ARTICLE IN PRESS

Journal of Archaeological Science xxx (2013) 1–10

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

# Past perspectives for the future: foundations for sustainable development in East Africa

Rob Marchant[a,*], Paul Lane[b,c]

[a] York Institute for Tropical Ecosystems (KITE), Environment Department, University of York, Heslington, York YO10 5DD, UK
[b] Historical Ecologies of East African Landscapes (HEEAL), Department of Archaeology, University of York, King's Manor, York YO1 7ED, UK
[c] GAES, University of the Witwatersrand, South Africa

ARTICLE INFO

*Article history:*
Received 18 April 2012
Received in revised form
25 February 2013
Accepted 3 July 2013

*Keywords:*
Archaeology
Climate change
Ecosystem services
Future Earth
Historical ecology
Palaeoecology
Resilience

ABSTRACT

East African ecosystems are shaped by long-term socio-ecological interactions with a dynamic climate and increasing human interventions. Whereas in the past these have often been regarded solely in a negative light, more recent research from the perspective of historical ecology has shown that there has often been a strong beneficial connection between people and ecosystems in East Africa. These relationships are now being strained by the rapidly developing and growing population, and their associated resource needs. Predicted future climatic and atmospheric change will further impact on human–ecosystem relationships culminating in a host of challenges for their management and sustainable development, compounded by a backdrop of governance, land tenure and economic constraints. Understanding how ecosystem–human interactions have changed over time and space can only be derived from combining archaeological, historical and palaeoecological data. Although crucial gaps remain, the number and resolution of these important archives from East Africa is growing rapidly, and the application of new techniques and proxies is allowing a more comprehensive understanding of past ecosystem response to climate change to be developed. When used together, it is possible to explore how human and climate change impacts become increasingly enmeshed and so assess interactions within coupled socio-ecological factors such as increased use of fire, changing herbivore densities and increased atmospheric $CO_2$ concentration. With forecasted environmental change it is imperative that our understanding of past human–ecosystem interactions is queried from the perspective of theories of entanglement to impart effective long term conservation and land use management strategies. Such an approach, that has its foundation in the long term, will enhance possibilities for a sustainable future for East African ecosystems and maximise the livelihoods of the populations that rely on them.



## 1. Introduction

There is no doubt that the world's environment is changing rapidly and in an unprecedented way. In the relatively short time *Homo sapiens sapiens* has been present on Earth ( ~200,000 years) there has never been a change in climate, as currently being experienced, from a warm (dry) to warmer (drier) state concomitant with higher concentrations of atmospheric $CO_2$. Some scholars have argued that the rate of temperature rise and amplitude of orbital forcing now being experienced have their closest analogue during the long interglacial corresponding to Marine Isotope Stage 11 (ca 395–425 kyr BP) (e.g. Loutre and Berger, 2003; Masson-Delmotte et al., 2006), prompting much new palaeoclimatic and palaeoenvironmental research. More recently, however, the suitability of this analogue has been questioned (Dickson et al., 2009). Moreover, while such research may well assist modelling of future ecosystem responses to very rapid increases in temperature and atmospheric $CO_2$, it can provide insights into how human societies have responded and adapted to such dramatic climate change. Archaeological, historical and palaeoecological perspectives need to be incorporated to enhance the potential for the sustainable use of ecosystems under a future characterised by rapid climate change and increasingly high levels of atmospheric $CO_2$. Furthermore, exploring how ecosystems respond to increasing global temperatures and rising levels of atmospheric $CO_2$ concentration, changing precipitation patterns via a series of feedback interactions between solar activity, atmospheric composition, precipitation, land surface conditions and ocean currents on ecosystem composition and distribution would benefit from re-analysis in terms of their historical and ongoing entanglement (Hodder, 2012), as opposed to

* Corresponding author. Tel.: +44 (0) 1904 434061; fax: +44 (0) 1904 432998.
*E-mail address:* robert.marchant@york.ac.uk (R. Marchant).

0305-4403/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jas.2013.07.005

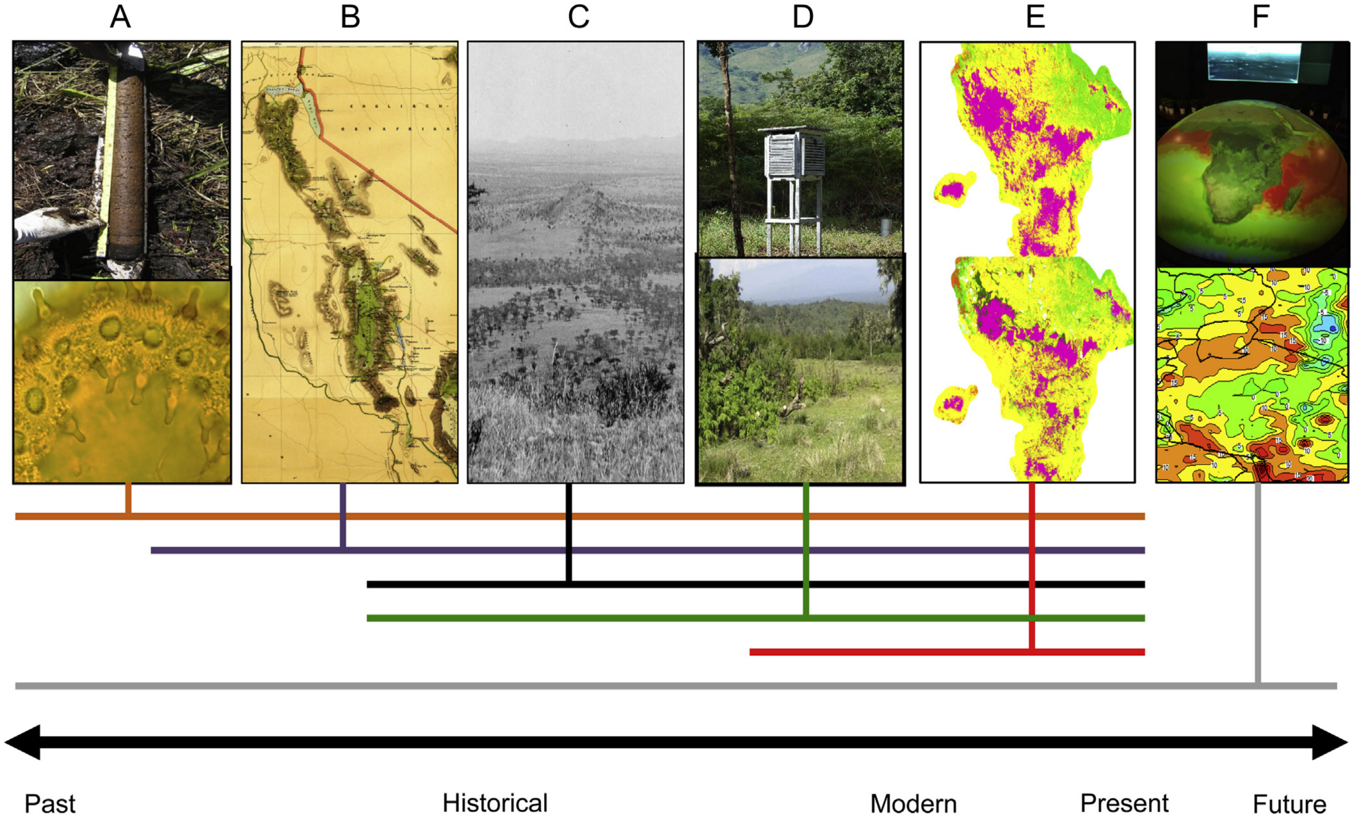


**Fig. 1.** Scale of investigation and how different environmental proxies combine to reconstruct climate and ecosystem dynamics through time. Accessing deep time is only possible via sedimentary records (A top) where a number of proxy tools such as pollen (A bottom) can be used to place the more recent indicators of environmental ecosystem change in context. Additional sources of information are varied but include historical maps (B), historical photographs (C) archive meteorological data (D top) and assessment of the impact of past land use management on present day species composition (D bottom) and satellite perspective of recently land use change in this case Landsat (1975) (E top) and SPOT (2005) images (E bottom) in context. Such a combined approach is essential to gain a comprehensive understanding of past ecosystem dynamics, human interactions and to engender the development of appropriate and sensitive modelling tools (F) that can be used to understand both the impacts that future climate and socio-development will have and to test some of the findings from the past.

the more conventional attempt to disentangle the relative contributions of different environmental and anthropogenic factors.

To explore these issues, with an aim of developing a roadmap for investigating coupled socioecological systems, we focus here on eastern Africa during the Holocene (with perspectives provided from the last glacial period) as, although humans have been interacting with ecosystems for much longer than the last 10,000 years, these millennia correspond to a significant increase in anthropogenically-dominated ecosystems (Foley et al., 2005; Ellis and Ramankutty, 2008), a trend which, until recently, has been conceptualised almost entirely in terms of an exponential rise in human 'impacts' over time. Yet, much of the newly available palaeoenvironmental research indicates that drought and flood episodes over the Holocene (the past 10,000 years) in East Africa have been much more dramatic, and persistent, than recorded by the instrumental record (Gasse, 2000). As one might expect, there has been much scholarly focus on how societies manage ecosystems in the present, particularly in a conservation context, and may do so in the future. However, the future character of East African ecosystems, given their dynamic ecology, complexity of human–ecosystem interactions and response to atmospheric, climate and land use change is uncertain; that a broader approach to studying past human–ecosystem–environmental interactions is needed with a particular focus on how humans managed and manipulated ecosystems in the past (e.g. Conte, 2010; Stump, 2010). Such a longer temporal focus is aided by a growing awareness, both within scientific and public arenas, about how environmental change impacts on ecosystems, and the human use of these, as the constituent plants and animals adapt to new conditions (Gelorini and Verschuren, 2013) as well as increased recognition of the need to extend the temporal depth of ecological baselines than currently available from observational records.

## 2. Researching East African palaeoenvironments

How ecosystems have responded to past environmental variability and change has been reconstructed from sedimentary records and to a lesser extent geomorphological signatures. Both are invaluable for studying the past impacts of climate change on natural systems (Willis and Birks, 2006; Willis and Bhagwat, 2010), and East Africa has long been of interest to palaeoecologists (see Marchant and Hooghiemstra (2004), Gelorini and Verschuren (2013), Kiage and Liu (2006) and Tierney et al. (2011) and references therein for details). This palaeoenvironmental research has been fuelled by the wealth of sedimentary deposits that range from ice caps to swamps, from estuaries to lakes, the latter extending from small crater lakes to the large Rift Valley lakes such as Lake Victoria (Fig. 1). Numerous studies reconstructing fluctuating past lake levels (e.g. Beuning et al., 1997; Ryner et al., 2006, 2008; Vincens et al., 2007; Garcin et al., 2007) and vegetation change (Hamilton, 1982; Jolly et al., 1997; Lamb et al., 2003; Gillson, 2004; Taylor et al., 2005) demonstrate the sensitive nature of the East African environment and ecosystems to register change, particularly in response to hydrological (Verschuren et al., 2000, 2009),