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What do we mean by wet? Geoarchaeology and the reconstruction of water availability.

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Abstract

Geoarchaeology has a key role to play in the human-climate-environment debate, including research into the controls and variability of water availability. However its interdisciplinarity can cause complications as well as advantages and leads to confusion as to what researchers should be investigating and how they should be reporting their findings. In this paper I investigate Geoarchaeology, and its place in 21st century science, as well as investigating its role in reconstructing past water availability and some of the challenges involved in ensuring these investigations are undertaken in a robust manner that will enhance academic knowledge and debate.

1. Introduction

Water availability is a politically sensitive issue in many parts of the world (Issar and Adar, 2010) and given projections of future climate (Meehl et al., 2007) and human population change (United Nations, 2011) the pressures on water as a resource and on those who manage it will increase. Changes in hydroclimatic conditions have significant impacts on natural ecosystems as well as people (Vörösmarty et al., 2010). Investigations of past changes in water availability and people's response, by adapting to or mitigating these changes, therefore play an important role in understanding what issues may arise in the future (cf. Bondre and Kiefer, 2012; Cornell et al., 2010;). Geoarchaeology, at the interface between the study of past environments and of past societies, should therefore be ideally placed to take a defining role in these investigations.

However, the interaction between people and the, or their, environment, is complex, both in terms of how people past, present and future interact with, use and abuse the 'natural' environment (e.g. Dearing, 2006), but also because of the multiple disciplines required to fully tackle the problems, both intellectual and practical, posed (e.g. O'Sullivan, 2008). This paper attempts to discuss some of these issues, focussing on the discipline of Geoarchaeology and the specific problem of reconstructing past water availability.

Geoarchaeology is a difficult subject to define and may have significantly developed since previous attempts to pigeon hole it (e.g. Leach, 1992). This volume therefore seems an appropriate place to rethink if Geoarchaeology, in its traditional sense, has a place in 21st century archaeology or geology, or if it requires a new definition for a new paradigm?

Water availability is controlled by a complex integration of potential forcings, including, importantly for this special issue, people (Fig. 1). These interactions include relationships that would traditionally come under the heading of archaeology e.g. people and vegetation, people and geomorphology, as well as geology e.g. tectonics and geomorphology but are difficult to tease apart on Quaternary, and particularly Holocene time scales. Yet water is a key resource for people both directly, for drinking, washing etc. as well as indirectly as a control on other resources such as animals and plants, and as a agent in industrial processes, and fully understanding how and why it has changed in the past, and the impacts this has had, are crucial for helping plan future policy.

2. Geoarchaeology:

2.1 A servant of two masters?

Like Truffaldino in Goldoni's famous 16th century play Geoarchaeology and by default geoarchaeologists can often be caught trying to please both the archaeological and geological communities, be it when funding is being sought, fieldwork undertaken, or results published. Wilson (2011) uses a similar analogy, arguing that Geoarchaeolgy is much more than a child of two parents, but is now a discipline in its own right.

Butzer (1982) however, describes a difference between Geoarchaoleogy i.e. archaeological research using methods and concepts from the Earth sciences, and Archaeological Geology, geological research undertaken by geologists to aid in the solution of archaeological problems. Taking this definition, many 'Geoarchaeology' sessions in mainly geological conferences, even in Quaternary focused ones, are dominated by 'Archaeological Geology' papers, and often include only geological investigations near archaeological sites, without the integration with on site evidence that is implied or required by 'Geoarchaeology' as defined by Butzer.

In fact in my experience 'Geoarchaeology' has nearly always meant 'Archaeological Geology', Geoarchaeology its self being viewed simply as a part of archaeology, and certainly an onsite discipline. This conflict between a name and a reality, in that Geoarchaeology has now moved beyond the archaeological site and into a more interdisciplinary space must lead us to question, if it matters, whether a) what we are doing under the geoarchaeological banner is in fact Geoarchaeolgy anymore, and/or b) if it is time to redefine the term for 21st century research questions?

2.2 An archaic geology?

If a geoarchaological community excits can the science, or the scientists, place themselves at the centre of the human –climate – environment debate? Or has science left Geoarchaeology behind and should we take the importance of interdisciplinary work by multiple specialists as granted in the 21st century?

From a Quaternary Science perspective, the idea of Geoarchaeology seems itself archaic, most attempts to define it have been from an arcaheolgical perspective rather than a geoscience one, and although geological investigations on and around archaeological sites have a place, it is when this work is combined with that of the other specialists that it becomes of most use, and vice versa. If people are an active agent of landscape, and therefore environmental and ultimately climatic, change then we are all geoarchaeologists, but not as traditionally defined.

Barker and Bintliff (1999), amongst others, discuss the idea of human ecology, a coherent sub-discipline which is "an integrated way of understanding humans in dynamic landscapes" and goes

beyond archaoelogy and/or geology to looking at broader questions more commonly discussed in areas of anthropology and sociology, questions that include human adaptation and choice. Messerli et al (2000) discuss the change from a natural ecosystem to one dominated by humans.

Very little Holocene geology, at least, can be undertaken without taking into account people as an active or passive agent of environmental change, and likewise archaeological questions can not be fully understood without understanding of the local and/or regional environment and climate at the given time, changing or not. It therefore become very difficult to draw apart the two disciplines if research questions are being robustly investigated; they are all geoarchaeological in its broadest possible definition. The best work, and the best development of the science (or sciences), is done when people with different approaches to the given question, whatever they call themselves, come together to understand all the possible landscapes under investigation. As Dearing (2006) says;

"a full understanding of causes of earth system change through (at least) the Holocene can come only through the most rigorous reconstruction of climate, human activities and earth processes, and importantly their interactions, at all locations and at all scales".

Scale is a key issue, and one I will return to below, but given that Rudiamn (2003) has suggested peple have impacted global climate for thousands of years, as well as their own back yards, understanding how far, spatially and temporally, we can push our data is key to robust investigations of water availibility, or other environmental or climatic issues, vital if the palaeosciences are to engage with the future climate change mitigation debate for example.

3. Wetness

3.1. What do we mean by wet?

This will depend on who "we" are, but in work focussed on reconstructing past climate or environments it can mean a number of things, and is mostly used in a qualitative way to describe change from one state to another. What is meant by wet, or dry, for example can describe changes in lake levels (e.g. Bartov, 2003), descriptions of change in precipitation amount (e.g. Bar-Matthews et al., 1997), or effective precipitation amount in areas where evaporation is significant (e.g. Jones et al., 2006). Often these palaeoclimate records are drawn from proxies with significant seasonality e.g. snails or ostracods that live primarily in the summer months (e.g. Jones et al., 2002) or from parts of the world where the climate of the different seasons are distinct, and controlled by larger scale climatic patterns centred in different parts of the globe e.g. The Mediterranean, where the 'wet' winters are dominantly controlled by North Atlantic sourced storm track and 'dry' summers are influenced by Hadley Cell circulation and Indian Monsoon variability.

A move from qualitative to quantitative, or at the very least qualified, palaeoenvironmental reconstruction is key if water availability and people's response to its variability can be usefully studied from the past and inform future planning and understanding. For example, it has been recognised for some time that drought may have played a significant role in the collapse of the Mayan civilisation (e.g. Hodell et al., 1995; Haug et al., 2003) however Medina-Elizalde and Rohling (2012) have recently showed that this drought may not have been as catastrophic or unprecedented as once thought, and that subtle variations in water availability may have been enough to significantly impact the Maya.

During and immediately prior to the Last Glacial Maximum, Lake Lisan lake levels are know to have been significantly higher than during the Holocene and yet how this relates to palaeoclimate reconstructions in still a topic of much debate (cf. Robinson et al., 2006; Enzel et al., 2007). Of interest is the interpretation of the lake level curve as a climate, rather than simply a water availability, proxy compared to other records from the region, such as those from Soreq Cave (e.g. Bar-Matthews et al., 1997) which have been interpreted as reflecting changes in rainfall amount, and suggest the Lake Lisan high stand period was one of reduced rainfall. The palaeoclimate story in the Eastern Mediterranean and Levant from the LGM through to the early Holocene is also crucial to long held views about the development of farming, and its links, or not (Balter, 2010), to global climatic changes. Key to testing any such hypothesis is having access to well dated, unequivocally interpreted paleaoclimate records, as well as archaeological information over a wider spatial scale than that currently available, and the use of local data rather than ideas based on global climatic shifts, the duration and intensity of which still require more work to fully understand for the Eastern Mediterranean.

3.2 Water availability

There is not a direct link between hydroclimate reconstruction and water availability, and therefore the latter can be reconstructed without need for understanding of, nor on the basis solely of the former. Scale is also important here, care must be taken when interpolating hydroclimatic changes based on climate records from areas which sit in different climate regimes today (see discussion below). There is also a danger in drawing palaeoclimatic information from palaeoenvironmental reconstructions, especially where significant human impact on a given region may have occurred.

Groundwater can also provide a valuable source of water, potentially providing a 'wet' environment in a 'dry' climate. The Azraq Oasis in eastern Jordan has been an important location for people from Palaeolithic times (e.g. Richter et al., 2010), only fully drying up due to groundwater extraction in the late 20th century. Such locations can provide water independent of short term climatic

changes allowing people within reach of such resources to survive any potential climatic forcing on their habitats. Jones and Richter (2011) showed that the springs feeding the Azraq Oasis were active during the LGM and early Holocene with probable standing water or lake environments in existence prior to the LGM. No sedimentary evidence is preserved through the LGIT but people were certainly living around the oasis through this time period. The findings show, that independent of any regional palaeoclimate debate water was available to people for much of this time period.

4. People and their waters

4.1 People as palaeoclimate proxies

If water is necessary for people to survive can we use people as a proxy for water and therefore climate, and if so over what time scales?

Kuper and Koelin (2006) for example, use people as a proxy to trace the drying of the Sahara through the mid Holocene, with the timing of their reconstruction matching the drying story as told from Atlantic sediment cores (deMenocal et al., 2000) for example. However this kind of work assumes that people have been only dependent on climate, or more particularly water availability, in the choices they have made, or that evidence only survives from those people who made the 'correct' choices and survived. However, we know that today people can move water from one catchment to another to ensure survival, a technological choice which negates climate as a forcing mechanism of change. There is therefore a shift from a time when people can be used to mark changes in water availability to one where they control it (cf. Messerli et al., 2000), a time after which deterministic arguments, independent of their current fashionable status, become less valid, or at least more complex.

4.2 Quality v. Quantity

Water is more than just a requirement of life for people, which complicates the interpretation of past societies relationship with water in a given environment at a given time. Water is also significant for health, faith and commerce, as well as simple curiosity (Hamlin, 2000).

Even if we take the simple assumption that people's primary want of a given water source is for drinking, the presence of water by its self does not mean it is available for people to drink, or to water their crops or livestock, domesticated or otherwise. People have been aware of the difference in water quality for a long time, Hamlin (2000) discusses Roman writers from the first century BC who understood that more stagnant waters, even from flat lands, were not as "good" as those from the higher regions where it was faster flowing. There are a significant number of lakes

in central Turkey, for example, named Acı Göl (Bitter Lake), where the water is not ‘sweet’, an example of water quality having a defining role in the history of given locations.

This ties in importantly with the discussion above. The presence of people in a place over a significant, i.e. multiple generation, period of time is evidence not only of water availability, but of potable water availability.

4.3 Local records for local people

Understandings the spatial, as well as temporal patterns of changes in water availability are key to fully understanding human-climate-environment relationships. Vital to robust investigations of such research hypotheses is the understanding of how people have been influenced by, and influence their local environment. Likewise, local data should be used with caution in the interpretation of regional or global scale isssues. Each site, and each study must be taken on its own merits.

Investigations of people and their environment at a given archaeological site, whether called geoarchaeolgy or not, should draw on evidnce from near- and off- site and not rely on palaeoclimatic records from, what maybe, a significant distance away. Local evidence may not be as complete as that from sites chosen specifically for palaeoenvironmental or palaeoclimatic study, but they can give a local picture of how sites do, or do not fit in with these more regional climaitic landscapes (e.g. Jones and Richter, 2011).

5. Summary

Attempts to define Geaoarchaeolgy, or more recent human-climate-environmental sciences have often come from a very narrow base of one field or another, arguing for a more interdisciplinary approach to the work. However this interdisciplinary work is now often the norm rather than the exception and the unique interdisciplinary space at the cross over between the ‘natural’ and ‘social’ sciences has been long occupied by geographers, archaeologists and to a degree Quaternary scientists. It matters less what we call ourselves, or which disciplines we call upon, and more that we utilise the correct techniques and skill sets to answer the research questions we are asking and are able to communicate our findings to a wide range of academic, political and public audiences.

Work in this multidisciplinary space is key to understanding water availability issues, past, present and future and the palaeosciences have a key role to play alongside colleagues from other disciplines. Complex issues lead to complex research questions which in turn require complex, yet robust approaches to investigate them. We shouldn’t be put off by the challenge but should demand thorough approaches to dealing with it.

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