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Discussions

Interactive comment on "A review of droughts in the African continent: a geospatial and long-term perspective" *by* I. Masih et al.

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Reply to Comments on paper 'A review of droughts in the African continent: a geospatial and long-term perspective' by Masih et al. (Manuscript ID C760-765)

The authors are grateful to the anonymous reviewer (reviewer # 2) for the valuable comments. The manuscript is substantially revised based on the comments. Most of the raised points are highly appreciated and addressed in the revised manuscript. Additionally, we explain it in the response given below in case we did not agree with a specific comment made by the reviewer. The section on causes of droughts is substantially enhanced by including findings from the studies indicated by the reviewer as well as by conducting review of more studies. Additional analysis is also conducted

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to support the findings on increasing geospatial extent of droughts in Africa (section 3.1). The replies and revisions are briefly described in the following report (directly after the original comments). Details can be found at the revised manuscript attached as supplement.

Reviewer #2: Manuscript: 'A review of droughts in the African continent: a geospatial and long-term perspective' by Masih et al. (Manuscript ID C760-765)

Although evaluating a complex phenomenon such as droughts from the past, present and future at multiple spatial scales and across the entire continent may have merit, doing so in a single review article doesn't seem feasible. Perhaps limiting either the spatial or temporal scale of the scope of the article would make the topic more tractable. This would allow the authors to adequately cover the topic in an article of manageable length. As it stands, aspects of the article provide a discussion that is too brief to be useful.

Response: We appreciate the reviewer comments. We acknowledge that covering both spatial and temporal aspects of drought at the continental scale is an ambitious undertaking. However, we strongly consider that both spatial and temporal aspects are intertwined and should be dealt together. As indicated in the paper, separate studies exist, which cover either temporal or spatial aspect of droughts for one country/region. Our study made a significant contribution in systematically reviewing the available evidence on both aspects of droughts. We give a concise review of available studies in Table 2 and elaborate on the issues within the scope of this paper in Table 2 and rest of the manuscript. The revised manuscript is improved by addressing the specific comments provided by the reviewers and conducting some additional review and analysis.

Section 3.3 (Causes of Drought) is, in places, inadequate in its representation of the literature. The description of the causes of drought in each region focuses primarily on ENSO, and largely ignores - or notes as an aside - other influencing factors. In

HESSD

11, C1988–C1993, 2014

East Africa and Southern Africa, for example, inadequate consideration is given to the influence of the Indian Ocean or the Walker circulation (Funk et al., 2008; Park and Funk 2011). Neither is there any discussion of the influence of the Atlantic Ocean and the Atlantic Multidecadal Oscillation for this region (Giannini et al., 2013). The description of causes of drought for Northwest Africa is virtually nonexistent. Northwest Africa should either be removed from this study, or this section needs to be substantially expanded.

Response: This section is substantially revised. Other drought influencing factors were added. All references indicated by the reviewer 1 and reviewer 2 are examined and found very useful. Additionally more studies are examined and included to improve this section. Please see section 3.3.

The conclusion that droughts will continue to become more frequent in the future based on comparisons of the four most intense droughts of the first half of the 20th century vs. the second half is not adequately supported. Without a physical mechanism, the difference is neither clear nor distinguishable between a one-time shift in climate and a continuing trend. Although the authors reference Giannini et al. (2008), this discussion should be emphasized (i.e. reference Fig. 1 from Giannini et al.). Choosing only four events for their figure leaves the reader wondering why only four were chosen and whether the relationship of increasing drying holds true across severities of drought as defined by intensity and frequency. The chosen diagram, for instance, tells the reader nothing about the evolution of the frequency of middle-intensity droughts across the continent. Droughts of the recent past are often listed as evidence of the increasing intensity of drought. Due to possible observation bias, listing droughts of the recent past is not sufficient to demonstrate that droughts have become more frequent (i.e. recent droughts have been well recorded while the more distant past is less well documented).

Response: This point is clarified and supported by additional analysis. A figure is added showing trend in SPEI over the period 1901-2011. A trend analysis is also conducted using Spearman test, which shows significant increasing trend on the area

HESSD

11, C1988–C1993, 2014

of the African continent under moderate, severe and extreme droughts. The drought events shown in the Figures 2 and 3 are carefully chosen based on the fact that these events are reported in most of the studies as severe droughts. Furthermore, as indicated in the paper, several specific studies show increasing trend in the droughts. Please see section 3.1.

The discussion of future droughts across the African continent seems muddied. The majority of the evidence – and of the description in the text – speaks to the difficulty of simulating droughts in GCMs, but the authors then conclude that despite the many complexities and limitations that droughts will almost certainly be "widespread and extreme" in the future. This seems to be implying that droughts will certainly intensify in the future, which is unsupported by the evidence provided. If this is not the case, it should be clarified. Additionally, it is unclear if this conclusion applies to the entire continent uniformly or whether different regions will experience differing patterns of drought in the future.

Response: As noted in the paper, we make this argument on intensification of droughts based on study of Dai (2013) and the conclusion is clearly stated for central and southern Africa. We do mention that for other regions, like Sahel, available studies do not agree on this issue. In our opinion, the key message on this subject is clear. Readers can refer to the given studies for further details.

Page 2685 lines 0-10: The authors note several ways that others have divided the continent into regions, but do not explicitly state how they will do so for this study.

Response: Information is added.

Page 2688 lines 27-28: Given the limited temporal coverage for most countries, as noted in lines 9-11 of the same page, is the EM-DAT data reliable for diagnosing this?

Response: We do acknowledge this limitation in our paper. But together with other evidence, EM-DAT data also substantiate the point.

HESSD

11, C1988–C1993, 2014

Page 2688 lines 28-29: refers to the three most intense droughts in the text but the actual figures show four droughts from each time period. What is the justification for the number of droughts chosen, and does this relationship hold true across a greater number of droughts?

Response: Corrected. As noted before, these droughts are most widely referred in literature as the most significant events. This point is added in the text in section 3.3.

Page 2689 lines 6-9: clarify this sentence, I'm not sure I understand it completely (i.e. which areas are vulnerable, and why is that information relevant to the frequency?)

Response: Revised.

Page 2689 lines 11-13: provide references for multi-year droughts in the Sahel being more common, and being less common in East Africa.

Response: Done as suggested.

Page 2689 lines 23-28: it seems unnecessary to list out all of the regions indicated as vulnerable. A figure could be useful, but the information in text form is cumbersome.

Response: The list is deleted. The reader can refer to the given reference Rojas et al. (2009) for further information.

Page 2692, L8-15: A mass-citation of studies is inappropriate. Please separate the references into more specific citations so as to be useful for the reader. For example, they could be separated based on those looking at natural phenomenon only, those that sought to identify anthropogenic causes and those that did both.

Response: The references were separated based on natural and anthropogenic phenomenon.

Page 2695 lines 10-20: Line 18 seems to imply increasing frequency and severity of droughts, which contradicts the uncertainty expressed in line 10. Please clarify.

HESSD

11, C1988–C1993, 2014

Response: As noted in the paper, the conclusion drawn in line 18 is based on the evidence available from the past (e.g. 1900-2013 and few centuries before). On the other hand line 10 speaks on the uncertainty in the projections made by using GCMs, though for some regions these are also quite convincing (e.g. for central and southern Africa most likely to face increased frequency and severity of droughts).

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/11/C1988/2014/hessd-11-C1988-2014-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 2679, 2014.