discussion article

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From climate and society to weather and landscape

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Abstract

This article asks whether there is a role for weather in archaeological narratives. In archaeology, ideas of weather have been expressed almost solely through the aggregated measure of climate. A number of theoretical and practical problems arise from this, specifically in questioning how climatic change can be related to social change. The article reviews how other disciplines have developed a sense of climate that is more embedded in the human experience of landscape. A case study of a township in Cumbria uses the inhabited perspectives of two 18th-century diarists to explore how we might develop and apply these ideas in an archaeological context. The conclusion outlines some of the challenges for future research, arguing that we should consider weather as a material condition of the landscape – something as much open to archaeological investigation as any other aspect of the past.

Keywords

Human–environment relations; landscape archaeology; palaeo-ecology; 18th-century Cumbria; inhabited perspectives; historical diaries

Introduction

At the beginning of his essay on approaches to perception in landscape archaeology, Robert Johnston (1998, 54) contrasts two versions of the same scene: a small group of prehistoric roundhouses located high on a mountainside in north-east England. On one hand, the houses can be perceived in a 'hostile landscape'; on the other, they are nestled in 'a comfortable and agreeable landscape'. The difference in interpretation is simple: the first scene is observed on a cold, foggy winter's morning, and the second in the warmth of a clear summer afternoon (ibid., 54). Christopher Tilley notes a similar effect when responding to Tim Ingold's (2005, 128) comments on *The materiality of stone*, stating that 'weather alters the landscape so people perceive these landscapes differently'. These brief observations represent two of the few examples where archaeological discourse has engaged the role of weather. It is, however, a weather that is merely the backdrop to human action – something that acts on the land, that contextualizes experience and

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archaeological observations, but does not require investigation. Even when Tilley (2008, 272; Ingold 2005, 128) suggests that an archaeology of weather might be developed, the weather is conceived as a separate sphere of research, isolated from the rest of the landscape.

In contrast to weather, climate has received growing attention within archaeology over the last two decades. A review of the index of the recently published *Handbook of landscape archaeology* reveals 20 references for 'climate', with many more for associated topics such as climate reconstruction, climate change and climatic impacts on human populations (David and Thomas 2010). Looking up 'weather', one is greeted by numerous references to weathering, but none for weather itself. The archaeologists' appreciation of the *longue durée* and the perceived limitations of archaeological data sets have driven an interpretive emphasis on long-term, broad-scale impacts (Bailey 2008). This agenda has been supported by the discovery of a wide array of proxies for palaeoclimate reconstruction that are, for the most part, poorly suited to high-resolution studies of weather (Bell and Walker 2005). Consequently, climate, defined by Lamb (1972, 5) as 'the sum total of the weather experienced at a place in the course of a year and over the years', is how weather is currently expressed within archaeology. There are problems, however, with relating changes in culture and society to understandings of past climates. This article uses a case study from 18th-century Cumbria to explore whether it might be more helpful to focus instead on weather and how it is integrated into people's daily lives and senses of place.

Climates of the past

By privileging climate over weather, it is thought that archaeologists are equipped with the perspective necessary to discuss cogently the impact of long-term environmental change on human societies (Mitchell 2008; Rowland 2010b). This perception has been fuelled by a research agenda that has, in response to contemporary concerns of global environmental change, increasingly placed climate at the centre of archaeological interpretations. However, problems of scale and of chronological resolution mean that correlating climate changes observed in proxies with environmental or cultural impacts observed in the archaeological record remains a complicated process (Bell and Walker 2005, 52; Baillie 1991). This problem is especially pertinent when archaeologists look to undisturbed environmental records from off-site locations in order to contextualize on-site stratigraphies. Consequently, archaeologists have looked to the environmental sciences of palaeoclimatology, palaeo-ecology and environmental archaeology to seek more refined correlations between proxy data sets and the material record (Peiser, Palmer and Bailey 1998; Sherratt 1997; Ryan and Pitman 2000; Bogaard and Whitehouse 2010; Rowland 2010a).

Perhaps as a result of the emphasis on scientific reconstruction of past environments, many archaeologists' attempts to explain correlations between climatic and social narratives have taken the form of simple causal mechanisms. Changes in climate have often been thought to constrain or enable economic activity during periods of widespread social upheaval (Weiss *et al.* 1993; Peiser, Palmer and Bailey 1998; Sherratt 1997; Ryan and

Pitman 2000; see Coombes and Barber 2005). In such examples, 'appeal to human intentionality and rational choice ... reveals only *proximate* causes of behaviour, while the *ultimate* cause lies in ... selective forces' (Ingold 2000, 33, original emphasis). This simplistic method of reconciling social and environmental narratives is at odds with the work of a growing number of scholars. Richard Tipping (2002, 10), for example, has been vocal in resisting what he describes as 'the recent trend to explain socio-economic change throughout the world by new forms of environmental catastrophism'. Yet despite this recent critique, many of the problems encountered when exploring the climate–society relationship were identified more than 30 years ago.

There is a great body of scholarship, reaching back to the original critiques of environmental determinism, that debates whether human history has been influenced by changes in the climate and how best to explore those changes. Influential scholars such as Le Roy Ladurie (1972), Braudel (1972) and Lamb (1972; 1966; 1977) have all discussed the issues to varying degrees, and there was an explosion of interest in the subject during the late 1970s and early 1980s. At that time, Robert McGhee (1981, 163) warned against correlative approaches, arguing that it was a 'facile' assumption that simply because two events occurred at approximately the same time they should be related. These researchers also understood the limitations of catastrophism, calling for research that moved away from bridging climatic and social chronologies using ever more complicated models of causation and ever more refined concepts of 'harm'. They wanted to focus instead on the range of possibilities of human response, and how these vary in relation to the human experience of climate (De Vries 1980; Rabb 1980). This initiated a trajectory of research that sought to better integrate social and climatic narratives. Meanwhile, in archaeology, scholars like Karl Butzer (1972; 1982) were working to present a more ecological understanding of how people related to the natural environment.

In the 1990s, a combination of these academic traditions inspired the growing historical ecology movement to look more closely at the human experience of climate. Its proponents were directly influenced by political concerns over humanity's role in radically altering the natural environment. They aimed, therefore, to create a more balanced understanding of how social relations developed, responded to and affected environmental change (Crumley 1994). As a result, historical ecology has developed to offer a quasi-ecological approach to human history that incorporates 'globally relevant archaeology, ethnohistory, ethnography, and related disciplines' (ibid., 7) under a rubric which emphasizes diversity, heterarchy and complex spatial analysis. Although ecological issues of adaptation, resilience and ecosystem thresholds come to the fore, a people-centred perspective is maintained: ecological concepts are only used with the caveat that neo-Malthusian approaches, and the expansionist critiques that followed, can explore only socially unmediated relations between humans and nature (Patterson 1994, 226–27). In a search for a scale of study that enables the integration of social and ecological concepts, the historical ecologists define *landscapes* as 'the material manifestation of the relation between humans and the environment' (Crumley 1994, 6).

This development of ecological perspectives on human–environment relationships has been highly influential within archaeology (Redman and Kinzig 2003; Nelson *et al.* 2006; Kirch 2007; McGovern *et al.* 2007). In contrast to previous dependencies on rational economics and simplistic mechanisms of causation, scholars now recognize that human perception guides people's actions in relation to environmental change. 'Widely used terms such as "stability," "change," "variability," "normal," or "degradation" only have meaning within defined scales of analysis' (McIntosh, Tainter and McIntosh 2000, 12) – scales that are relevant to human experience. The vigorous critique of the systems modelling that took place in archaeology during the 1960s and 1970s has been addressed by a new generation of model-builders (Hodder 1991). They employ complex modelling techniques that include a recognition of non-linear dynamics, self-organization, criticality and resilience (Van der Leeuw and McGlade 1997; Gunn and Folan 2000; Redman and Kinzig 2003; Kirch 2007; Wilkinson *et al.* 2007). Some are explicitly 'agent-based', focusing on the choices that past people would have faced (Wilkinson *et al.* 2007). The result is a more theoretically informed method, in which sophisticated models better accommodate the dynamism of human agency. Elsewhere, palaeo-ecologists have begun to tackle some of the problems of disparate data sets and poorly defined chronologies that have tended to preclude more sophisticated interpretations (Davies and Watson 2007; Schulting 2010). The objective is a level of spatial and temporal analysis in which the changes experienced, recognized and responded to by past communities are apprehended (McIntosh, Tainter and McIntosh 2000).

Climates of the present

Methodological improvements have occurred in combination with theoretical advances. The concept of social memory, for example, is derived in part from anthropological studies of the Mande of West Africa (McIntosh 2000). It describes how communities can store information about past climates and successful responses to change within their own world view and social perceptions of the landscape. When tackling immediate problems, this information can be actively accessed and sorted in the search for appropriate responses (McIntosh, Tainter and McIntosh 2000, 25). In application, this is an attempt to address the problem of intentional action, juxtaposed against the limits of human perception and experience. It is a model that explicitly demonstrates how a society's attitudes and reactions to changing climates are culturally conditioned through experience and the transmitted experiences of ancestors. In this respect, the concept of climate has evolved from being something that defines, yet is isolated from, human action, to something that is integral to social formation.

This integration between people and climate has been explored further in anthropology (Strauss and Orlove 2003b; Hsu and Low 2007; Crate and Nuttall 2009), where topics range from farmers' perceptions of climate variability (West and Vásquez-León 2003) and the ways in which social relations engender differing degrees of resilience in the face of climate change (Green 2008), to exploring our cognitive understanding and sensual perception of weather (Ingold 2007; 2011). Like many other disciplines, anthropology has

found itself influenced by the growing public concern with environmental issues and, specifically, global environmental change. Consequently, there is a strong desire to produce research that is of direct relevance in characterizing and responding to global problems (Crate and Nuttall 2009). So whilst anthropologists have recognized the importance of the idea of weather, an interpretative emphasis on the long-term aggregations of climate has been maintained (Strauss and Orlove 2003a). It is clear, however, that in this respect anthropologists feel constrained by the narrow temporal focus of their studies (Peterson and Broad 2008, 78). As Roncoli, Crane and Orlove (2008, 104) state, 'the multiscale and long-range nature of climate change is leading anthropologists to field settings that do not always lend themselves to approaches familiar to anthropologists, particularly those that hinge on personal interactions and sustained observations of everyday life'.

A role for weather

This has created a curious situation in which historical studies are looking to anthropological studies to explore the social and cultural dimension of climate change, while anthropology is looking the other way, desiring a longer-term view on human action. Meanwhile, Robert van de Noort (2011, 1046–47) has recently argued that following the developments outlined above, 'different theoretical strands in archaeology are not in opposition when it comes to explaining the diverse connections between climate, environment, landscape and people'. Yet, when historical ecologists regard the concept of landscape as central to the study of human–environment relations, in the realm of past climate studies, landscape archaeologists continue to outsource this work to their colleagues in the environmental sciences (Bogaard and Whitehouse 2010). Modelling has been revolutionized in recent years, but even the most complex models still fail to fully account for 'the great richness, variability and specificity of cultural production' (Hodder 1991, 34). The concept of social memory locates human response to environmental changes within culturally embedded frameworks for action. However, the emphasis is on how environmental knowledge is coded and transmitted across generations. There is little discussion of how the lived experiences of people and communities cause that knowledge to be recalled and acted upon. In short, although developments in 'climate-change archaeology' have been significant over recent years, there remain a number of problems (Van de Noort 2011). Archaeologists and researchers from other disciplines still struggle to move between the social and scientific, the long and the short term, the lived experience of individuals and broader narratives of societal change. There is still a question whether we, as archaeologists, can ever reconcile our diverse data sets and imprecise chronologies with detailed studies of how humans encountered the climate changes of the past.

I would argue that, to start tackling these issues, we need think less about climate and more about weather. After all, if, as historical ecologists suggest, the landscape is the 'material manifestation' (Crumley 1994, 6) of human–environment relationships, we should think about how this manifestation takes shape. That is not in the aggregated abstractions of climate and climate change, but in the immediate experiences of weather. Tim Ingold (2005; 2007; 2011) has, for example, often been keen to emphasize the importance

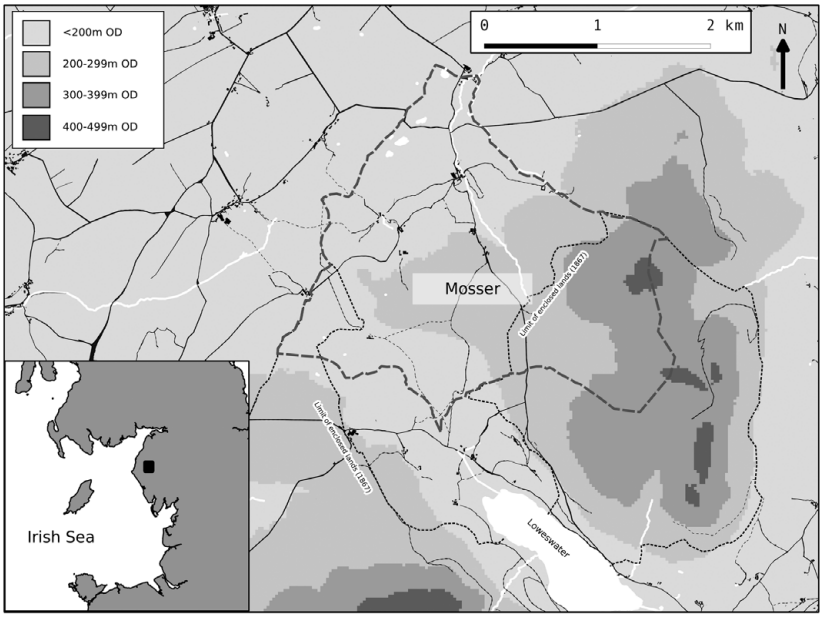

Figure 1 The location of Mosser and its surrounds. Original data: © Crown Copyright/database right 2011. An Ordnance Survey/EDINA supplied service.

of weather, arguing that landscapes should be seen as 'weather-worlds'. Rather than being impervious to its action, the land responds in countless ways to the weather's myriad expressions as the medium in which we live. Conversely, the land, with its juxtaposition with the sea and its extension into the sky, helps define those myriad expressions into prevailing weather conditions. 'The more one reads into the land', writes Ingold (2007, S33), 'the more difficult it becomes to ascertain with certainty where the substance ends and the medium begins'. When viewed like this, it serves no purpose to distinguish between land and the weather: the two are enmeshed in constant flux. Jan Golinski (2003, 18) has argued that the British sense of weather, 'its peculiarities and regularities, and its providential role in the life of the nation', was central to national identity during the Enlightenment. Golinski is not alone in pointing out this cultural connection between weather and location (Ingold and Kurttila 2000; Rantala, Valtonen and Markuksela 2011). It seems the weather *in* which one stands can be as much responsible for generating a sense and use of place as the ground *on* which one stands. It is a conception of nature that does not separate out people, weather and land into discrete spheres; they are all bound up in a singular sense of the natural environment, that of the landscape.

'Weather continues very favourable'

My research in a small township called Mosser on the north-western edge of the Lake District has sought to build on the idea that the experience of climate is embedded in cultural practice by establishing ways of thinking about the weather as an aspect of landscape in archaeology (figures 1 and 2). The

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Figure 2 The landscape of Mosser. Looking east towards Sosgill from Bramley Seat.

project involved comparing and integrating three distinct narratives of change, derived from a number of different methods and scales of analysis, within a single landscape study. The results of more traditional environmental studies and archaeological landscape survey were compared and integrated with the first-hand experience of weather, as recorded in two 18th-century diaries. As well as containing detailed, predominantly non-instrumental, descriptions of weather, the diaries provide useful commentary as to its effects on farming routines and the general populace. The first, the diary of Isaac Fletcher, studiously transcribed and compiled by Angus Winchester (1994), is from within the Mosser area and runs from 1756 to 1781. There is an almost daily record of the weather, and places and events can be linked to the features, boundaries and historical processes observed as part of a traditional field- and desk-based landscape survey. The second, Elihu Robinson's, consisting of unpublished documents held in the Library of the Religious Society of Friends (RSS Box R3), runs from 1779 to 1806. It contains a weekly or monthly summary of weather, and though from just outside the Mosser township, extends the weather record into the turbulent years of the late 18th century – a time of war, soaring food prices and widespread change across the landscape.

Comparing weathers A first step was to see whether the weather recorded in the diaries correlated with well-known instrumental records, such as the Central England Temperatures (CET) series (Parker, Legg and Folland 1992) and the England and Wales Precipitation (EWP) series (Alexander and Jones 2000). Although these series do not focus on Mosser or Cumbria, they are recognized as two of the world's most accurate and longest-running weather

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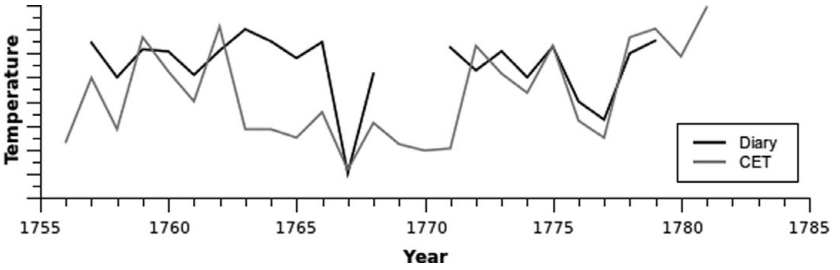

Figure 3 A quantitative reconstruction of summer (June–July–August) temperature trends from Isaac Fletcher's diary (Winchester 1994) compared with seasonal averages compiled from the CET (Parker, Legg and Folland 1992). There is good correlation between data sets, particularly from 1773 onwards.

records. Both have been found to be useful in describing and comparing trends across areas well beyond their original bounds (Jones and Hulme 1997; Croxton *et al.* 2006). Using methods more commonly applied in historical climatology (cf. Pfister *et al.* 1999; Brázdil *et al.* 2005), I was able to place the diarists' qualitative, descriptive statements about weather on quantitative ordinal scales, which in some instances closely tracked trends in the instrumental series (figure 3). On the whole, though, I found only a few statistical correlations between data sets. The possible reasons for this are too numerous to mention in detail here, but range from differing weather patterns in Cumbria compared to the rest of the country, or weaknesses in the method for translating qualitative to quantitative data, to problems in the constitution of the scientific series themselves. In contrast to many archaeological studies, I was able to access a highly detailed and well-respected instrumental series, but even at this level of resolution the results show that we cannot assume a direct correspondence between the scientific measure of weather and the experience on the ground. There is a relationship but it is a qualified one. It raises a question: how can archaeologists draw upon proxy records, with all their flaws, to produce accurate portrayals of past climates, if we can only tenuously do so using high-resolution data from the recent past?

Landscape change Mirroring the kinds of problem encountered in late 1970s and early 1980s, it was also a struggle to ascertain whether social and economic processes could be linked to the changing weather (De Vries 1980). There were a number of changes to the Cumbrian farming regime occurring in the late 18th century that were worth investigating in this respect (Bailey and Culley 1794; Dilley 1991). In particular, one of the most discussed issues is the enclosure of common lands and the decline of common rights. Much has been written about the widespread parliamentary enclosures post-1801 (Elliott 1959; Whyte 2003). However, Robert Dilley (1991) argues that, prior to this, enclosure by private agreement may well have played a significant role in the consolidation and extension of farm holdings. On the ground, a walkover survey of the parish undertaken as part of the project revealed a significant number of former boundaries, but Isaac Fletcher's diary can provide details of the enclosure process in action. Angus Winchester (1994, xix) notes how Fletcher's 'evident skill as a land surveyor' led him to direct the enclosure of

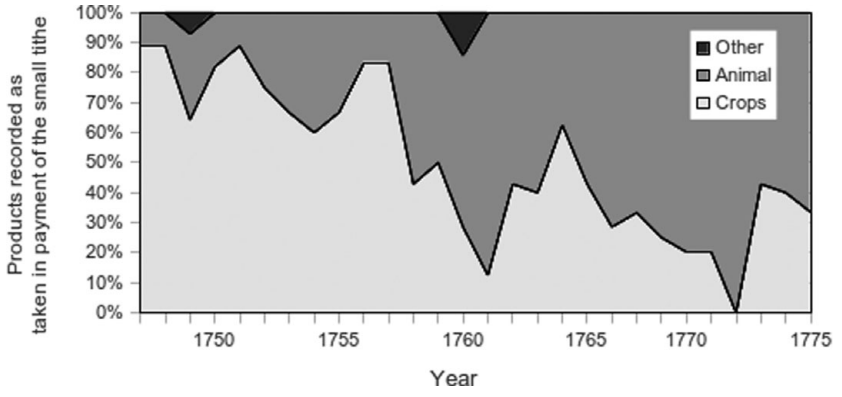

Figure 4 The change over time in types of product taken from Quaker households in Mosser as payment for the small tithe (Wh DFCF/1/116). Animal products appear to become increasingly important from 1747 to 1775.

a number of fields, including nearby Toddell Pasture in 1775. Within Mosser itself, Fletcher records an unsuccessful attempt by the inhabitants to buy the Mosser Commons from the Earl of Egremont in 1758/59. Nevertheless, Mosser Moss was successfully divided and enclosed in 1772–73, and Fletcher also notes agreements regarding the division of Mossergate Outfield and Pasture from 1757–59.

There are numerous potential causes that could have driven this process of consolidation and extension. Perhaps the most convincing explanation lies partly in the rapid urbanization of north-west Cumberland. During the late 18th century, Whitehaven had grown to become the second-biggest port in the country, and other urban centres were growing at Workington, Maryport, Carlisle, Cockermouth and Keswick (Hughes 1965; Bouch and Jones 1961). This, combined with an improving transport and communication network, linked the Lake District with increasing urban demand for meat and dairy products (Dilley 1991, 128). An analysis of small tithe records in Mosser as part of my research seems to indicate a growing role for animal products from *c.*1747–75 (figure 4, Wh DFCF/1/116), and this would have been supported by a doubling of the price of beef and mutton in Carlisle during the last 30 years of the 18th century (Searle 1983, 126). Similarly, G. Elliott (1973, 72) argues that

> a rise in the price of corn during the second half of the 18th century, growing specialisation in agriculture, increased returns from improved land, the accumulation of capital and the willingness to invest it in land, and the expansion of industry all contributed to the increase in enclosing activity.

Food prices and the overall profitability of farming were, of course, affected by a wide range of factors beyond increasing urban demand (Jones 1964). These include damages to trade during the wars in America and Europe, as well as variations in seasonal supply. Taken as a whole, there is a range of complex socio-economic processes that might have brought about farming regime and landscape change. As farmers sought to satisfy urban demand and maximize

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profits, common rights were eschewed in favour of greater control over landholdings. As in many archaeological narratives, this is a characterization of the past where weather and climate are either forgotten or ignored.

A climate-informed interpretation Despite this emphasis on socio-economic factors in the documentary histories, it is also possible to apply a climate-informed interpretation to this process. In the traditional parlance of climate–society relationships, we might expect changing weather conditions to impact farms and farming practices (Parry 1978) most significantly. According to the CET, the period from 1750 to 1774 is characterized by relatively stable annual temperatures, with a run of particularly warm years around 1760 (Parker, Legg and Folland 1992). The period from 1775 to 1799 is more variable, with a period of warmth around 1780 quickly descending into a run of cold years. The flurry of land enclosures in the late 1750s correlates well with the period of warm, stable weather and good harvests. It could be that the steady harvests of the 1750s allowed farmers to focus on improving their farms. As well as dividing land held in common, a process of improvement can also be seen on Isaac Fletcher's farms with the construction of a new byre and stable. Conversely, Mosser Moss, an area of low-lying boggy ground, was divided, drained and converted to pasture after a run of poor, rain-affected harvests in the 1770s, at the start of the period of more variable weather. It is possible that this is an example of how upland communities could be resilient in the face of climate change (Tipping 2002). It would have enabled Isaac Fletcher to maintain both his livestock herds and cereal harvests in the face of climatic adversity by turning his better-drained pasture into arable land. This is hinted at in the diary, as two fields are cultivated for the first time soon after the division of the Moss.

At the very least, we are thus able to explain widespread landscape change in late 18th-century Cumberland in two ways: either as a result of climatic influence or as purely a socio-economic process. Even if we are to assume that both explanations played a role, we have no means of deducing the relative influence of each. What is clear, however, is that there is no simple deterministic relationship. A wide range of factors, from trade relations to farm diversification, could have affected how people respond to the effects of bad weather (Tipping 2002, 21; Dugmore, Keller and McGovern 2007).

Isaac Fletcher's diary allows us to examine the period in unparalleled detail, yet this brings us no closer to a climatic-cause-and-social-effect model – an approach often derided, and yet so often used in past archaeological studies (Coombes and Barber 2005; Tipping 2002). This is not surprising: other studies are revealing increasingly diverse and complex relationships between climate, society and economy, operating across a variety of spatial and temporal scales (Dugmore, Keller and McGovern 2007). Yet many would argue that the scale of analysis in this study is too detailed, that the true climate 'signal' is obscured by the 'noise' of day-to-day weather. Nevertheless, that begs the question, how much do we have to smudge things before noise morphs into signal? Abstractions of the climate–society relationship have tended to yield unsatisfying results, in which the individual is either blurred out of focus or, worse, forgotten altogether (Sherratt 1997; Peiser, Palmer

and Bailey 1998; Ryan and Pitman 2000; Rowland 2010a). Perhaps we need to take a more positive view. Despite the potential flaws in the analysis, it is clear that at certain times, and for certain conditions, the weather experienced by these people *does* bear some relation to our own instrumental records. These records, and others like them, have often been used to calibrate other palaeoclimatic proxies – ones that allow us to delve back into the deeper past (Jones, Osborn and Briffa 2001; Brázdil *et al.* 2005; Baker, Proctor and Barnes 2002; Charman 2007). As such, weather, as experienced by individuals, can, to a certain extent, be related to long-term climatic changes observed in proxy records. More to the point, I think there are advantages to thinking about the weather and how it was experienced by individuals.

Attitudes to weather Whilst Isaac Fletcher's diary is written as a rather dry record of events, Elihu Robinson intersperses his own record with more personal, reflective commentaries. Using these, we can begin to access how people at the time perceived the weather and its relation to world events. Some of the comments are useful on a practical level. For example, Robinson laments that 'many of our expectations "in disappointment end"' when an otherwise good hay harvest was ruined by heavy showers – implying that only a short spell of bad weather at the wrong time can have a serious impact on the year's yield. Moreover, a number of comments reflect on poor conditions for sheep and lambs, stressing the importance of livestock and a vulnerability to poor weather that extends beyond crop harvests. The entries also provide insights on the range of other effects the weather was deemed to have: 'such sudden changes [in the weather] seem very unfavourable to health! Hath been a sickly time (I suppose) through ye Nation, but not very mortal'. In times of distress, Robinson can attribute bad events to divine retribution for national indiscretions – 'Do we not merit punishment as well as the surrounding Nations?' – and mirroring comments to be found in contemporary newspapers, like the *Cumberland Pacquet*, Robinson displays a penchant for exaggeration when describing the seasons. All too often a year, season or harvest might be described as the best, worst, 'back most' (latest), or 'most forward' (earliest) in memory. The likelihood of this being true is diminished by the number of times it is claimed, but they are comments that do well in reflecting the hopes, fears and perceptions of people when the weather was becoming noticeably more erratic towards the end of the 18th century.

The overall impression one gets from these two diaries is not of some overarching climatic force, subtly or unsubtly controlling historical processes. Mirroring the historical ecologists' concept of heterarchy, there is a meshwork of interrelated and unranked processes (Crumley 1994, 12). The climate and how it is experienced, as weather, is just one part of this whole. We can no more ignore its influence than we can proclaim its dominance. The very diaries themselves, as diligent records of weather written side-by-side with summaries of farming activity, are testament to how embedded a sense of weather was in daily lives. Both Isaac Fletcher and Elihu Robinson make use of new technology in order to try to understand the weather better. On one occasion, Robinson remarks that he was 'particularly cheated out of getting

2 or more cart loads of oats by dependence on ye barometer'. For the diarists, this was a time in which Enlightenment ideals of scientific knowledge collided with folklore and superstitions of divine intervention (Golinski 2003). For us, the way this confluence of ideas played out in the recording of daily lives helps us think about what changing weather actually meant to people in the past, and how that relates to the scientific reconstructions of climate and climate change. From this, we can see that the role of weather cannot just be reduced to single events or long-term climatic trends. It was felt, experienced and responded to on a day-to-day basis. Nothing is straightforward, cause and effect are almost entirely intractable, and yet there is nothing to dismiss the notion that weather, like the land itself, held an intimate significance for people's sense and use of place.

Constructing weather-worlds

So how do we begin to think about weather in archaeologies of the more distant past? How do we begin to create weather-worlds from landscapes (Ingold 2011)? What are the challenges? One of the biggest problems, of course, is in the reconstruction of past climates. Palaeoclimatologists are good at describing past climates in terms of deviations from the recent mean, or otherwise in the most general terms. But as far back as 1967, Robert Raikes (1967, 10) asked, 'what do people mean when they write of wetter, drier, warmer, more genial, and all the rest of the comparative adjectives that are used so profusely?' Surely if we are to work at human scales, and with advancements in proxy studies and climatic modelling, we should strive towards a more comprehensive overview of what past weather was like, and how it might have changed over time. These are not easy questions, and we will find no concrete answers – but that is nothing new in archaeology. To achieve this goal, archaeologists will have to work much more closely with environmental scientists, and therein lies a potential barrier in itself (McIntosh, Tainter and McIntosh 2000, 7–9), but one that is already being tackled by people like Richard Tipping (2002), Arlene Rosen (2007), Schibler and Jacomet (2010), Althea Davies and Fiona Watson (2007), and others.

As for relating climate to society, it is clear across the discipline that the simplistic notion of climatic cause and social effect no longer holds water (Van de Noort 2011). Whilst this has been an oft-recanted observation, it has commonly been assumed that it is the historical nature of climate–society studies that has limited our inferences (cf. Bailey 2008, 14; Schulting 2010). However, this and other studies have shown that it does not matter how 'complete' your data set is; reducing social processes to environmental prime movers is always fraught with difficulty. Indeed, as was demonstrated when I tried to look at how weather affected the day-to-day running of society, the problem was not lack of detail, but too much detail.

Landscape archaeologists need to completely rethink how to approach the idea of climate. It is counterproductive to separate landscape from climatic and social processes: they are all bound up together. This builds upon the historical ecologists' concept of heterarchy (Crumley 1994). Different arbitrarily defined spheres of non-linear processes have influences over one another (McGlade and Van der Leeuw 1997). However, the categorization of

such spheres causes us to labour heavily on problems of cause and effect that are all but intractable. We should abandon the notion that scales of analysis create insurmountable barriers. Climate is integral to landscape, and weather is how that integration is expressed and experienced on a daily basis. The recent reinvigoration of interest in the idea of time perspectivism emphasizes the temporal nature of the archaeological record: 'increasing the distance between the observer and what is observed not only creates distortions that require correction but also places particulars in a wider perspective that can introduce new understandings and perception of new relationships' (Bailey 2008, 15). So although we can accept the difficulties of moving between scales in a methodological sense, that should not necessitate a theoretical division that separates out history into a focus on arbitrarily defined and independently constituted scales of action. Deep structuring processes, such as climate change, are only made relevant in the lived temporality of human lives. Isaac Fletcher and Elihu Robinson were not concerned with overarching trends, but with how their activities were affected from one day, and one season, to the next. This, however, does not mean that the people of the past were divorced from or unaffected by processes that were operating on levels beyond their direct understanding.

The concept of social memory is seen as a way of moving between actions occurring at a societal level and supra-generational processes of change; but by giving primacy to the role of societies, the individual is forced into the background. In the deeper past, without the detail of first-hand observation or historical documents, this scale of working is understandable. Yet even at this level, appeals to social memory have been vague and unsatisfying (Evans 2003; Tipping 2002). Although some have argued against striving too hard to see what is not directly observable, and that we should be content with examining the broader scales of sociocultural evolution (Dean 2000), this study shows such thinking to be flawed. Fletcher and Robinson's daily weather tribulations both form and are formed by long-term narratives of change. Our attempts to reconstruct the material conditions of past action should be focused on the context of individual experience (Harding 2005). Through this perspective we can begin to generate interpretations based upon ethnographic and phenomenological analogy that do not run the risk of one-size-fits-all caricature (Thomas 2004, 239–42).

Conclusion

The problems associated with examining the relationships between societies and the climates in which they live have long been understood. Indeed, they have changed very little since they were first outlined in the late 1970s and early 1980s. A number of recent developments have helped archaeologists move away from broad-scale deterministic narratives or sociocultural explanations that ignore the role of climate altogether. My study of Mosser reflects this, showing how a traditional climatic-cause-and-social-effect model would be problematic in almost any context. Yet the diaries show that an understanding of the weather is bound deeply into people's lives, their cosmologies and their senses and uses of the landscape. Despite advances in both theory and practice, archaeological approaches often still fail

to recognize that it is through weather that changes in climate are expressed, and that weather is intimately bound up in the landscape of a place. I have attempted to stake out some of the key problems and potential solutions in transforming our conceptual emphasis on climate and society to one based on landscape and the lived experience of weather. Landscape archaeologists have long outsourced the study of climate to their colleagues working in environmental science. Of course, environmental science is critical to the reconstruction of past climates and landscapes, but landscape archaeologists can bring to bear complementary social, experiential and inhabited perspectives. Through these, we can begin to think less about climate as a prime mover, and more about weather as a material condition of the landscape – one that is embedded in social and cultural formation, and thus as much open to archaeological investigation as any other aspect of the past.

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Climate change, extreme weather events and issues of human perception

*Martin Bell**

The central proposition of Toby Pillatt is that in developing an understanding of past human affairs weather is as important as, or more so than, climate. Climate may be simply defined as average weather, whilst weather is the day-to-day occurrence of atmospheric phenomena which impact in perceptible ways on people's lives. The general proposition is sound enough; the challenges come in implementing these ideas in ways which advance our understanding of past people–environment relationships.

The paper is based on historical sources: two 18th-century diaries recording weather in the Lake District compared with the Central England

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Temperatures series compiled from instrumental records since 1772 (Parker, Legg and Folland 1992). It is shown that perception on the ground may differ from instrumental records or secular trends (i.e. major period of distinctive climate). Furthermore, agricultural changes concerned with land use may relate more to economic and social factors than to weather or secular climatic episodes. Pillat makes a fair point in arguing that archaeologists have given great emphasis to climate change, without much consideration of weather. Also in need of consideration is the timescale of climate change, whether it would have been perceptible to human communities or, if it was not perceived, by what precise mechanisms it engendered less conscious social or economic change. However, the argument as presented is founded largely on historical sources and it does not resolve how we can investigate weather phenomena in those periods for which no historical sources are available and where we are often reliant on proxy evidence (i.e. indirect palaeoclimatic records).

In order to factor weather into our thinking we need to consider the basic distinction between climate and weather and the evidence which is available to us as archaeologists. Of particular significance is the timescale of the weather and climate phenomena in question and thus the extent to which changes would have been perceptible. This includes consideration of extreme events which may, or may not, be part of secular climatic trends. Such questions are a familiar part of current debate between those who identify global warming as a major environmental and political issue and the small minority of scientists who are global-warming sceptics. It is debated whether particular episodes of more extreme weather – e.g. warmer summers, colder winters, or more stormy conditions – are parts of longer-term secular trends or further evidence of the natural variability of climate. The sequence of international meetings, beginning with Rio and Kyoto, and most recently in Durban, highlight the significance of developing an increasingly refined understanding of the timescales of climate phenomena and extreme events and also how they affect human communities in various economic stages and geographical situations. As Mitchell (2008) and Van de Noort (2011) have emphasized, archaeology can, and should, be playing a far more active role in the ongoing debates about climate change and the coping strategies of past and future societies.

Of particular interest are periods of especially marked climate change, or extreme weather conditions, which are increasingly recognized, closely dated and likely to have impacted on human communities. Outstanding among these are the very rapid climate changes at the end of the last glaciation within less than a human generation (Alley 2000). Within the Holocene, millennial-scale cyclical cooling episodes are marked by ice-rafted debris in deep ocean cores, the so-called Bond events (Bond *et al.* 1997). The most marked of these Holocene events at 8200 B.P. was apparently caused by catastrophic discharge of water from the Laurentide ice sheet and its effect on North Atlantic oceanographic circulation.

The increasing availability of well-dated, sometimes annual palaeo-environmental records from ice cores, tree rings and laminated sediments creates opportunities for correlating cultural changes with both secular climatic trends and weather phenomena represented by extreme events. Ice cores with high, at times annual, resolution for much of the Holocene preserve

isotopic records as well as trace gasses, atmospheric dust records, geochemical sequences and carbon-particle records of palaeofire occurrence, all of which contribute as proxy sources to palaeoclimate studies (Bell and Walker 2005). Tree ring sequences also provide palaeoclimatic records, including evidence for extreme weather events in particular areas (Baillie 1995). Annually laminated sediments can provide long datable annual-scale palaeoclimate records in areas such as Scandinavia where lakes are frozen for part of the year. Shorter, and not precisely datable, coastal laminated sequences have also been shown to exhibit annual banding and to have potential for the investigation of climate/weather variability (Dark and Allen 2005). It must be acknowledged that, however precisely dated a particular environmental change is, it often still poses significant challenges of correlation with cultural changes. Baillie (1991) highlighted the problem which he labelled 'suck in and smear', whereby precisely dated palaeo-environmental events are correlated with cultural changes which are sometimes not at all precisely dated. An example is a well-attested climatic deterioration *c.*800 B.C. for which there is good evidence in peat bog and other palaeo-environmental sequences over a wide geographical area (Van Geel, Buurman and Waterbolk 1996). To this deterioration has been attributed the abandonment of burnt mounds and field systems in many upland areas of the British Isles. However, the abandonments are much less precisely dated and no correlation or climatic causation can necessarily be assumed without specifically testing the hypothesis. Indeed, as Pillatt identifies, many factors apart from climate can lead to abandonment, or establishment, of upland fields.

During the 19th century and most of the 20th, environmental and biological science was founded on gradualism (processes operating at very slow rates by tiny increments), and a literal (or substantive) adherence to uniformitarianism (the present is the key to the past). In early ecology this led to the factoring out of human agency in the quest for 'natural ecology', which became increasingly problematic with the recognition that so many habitats, once considered pristine, have been affected by long histories of human activity. Today there is greater recognition of the significance of contingency (chance factors) and punctuated equilibrium (periods of rapid change and stasis), and thus awareness of the transformative potential of high-magnitude, low-frequency events (Gould 1999), which include weather phenomena. These have been significant developments for archaeology because human agency can now take its place as part of a spectrum of environmental disturbance factors, including not only weather, but also faunal agents, disease and many others (Bell and Walker 2005, chapter 6). For palaeo-environmental scientists working in Britain a particularly significant event was the great storm, or hurricane, which hit southern England on 16 October 1987, felling 15 million trees (T. Brown 1997; Lamb and Frydendahl 1991, 189). Prior to this there had been a tendency among palaeo-environmentalists working in Western Europe to attribute environmental disturbance uncritically to human agency, perhaps because there such extreme events are – by comparison with the Caribbean or southern United States, for instance – so rarely observed.

The effects of extreme weather conditions are particularly apparent to archaeologists working in a coastal and maritime context. Most shipwrecks

are the result of extreme storm events (Fenwick and Gale 1998). In some storms very large numbers of ships were lost, the series of storms which destroyed the Spanish Armada in A.D. 1588 being a particularly significant historical example for which the meteorological conditions have been reconstructed using historical sources (Lamb and Frydendahl 1991, 40). Coastal sediment sequences also reveal evidence of extreme storm events in the form of coarser sediment increments, and many of the major coastal changes will result not from average conditions, but from the high-energy conditions associated with high-magnitude, low-frequency weather-related events. Examples would be the inundation of coastal forests to create submerged forests, the breaching or formation of coastal barriers and lagoons, and so on. Similarly, in coastal dune contexts, burial of archaeological sites and landscapes will have been concentrated during storm events. Such episodes seem to have been particularly frequent during the Little Ice Age secular climatic episode, from 1550 to 1850 A.D. (Grove 2002), when many coastal settlements along the Atlantic seaboard from Brittany to Scotland were inundated by sand dunes. It is of interest that there is also evidence for episodic dune deposition punctuated by stable conditions more locally in western Britain during the Bronze Age.

Although not always so obvious, weather events are similarly significant in many fully terrestrial contexts. Many sediment increments which archaeologists encounter may not derive from average conditions over extended timescales but from particularly intensive periods of high geomorphic activity related to particular weather events. This will apply to riverine processes, including extreme overbank flooding, changes of river course and the deposition of major sediment increments. These can sometimes be recognized as the result of major flood events, as in the case of the dendrochronologically dated medieval Hemington bridges in the River Trent (A.G. Brown 1997, 2009). Likewise, in the case of colluvial slope processes, comparison of present and past erosion evidence on arable land highlights the role of infrequent high-magnitude rainfall events (Bell and Boardman 1992).

Archaeologists have had a tendency to make deterministic assumptions about particular climate or weather phenomena. As Pillatt shows, historical records can be valuable in revealing how particular events were perceived and the reaction this produced. The concentration of witch burnings in years of particularly adverse weather represents an extreme example (Behringer 1999). A major flood event which impacted in the Bristol Channel and Severn Estuary in A.D. 1606 was attributed to God's warning (anon. 1607). It is debated whether this event resulted from a major Atlantic storm or a tsunami (Haslett 2007). The Great Till Flood in a Wiltshire valley resulted from storm runoff from agricultural land in 1841, leaving three dead and 200 homeless; it prompted a local vicar to write a poem, sold to aid the distressed, which suggested the event was retribution for the 'wasted hours and squandered days' of those affected (Cross 1967). Such perceptions as late as the mid-19th century indicate the probability of past responses to events very different from those which might be anticipated from a post-Enlightenment scientific perspective.

This contribution supports Pillatt's proposition that archaeologists and palaeo-environmental scientists need to give greater consideration to weather-related phenomena. This is becoming increasingly realistic as high-resolution and well-dated paleoclimatic records from tree rings and annually laminated sediments facilitate the identification of periods of rapid climate change and unusual years, even seasons. The sediments within which archaeological contexts lie are probably, more often than we recognize, the products of high-magnitude, low-frequency events. It is acknowledged that archaeologically based palaeo-environmental investigations are seldom directed towards establishing whether a particular deposit reflects a short-term event or gradual deposition. This highlights the value of more event-specific modern analogue studies such as comparisons with biota or sediments from recent floods. There is also a tendency to make simple, generally deterministic, assumptions about the effects of particular climate and weather-related phenomena on people. The perceptual points made augment Pillatt's argument concerning the complexity and close relationship between environment and society. The current significance of debates about climate change and sustainability, and the contribution which archaeology has to make to them, require development of a more sophisticated conceptual toolkit than has generally been employed in archaeological discussions of these issues, as Van de Noort (2011) has argued. This should develop beyond the identification of simple deterministic relationships between weather, climate and social change and give greater consideration to the precise timescale of the changes we record, to the question whether they are likely to have been perceptible to human communities at the time, to the role of human agency (Mitchell 2008) and to the evaluation of the diverse spectrum of possible coping strategies (Bell and Walker 2005, 140) which past societies may have employed.

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Weathering climate change. The value of social memory and ecological knowledge

*Jago Cooper**

Weather and people

Pillatt's research provides exactly the type of critique needed to stimulate debate surrounding the role of archaeology and history in climate studies. The perceptive micro-scale deconstruction of weather, landscape and people in early modern Mosser highlights the precarious disjuncture between the human experience of weather and the processes of climate variability. However, I am certainly a lot more optimistic and positive about the role that archaeology and history have to play in this debate and will perhaps provide a more macro-scale contribution to this particular archaeological dialogue. I would argue that the time-depth of human experience will always be essential in

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offering context and understanding to individual weather events and longer-term climate variability.

The correlation of documented historical descriptions of weather in 18th-century Cumbria with instrumental records, such as the Central England Temperatures (CET) series and England and Wales Precipitation (EWP) series, provides a tantalizing glimpse of the temporally fluid interface between experience of weather and the impacts of climatic variability. This case study reflects a methodology practised by colleagues working around the world and I believe that such studies show the inherent value in long-term descriptions of weather events and comparisons with the records of meteorological conditions (Demarée and Ogilvie 2008; Lamb 1982; Russell 1998). Such work is an essential component if we, the archaeological and historical community, are to provide the illustrative examples of micro-scale perceptions of weather that are the fundamental building blocks for producing macro-scale societal understandings of the impacts of global climatic change.

Pillatt's paper challenges us to reconsider the role of archaeology and environmental history in understanding the human experience of weather and, perhaps more importantly, forces us to question the fundamentally differing timescales at which both weather and people, and climate and society, operate. I find that the highly personalized accounts from Robinson's papers and Fletcher's diary inspire consideration of the wider relationships between social memory and the resilience of different communities to climatic variability. Such a discussion inevitably leads us to the wider questions of exactly what the time-depth of human experience can offer and of how long-term perspectives can inform modern-day mitigation strategies for global climatic change. This journey, from understanding the human experience of weather variability, through the importance of social memory, and all the way up to the mitigation of modern climate change, involves a winding and precarious path but it is a journey that this paper encourages us to take.

Climate and society

As Pillatt rightly suggests, climate has become a more hotly discussed topic in archaeology in recent years (Mitchell 2008; Van de Noort 2011), but personally I think this is being done very conscientiously by many scholars and is not being directly linked to explanations for social change. There are currently numerous large-scale interdisciplinary projects being led by archaeologists and historians who are attempting to produce multispatial and multitemporal studies of human–weather–landscape and human–climate–environment relationships, such as McGovern *et al.*'s North Atlantic Biocultural Organization (McGovern *et al.* 2007), Hegmon *et al.*'s Long Term Vulnerability and Threat Project (Hegmon *et al.* 2008) and Kirch's Hawaiian Biocomplexity Project (Kirch 2007). This work has moved well beyond the 'form of simple causal mechanisms' (p. 30) that Pillatt is right to have reservations about. These studies, in collaboration with environmental scientists, often use weather event records that include the resolution of seasonally variable rainfall (Nelson *et al.* 2010) and early or late winters (Adderley, Simpson and Vésteinsson 2008) to show how human communities lived through periods of weather variability in the past. Indeed, the results of this work are beginning

to impact world discussions, that, I think, they rightfully deserve, and this highlights the importance of these long-term perspectives to this global debate (see the Global Human Ecodynamics Alliance at www.gheahome.org, and the Integrated History and Future of Peoples on Earth at www.stockholmresilience.org/ihope). I consider these to be exciting projects that highlight the role of time-depth in providing the necessary context to demonstrate the realities of human ecodynamics and, more specifically, to

1 understand the vulnerabilities of human communities to extreme weather events,
2 demonstrate the success and failure of differing mitigation strategies over the long term and
3 reveal the relative resilience of different human lifeways to the impacts of climate variability.

It is true that the topic of causality between climatic variability and societal change, so heavily critiqued in the 1980s and discussed by Pillatt, is still an easy scapegoat for many scholars. However, there are now some good studies of the nuanced ways in which climate variability and environment change interact with social development. Certainly, the idea that the human experience of weather events collapsed societies, as in the Maya region (Hodell *et al.* 2001) and Rapa Nui (Easter Island) (Diamond 2005), is often promoted by those outside our social-science disciplines, but this conception is being carefully countered based on more informed perspectives of the human experience of weather variability and landscape change (Aimers 2007; Hunt and Lipo 2009). Therefore the question is how studies such as this, that highlight the role of individuals inhabiting a living landscape and their experience of weather, fit within these wider debates.

Pillatt's discussion of 18th-century rainfall and winters in Mosser and their lack of correspondence with the recorded meteorological data from the CET/EWP series clearly shows the fundamentally different timescales at which the human experience of weather events differs from wider meteorological conditions. Whilst this micro-scale is important, I would perhaps also look at this topic from the macro-scale and ask how we should understand the impacts of climate variability in North Atlantic climate systems if not by reconstructing the long-term human experience of weather in places such as Mosser. Since the Intergovernmental Panel on Climate Change was set up by the United Nations Environment Programme and the World Meteorological Organization in 1988, substantial resources have gone into research on global climate systems and the manifestation of climate change in recorded weather data. Given its crucial role in thermohaline systems, the North Atlantic has been a focus for this research (Marshall *et al.* 2001) (see CLIVAR at www.clivar.org/index.php) and a review of this research shows the multiple cycles of complexity within which weather events and climate variability are tiered at millennial (solar radiation), centennial (Dansgaard–Oeschger/Heinrich events), decadal (North Atlantic oscillation), annual (El Niño/La Niña) and daily (pressure systems) timescales. So while the daily human experience of North Atlantic climate systems in Mosser in 18th-century Cumbria represents the human face of these events, it is only through the cumulative gathering of data like these on a much greater scale that

event-led understandings of weather experiences, such as the cold winter anomaly in the winter of 2009–10 (Seager *et al.* 2010), can be given context.

The importance of social memory

This example of the disjuncture between both weather and climate, and people and society, shows the importance of understanding the scaled temporalities within which people experience weather events and the masked visibility of the tipping points at which weather variability changes into climatic change. The salient observation by Pillatt of the paradoxical number of earliest, latest, best and worst weather events that litter the descriptions in the historical sources highlights just how immediate yet ephemeral these sorts of reaction to weather can be. Perhaps these observations reflect the nature of the historical sources that record the daily and immediate reaction to events. Such immediate perspectives do not take into account the filtering process of social memory. The passage of time provides a more reflective perspective on the worst events in living memory that include the context of ecological knowledge often maintained over the longer term.

Therefore, whilst non-linear and highly variable in nature, there is certainly a relationship between the scale of impacts of particular weather events and the longevity with which they are remembered within any human community (Crate 2008). This temporally layered relationship between impact and memory is also spatially scaled and dependent on the locality of impact and the communication between communities. In the southern United States it is likely that Hurricane Katrina in 2005 will be remembered for a lot longer than Hurricane Rita of the same year due to the scale of impact on New Orleans, but perhaps this will not be the case for the parish of Cameron in Louisiana, which was largely destroyed by Hurricane Rita. However, it is not social memory alone but, more importantly, the associated ecological knowledge of threat, vulnerability, risk and best course of action should such an event happen again which is most pertinent to a human society. For example, I would be intrigued to know more about the reactions to the weather events within the Fletcher diaries and to understand if knowledge accumulated over time still persists among the farmers of Cumbria. It would lead us to question how far the insidious introduction of technology as a means of understanding weather has gone in replacing local ecological knowledge in Mosser. I would wager the BBC weather forecast is just as chastised today as was the barometer that cost the farmer his crop in this 18th-century source. Tied closely to this discussion is the accumulation of traditional ecological knowledge, which is centrally important for societal resilience, as demonstrated by its crucial role within indigenous societies living in marginal environments, and is tied up closely with this discussion (Watson, Alessa and Glaspell 2003).

Applying traditional ecological knowledge

By definition, traditional ecological knowledge (TEK) takes time to accumulate, with knowledge of extreme weather events often passed through generations for hundreds of years. Current research involving traditional ecological knowledge shows how an important interface between TEK and global climate change monitoring is developing that recognizes the importance of social memory in understanding the impacts of global climatic change. The work of Gearheard *et al.* highlights this. They have

equipped indigenous community members in the Arctic with the means to observe, track and record the active changes in weather conditions, snow characteristics and animal behaviour. The human experiences of weather shine through in these examples, as does the time-depth of knowledge necessary to contextualize them:

> Inuit have this traditional juggling game where you juggle three rocks and we keep changing the rocks from one hand to the other. The weather is sort of like that now; it's like the weather is being juggled, the weather keeps changing so quickly and so dramatically (personal communication by Attungala cited from Weatherhead, Gearheard and Barry 2010, 424).

By using specially designed Garmin GPS interfaces to document the observational data, the relationship between human experience, ecological knowledge and global environmental change plays out in real time and, through Gearheard's work, links directly back to policy. I see some real parallels with this work and Pillatt's research, as both actively record the human experience of weather events and landscape change. Just as Gearheard *et al*. have applied the recorded evidence for the human experience of weather to contextualize and understand climate variability, so too can a project be delivered expanding on Pillatt's data and methodologies to inform our understanding of climate variability in northern England.

An archaeological perspective on the importance of social memory and traditional ecological knowledge has been highlighted by my own Leverhulme-funded research into the Archaeology of Climate Change in the Caribbean (Cooper and Peros 2010). The islands of the Caribbean are extremely vulnerable to the cycles and fluctuations in the North Atlantic climate systems (Cooper and Boothroyd 2011). Therefore human communities have been living with the impacts of this weather variability for over 6,000 years. Comparative research focused on the relative resilience of pre-Columbian (4000 B.C.–A.D. 1600) and early modern/modern (A.D. 1600–2011) lifeways to specific weather events has revealed some interesting contrasts in vulnerabilities. In particular, the time-depth of human experience provides an increased understanding of the temporal cycles within which precipitation variation and hurricane landfalls occur in this region. The settlement locations, household architecture and food procurement strategies developed by pre-Columbian communities through time reflect an improved resilience to these extreme weather events (Cooper 2012). At a time when extreme weather events are the greatest fear for many communities currently living in the Caribbean (Caribbean Community Climate Change Centre 2009), such long-term perspectives can provide a context within which to understand the weather event manifestation of climate variability in the region.

Projects such as these, which detail the human experience of weather events as it relates to longer-term climatic variability, show not only the scale of impact that occurs but also, rather, the timing of event and speed of impact that is just as important. Such projects can then reveal the threshold at which weather events and their impacts of climate variability exceed social memory and societal ecological knowledge and thus transcend the boundaries of inherent mitigation in the lifeways of past peoples. These studies highlight the inherent resilience of communities whose cumulative experience of weather

events over the long term provides knowledge and understanding of, and by extension preparedness against threshold events in climate manifested through extreme weather. Certainly the global change research community are well aware of this and such ideas of thresholds in the societal capabilities for specific weather events are very pertinent to current discussions (Alley *et al.* 2003; Lenton *et al.* 2008).

Communicating beyond archaeology

Therefore I believe that the experience of the rather wet and windy weather of Mosser in Cumbria offers a small part of a wider sum that does have direct relevance to the broader issues of understanding the human experience of global climate change. Such micro-scale case studies are important, highlighting the necessary critiques of time, agency and landscape, but a wider picture has to be appreciated in which we, as a community working with time-depth, have an important contribution to make. Such work, being done by scholars around the world, is now being delivered to the wider academic and policy-making community currently involved in planning mitigation for global climate change (Redman 2012). Archaeologists talking in sessions such as 'Informing the Future by Understanding the Past' at the Copenhagen Climate Change Congress in 2009, 'Climate Change and the Long-Term Sustainability of Human Societies' at the American Association for the Advancement of Science Meeting in Vancouver in 2012 and 'Searching the Past for Clues to the Future' Planet under Pressure in London in 2012 show how archaeologists are delivering this important message beyond our own discipline. Taking this to the next stage is clearly possible as one of the first rounds of the National Science Foundation for Science, Engineering and Education for Sustainability grants was awarded to archaeologists, from within the Global Human Ecodynamics Alliance (see www.nsf.gov/news/news_summ.jsp?cntn_id=122028). This shows how other disciplines and peer-review panels already recognize the importance of archaeology in these discussions. Such interdisciplinary peer recognition is based on their appreciation of the informed and critical perspectives of human experience that are exemplified by Pillatt's research. Therefore I would argue that it is vital for the archaeological community to further develop these initiatives and communicate the importance of social memory and ecological knowledge to those hoping to weather the impacts of climate change.

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Palaeo-environments and human experience

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As a palaeo-ecologist, working with historians has made me look critically at the strengths and limitations of my discipline. Resisting the temptation

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to defer to documents that, however partial or biased, remain far closer to human experience of the land than any pollen sequence, is essential (see Davies and Watson 2007; Hamilton *et al.* 2009). Richard Tipping (2004) recognized this lure when he distinguished two philosophical approaches to interpreting historic landscape change. These are my starting point for offering an environmental archaeologist's response to the archaeological and interdisciplinary challenges discussed by Toby Pillatt. First, Tipping defined a 'confirmatory' approach, in which palaeo-ecologists have sought correlations with written records, but only to confirm documented events, not to challenge them. In this, they have usually relied on selective readings and secondary, often generalized, historical sources. Reading this paper, it is evident that this is not only a one-way process, as those discussing human experience of the environment have been led by models and issues from the environmental sciences, including contemporary concerns. Indeed, a reader of Dawson's (2009) history of Scotland's weather and climate may be forgiven for thinking that all weather was bad weather, with possibly unfavourable expectations for human experience.

Second, Tipping sought to give palaeo-ecological records a stronger voice by using the data to test hypotheses developed from historical sources. In his 2004 paper, this included paying more critical attention to potential causal relations between sociopolitical instability and agrarian practices since assuming causality must, by definition, imply a mechanism of influence. More pertinent to this commentary, Tipping (1998; 2002) has also used pollen records to test Parry's (1978; 1981) model of progressive withdrawal from 'recurrently marginal' upland areas during the Little Ice Age, concluding that cultural attachment and socio-economic factors were stronger drivers of cereal production than climate. Clearly, therefore, the problems confronting archaeologists when tackling human–climate/weather relations are by no means unique, since environmental archaeologists and palaeo-ecologists also face challenges in finding a balance when debating coincidence and causality across processes that span a potential multitude of scales in both time and space.

Pillatt deals with several relevant concepts and problems involved in this process that I would like to comment on in order to suggest opportunities for developing joint ways forward: (1) how prevailing ideas and philosophies influence our approach; that is, the interpretative frameworks that inform our thinking; and (2) how we might approach the challenges of informed and critical thinking across disciplines to deal with issues of correlation and causality. In a critique of work correlating volcanic activity with human responses, Buckland, Dugmore and Edwards (1997) stress the need for improved communication across disciplines to ensure that the limitations of differing lines of evidence are recognized and that the most recent advances in methodology and understanding of climate change reconstruction are considered. My suggestions deal with ways in which we might help keep our disciplines in step when moving debates over past human–climate relations forward.

Central to this commentary is how we, as researchers concerned with complex social–ecological systems (Berkes and Folke 1998), expect people

to respond to the weather and their consciousness of changing patterns, including 'normal' levels of variability, extreme events and longer climate trends. This will determine what response we infer and how this may be recorded through material remains. For instance, Pillatt comments on the complexities of constructing and interpreting weather records. As a result I found myself questioning whether the expectation that local weather records should match a regional amalgam (from another area) was justifiable and, as he discusses later in the paper, how the hopes and outlooks of past individuals or societies coloured their view of the weather. When I first began research in the Scottish Highlands I thought the landscape bleak and oppressive. I was also acutely aware that I was a foreigner in that landscape and careful that my preconceptions did not colour my interpretation – I am reminded of this when reading historical travellers' colourful or disparaging accounts of their journeys into the Highlands. This increased my desire to understand how inhabitants from various periods felt about where they lived, how they adapted to make the most of its potential whilst buffering themselves against its limits, and what view they had of the wider world with which to compare life in a Highland glen. I have discussed how upland communities may have used their understanding of the land as well as social relations to buffer themselves against the vicissitudes of the upland environment, making climate change alone an insufficient predictor of land-use dynamics in north-west Scotland (Davies 2007). I recognize that this is, no doubt, in many respects a simplistic model, as shown by the discussions of Whyte (1981) and Dodgshon (2004; 2006) on the complex factors and feedback loops that may interpose between the weather and human decisions. Opportunities for palaeo-ecology to engage more with human experience of landscapes and environments are discussed further below.

While I recognize the potential for interpretative frameworks to become limiting, and prevailing paradigms are, as Pillatt discusses, often historically contingent, current theories on social–ecological system complexity can be used to bring together archaeological and palaeo-environmental interests in human–weather relations. The concept of resilience (the adaptive capacity of an ecosystem), for example, incorporates both 'slow' and 'fast' processes/responses and has been applied to environmental (e.g. Dearing 2008) and human systems (e.g. Fraser 2003; 2007). Evan Fraser used historical case studies to examine the vulnerability of food systems to climate change, including the Irish potato famine. While his interest was primarily in the value of hindsight to characterize vulnerability (Fraser 2007), similar institutional factors and ways of thinking have been proposed in archaeological studies of system collapse, also applying a resilience framework and using the notion of social memory (e.g. Redman and Kinzig 2003). These are potentially useful starting points for exploring common interests.

As well as concepts and theories that provide a common interpretative framework, we also need tools that facilitate the exchange, exploration, development and discussion of new ideas. Fyfe, Caseldine and Gillings (2010) present examples of how palaeo-ecologists have used modelling to develop visualizations of past landscapes, while also recognizing that these are interpretations, not reality. Rather than definitive reconstructions, these

are heuristic devices and 'formal methods of speculation' (ibid., 156) which can be used as part of a discourse with archaeologists on the implications for past human perceptions and experience of a landscape. The examples published to date deal with vegetation mosaics (e.g. Caseldine and Fyfe 2006) and archaeological monuments (e.g. Winterbottom and Long 2006; Tipping *et al.* 2009), not climate, but they may provide interactive space for dealing with processes and perceptions that span differing scales and sensitivities. In particular, they may offer a way of transposing the ideas developed by Pillatt to material culture and remains, as the translation of human–weather relations from archaeological dialogue to on-site context are not considered in the paper.

As Pillatt concludes, weather is an inconstant, but inseparable, strand in complex human behaviour. His paper opens opportunities for further dialogue to explore our understanding and interpretative frameworks. I suggest that we also need to observe and learn from our own experience when thinking about past perceptions of weather and how this may affect behaviour and land use. Public support for many environmental issues is declining and there is a growth in climate-change denial (Dyson 2005; Gleick *et al.* 2010), despite our ever-improving understanding of climate-change mechanisms, many past examples of adaptation and failure, and an overwhelming catalogue of evidence for global environmental change, including predictions that we face a non-analogue future (Williams and Jackson 2007). What does this suggest about our individual and collective social memory? It reminds us as researchers to constantly challenge our own interpretative assumptions to maintain dynamic interdisciplinary dialogue and communicate its relevance (e.g. Bailey and Lindenmayer 2011). Perhaps it is fortunate that part of any palaeo-environmental–archaeological dialogue involves physical environmental processes which may be justifiably interpreted using principles of uniformitarianism.

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Yes and No. How applicable is a focus on palaeo-weather? *Detlef Gronenborn**

Toby Pillatt is right. Weather is important. Weather is important every day, as is evident from almost every news broadcast we watch or hear. This is not only true for extreme weather situations – which currently abound in the news – but for ordinary weather conditions at any time. The importance is quite clearly reflected in the numerous weather channels and weather websites and the weather forecast at the end of every news programme. Despite the

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'benefits of civilization' which today make us often independent of outside influences, many simple daily decisions are still based on the current weather situation. Weather is our first and most immediate environmental experience. It was no different in the past. On the contrary, weather-based decisions were much more important historically than at present, both for individuals and for entire societies. No doubt, then, weather should be of concern also for historical studies. Hence Toby Pillat is right. He is also correct in stating that by involving a palaeo-weather perspective we can add much to our understanding about how past societies operated.

But how applicable is a focus on weather in archaeology and what kind of information would we gain? Palaeo-weather-related studies, as suggested by Pillatt, would entail a component of sensing. Sensing is certainly an important factor in shaping mentalities, sometimes of large social entities. However, sensing may only be analysed if past peoples leave records of their ways of thinking. In most cases these would be written records, sometimes pieces of art – drawings, paintings, sketches, possibly on cave walls, or figurative art. If no such records exist, then the academic concern with sensing becomes a matter of guessing, of vague interpretation. Often such studies tell you more about the scholar than about the period under investigation (this is certainly also true for any historic text or image analysis, yet presumably to a lesser degree). In any case, thorough and methodologically sound approaches to weather and its effect on humans are largely limited to periods from which textual sources exist, through which we may gain an immediate eyewitness internal perspective.

There are but few exemptions. Extreme weather situations often leave evident records in the environment – flood layers, landslides and so on. Under fortunate circumstances such evidence may be dated quite precisely. It may then be brought in connection to archaeological evidence and the possible effects of such extreme weather events on the societies may be contemplated. For less-pronounced weather effects and for less-well-dated events any robust correlation is hardly possible. This brings me to the next problem: dating.

Any palaeoclimatology, or palaeo-weather-informed archaeology, faces one major and immediate problem: the correlation of archaeological chronologies and palaeoclimatological age models. No robust cause-and-effect hypothesis can be phrased if the chronologies are not well controlled. Often, contemporaneity may only be established on a rather coarse level. This then leaves ample room for speculation but no room for sound detailed theories. The entire discipline is dependent on fine-grained and robust chronological schemes in both the historic and the palaeoclimatological disciplines. Such fine-grained chronologies exist for recent periods which are text-documented but not for the more distant past, nor for any prehistoric period. For these periods we will have to rely on more coarsely grained approaches, based on climate rather than on weather and on quiet sources provided by prehistoric archaeologies rather than on text exegeses. A third problem is rooted in the data sets themselves. Palaeoclimate is mostly documented in proxy records, not actual records of temperature or amount of precipitation, for example. Individual weather situations are extremely difficult to extract from such data sets.

Beyond these questions of scale, data quality and resolution, there is another aspect to why 'traditional' palaeoclimate-informed archaeology should not be neglected. The dichotomy of terms suggested by Pillatt's title, 'From climate and society to weather and landscape', does not – in reality – exist. These two pairs of terms are not contradictions but rather two coexisting approaches and – as I said above – they are two approaches at different scales of resolution. Studies focusing on climate and society are concerned with questions of economy, possibly politics and perhaps other social matters. They focus on resource utilization, economic and ecological margins, crises, reformations and searches for processes and mechanisms within and between various groups and societies. This approach is – in a way – related to the processual approaches which, at least in geography and other palaeoclimate-focused disciplines, have never vanished.

Weather- and landscape-based studies – in the sense promoted by Pillatt – focus on sensing and experience, search for the individual and the individual's response to outside challenges, and are related to the postprocessual approaches of the 1990s. These are two different research agendas targeted at different results and maybe also at different academic audiences. In any case, they do not contradict each other; in fact, they complement each other. Lastly, any historical process is composed of innumerable individual experiences. If, however – and this Pillatt admits – each and every one of these experiences had survived and needed to be analysed, a thorough understanding of the period in question might not be reached as the data would be overwhelming. Thus a certain amount of abstraction would have to be applied and conclusions would have to be drawn from this level of abstraction, bearing in mind that individual experiences of the phenomenon under investigation might give different impressions. This level of abstraction is applied by the more coarser-grained palaeoclimate-informed studies.

Pillatt's call for weather and landscape is justified. Weather and, where possible, its effect on humans should be incorporated into holistic approaches to the past. Certainly it was weather and not abstract climate that was felt by past peoples and it was to weather that they reacted. But possibilities to focus on weather are extremely limited, largely to periods covered by texts or to single events. The great majority of the human past is not documented by internal texts, and, moreover, archaeological relics have survived only in fragments – the gaps of knowledge are wide and deep. This is also true for most of the palaeoclimatic data sets. This, then, limits the approach suggested by Pillatt to Europe no earlier than about a thousand years ago and to much of the rest of the globe no earlier than about a hundred years ago. For any other period a fine-grained approach at the resolution required for weather (i.e. days, weeks or, depending on definition, months) is not and maybe will never be possible. Pillatt is aware of these problems for the 'more distant past'; however, I find his suggestions to overcome them rather vague. His last call for a more detailed and thoughtful consideration of the relations between 'climatic cause and social effect' (p. 41) is on a much firmer basis. At present, however, the limits to such detailed hypotheses and the theories built from them remain considerable for most periods and regions of archaeological investigation.

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Weather and climate proxy records

*T.J. Wilkinson**

Although it is easy to agree with Toby Pillatt that the role of weather in the archaeological record has been understated, it is more difficult to provide a clear method for incorporating the weather into archaeological interpretation. His concerns about the dominance of climate in interpretations are also acknowledged. Whereas climate and weather are indeed important to the interpretation of past ways of life, when we do try to recognize a direct correlation between, for example, a climate proxy record and any specific human behaviour, it is common to discover that any neighbouring proxy record will show a different set of relationships. Although there is a long history critiquing this approach, there is still a tendency for the uncritical to draw simplistic conclusions.

Of the many factors that can obscure the long-term relationship between humans and the environment, that of chronological imprecision continues to impede robust conclusions. Roberts (2011) has pointed out problems that arise from using environmental and archaeological chronologies, especially those that rely upon radiocarbon dating that has a precision of say ± 50 years. Although occasional varve chronologies provide annual laminations for proxy records from the lake basin sediments themselves, the archaeologist who strives to compare such records with terrestrial archaeological records (such as excavations or surveys) is then confronted with the problem raised by the lack of precision of the standard archaeological chronologies. On the other hand, when the indicators of human activity and climate derive from precisely the same sedimentary layers, there is a clear case for the proxy indicators being contemporaneous. In the case of the laminated varved sequence from Nar Lake in Cappadocia, Turkey, Roberts concludes,

> Examination of climatic and cultural history from the same sedimentary archive provides a rigorous test of the hypothesis that the Late Antique societal crisis was prompted or inflamed by climatic stress, and it has been shown not to be the case (Roberts 2011, 31).

The results from Nar Lake are not only informative concerning the lack of correlation between, in this case, an arid event (here aridity is derived from oxygen isotopes) and a period of large-scale abandonment; they are also starting to fall in line with a large corpus of evidence from archaeological landscape and settlement surveys that show the huge impact of Late Antique imperial policies on the landscape. One must emphasize, however, that by showing a lack of correspondence between an arid event and an abandonment phase, Roberts is not saying that climate is unimportant; rather, his point is

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that the relationships are not necessarily simple and straightforward. This is very much in agreement with Pillatt's article.

But in a world of proxy climate records (we must all have been rendered cross-eyed by the mind-boggling array of graphs in many recent reviews of climate change), how can we capture and incorporate the record of weather and relate it to human actions and landscape? I tend to agree with Pillatt that it is both worthwhile and relevant for the following reasons.

If we are to incorporate the weather, or perceive the landscape as 'weather-worlds', from where are we going to obtain our records? Pillatt is fortunate enough to have the assistance of Isaac Fletcher and Elihu Robinson, two 18th-century diarists who provide terse but valuable time-sequence records for Cumbria. Textual sources are, in general, the key to providing a record of past weather and these usually take the form of diaries or letters setting out specific events; rarely do they provide a longer-term record of climate. In the Cumbrian case, the records are relatively recent; however, similar, albeit more interrupted, records in the form of letters written in cuneiform script can be found in the Middle East going back to roughly 1200 B.C., or even to the 3rd millennium B.C. (Neumann and Parpola 1987; Cooper 1983; Widell 2007).

Closer to the period under discussion, the remarkable records of Michael the Syrian provide a graphic record of weather and other events, which until recently had not been set alongside archaeological evidence (Widell 2007). Such records provide an illuminating picture of the variety of challenges faced by ancient populations, but also their complexity. Michael the Syrian, elected Patriarch of Antioch from 1166 to 1199, provides an array of information concerning numerous climatic and agricultural catastrophes that took place in northern Syria and neighbouring areas from the sixth century A.D. until A.D. 1196. His records not only provide evidence on weather, they also show that humans in this semi-arid part of the Fertile Crescent experienced a wide range of disasters in addition to the atmospheric ones that have been the focus of many scientists and archaeologists in recent years.

Widell's synthesis of the diaries lists the following, in order of frequency of citation: severe winters, locusts, drought, snow, stormy winds, freezing conditions, hail, flood, plague, mildew, rain, rats and weevils. Of these, drought, which is normally the disaster of choice of climatologists, came third in frequency with 13 attestations over 276 years (Widell 2007, table 2), or one year in every 21. Of course, one might object that not all of those events that relate to the atmosphere are really weather: droughts might be rather longer-term climatic events or they may represent relatively short but severe episodes. Neither might they be seen as solely climatic; some may be due to political or economic circumstances. Nevertheless, they do provide a record of atmospheric events that were *experienced* by humans, and some, such as episodes of freezing conditions or 'hail breaking trees and grapevines in the region of Militene' (ibid., 52) come much closer to being weather events. Moreover, these records remind us of the importance of other weather, such as freezing conditions, that resulted in the catastrophic loss of livestock in the Aleppo region in 1911 (Lewis 1988).

What is particularly interesting about the record of Michael the Syrian is its richness: the communities had to cope with a much wider range

of challenges than are normally included in many analyses of human–environment interactions. Moreover, as Widell concludes, 'The constantly recurring catastrophes enumerated by Michael the Syrian demonstrate the resilient nature of the settlements in this region in antiquity' (Widell 2007, 55). In other words, life in this populous region continued, despite the challenges – a point to which I return later.

Although it is relatively straightforward to incorporate climate or climate proxy records into the interpretation of the archaeological records, weather and short-term events are more difficult to use. As Pillatt observes, agent-based models provide one way of incorporating such episodic or short-term events and such methods offer a more nuanced and interesting response than simple cause and effect. For example, one modelled scenario employed for a Near Eastern model community attempted to estimate the responses of the model community to a run of dry years (Wilkinson *et al.* 2007, cited above by Pillatt). Because the community was not simply viewed as a physical system of production, but was endowed with a range of social behaviours such as allowing exchanges between families, offering loans, setting bride prices and so on, the responses to the 'events' were more complex and non-linear than the normal interpretations offered in much literature on human–environment interactions. One outcome was that the 'cyber community' reacted to the five-year dry spell with a flurry of exchanges within the community. In this case the affected households attempted to exchange what they had (animals) for what was in short supply (usually, but not necessarily, grain). In many cases this resulted in those households that were in a position of economic advantage gaining by trading grain for animals. Because many households were low on grain, animals were in surplus, therefore 'elite' households were in a position to accumulate large holdings of animals. These could then be exchanged later, and at an advantage, for more grain.

Such transactions do not assume the functioning of formal exchange economies, and in the case of the modelled non-market economies the models demonstrate that a climatic event was translated through social interactions to produce an economic output. However, the impact of such economic transactions would vary across the community and might result in very different outcomes for different households depending upon their initial circumstances or ongoing decisions. One can perceive a similar degree of complexity in the Cumbrian examples presented by Pillatt. Although agent-based methods could be employed in north-west England, it is crucial to emphasize that any formal models that incorporate large-scale processes such as urbanization in north-west England need to include a much greater degree of complexity than if models were simply restricted to a single farm or household. Nevertheless, the models do enable different scenarios to be run and allow the modeller to do 'experiments' to see which scenarios might have been more plausible. Agent-based models can also incorporate weather, not just climate.

An important feature of weather records is that, as such, 'weather, as experienced by individuals, can, to a certain extent, be related to long-term climatic changes observed in proxy records' (p. 39). Because they derive from

the observations of humans, weather records can 'humanize' and add life to proxy records. For example, it is a fairly straightforward task to place the records of Michael the Syrian alongside the climate proxy record from, say, Nar Lake in Turkey, either to see how they correspond or to flesh out points of detail. Unfortunately, in this particular case the records are too far apart geographically to provide true complements to each other. Nevertheless, the principle that climate proxy records and human weather observations form complementary resources is important, because, by being interpreted through the lens of humans, weather records provide a different class of information. This is especially the case when the observer inserts an additional subjective interpretation that may shed light on how any particular weather may have influenced decision making at the farm level. Overall, weather records could serve to animate, validate and humanize long-term proxy records.

Although I find myself in agreement with most of Pillatt's points about the relationship between climate and weather, I am less convinced by the assertion that landscape archaeologists 'need to completely rethink how to approach the idea of climate' (p. 40), or that 'in the realm of past climate studies, landscape archaeologists continue to outsource this work to their colleagues in the environmental sciences' (p. 33). The field of landscape archaeology is so broad and there are so many different types of landscape archaeologist that although some might have taken to 'outsourcing', others explicitly include the use of climate proxy records within their investigations. This is particularly the case in the Middle East where many landscape study areas are situated within climatically marginal regions. Hence it is quite common in Middle Eastern regional, settlement or landscape studies to see climate proxy records used alongside landscape and settlement records and in some cases archaeologists have been involved in the collection of the record itself. Perhaps Pillatt's comments relate more to UK-based landscape archaeology, which, it is true, has a different history and methodological base than its Middle Eastern or Mediterranean counterparts.

The concept of 'weather-worlds' opens up many possibilities, especially in the context of Ingold's observation that 'the land responds in countless ways to the weather's myriad expressions as the medium in which we live', as Pillatt summarizes it (p. 34). This requires that we consider soil climate, a neglected field that provides insights into subterranean landscapes as well as practices of human use of the land.

Although there is an assumption that crops respond to atmospheric climate in a fairly lock-step manner, roots are encapsulated within the soil and so crops are more likely to respond to soil climate. 'Soil climate' is therefore a useful concept because it relates to conditions that actively influence crop growth. Soil climate includes soil moisture, which in the Middle East is crucial to crop development and yields. In the case of cereal cultivation, autumnal and winter rainfall nourishes the crop and if there is enough soil moisture, crops grow and yields may be sufficient for seed, consumption and some storage. However, traditional and ancient practice inserts a fallow year into the seasonal cycle (i.e. biennial fallow), with the result that a small percentage of soil moisture is carried over during the fallow year into the cropping year.

This results in a bonus in soil moisture, which might be anywhere from 5 to 20 per cent and increases crop growth as well as acting to stabilize crop yields (Janssen 1970; Wilkinson 1994). The practice of violating fallow has been noted to contribute to greater instability of cropping in the former Soviet Union (Parry 1990) and could have amplified any effects of climate change in the ancient Middle East. Therefore a simple change in the land-use regime from biennial to annual cropping can result in a decrease in soil moisture and loss of yield. Overall, human practices that vary the fallowing interval can have a significant effect on the soil climate and sustainability of the cropping system, perhaps even equivalent to many climatic 'events'.

In Britain, soil climate will vary spatially because of the variegated nature of the cultural landscape itself. Because the inhabitants of the countryside, including the Cumbrian farmer, are usually very knowledgeable about their local soils and micro-climates, any records might include both weather and comments on the response of the soil to such weather. Perhaps, as Tom Williamson (2003) has argued, landscape archaeologists need to be more sensitive to soils and their patterning.

In addition to the points made by Pillatt, archaeologists could shift away from the use of atmospheric climate change alone and engage with at least three components of climate: climate, weather and soil climate. To these one could add, at the most general level, a fourth component, namely a cumulative measure of climate such as the particularly informative 'cumulative deviations from the mean approach' employed by McGovern *et al.* (2007) (cited by Pillatt). By including a sequence of cumulative climatic records it is possible not only to incorporate a 'memory effect' but also to provide evidence of major turning points in the atmospheric record.

Finally, I agree that there has been a tendency for archaeologists and environmental scientists to be too keen to find causal relations from correlations between climatic events and human societies. This has often led to the 'cherry picking' of data to draw particular attention to apparent correspondences between climatic downturns (droughts in the Middle East) and social devolution or even collapse, at the expense of other relationships. What is often of much greater interest (to this respondent at least) is how humans manage to maintain their societies *through* major periods of stress, be they from weather or climatic events. If a community manages to survive a climatic event of some severity by adopting a suite of responses, that is every bit as interesting as if they had succumbed. Such results not only tell us about community resilience, they also demonstrate strategies that may be useful for survival: 'human resilience in the face of adverse circumstances' is surely every bit as useful as the recognition of societal collapse or devolution. More efforts should therefore be focused on recording what happens archaeologically across periods of significant climate change. Questions to ask should include: what changes in land use and crop type occurred? Did any other forms of agrarian practice change (e.g. fallowing, manuring)? In the Near East, was there an attempt to introduce irrigation? And so on.

To conclude, climate change has for too long dominated the agenda of global-change archaeology, and it is certainly time for weather (and weather-worlds, soilscapes) to be examined alongside it. However, rather than jettison

climate or climate proxy records, weather and climate (and, indeed, soil climate) should be seen as complementary facets of the atmosphere, and bringing them into a broader perspective of long-term socio-economic change is to be welcomed.

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Resilience theory and social memory. Avoiding abstraction *Toby Pillatt*

The aim of my article is to stimulate debate about the roles weather and climate might play in archaeological interpretations. It is, therefore, encouraging that the respondents have sought to develop and build upon the theoretical themes highlighted. Respondents have tended to agree with me that weather is and was an integral part of people's lives, and also that this is a subject worthy of archaeological research. This was by no means a certainty when we are considering something so ephemeral as weather in a discipline often held in thrall by the imprecisions of chronologies, and which has a penchant for the broad scale and the long term. Of course, these concerns do partly remain, yet the importance of weather, both as the lived experience of climate and as a medium through which people live their daily lives, is not questioned. As Wilkinson points out, the record of Michael the Syrian illuminates the many and varied environmental trials faced by past people, but Davies's anecdote concerning her perception of the Highland landscape warns against assuming that all people recognized and responded to similar weather (or climate) events in similar ways. This suggests that there is value in exploring a weather-based perspective. The question is, how do we get at the human experience of climate in the deeper past, when chronological resolution is coarser and where the lack of written records restricts access to people's perceptions?

In one sense, our ability to answer this question is a function of the data available to us as archaeologists, and the methods and techniques used to collect and collate such data. Although Gronenborn is right to be concerned that the archaeological record only provides limited opportunities for examining the weather, and nearly all the authors highlight the problems surrounding chronological imprecision, there are reasons to be positive. Martin Bell's contribution shows the continuing advances in this area, and demonstrates how previous emphases on long-term, gradual processes are being challenged by research that explores the significance of infrequent high-magnitude events. Wilkinson's call for a greater appreciation of soil climate is one way in which information about past environments can be more closely related to human experience, in this case through agriculture. There is a growing appreciation of what high-resolution environmental data can be gleaned from archaeological contexts, as well as an understanding of how this can be mobilized when examining archaeological questions.

Supporting these methods and techniques, there must be a body of theory that enables us to produce interpretations that recognize and characterize the relationships between human and climate history. My article argues against deterministic or simplistic mechanisms, and for more experiential perspectives on social and climatic change. For the most part, archaeologists have ignored the weather of the past, and this is something that the article sets out to change. As a number of the respondents have pointed out, however, there are already concepts in existence that can provide the foundations for weather-conscious archaeological research. First among these is resilience theory.

The concept of resilience is attractive because, as well as dealing with times of instability and change, it also describes stability, particularly in the face of adversity (Van der Leeuw 2000). In doing so, it attempts to identify and explain the dynamic relationships between long- and short-term processes, and to provide a common point of reference between social and natural processes (Redman and Kinzig 2003). This, combined with an emphasis on adaptive cycles, means that it is conceivable that resilience theory could help describe how individual interactions with weather are related to whole societies' experiences of and responses to climate change. There are reasons to be cautious, however. Redman and Kinzig (ibid.) recognize that, applied uncritically, a resilience model is potentially unsettling: 'it suggests an underlying uniformity to cultural history'. Moreover, existing applications of resilience theory have tended to focus primarily on economy and population dynamics. For example, Nelson *et al.* (2010) use resilience theory to perform a comparative analysis of human–environment relations in the irrigation-dependent societies of the US south-west, yet the result is a predominantly functionalist assessment of the economic processes that result from interplay between society and environment. There is a danger that interpretations employing resilience theory could become exposed to the well-known, convincing critiques of systems theory and processual archaeology (e.g. Hodder 1991; Barrett 2001). As Nelson *et al.* (2010) state, it would require a different sort of analysis in order to define the extent to which social changes were enacted in response to self-identified vulnerabilities to the environment.

This brings me on to a second concept identified by the respondents, that of social memory. Social memory is seen as a way of bridging the long-term processes of climate change and the immediate decisions made by past people in response to the weather. As such, it is linked directly to resilience theory as a means of describing the information flows that help determine human responses to change. It is suggested that social memory acts as a conceptual and symbolic reservoir, through which communities' environmental knowledge can be transmitted across generations (McIntosh, Tainter and McIntosh 2000). Actions at a particular point in history are dependent on perceptions of the environment as they are filtered through the collective knowledge of past experiences stored as social memory. Davies points out that, used in conjunction with resilience theory, social memory might provide a conceptual framework through which climate and weather can be examined from both human and environmental perspectives. In this

respect, my study and others like it can be used, as Cooper suggests, to explore the variability and diversity of social memory across human societies, and to assess how this is reflected in the development, transmission and application of traditional ecological knowledge. Problems arise, however, when social memory is abstracted to the societal level.

By conceiving human action and understanding to be underlain by 'a huge database' that provides 'all the information necessary to generate appropriate responses under any given environmental circumstances' (Ingold 2000, 164), the proponents of social memory reference the field of cognitive anthropology. They present a conception of knowledgeability grounded in Cartesian ontology: the natural body is the input device, conceived separate from the cultural mind, which operates on a societal level. In drawing upon the ecological psychology of James Gibson, as well as elements of phenomenological philosophy, Ingold's (1992; 2000; 2007; 2011) appeals for understanding people within the weather-world rest on a different conception of knowledgeability. Ingold argues that because knowledge 'merges into life in an active process of remembering rather than being set aside as a passive object of memory, *it is not transmitted*' (Ingold 2011, 161, original emphasis). This is a subtle difference, but it is an important one: it foregrounds the importance of lived experience. The aim is not to portray a transcendent individual, completely free from the influence of others, but to recognize that individuals are 'agent[s]-in-the-environment' (Ingold 2000, 171; see also Barrett 2001; Thomas 2004, 148). Information can be passed from person to person, and certain groups of people may reference certain forms of information in similar ways, but transmitted information is only made meaningful when people put it into the context of their own lived experiences. The abstracted level of societal understanding is replaced with the engaged level of the individual and their journey through life: 'It is through wayfaring, not transmission, that knowledge is carried on' (Ingold 2011, 162). Knowledge about how to act in certain situations is, therefore, *made* through active engagement in the present, not *transmitted* wholesale from the past through the medium of culturally encoded messages.

Wilkinson is concerned that this focus on experience could result in a jettisoning of climate as an object of study and climate proxies as a data source. It is a worry that perhaps stems from my title, 'From climate and society to weather and landscape', but it is not my intention to abandon the concept of climate. Instead, I wish to reaffirm the principle that the people of the past interacted with climate through the day-to-day experience of weather. My study shows that experience to be heavily dependent not only on the physical characteristics of the weather, but also on individual perceptions and world views. And though not discussed in the article, it is clear that amongst different members of one community that experience could vary considerably. The danger is that, if approaches abstract as they apply social memory and resilience theory, this human perspective is lost, and emergent in its place is an anthropomorphic caricature of society, replete with its own memory, sense of self and capacity to act knowledgeably.

As archaeologists, it is important that we never lose perspective on the constitution of societies (cf. Barrett 2001). They are not organisms, but

the material and metaphysical manifestations of the combined experiences of myriad individuals. This is where identifying diversity, variability and historical particularity become so important, because it is through these experiences that widespread, long-term social and environmental change is both constituted and contextualized. My particular outlook sees these relationships studied through the landscape archaeology of weather-worlds. To be clear, through the emphasis on experience, I do not advocate the essentialism of some phenomenological approaches to archaeological interpretation (Tilley 1994; 2004). Experience here is about shifting focus away from conglomerated societies and towards the lives of people as lived. The archaeological programme is thus devoted to identifying the material conditions that past people were subject to, and then exploring how different actions were thus made possible in different circumstances (Barrett and Ko 2009). Through this approach, when there is no direct access to past people's perceptions of the weather-world, the phenomenological and ethnographic analogy that is mobilized in its place can be more closely attuned to particular historical realities. As we begin to think about weather more, the more likely we are to discover ways in which engagement with the weather-world is referenced in material remains – for example, through house technologies and settlement patterns (Cooper and Peros 2010), or even art (Thornes and Metherell 2003). From there, resilience theory, social memory and complex modelling can play a role in moving the analysis across scales, but only if the initial people-centred perspective is maintained.

To conclude, I think the respondents are right to highlight debates concerning contemporary global environmental change as areas where archaeological research can have a direct impact on policy making. As archaeologists, our contribution is expected to cover the deep time of human existence and provide insights on long-term change. Conceptions of social memory and resilience theory have been devoted to these scalar issues as part of attempts to reconcile social and natural processes within comprehensive historical narratives. When dealing with climate and low chronological resolution, however, there is a tendency to abstract these concepts to the societal level. The diversity and variability of social memory is obscured, and resilience theory is expressed in terms of functionalist economics. My article outlines the importance of examining change (and stability) from inhabited, experiential perspectives, centred on people's senses and uses of landscape. In terms of practical archaeological investigation, this means identifying the material conditions of past action, exploring how different actions were made possible by those conditions, and using ethnographic and phenomenological analogy to develop interpretations that centre on interactions with the weather-world. It is an approach that integrates weather and climate within the study of landscape archaeology. The challenge is to then use concepts like social memory and resilience theory to place the resulting weather-centred narratives within the context of long-term interactions with climate – thereby making an invaluable archaeological contribution to those studying contemporary environmental change. After all, in the words of Elihu Robinson, 'to murmer against ye weather can avail nothing & cannot be right'.

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