Towards a New Social Contract for Archaeology and Climate Change Adaptation

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Introduction

Anthropogenic climate change is one of the greatest challenges facing society in the twenty-first century. Climate impacts present wicked and messy challenges that require a cross-disciplinary understanding of social and biophysical change (Tengö et al. 2017). There is a growing body of evidence that climate change will have impacts on food production (Barrett 2010), global health (Watts et al. 2015, 2017), frequency of hazardous events (IPCC 2014), resource conflict (Barnett and Adger 2007) and displacement of people (Adger et al. 2013a; Bettini 2013, 2017). Curiously, archaeology, a subject with a long history of studying human-environment interactions, plays a very limited role in contemporary debates about appropriate responses to climate challenges (Costanzo et al. 2007; Dearing et al. 2006; Van de Noort 2013). This paper develops recent calls for archaeology to more actively participate in contemporary climate-adaptation research, public education and community empowerment (Riede 2014a; Riede et al. 2016a; Van de Noort 2013). Firstly, we outline the ways in which long-term perspectives of human interactions with changing climates (and thus archaeology) can contribute to global change research (GCR). Secondly, we outline the idea of a 'social contract' in archaeology as a way to enhance GCR. This 'social contract' would:

(a) encourage interdisciplinary publications that synthesize archaeological research focusing on evidence of the long-term impacts of climate change on human societies;

(b) encourage museums to engage the public with thematic exhibitions that outline impacts of climate change on cultures in the past in ways that make explicit connections to contemporary debates;

(c) encourage transdisciplinary projects that better engage the physical sciences with the social sciences and the humanities, as well as with the academy and civil society.

Global Change Research

Over the last 30 years, GCR has sought to alert policymakers to the biophysical and human impacts of climate change (Castree 2016). GCR was initially pioneered in the natural sciences, examining the degree to which anthropogenic activities have contributed to shifts in Earth system processes. The identification of human contributions to global change and, in turn, the climate's impacts on human societies have encouraged the natural and social sciences to develop the concept of 'coupled human-environmental systems' (Castree et al. 2014; DeFries et al. 2012). Anthropogenic activities are visibly affecting the resource systems necessary for provisioning, regulating and supporting services vital to human well-being (MEA 2005). On a planetary scale, ecosystems are showing visible 'tipping points' (Barnosky et al. 2012) or 'critical thresholds' (Scheffer et al. 2012), such as coral bleaching caused by ocean acidification (Mooney et al. 2009), loss of global biodiversity (Ceballos et al. 2017) and movement outside safe and just operating spaces for humanity (Dearing et al. 2014; Rockström et al. 2009a, 2009b; Scheffer et al. 2015), all of which highlight the need to limit human activities contributing to climate change (DeFries et al. 2012).

Since 1990, high profile reports by the Intergovernmental Panel on Climate Change (IPCC) have synthesized the current scientific evidence of global environmental change and connected GCR with public policy (Castree 2017). IPCC Assessment Reports (AR) are divided into three working groups, all of which base their reports on published materials. The first working group (WG1) monitors physical changes to the

climate system and considers the effects of change on Earth system processes. Working Group Two (WG2) examines the management of risks arising from climate change (impacts, adaptation and vulnerability), and Working Group Three (WG3) examines the mitigation of further contributions to climate change (IPCC 2014). The IPCC has the ambitious goal of presenting a consensus view from the global scientific community. This has made a significant contribution to policy-making while prompting intense debate. The key challenge of how to make research actionable and bring about the social transformations required to avoid dangerous climate change has become a salient concern for GCR in recent years (O'Brien 2012, 2015). This is because the current 'incremental' pace of action to transition energy systems and adapt society to climate change impacts is too slow to limit global temperatures to a 'safe' or 'moderate' target of a 1.5–2°C increase on pre-industrial levels by 2100 (O'Brien and Sygna 2013; Park et al. 2012; Raftery et al. 2017). To meet these targets, more radical actions are arguably needed, and calls have been made for a social contract in GCR to speak for the need of societies to change, rather than speak of the need for change (O'Brien 2015; Pelling 2011).

Vulnerability and Adaptation

In recent years, archaeologists, historians and geographers have used 'natural experiments' of history, extending over multi-generational timescales, to analyse the relationship between climate and cultural change (Diamond and Robinson 2010). Using the past as a 'completed experiment', key controls on cultural change can be examined using quantitative and qualitative methods (Kirch 2010; Speilmann et al. 2016). Archaeology provides a crucial long-term perspective on human vulnerability to climate change because it is possible to study social change over multi-generational and, at times, multi-millennial timescales (Smith et al. 2012). Plotting the transformation of societies through evolving social traditions, religious practices, politico-ideological structures and economic transactions, as well as the impacts of climate change on the resilience of resource systems, offers a distinctive perspective on vulnerability, adaptation and resilience (Butzer 2012; Butzer and Enfield 2012). In this way, observations can be extended to cover complete phases of social and environmental change and thus encompass both the waxing

and waning of cultures in relation to multiple hazards and environmental as well as social processes (Dearing et al. 2006; Redman 2005).

Addressing human security issues will be essential if societies are to reduce their vulnerability to future climate conditions (Barnett 2013; O'Brien et al. 2013). Without evidence of the impacts of climate change on human populations and of the sustainability of adaptive strategies over long periods of time, resilience is likely to remain out of reach (see Redman 2005). Resilience is defined as the "capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al. 2004: 10). This infers a long-term capacity to respond to either 'specified' or 'general' exposure(s) to change (Miller et al. 2010). Specified resilience is the ability of the system to respond to specific stresses (Carpenter et al. 2001), such as sustaining food security through periods of drought with irrigation systems or drought-tolerant crops designed to reduce stress. General resilience, on the other hand, is the capacity of each aspect of a system to respond to stress (Resilience Alliance 2010). For example, Transition Town initiatives look to transform local energy systems (such as food and electricity production), with the aim of increasing self-sufficiency and reducing community-scale vulnerability to the impacts of climate change (Hopkins 2008; Wilson 2012). It is important to stress, however, that it is still unknown whether attempts to design resilience are sustainable in the long term, but 'general' resilience can arguably be promoted through measures that have been tried and tested in the past (Barthel et al. 2013b; Dugmore et al. 2013). This is where archaeology (and other historical disciplines) come into play (cf. Dukes 2013; Rockman 2012).

Archaeology is not capable of offering specific solutions to climate stress, but it could offer lessons to guide 'general' resilience in the long run (Redman 2005). For instance, local food initiatives in the UK have become increasingly widespread through community-scale movements (Seyfang 2009; Seyfang and Smith 2007). For these initiatives, safeguarding food production involves growing sufficient food at the local level, without the need for mechanized production and transportation (North 2010). These so-called 'eco-localist' Transition Town initiatives aim to promote sustainability by reducing the distance between consumers and producers and

more effectively utilizing the resources and expertise that are accessible at the local scale (Hopkins 2008; North 2010). Safeguarding expertise in small-scale production, as Barthes et al. (2013a) have discussed, involves drawing upon traditional forms of knowledge that have been tested over long periods of time. As Hopkins (2010) notes, Transition Town initiatives aim to re-skill communities with knowledge and practices that were applied during World War Two, such as production of community food, utilization of resources and reuse and repurposing of furniture and clothing. Skills required to conduct sustainable food production have, in many cases, been preserved inter-generationally from memories of communal gardening (such as 'dig for victory') on the homefront (Hopkins 2010). Barthel and colleagues (2013a) have extended this by calling for the conservation of cultural traditions to maintain biocultural knowledge that is essential to sustaining food production in its local ecological context. Traditional agricultural practices, such as crofting in the highlands and islands, have been adjusted and maintained over multi-century timescales (Grant 1961). Such practices cannot guarantee adaptation to climate change, but they have been tested over extensive periods of climate variation.

The inclusion of deep time case studies can also shed light on the failures of past societies to adjust to social-ecological changes over multi-century and multi-millennial timescales (Costanza et al. 2007; Dearing 2007). Archaeology illustrates how resilient societies must be capable of substantial flexibility regarding short-term challenges but also capable of withstanding the long-term impacts of climate change and other coinciding social changes (Dugmore et al. 2013; Nelson et al. 2016). Navigating climate change was, in other words, as much a challenge of addressing vulnerabilities contextual to society as one of understanding the future impacts of climate change on subsistence. Archaeological data extending across space and time can be used to assess the impact of climate change on the capacity of past societies to respond to change, as well as provide information vital to societal resilience.

Archaeology: Potential Contributions from the Current Margins of Global Change Research

A key question, therefore, is how archaeological perspectives can move from the margins of GCR into the mainstream. An illustration of how this may

happen is given by Future Earth, an initiative under the GCR umbrella that promotes the advancement of global sustainability science and advocates a more robust, transformative commitment by global change scientists to use scientific research "to more revolutionary ends" (Castree 2017: 64). A broad range of research projects are supported under the Future Earth initiative to advance understandings of human sustainability in both the present and the past. One of these, the Integrated History and Future of People on Earth (IHOPE) project, aims to integrate biophysical and human systems over multi-millennial timescales, understand the co-evolving relationship between climate and society and transfer understandings of past change to inform our interpretation of future challenges (Costanza et al. 2007).

IHOPE comprises an international network of natural scientists, archaeologists and humanities researchers studying the co-evolution of society and culture in a changing environment (Costanza et al. 2007). A three-fold approach to research is adopted, thereby incorporating historical ecology's holistic integration of biophysical and human systems; environmental humanities' exploration of beliefs, values and attitudes; and future studies that integrate history with present-day environmental concerns (http://ihopenet.org/about/). The North Atlantic Biocultural Organization (NABO), an initiative within the IHOPE network, has been exploring cultures and long-term human-environment interactions across the North Atlantic, focusing on the Scandinavian Norse, Inuit and Celtic cultures (http://www.nabohome.org). Integrative work melding archaeological studies, environmental sciences and historical literatures from Norse settlements in the Northern British Isles, Faroes, Iceland, Greenland and Vinland has sought to elucidate human perceptions of and responses to environmental change (Hartman et al. 2016, 2017; Lethbridge and Hartman 2016).

These initiatives illustrate how interdisciplinary projects can highlight (pre-)history's contribution to studies of resilience, adaptation and vulnerability (Costanza et al. 2007; Hartman et al. 2017; Nelson et al. 2016; Spielmann et al. 2016). Advances in computational models and datasets from ancient DNA, stable isotopes and microfossils have increased deep time resolution and expanded scientific understandings of human resource use, environmental impacts and settlement dynamics over the *longue durée* (Boivin et al. 2016; d'Alpoim Guedes et al. 2016). But there

Fig. 1. The Demise of Norse Greenland.

is still limited attention paid to deep time perspectives in contemporary mainstream studies of adaptation to climate change (Riede 2014a). The short timescales used in contemporary adaptation research are often limited to the multi-decadal timescales captured by instrumental readings; this limits our understanding of social-ecological resilience (Redman 2005; Voss et al. 2014). Long-term historical datasets offer known social-ecological responses to climate impacts, human resource use and extreme geophysical events (Pandolfi et al. 2003; Riede 2014b). These historical and archaeological resources are significant if we are to understand how sustainable today's adaptation planning will be to future climate change (Adger and Barnett 2009; Erikson and Brown 2011; Hartman et al. 2017; Redman 2005). Cases of societal collapse (or demise), such as that of Norse Greenland (fig. 1), have the potential to explain how cultural continuity and social and economic structures in society can limit capacities to respond to environmental change (see Dugmore et al. 2012,

2013) and illustrate the importance of preserved ecological knowledge in traditions and local communities (see Barthel et al. 2013a, 2013b).

Though the relevance of deep time perspectives has been outlined at length in archaeological and scientific journals, there is an absence of engagement in highly-cited journals read by adaptation specialists. Contemporary studies focusing on vulnerability and adaptation tend to look at cases limited to single events rather than medium- or long-term changes to community resilience (Miller et al. 2010; Redman 2005). Distilling technical details within archaeological literatures and extracting important lessons from them in order to learn from studies of past societies can help plan for future uncertainty. Bringing the 'lessons learned' to the forefront of research projects (see, for example, Cooper and Sheets 2012; Dugmore and Vésteinsson 2012) could enhance archaeology's visibility in GCR and contribute towards adaptation debates in contemporary literatures. In addition to these research goals, archaeology also has an opportunity to develop public engagement through museum exhibitions focusing on the long-term impacts of climate change on past societies.

The scale and pace of climate change has triggered many calls within GCR for a new social contract to move beyond discussions of biophysical limits and towards solution-oriented research (DeFries et al. 2012; O'Brien 2012). Researchers, particularly from the social sciences and humanities, have called for actionable research and have pushed for a practice of science that goes beyond speaking for itself (Castree 2017). In this context, archaeology has an opportunity to engage with mainstream adaptation research, particularly GCR. What follows is a potential route towards such a new social contract for archaeology. This could include publishing in interdisciplinary journals that have the aims and scope to address adaptation to climate change, engaging the public with the impacts of climate change on societies in the past through museum exhibitions and designing and collaborating in transdisciplinary projects to highlight long-term impacts of climate change as well as preservation of the traditional ecological knowledge required to manage the impacts of future climate change. In the following section, each of these areas are explored to outline how archaeology can raise its disciplinary profile in GCR.

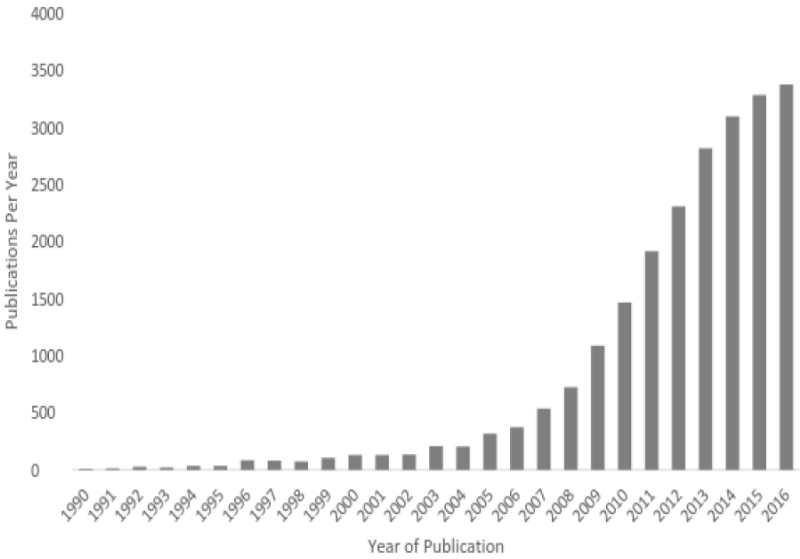

Fig. 2. Number of publications per year including "*adapt* AND climate change" in Scopus between 1990 and 2016 (n = 22,579). * in Scopus refers to any derivations of terms including 'adapt', such as maladaptation, adaptiveness, adaptation, etc. (data downloaded from Scopus on 9 Aug. 2017). Criteria for inclusion is limited to published articles, review papers, editorials, books, book chapters and articles in press (articles in press include articles published online in 2016).

Publishing in Interdisciplinary Journals

Since the early 2000s, there has been a notable increase in the number of journal publications addressing climate change adaptation (fig. 2), but the increasing frequency of such publications has been met with limited response in archaeological research. There remains an absence of palaeosocietal datasets in the IPCC reports, despite an increased resolution on challenges facing populations in the past (Riede 2014a). Deep time perspectives provide empirical evidence of limits to adaptation and, more importantly, opportunities to test the sustainability of adaptive strategies across long periods of climate stress (see Dow et al. 2013). One way to contribute archaeological data is to synthesize human and environmental

research to offer a chronology of the challenges faced by societies adapting to climate change, such as fluctuating resource access and attendant management practices (see Altschul et al. 2017). This information has the potential to inform strategic management, offering lessons regarding the potential of unforeseen or synergistic changes to undermine long-term resilience (Dugmore and Vésteinsson 2012. Publications addressing food security and the resilience of food systems to the impacts of climate change have explained the value of traditional ecological knowledge, co-evolved over millennial timescales, and flexible production systems—and archaeological heritage represents the tangible aspects of such knowledge (see Barthel et al. 2013a; Nelson et al. 2016). Publications in climate-adaptation journals that are frequently cited across GCR and in the IPCC reports could increase the visibility of completed experiments on the past and the value of deep timescales in expanding adaptive knowledge.

Research cited in the IPCC Working Group Two (WG2) report is guided by influential publications representing the current state of climate-adaptation research (Bassett and Fogelman 2013). If archaeologists are to contribute impactful climate-adaptation research to be cited in WG2, it is necessary to examine the journals with the greatest impact in AR5 (the latest IPCC assessment report). Results presented in Table 1 show the contents of citation-frequency analysis of 'global and sectoral aspects' of IPCC WG2 AR5. Climatic Change and Global Environmental Change are by far the most cited journals across the 20 chapters that make up this report. This may be explained by their broad focus on adaptation, with the aim of incorporating all aspects of human adaptation to climate change. Journals cited in the IPCC WG2 also figure highly in Scopus search results for '*adapt*' and 'climate change' (see table 1). But although there is a notable absence of 'historical perspectives' in IPCC reports—other than a small text box—the aims and scope of journals frequently cited in the WG2 are in principle amenable to submissions arising from archaeological and historical research. In Table 1, journals highlighted in green have sufficient aims and scope to include submissions from archaeological research. Designing projects with the aim of publishing in these journals would increase archaeology's profile in GCR while building bridges to a more actionable output from research on societies in the past to concerns facing society in the present.

IPCC AR5 WG2 Part A – Global and Sectoral Aspects			Scopus Search			Journal	Overall Rank
Rank	Journal Name	Citation Frequency	Rank	Journal Name	Publications: '*adapt*' & 'Climate Change'		
1	*Climatic Change*	481	1	*Climatic Change*	648	*Climatic Change*	1
2	*Global Envtl. Change*	426	2	*PLOS ONE*	378	*Global Environmental Change*	2
3	*PNAS*	267	3	*Global Environmental Change*	326	*PLOS ONE*	3
4	*Global Change Biology*	260	4	*Regional Envtl. Change*	289	*Global Change Biology*	3
5	*Nature Climate Change*	175	5	*Global Change Biology*	288	*PNAS*	5
6	*Mitigation & Adaptation Strategies for Global Change*	116	6	*Mitigation & Adaptation Strategies for Global Change*	286	*Mitigation & Adaptation Strategies for Global Change*	5
7	*PLOS ONE*	83	7	*Envtl. Science & Policy*	211	*Regional Environmental Change*	7
8	*Envtl. Science & Policy*	80	8	*Climate & Development*	182	*Envtl. Science & Policy*	8
9	*Ecological Economics*	75	9	*PNAS*	167	*Climate & Development*	9
10	*Regional Envtl. Change*	70	10	*Climate Research*	165	*Nature Climate Change*	10
11	*Climate Research*	66	11	*Forest Ecology & Management*	158	*Climate Research*	10
12	*Natural Hazards*	58	12	*Ecology and Society*	152	*Climate Policy*	12
12	*Climate Policy*	58	13	*Shengta Xuebao Acta Ecologica Sinica*	131	*Ecology and Society*	13
12	*Climate & Development*	58	14	*Climate Policy*	124	*Natural Hazards*	14
15	*Ecology and Society*	54	15	*Environmental Research Letters*	121	*Wiley Interdisciplinary Reviews: Climate Change*	15

[1] *adapt* in Scopus includes any combination of words containing adapt, such as 'adaptation', 'maladaptive', 'adaptive', etc.

Table 1. List of journals cited in IPCC WG2 AR5, citation frequency and frequency of scopus search for *adapt* and climate change.

Engagement in Museums

Museums have a "unique position in the media and political landscape" (Cameron et al. 2013: 9), occupying the space between academic and public domains. It is for this reason that museums have a major role to play in disseminating and engaging publics with evidence of climate impacts on the environment and society (Rees 2017). Museums are trusted because they are considered neutral and safe spaces with authority and creativity (Cameron et al. 2013; Cameron and Neilson 2015), but many exhibitions remain conservative in their portrayal of human-environment interaction over multi-century timescales (Moser 2010). In archaeology and cultural history exhibitions, information is often conveyed as linear, rigid progressions of societies from prehistory to modernity (Moser 2001, 2010; Smiles and Moser 2005). Exhibitions tend to decontextualize material cultures from their environmental contexts, often focusing instead on the production, distribution and consumption of goods or on political power and warfare as drivers of societal change. While these emphases might be driven by constraints on time, space and resources, more could be done to engage the public's 'tacit expertise' (Yearly 2013: 253) by exploring material and cultural histories in their broader environmental contexts (Cameron and Descales 2011). Evidence of how societies succeeded and failed can illustrate the social impacts of climate and natural hazards.

Impacts of climate change on societies in the past could be linked to key academic debates such as those over the proposed 'Anthropocene' epoch (Crutzen 2002). Interactive exhibitions like the 'Mild Apocalypse' exhibition at Moesgaard Museum can position artefacts as the "point of entry into [discussions] of the environmental dimensions of human impact" (Riede et al. 2016b: 4) and use the public's tacit expertise to question human impacts on the Earth System over time (see Vestergaard and Riede, this issue). Developing thematic exhibitions that centre on climate change could invite 'critical thinking' and promote 'social action' (Moser 2003: 10). This has been a key avenue for research focusing on climate change, as projects looking to engage with publics in a co-constitutive process of learning are launched. Rees (2017) has recently called for museums to become catalysts for change at the local and regional scales by engaging local communities with the impacts human activi-

ties have had on their environment. Building on this proposal, archaeological museums could have a significant influence on communities by illustrating the influence of human activities over multi-millennial timescales, from the origins of human expansion, environmental modification and plant and animal domestication to the formation of traditional towns and sprawling infrastructures (see Boivin et al. 2016).

In addition to understanding human impacts on the environment, more could be done to promote and preserve traditional knowledge of sustainable resource use. Museums must be encouraged to explore diverse traditions and environmental knowledge and to invite the public to protect and disseminate biocultural knowledge and practices that are vital to human security (Barthel et al. 2013a, 2013b). This is not to say that the obligation is solely in the hands of museums to address the dissemination of academic and biocultural knowledge; rather, it is the responsibility of governing organizations and research councils to fund advances in museology and the communication of scientific research.

Transdisciplinarity

So far, we have outlined how archaeology can become more visible and engaged in contemporary adaptation literature and extended calls for museums to curate exhibitions focusing on human impacts of climate change in a balanced and careful manner. In this final section, we push for archaeology to become more involved in transdisciplinary research projects. Transdisciplinarity involves more comprehensive collaboration between academic disciplines and agents outside academia (Ismail-Zadeh et al. 2017). Subjects focusing on environmental change have, in recent years, pushed for further interdisciplinary collaboration outside traditional academia. Calls for GCR to speak for society's need to change also call for engagement with non-academic actors to co-create knowledge. The academy and wider civil society need to co-design, co-produce and disseminate research that builds upon public expertise and local concerns (Mauser et al. 2013; Yearly 2013).

Environmental humanities are an emerging perspective in global environmental change research programmes (Hartman et al. 2016, 2017). The

role of the environmental humanities has been established by prominent voices in geography, such as Mike Hulme (2011) and Noel Castree (2015). Integrating culture into our understanding of global change is essential to engage civil society with the impact climate change will have on all of society (Adger et al. 2013b; Hulme 2009, 2011). It is also important to recognize different interpretations of climate and different discourses co-producing climate through history (Hulme 2008, 2016). In archaeology, research groups within the environmental humanities, such as Aarhus Centre for Environmental Humanities (CEH; http://ceh.au.dk) or the more far-flung Nordic Network for Interdisciplinary Environmental Studies (NIES; https://www.miun.se/nies), have sought to engage different interpretations of climate in multidisciplinary collaborations. Collaborations of this kind, while still small-scale, have been largely successful at securing funding to organize collaboration at the university and local scale.

Through the well-established tools of community archaeology (such as Marshall 2002; Moshenska and Dhanjal 2011), the discipline and its practitioners have an opportunity to increase their engagement with communities that have vested interests in the local environment and the cultural history of the area. Working with local communities, archaeologists can promote the conservation of the material archaeological record and co-produce knowledge of the past. This can include environmental knowledge preserved in cultural traditions, folklore, symbolic practices and stories and myths (Berkes 2008; Riede 2012). IHOPE's HERCULES project, for instance, is a Europe-wide project working with public and private actors to protect and manage landscapes possessing "significant cultural, socio-economic, historical, natural and archaeological value" (http://ihopenet.org/hercules/). The protection of valued landscapes, as Barthel et al. (2013a: 1142) have discussed, can conserve practical knowledge and "management practices that have co-evolved in relation to local environmental fluctuations … practices that are carried forward by both biophysical and social features in bio-cultural refugia including; genotypes, artefacts, written accounts, as well as embodied rituals, art, oral traditions and self-organized systems of rules".

Encouraging developments are underway. Projects to conserve cultural heritage include the Remains of Greenland project, which explores the

current impact of permafrost thaw on Inuit and Norse material cultures (Hollesen et al. 2015, 2016), and the ongoing UNESCO bid to conserve the subarctic farming landscape in southwest Greenland. Transdisciplinary projects that aim to conserve rapidly eroding sites of considerable local and national interest include the Scottish SCAPE (see Graham-Allsop et al., this issue) and English CITiZAN projects. These projects both use smartphone apps to encourage the public to record coastal sites threatened by significant coastal erosion. Engaging the public in citizen science increases the possible scope of heritage site recording along the English and Scottish coastline, but it also allows the public to assess the severity of risk to sites and monitor the progress of erosion along the shoreline. Giving the public a voice in archaeological research can, as these examples illustrate, broaden the scope of research by increasing our ability to collect, preserve and disseminate cultural and practical knowledge for our future. Similarly, the recently launched EU-funded project Coast to Coast Climate Challenge, aimed at better articulating and improving regional and municipal adaptation plans to climate-driven hydrological changes, includes a sub-project that synthesizes natural and cultural history in the study area of central western Denmark (http://www.c2ccc.eu/). Importantly, funding for this and similar initiatives no longer comes from instruments earmarked for the humanities, but instead from those that address environmental concerns in a wider sense. These have traditionally been leveraged almost exclusively by natural sciences and engineering approaches, but projects that adopt this form of applied environmental community archaeology increasingly have an impact in this arena. In the longer term, these projects are likely to contribute not just important knowledge and action at the local level, but changes in the image of what archaeology can contribute vis-à-vis the environmental crisis.

Conclusion

In this paper, we have outlined key elements of a new social contract for archaeology to engage with climate change adaptation. We have set out three ways the discipline can contribute to contemporary social concerns about climate change. Firstly, given the limited visibility of archaeological data and resources to GCR, we encourage academics and practitioners to engage with GCR through publication in journals with a focus on

climate change adaptation. Down the line, this would likely increase the visibility of archaeological case studies in mainstream adaptation literature, such as the literature cited in the IPCC reports, and hence pave the way for greater public and policy impacts. Secondly, to stimulate debate, we recommend engaging the public through museum exhibitions focused on the long-term impacts of climate change on past societies. Emphasizing the role of the environment as a critical historical actor and showing how communities and societies have coped (or failed to cope) with past environmental change may lead to a higher literacy with regards to such issues. Thirdly, we encourage designing transdisciplinary research projects between archaeology, natural sciences and environmental humanities to engage with civil actors. Such initiatives can cover a wide range of subjects, from local environmental change to preserving and disseminating local bio- and eco-cultural knowledge that may inform sustainable farming and food production (see Barthel et al. 2013a). We suggest that archaeology offers great potential to collaborate with GCR, engage with the public and work to preserve cultural heritage. Depicting the longevity of climate impacts on human societies offers a powerful narrative, one that illustrates the utility of the past as a 'completed experiment' with lessons and cautions for future generations facing climate change.

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