Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2020-67-AC2, 2020

Natural Hazards and Earth System Sciences
Discussions
Open Access

Interactive comment on "Skill of large-scale seasonal drought impact forecasts" *by* Samuel J. Sutanto et al.

Samuel J. Sutanto et al.

samuel.sutanto@wur.nl

Received and published: 11 May 2020

Reply to Referees

We would like to thank the Referee 2 for the comments, recommendation, and valuable suggestions. In this document, we reply to each of the comments. (Laa-bb refers to line numbers aa to bb and Px refers to page number x in the revised manuscript).

1. The manuscript is well written and structured. The results are sound and discussions (incomplete though) support the results clearly. I have, however, some comments/suggestions that I would like the authors to address.

We thank the referee for his/her positive response and support in improving our manuscript.

Printer-friendly version

Discussion paper

2. Based on McKee et al. (1993), the length of precipitation record for SPI calculation should be ideally a continuous period of at least 30 years. The same criterion is valid for SPEI. A short record of 28 years was however used to quantify drought hazards in this study. How would this short record length of the data affect the results? Specifically, how would the results be affected by natural climate variability (laying on oscillation high or low period)?

The referee has a point here that indeed the standardized indices require preferably 30 years record. However, we could only use 28 years of observational record (proxy) from 1990 to 2017 due to data availability. EFAS data before 1990 are not available and we only had data up to 2017. The length of the observational data might have some implications on the calculation of parameters of the monthly distributions, which affects the calculation of the drought severity index. For example, if the records (< 30 years) do not include extreme low/high events, then the calculation of drought indices will overestimate these low/high severities, if these would occur, due to lack of outliers in the low/high of normal distribution. For our study, we argue that 2 years missing in the record do not significantly influence our results for following reasons: 1) years 1988 and 1989 were not recorded as extreme drought years, 2) we included drought years in parts of Europe, e.g. 1991-1992, 1995, 1996-1997, 2003, 2006, 2008, and 2015 (Spinoni et al., 2015). We added information about the influence of data length in the revised manuscript (P9L266-274).

3. The Standardized Precipitation Index (SPI) and the Standardized Precipitation Evaporation Index (SPEI) were applied to quantify meteorological droughts and the Standardized Runoff Index (SRI) for hydrological droughts, all of them for accumulation periods of 1, 3, 6, and 12 months. While there exist many drought indices, the choice of the SPI, SPEI, and SRI indices might be justified. An explanation might also be added to why the authors limited the accumulation periods to 12 months and didn't try longer periods (e.g., 24 months)?

The SPI, SPEI, and SRI were chosen in our study, because first these indices are widely used both in the scientific community and by end-users, such as water agencies. Second, these indices were used in previous studies to link the historical drought hazards with its impacts and showed promising results to develop the drought impact functions (previous version P2L47-52). We decided to use the standardized indices with accumulation periods of 1, 3, 6, and 12 months because higher accumulation periods, e.g. beyond 12 months, consist of long series of observation data relative to the lead time, which is a caveat for forecasting skill assessment. Higher proportion of observed data will artificially inflate forecast scores (Sutanto et al., 2020). For example, SPI-12 with a lead-time of 1-month consists of 11 months observed data and 1-month forecast data. SPI-12 with a lead-time of 7-month consists of 5 months of observed data and 7 months forecasts. We added this information in the revised manuscript (P11L337-342).

4. There are many methods for calculation of potential evapotranspiration, ranging from simple temperature-based methods to the standard Penman-Monteith method. It is not mentioned in the paper which method was used for the potential evapotranspiration calculation for the SPEI index and to simulate gridded runoff?

Potential evapotranspiration is calculated through the offline LISVAP pre-processor based on the Penman-Monteith equation (Van Der Knijff, 2008). This information was added to the revised manuscript, including the reference (P4L119-120).

5. Simulated runoff was used as gridded observed runoff was not available. Is the bias of runoff simulations available to be added to the paper?

Observed runoff data are not available, these cannot be measured by definition. Streamflow can be measured, but runoff cannot. Thus, we could not calculate the bias of simulated runoff. Streamflow data in some rivers are available (>250 catchments across Europe) and these were used in previous studies to calibrate and validate the hydrological model, LISFLOOD, from which outcome has been applied in this study (e.g., Feyen and Dankers, 2009; Forzieri et al. 2014). LISFLOOD obtained a median Nash Sutcliffe Efficiency (NSE) of 0.57 over the validation period. We added this information in the revised manuscript (P4L122-125).

6. It was found that the SPEI index shows higher skill than the SPI for short accumulation periods. Can it be because of a long memory of drought hazard calculated from SPEI which is based on water balance (precipitation minus potential evapotranspiration) compared to SPI which is based on only precipitation?

The SPEI drought forecasts have slightly higher skill than the SPI (Fig. 2), especially in autumn and winter. In general, the source of predictability of SPEI comes from the higher temperature predictability due to NAO in Europe than precipitation. Temperature is one of the weather variables that controls potential evapotranspiration. We added this information in the revised manuscript (P7L212-214). Longer memory of drought hazard is only found for the hydrological drought (here runoff, SRI approach), associated with memory represented in initial hydrological conditions and storage in the hydrological system (previous version P10L302).

7. It was found that "drought indices with longer accumulation periods perform better than the ones with short accumulation periods". Isn't it trivial as shorter drought indices with short (long) accumulation periods have more (less) fluctuations/noise and more difficult (easier) to forecast?

The score of meteorological drought forecasts improves with the increase of the accumulation periods of the SPI and SPEI because of a higher proportion of observed data, which artificially inflates forecast scores (Sutanto et al., 2020) (see point 3). Likely, forecast skill of drought indices with longer accumulation periods (long drought indices) also is positively affected by the lower fluctuation/noise in the index compared to shorter accumulation periods. However, we cannot attribute the higher skill of the longer drought indices either to longer period of observations in the forecast, or to the smoother time series. We added this information in the revised manuscript (P11L337-342).

8. Figures 2-4: The black dashed line in the figures indicates the threshold. It was explained in the caption of Figures 3 and 4, while it was defined as “Thres” in the legend of Figure 2. The same format might be used throughout the paper to keep consistency.

We agree with the referee. We revised Figure 2 accordingly (P19).

9. Figures 3 and 4: “ROC” can be added as y-axis label in Figures 3 and 4 and removed from the top.

We moved the ROC legend to the y-axis in Figures 3 and 4 in the revised manuscript (P20-21).

10. Legends of Figures 3 and 4: The legend can be moved to the bottom of the plot with the explanation of each case in front of it.

We moved the legend in Figures 3 and 4 accordingly (P20-21).

11. Caption of Figures 3 and 4: “The performance is measured using ROC” should be removed from the caption of Figure 3 as the plot and the other sentences in the caption clearly show it. The same comment goes for the caption of Figure 4. Revise the sentence in the caption of Figure 4 as “The boxes indicate the spread of ROC values for drought impact functions (15 ensemble members) for a) short lead-times (1-3 months), and b) long lead-times (4-7 months).”

It is a good suggestion. We revised Figure captions accordingly (P20-21).

12. Caption of Figure 5: In the statement "four different impact groups" - the word different is not needed. By stating that they are plural, i.e., four impact groups, the logical syntax of the statement means that they must be different.

We removed the word different in the caption (P22).

13. Figure S2: Text on the plots is very small and not readable.

We revised the Figure by placing figures S2a (now S2) at the top and S2b (now S3) at the bottom to increase the readability (SM P2-3).

References Spinoni, J., G. Naumann, J. V. Vogt, and P. Babosa., 2015: The biggest drought events in Europe from 1950 to 2012. Journal of Hydrology: Regional Studies, 3, 509-524, http://dx.doi.org/10.1016/j.ejrh.2015.01.001.

Sutanto, S. J., F. Wetterhall, and H. A. J. Van Lanen., 2020: Hydrological drought forecasts outperform meteorological drought forecasts. Environ. Res. Lett. in press https://doi.org/10.1088/1748-9326/ab8b13.

Van Der Knijff, J. 2008. LISVAP: Evaporation Pre-Processor for the LISFLOOD Water Balance and Flood Simulation Model. EUR 22639 EN/2.

Feyen, L., and R. Dankers, 2009: Impact of global warming on streamflow drought in europe. J. Geophys. Res., 114, D17 116, doi:10.1029/2008JD011438.

Forzieri, G., L. Feyen, R. Rojas, M. Flörke, F. Wimmer, and A. Bianchi., 2014: Ensemble projections of future streamflow droughts in europe. Hydrol. Earth Syst. Sci., 18, 85–108, doi: 10.5194/hess-18-85-2014.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2020-67, 2020.