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Natural Hazards and Earth System Sciences
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Discussions

Interactive comment on "The influence of antecedent conditions on flood risk in sub-Saharan Africa" *by* Konstantinos Bischiniotis et al.

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Reviewer #2: Approach of potential interest but currently lacking significant statistical evidence

GENERAL COMMENT: Dear authors and editors, I evaluated this paper exploring the use of SPEI and 7-days antecedent precipitation as indicators of damage triggering floods in the sub-Saharan Africa. If I put the glasses and look at the manuscript in the viewpoint of an NGO looking for an assessment about this topic, then I would be rather satisfied with this report. As contribution for the scientific community this manuscript: - lacks of rigorous description of the data sources and their limitations;

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Discussion paper

- makes in my opinion wrong use of the term "lead time" in many sections; - has a rather small sample; - do not looks at missed events; - presents a very simplistic descriptive statistical evaluation; - poorly acknowledges recent effort in seasonal forecasting (e.g. http://www.hydrol-earth-systsci.net/special_issue824.html). Concerning the missed events, have you tried to obtain information about events not reported in the Münich-RE report, but being taxed as potential flooding in FPU with less than 5 events? I am generally very positive with respect to pragmatic approaches like this, but here I have the feeling that here more efforts are needed in order to better support the statements concerning the potential of this method as a early indicator of floods. Please consider also the comments in the PDF.

RESPONSE: We thank the reviewer for his/her comments, and we are pleased that he/she is very positive about pragmatic approaches like this. Upon his/her comments, we have thoroughly revised the paper. The revised manuscript in preparation includes an extended statistical analysis to support our conclusions. We have also addressed the limitations of our study that have been mentioned by the reviewer, and have removed some of our results, which could not be supported by statistical analysis. At the end of this response, we present the additional new figures proposed to be included in the revised manuscript and we look forward to other comments. Below, we address the comments point-by-point. Please note that the new figures are in pdf file in the supplement.

COMMENT 1: The manuscript lacks of rigorous description of the data sources and their limitations.

RESPONSE 1: We thank Reviewer #2 for his/her comment and after re-reading the manuscript, we agree that the strengths and limitations of the data sources were not presented thoroughly. In the revised version we have addressed the following descriptions;

a) The uncertainty in disaster datasets, and the reasons for the discrepancies between them (e.g. different entry criteria, time period covered) b) An extended description of the sources of NatCatSERVICE database. c) The possible explanations of the upward trend in reported floods over time. d) The difference between a hydrological flood event and a reported flood event as listed in the Munich RE database, and how this is associated with missed events. e) The uncertainty of hydrological variables in the reanalysis dataset due to the lack of ground-based precipitation records, especially in developing countries. f) The sensitivity of the reanalysis product in the resolution choice. g) The uncertainty in hydrological variables in tropical regions and in southern Africa h) The large uncertainty of daily precipitation reanalysis due to the incapacity of capturing local-scale high intensity precipitation events.

COMMENT 2: It makes in my opinion wrong use of the term "lead time" in many sections.

RESPONSE 2: Yes, that is correct. The term ‘lead time’ is associated with forecasts, while this paper examines the conditions prior to the flood events. We have replaced ‘lead time’ with ‘antecedent time’, throughout the revised paper.

COMMENT 3: It has a rather small sample. COMMENT 4: It does not look at missed events. COMMENT 5: Concerning the missed events, have you tried to obtain information about events not reported in the Münich-RE report, but being taxed as potential flooding in FPU with less than 5 events?

RESPONSE 3, 4, 5: We agree that the sample used in our study is rather small. To increase the sample size, we also included flood events reported in the earlier years of the dataset (i.e. from the 1980s onwards). Regarding the missed events, we would like to emphasize that NatCatSERVICE database does not include a flood based on the hydrological definition (i.e. high water levels, peak discharges). Instead, an event enters the dataset when there is property damage and/or when there are people affected. Hence, the paper focuses only on these damaging events, which are usually the ones that humanitarian organizations are interested in. However, by examining only the grid points where floods were reported and not all the grid points of sub-Saharan Africa, we have decreased the number of missed events. In the revised version, we explicitly mention these assumptions. Finally, when revising our paper, we have omitted analyses based on regional FPUs, since we feel that our dataset is too limited to identify enough data points per FPU.

COMMENT 6: It presents a very simplistic descriptive statistical evaluation.

RESPONSE 6: We agree that the original version of the paper presented a descriptive statistical rather than inferential statistical evaluation. In the revised version, we now perform statistical significance tests, which are carried out for;

a) The SPEIs of flood and no-flood events (figures 1, 2) b) The 7-day precipitation of flood and no-flood events (Figure 3) c) Both 7-day precipitation and SPEIs across different climatological areas (Figure 4) d) The SPEIs of different 7-day precipitation percentiles (Figure 5)

Figures 1 and 2 show the SPEI values of all flood and no-flood events on different time scales (0, 1, 3 and 6 months prior to the recorded flood). The no-flood cases considered refer, for each 'flooded cell', to the particular flood onset month of the no-flood years. Due to the very high number of no-flood events, the median value at all time scales is close to 0. The SPEI0-SPEI6 median values of floods are significantly higher, which is underpinned by the results of the z-test (p=0.05). More specifically, the median value of SPEI0, exhibits a value close to 1. This indicates that, as expected, the wetness in the end of these months was high, demonstrating that SPEI0 could be used as a flood monitoring tool. On the (overlapping) seasonal time scales we see a positive relationship between reported floods and SPEI, which reduces while moving from SPEI1 to SPEI6 (0.5 to 0.1).

In addition, we compare the maximum 7-day precipitation of each location during the no-flood years to the 7-day precipitation that preceded the flood events. For each flood, we standardized the 31 values over our 31 year of data (1 for the Flood (F) and the 30 for No Floods (NF), with a mean of 0 and standard deviation of 1 (see Figure 3). This figure presents in boxplots the standardized 7-day precipitation (PRE7) of Flood (F) and No-Floods (NF) events. The results of the z-test showed that preceding PRE7 of floods did not exhibit any significant difference with that of no-floods (p= 0.1). This shows that although PRE7 that preceded the flood is high, it does not fully explains the flood generation. There were probably also similar magnitude events, in the same locations and during the same months that floods were reported, that did not lead to a (reported) flood.

Being aware of the dataset limitations (e.g. incapacity of reanalysis datasets to capture convective rainfall events, likely inaccurate onset date, etc.), the message that we want to convey is that since we observe a relation between seasonal SPEI and flooding and that this relation does not need a relation via weather-scale precipitation, implies that there probably is another factor that affects flooding on a seasonal scale prior to flood generation. One factor might be the soil saturation due to limited water storage capacity. This has been discussed in the revised version of the paper.

Finally, we have omitted the original Figure 8 (SPEI per precipitation class) in the revised version, since conclusions based on this figure could not be supported with statistical significant differences.

COMMENT 7: It poorly acknowledges recent effort in seasonal forecasting (e.g. http://www.hydrol-earth-systsci.net/special_issue824.html).

RESPONSE 7: We thank Reviewer #2 for the link. In the revised version, we include some of these references (see ‘Additional References’).

Comments in the PDF

COMMENT 8: Consequently, they are more reliant on post-disaster response and preparedness activities, often assisted by international donors and humanitarian organizations. Consider here to have a look at Stephens et al. "Floodiness" approach.

Stephens, E., J. J. Day, F. Pappenberger, and H. Cloke (2015), Precipitation and floodiness, Geophys. Res. Lett., 42, 10,316–10,323, doi:10.1002/2015GL066779.

RESPONSE 8: In the revised version, we have included this reference.

COMMENT 9: Here you might have a look at a recent HEPEX-HESS special issue on sub-seasonal to seasonal forecasting http://www.hydrol-earth-syst-sci.net/special_issue824.html RESPONSE 9: We have read some interesting and relevant papers of the HEPEX-HESS special issue and we have included some of them in the revised version (see 'Additional References').

COMMENT 10: The long-term ('seasonal-scale') wetness reflected in the SPEI for the preceding 1, 3 and 6 months, and (b) the short-term ('weather-scale') cumulative rainfall over the 7 days preceding the event. You could call this also long-memory and short memory disposition. RESPONSE 10: Thank you for your remark. The text of the revised version has been changed significantly and we have taken this remark into consideration.

COMMENT 11: Figure 1: Schematic overview of the approach followed in this study. %False alarms seems a quite trivial metric for a sound assessment. RESPONSE 11: We agree.

COMMENT 12: Munich Re NatCatSERVICE disaster database. Is there any cross-validation of the accuracy/completeness of this data source? RESPONSE 12: Unfortunately, we have not conducted any cross-validation of NatCatSERVICE database. The reason is that it is the only dataset at our disposal that provides details of reported flood events, such as coordinates, onset and end dates for the entire sub-Saharan Africa since 1980. We have also looked at other disaster datasets such as EM-DAT and DesInventar, but a systematic cross-validation was not possible as they did not have detailed geographical descriptions, and have only a limited number of reported floods. In the revised version, we recommend to conduct a cross-validation in future research when new reporting data will emerge.

COMMENT 13: How you deal with the mismatch between the 0.5° and the 2.5° resolution? Wouldn't TRMM be an option to evaluate recent years? RESPONSE 13: We think that the datasets should be consistent in their spatial scale and therefore in the revised version, we have upscaled the 0.5° to 2.5° resolution, in order to take into account a larger flood affected area. TRMM provides observations only since 2000 and therefore we'd rather not use it for the sake of consistency throughout the paper.

COMMENT 14: A statistical procedure was applied to fit the accumulated records to a log-logistic distribution with a mean of 0 and a standard deviation of 1. This should be shown or referenced RESPONSE 14: We agree. In the methods sections of the revised manuscript we include the relevant references.

COMMENT 15: Above you speak about 7 days preceding the event, and here you speak about 7 days "lead time". In my understanding lead time is associated to forecasts RESPONSE 15: That is correct. We agree that the 7 days preceding the event would rather be called "antecedent time" and not "lead time". We now only refer to 'lead time' when we talk about forecasts.

COMMENT 16: Figure 2: In this sketch I have the impression that you are dealing with a rather trivial problem, since 7 days prior to the flood peak you have already about 50% of the flood volume and 90% of the peak level. Please discuss. Minor: Add also SPEI0, Minor: Think about the word "lead time" RESPONSE 16: We thank reviewer #2 for this remark. We agree that the graph is confusing. The purpose of this graph is mainly to provide the reader a better understanding of the time points of SPEI and 7-day precipitation. The figure doesn't show any real flood event. We agree that usually a flood is defined with a significant discharge increase close the flood onset. In the revised manuscript, we replaced the graph with a more realistic one. Moreover, SPEI0 is shown on the map. Finally, we have substituted 'lead time' with 'antecedent time'.

COMMENT 17: How efficient is the flood reporting for each country? RESPONSE 17: Unfortunately, to our knowledge, there is not any research that analyzes the efficiency of the flood reporting in each African country.

COMMENT 18: High correlation between flooding and wetter-than-average conditions. (trivial) RESPONSE 18 Indeed, we agree that this sentence does not give any important information to the results and we have removed it.

COMMENT 19: In how many cases was SPEI1> 1 but no flood was recorded? RESPONSE 19: Taking into account all the 'flooded cells' and the months that in each one the flood was generated, we get 1731 cases with SPEI1>1 that no flood was recorded. This number accounts for 11.5% of all no-flood cases. In the revised version, we compare the percentages of flood and no-flood events that exceeded different thresholds and we quantify the elevated probability found for flood events (see Figure 6).

COMMENT 20: SPEI3 > 0.5 was slightly above average (52%), Is my understanding correct: If SPEI3 is > 0.5 then in about 50% of the cases you might expect a flood. Is this not very close to throwing a coin? RESPONSE 20: Our dataset consists of 501 floods over 31 years. Every flood is placed on a grid cell and therefore for each grid cell there is 1 flood and 30 no floods in the record. Therefore, there are 15030 cases of no-floods. SPEI0>1 for 1666 no-flood cases (11%), SPEI1>1 for 1731 (11.5%) no-flood cases (11.5%), SPEI3>1 for 1571 no-flood cases (10.5%) and SPEI6>1 for 1454 no-flood cases (9.5%), while the corresponding percentages for floods is 41% (SPEI0), 27% (SPEI1), 21.5% (SPEI3), 16% (SPEI6). In the revised version, we present these increased probabilities (see Figure 6). Moreover, in the revised manuscript, we also combine the seasonal SPEIs with SPEI0 and 7-day precipitation. Following the same way of thinking, comparing the percentage of floods and no-floods that exhibited an SPEI3>0.5, we are arguing that it is twice more likely to have a flood in the location, where a flood was reported, when SPEI3> 0.5.

COMMENT 21: Fig.7 Why not showing S here? RESPONSE 21: We have used boxplots in the revised version of our paper (e.g. see Figures 1, 3, 4 and 5).

COMMENT 22: Limpopo basin - Check the references Seibert, M., Merz, B., and Apel,

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H.: Seasonal forecasting of hydrological drought in the Limpopo Basin: a comparison of statistical methods, Hydrol. Earth Syst. Sci., 21, 1611-1629, doi:10.5194/hess-21-1611-2017, 2017. Trambauer, P., Werner, M., Winsemius, H. C., Maskey, S., Dutra, E., and Uhlenbrook, S.: Hydrological drought forecasting and skill assessment for the Limpopo River basin, southern Africa, Hydrol. Earth Syst. Sci., 19, 1695-1711, doi:10.5194/hess-19-1695-2015, 2015. Dutra, E., Di Giuseppe, F., Wetterhall, F., and Pappenberger, F.: Seasonal forecasts of droughts in African basins using the Standardized Precipitation Index, Hydrol. Earth Syst. Sci., 17, 2359-2373, doi:10.5194/hess-17-2359-2013, 2013. RESPONSE 22: We thank Reviewer #2 for these relevant and interesting articles. In the revised version, we have included include some of them (see 'Additional References').

COMMENT 23: (> 99th percentile) How many samples are in each 7-day precipitation category for the reported flood events? RESPONSE 23: The samples in each 7-day category are: 0-33 percentile: 53 cases, 33-66 percentile: 119 cases, 66-100 percentile: 329 cases.

COMMENT 24: Fig9. 5-colored boxplots welcome RRESPONSE 24: We have included boxplots in our figures.

COMMENT 25: Fig10 I try to understand, If SPEI1&0 are above 2, then in about 50% of the cases a flood occurred. Correct? RESPONSE 25: Yes, that is correct. However, as explained in R.12, the no-flood cases are way more than the flood cases. In the revised version, we include Figure 7, in which we show the elevated probability of having a flood when SPEI0 & SPEI1>0.

Additional References

In the revised document, we aim to include the following references;

Dutra, E., Di Giuseppe, F., Wetterhall, F., and Pappenberger, F.: Seasonal forecasts of droughts in African basins using the Standardized Precipitation Index, Hydrol.

Earth Syst. Sci., 17, 2359-2373, doi:10.5194/hess-17-2359-2013, 2013 Stephens, E., J. J. Day, F. Pappenberger, and H. Cloke (2015),Precipitation and ïňĆoodiness, Geophys. Res. Lett., 42, 10,316–10,323, doi:10.1002/ 2015GL066779 Coughlan de Perez, E., Stephens, E., Bischiniotis, K., van Aalst, M., van den Hurk, B., Mason, S., Nissan, H., and Pappenberger, F.: Should seasonal rainfall forecasts be used for flood preparedness?, Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2017-40, in review, 2017 Seibert, M., Merz, B., and Apel, H.: Seasonal forecasting of hydrological drought in the Limpopo Basin: a comparison of statistical methods, Hydrol. Earth Syst. Sci., 21, 1611-1629, doi:10.5194/hess-21-1611-2017, 2017 Zhang, Y., Moges, S., and Block, P.: Does objective cluster analysis serve as a useful precursor to seasonal precipitation prediction at local scale? Application to western Ethiopia, Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2017-70, in review, 2017 Tschoegl L., Below R. and GuhaâĂŘSapir D. (2006). An Analytical review of selected data sets on natural disasters and impacts. Paper prepared for the UNDP/CRED Workshop on Improving Compilation of Reliable Data on Disaster Occurrence and Impact. Bangkok, 2âĂŘ4 April 2008. Below R, Wirtz, A. and Guha-Sapir D. (2009), Disaster category classification and peril terminology for operational purposes. Paper prepared fror CRED and Munich Re, October 2009. Lorenz, C., and H. Kunstmann (2012), The Hydrological cycle in three state-of-the-art reanalyses: Intercomparison and performance analysis,J. Hydrometeorol.,13(5), 1397–1420, doi:10.1175/JHM-D-11-088.1 Herold, N., A. Behrangi, and L. V. Alexander (2017), Large uncertainties in observed daily precipitation extremes over land, J. Geophys. Res. Atmos., 122, 668–681, doi:10.1002/2016JD025842. Zhan, W., K. Guan, J. Sheffield, and E. F.Wood (2016), Depiction of drought oversub-Saharan Africa using reanalyses precipitation data sets,J. Geophys. Res.Atmos.,121, 10,555–10,574, doi:10.1002/2016JD02485). 8 Zhang, Q., H. Körnich, and K. Holmgren (2013), How well do reanalyses represent the southern African precipitation?,Clim. Dyn.,40(3–4),951–962, doi:10.1007/s00382-012-1423-z

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Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2017-58/nhess-2017-58-AC2-supplement.pdf

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