

## ***Interactive comment on “Palaeoenvironmental perspectives for sustainable development in East Africa” by R. Marchant et al.***

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### 1. General comment

This paper aims to demonstrate how the long-term historical perspective provided by paleoecological data can create critical insight into tropical ecosystem dynamics needed for sustainable management and conservation of ecosystems in East Africa. It uses similar arguments as the CPD paper by Willis and Bhagwat ‘Questions of importance to the conservation of global biological diversity: answers from the past’, reflecting frustration of why conservation ecologists and ecosystem managers still fail to fully exploit this information of evident relevance to their task. Marchant et al. also bemoan the relative neglect of anthropogenic impacts on East African ecosystems compared to those in Amazonia and Antarctica, culminating their case in a plea for

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this neglect to stop (p. 969 line 27-28). This paper does not introduce substantial new concepts, but applies some the arguments developed earlier by Willis, Birks and others about the role of palaeoecology in biodiversity and ecosystem conservation to the specific situation of eastern tropical Africa, a region where establishing a sustainable agricultural economy and improving the general quality of life critically depends on preservation of the functions and services of natural ecosystems. Marchant et al. do this through case studies and anecdotes drawn in large part from the authors’ own research. This is a useful paper to advertise the recent founding of the ESSP’s cross-cutting thematic programme IHOPE (Integrated History of People on Earth), however I concur with John Dearing that it can be significantly improved, primarily by giving it a more rigorous structure of Introduction, Case Studies (with subtitles for different time scales and themes), General Discussion, Conclusions and Future Perspectives. On first reading the paper appears a collage of text recycled from research proposals and project reports, with only modest streamlining and pruning; occasionally also sentence structure is poor. Throughout the paper statements and thoughts are presented that belong in the Introduction; if these are all moved forward the introductory material can be adequately pruned of unnecessary ballast. Second, since this paper is clearly not intended to be a review of all relevant paleodata, the authors should think carefully about which published data can serve as best examples to illustrate the specific contributions of paleoecology to key aspects of ecosystem conservation and sustainable development. The only paleodata shown now (Figure 4) serve the apparent function to show that East African terrestrial ecosystems are dynamic on all timescales. But this figure is not very successful, at least for a non-palynologist audience, in showing the patterns mentioned in the text that it is supposed to show. It also fails to show the clear link between long-term ecosystem dynamics and its two principal interacting drivers: natural climate variability and human impact. Third, what readers outside the discipline (such as conservation ecologists and ecosystem managers) may view as a weakness is that many patterns of change observed in East African paleorecords are open to multiple alternative interpretations (e.g., p.974, lines 7-9; p.977, lines 8-10). Marchant

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et al. choose to emphasize the tremendous potential, attributing these alternative explanations to 'complex interplays of drivers and system responses through space and time'. This remains in my view the Achilles' heel of contemporary paleoecology. If we want effective knowledge transfer, we must design our research such that explanations for past patterns are robust and have limited degrees of freedom. In part this can be achieved by better integration of archeological and paleoecological approaches and by combining reconstructions and modeling, as advocated by Marchant et al. But uncertainty in interpretation also results from inadequate time resolution, poor age control, and inadequate understanding of the exact link between a proxy and its target variable. This can be resolved in large part with careful site selection, multi-proxy reconstructions, and proxy calibration. Finally, to simplify things the time frame of this paper might usefully be limited to the later Holocene, such that it does not have to deal with the massive hydrological and ecosystem upheaval which has impacted African landscapes due to variations in orbital monsoon forcing. I would say that this cause of long-term ecosystem change is of modest relevance only to development of strategies towards sustainability over the next centuries. In my opinion, the principal message should be that also under the current boundary conditions of earth's orbit around the Sun, climate and ecosystems in East Africa have been highly dynamic through time due to a diverse range of processes, some natural and some man-made.

## 2. Technical comments (including a selection of typographical corrections)

Abstract, p.964: Line 2: "interactions between changing climate,..." Line 14: "although crucial gaps remain, ..." Line 15: "East Africa is growing rapidly. ..."

Introduction, p.965: Line 15: "present on Earth (~200,000 years)..."

p.966: Lines 8-14: cf. above, any selection is necessarily biased. I recommend to limit to (late-) Holocene records of hydrological change. Here and elsewhere please note spelling of 'Verschuren'. Lamb et al. (2003) and Darbyshire et al. (2002) are useful additions to the cited references on vegetation change.

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p.967: Line 15: "where it conjoins". Line 26: add reference on the most important climate variables for determining ecosystem [actually 'vegetation' or 'plant species'] distribution".

p.968: Lines 1 and 11: reference is made to Fig.2, not Fig.3 (also line 14 on p.969). Lines 18-19: ENSO and IOD are interannual variability, not interdecadal. Line 26: reference is made to Fig.3, not Fig.2.

p.969: Lines 17-21: please add reference to discussion about the Serengeti.

p.970: Line 7: start new sentence "The development. ..."

p.971: Line 10-14: see Gasse et al. (2008) for an alternative explanation of wet vs. dry LGM episodes, based on regional climatology rather than elevation; but I suggest to delete discussion of the LGM. Line 18, "anomalously low": you mean "at an anomalously low elevation compared to other East African highlands"? Lines 24-26: OK, but I am not sure this can be simply extrapolated to what happened during the last glacial period (lines 21-24). Line 27, "...extensive clearance of the Ocotoa-dominated forest": according to Hemp (2005) the major impact on mountain hydrology is from increased fire frequency which shifted subalpine Ericaceous belt downslope, being replaced at high elevations by *Helichrysum* cushion vegetation.

p.972: Lines 1-4, "such visions...": which visions are referred to here? And specifically which aspects of current paleoclimate reconstructions are potentially erroneous? Line 10: deMenocal (2000) is missing in the references. Lines 8-25: is it valid to directly link Bantu migration (~2500-3000 yr BP) via the 4000 yr BP event to the supposedly abrupt drying of North Africa 5500 yr BP? Lines 28-29: is Pearl & Dickson (2004) the primary reference for this statement?

p.973: Line 5: "East Africa". Line 8: "both large and small Rift valley lakes" (Naivasha is not normally listed among the large Rift lakes). Line 23: "environmental shifts". Line 29-1: Bessems et al. (2008) documented that lakes Chibwera, Kanyamukali and Baringo

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stood all dry in the late 18th century and the early 19th century. These lakes provide no information on how long this drought had already persisted in each region. In western Uganda (Chibwera, Kanyamukali) it may have started in the early 16th century, as at Lake Edward (Russell & Johnson 2007); in central Kenya (Baringo) it likely was of much shorter duration, as at Lake Naivasha (Verschuren et al. 2000); Lake Victoria shows an intermediate pattern (Stager et al. 2005); see Verschuren & Charman (2008) for a review.

p.974: Line 21, “than ‘just’”. Line 26, “inter-linkages”: pleonasm.

p.976: Line 7: “(Lejju et al., 2005)”. Lines 14-18: The question then is whether one aims to find out whether humans were present in a region; or is concerned only when humans with a particular lifestyle, technology and density significantly impact on natural ecosystem dynamics.

p.977: Line 13: “and is valued today as a habitat...”. Lines 15-16: “it is likely some degree of protection was afforded...”. Line 19, “border between territories”: of the Bantu, or the Batwa ? Line 22: “last millennium”.

p.978: Lines 26-27: note location of comma’s in “We can see, from how past communities have responded to droughts, that coping mechanisms combined with...”.

p.979: Line 6, “greenhouse gas emissions”. Line 27, “a 90% drop”.

p.980: Line 2, “personal communication” Line 5, “Kenya Wildlife Service”.

p.981: Line 2, “computationally challenging”.

p.984: Line 16, “used to manage the future”.

p.985: Line 2, “Corvallis”.

p.999: Fig.3 caption: “distribution of major vegetation classes”.

p.1005: Plate 1 caption: “Maasai”; “Senecio”; “. . .Africa in generating a hydrological. . .”

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p.1006: Plate 2 caption: “Formerly extensive. . .”

Additional references:

Hemp A, 2005. Climate change-driven forest fires marginalize the impact of ice cap wasting on Kilimanjaro. *Global Change Biology* 11, 1013-1023. Russell J.M. & Johnson T.C. (2007) Little Ice Age drought in equatorial Africa: ITCZ migrations and ENSO variability. *Geology*, 35, 21-24. Stager J.C., Ryves D., Cumming B.F., Meeker L.D. & Beer J. (2005) Solar variability and the levels of Lake Victoria, East Africa, during the last millennium. *Journal of Paleolimnology*, 33, 243-251. Verschuren, D., Charman, D., 2008. Latitudinal linkages in late-Holocene moisture-balance variation. Pp. 189-231 in R.W.Battarbee et al. (eds.), *Natural climate variability and global warming*. Blackwell.

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