturalists use past experience to inform local economic decisions (Kennett and Marwan, 2015). Decisions about cropping, harvesting, grazing, irrigation, grain storage, trade and political-economic integration require the navigation of economic constraints and memory of climatic variability and are as important today as long ago. Likewise, managing private and local common-pool resources is as much a socio-environmental and economic challenge of the present as it was in the past (Ostrom et al., 1994, 2007).

Climate change, political and economic stability, food security and human migration have been major concerns to past as well as contemporary societies, but examples of how these problems become interrelated, and 'wicked', are missing from future scenario planning (Palmer and Smith, 2014). History can tell us how vulnerable societies functioned before and after disaster events (Riede, 2014b), what impact cultural limits played in long-term adaptation to climate variability (Dugmore et al., 2012; Spielmann et al., 2016), and how multiple exposures undermined societal resilience (Dugmore et al., 2013).

3. The use of the past in the present

In the 21st century, archaeology and history have increased their efforts to apply long-term data to contemporary social and environmental challenges—including climate-adaptation and sustainability (Redman, 2005; Costanza et al., 2007). New and expanded archaeological methods, such as those using stable isotopes, statistical models and microfossil analysis, have enhanced reconstructions of human-environment interaction, human dietary response to changing resource abundance, human migration and settlement abandonment (Boivin et al., 2016; d'Alpoim Guedes et al., 2016); historians have shown how culture shapes changing ideas of climate (Adamson et al., 2018; Hulme, 2008).

Developing more effective interdisciplinary collaborations can provide holistic information on climate-adaptation using extended timescales to explain how vulnerabilities develop across different spatial and socio-cultural contexts—to reconstruct a global perspective on climate impacts and adaptation in the past. Box 1 provides six well-known examples of environmental and social change. North Atlantic researchers from the geosciences, historical ecology, environmental humanities and social sciences have outlined the benefits of long-term integrative approaches using the comparative cases of Medieval Greenland and Iceland (Box 2). In the following subsections we explore two further cases of societal transformation (Classic Maya and the pre-Hispanic US Southwest) to illustrate the potential of historical records and their completed experiments to inform contemporary and future climate-adaptation scenario planning.

3.1. Classic Maya: climate variability, uncertainty and conflict

The decline of Classic Maya (~750-1050 CE) is among the most widely discussed cases of societal "collapse" (Middleton, 2017). Recent comparative climate and archaeological research supports the hypothesis that prolonged, multiyear drought triggered regional political disintegration during the Terminal Classic (9^{th}-10^{th} centuries CE) (Kennett et al., 2012; Hoggarth et al., 2016). In wealthy Maya polities, conflict and tribute-based status encouraged population agglomeration. This escalated environmental stress, increasing the chance of local-scale soil erosion and reduced crop yields (Turner and Sabloff, 2012). In the elevated interior of the Yucatan, an extensive dry season made settlements dependent on household and urban reservoirs to store water (Dunning et al., 2012). Multiyear drought increased resource stress, triggering conflict for political and economic gain over neighbouring polities (Kennett and Beach, 2013). This resulted in increased political disintegration and population decline as resource stress and conflict reinforced one another in a 'risk spiral' (Hoggarth et al., 2016, 2017; Dunning et al., 2012).

3.2. US Southwest: climate variability and infrastructure rigidity

Research focused on the pre-Hispanic ancestral Puebloan communities of the US Southwest has examined decision-making and actions that contributed to both vulnerability and adaptive capacity (Nelson et al., 2016). Using archaeological records and climate reconstructions, multidisciplinary approaches have compared long-term records of social-ecological stability and change across the US Southwest (Kohler et al., 2012). In the Mesa Verde region, there is a strong correlation between maize-niche size and ancestral Puebloan populations. From 1200 CE, declining maize productivity contributed to food shortages followed by violence and regional social collapse (Schwindt et al., 2016). In the Phoenix basin, Hohokam, communities successfully managed interannual water scarcity using large-scale canal networks. The irrigation capacity they generated for agricultural productivity supported the creation of a regional-scale economy, but over-dependence on a predictable water supply formed *rigidity traps*. Extreme climatic events in the 14^{th} century, including floods that disrupted channel-head connections to the river, devastated irrigation infrastructures that supported agriculture (Nelson et al., 2012). At a broader scale, regional networks became balkanized by social-ecological change, triggering depopulation and the collapse of trade networks. A comparative study by Hegmon et al. (2008) found more rigidly organised settlements—including those of Mesa Verde and the Phoenix Basin—to be more prone to severe transformation than less integrated and less hierarchical societies such as Mimbres (and Zuni; see Spielmann et al., 2016).

These case studies illustrate how unanticipated and unprecedented