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Discussions

Interactive comment on "From meteorological to hydrological drought using standardised indicators" *by* L. J. Barker et al.

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Review of "From meteorological to hydrological drought using standardised indicators" by L.J. Barker et al. This study analyses drought in the UK. Probably this is the most complete analysis published to date on the spatial and temporal variability of hydrological and climate droughts in the UK. The authors have analysed the characteristics of hydrological and climate droughts across UK but also the relationship between climate and hydrological droughts and the different factors that determine this relationship. The manuscript is very well written, it includes an update literature review and a coherent discussion section. The research topic is highly suitable for HESS and it has strong scientific but also applied interest. Knowing drought characteristics and how drought propagates throughout the hydrological cycle is essential to improve drought monitor-

ing and early warning and to facilitate drought preparedness and mitigation.

I would recommend the publication of the manuscript in HESS. Nevertheless, I also think necessary that authors clarify some issues (mainly in the methodology section) and reorganize the last section of the results to improve readability. In addition, I include some points below; most of them should be considered as suggestions for further research related to the topic.

Minor comments: 12830. Line 4. Examples of drought monitoring systems using streamflow data should be cited here since they are not common worldwide.

12830. Lines10-14. I agree with multiple advantages of the SPI regarding to other indices, but also some of the deficiencies of this index should be mentioned, e.g. it does not take into account the effect of other variables different to precipitation on drought severity (e.g. the Atmospheric Evaporative Demand, see e.g., Vicente-Serrano et al., 2010 and 2014 Environ. Res. Lett. 9 (2014) 044001 (9pp) and Beguería et al. (2014) Int. J. Climatol. 34: 3001–3023), it does not provide reliable estimations in arid climates (Wu et al., 2007: Int. J. Climatol. 27: 65–79.) and the cumulative character of SPI causes that neighbor areas show very different behavior in temporal evolution of droughts considering long-time scales given the role of high precipitation events affecting local areas, with influence during long time-periods (Vicente-Serrano, 2006, Water Resources Management 20 (1), 37-60).

12832. Line 8. Maybe the study by López-Moreno et al. (2013) Journal of Hydrology 477, 175-188, could be cited here given it is closely related to the research topic.

12833. Line 15-19. I agree with authors that water regulation and water management disrupt the relationship between climate variability and streamflow. Nevertheless, hydrological basins are currently highly modified and this is not caused by water management, damming or water extractions, but also by several land use-land cover modifications during centuries, which have strong influence on streamflow magnitude and river regimes (See further details and references in García-Ruiz et al., 2012, Earth-

Science Reviews 105 (3), 121-139). Really it is very difficult to find “natural basins” in European countries given strong alterations of vegetation and soil properties, which have several hydrological implications.

In addition, to know the response of hydrological droughts to climate drought conditions in regulated basins is also highly relevant since several water uses (hydropower, water consumption, hydropower production, etc.) are usually affected by drought events. I understand that knowing the response of hydrological droughts to these events is much more difficult than in “natural basins” since a number of factors may affect the streamflow behaviour. Nevertheless, to know the possible differences in the hydrological response to climate droughts between “natural” and regulated basins, or to determine how regulation or water uses have changed this response is highly useful for drought management. I am not asking to authors to include regulated basins here, but further discussion about this issue would be welcome and/or mentioned in the section 5.5 related to further research.

12833. Section 2. The section of data description is only focused on the streamflow records but there are not details on the precipitation data used. It is essential to mention some information on the precipitation data used (stations or gridded?), if individual stations are used, it is essential to explain if the stations are representative for the entire basins (for example in mountainous areas it is common to have the meteorological stations in the bottom valleys, whose climate characteristics are different to those found in the mountain peaks), is precipitation data quality controlled and homogenized?, This is essential in any climate study using time series of meteorological variables.

In 12837. Line 25, it is mentioned that data may contain gaps. If this refers to the streamflow or precipitation data should be mentioned in the data section, and maybe to include a table with the percentage of data gaps in the different groups of basins (both for streamflow and precipitation). How data gaps may affect results? Why not to filling gaps using neighbor gauging stations in the same river or Neighbor Rivers? Given the high availability of streamflow series in the UK I think it could be possible

with few errors.

Section 3.1 Here it is explained the methodology used to calculate SPI and SSI, but it is not explained to which data is applied (maybe a unique series for the drainage basin corresponding to each gauging station?, from gridded series or averaging precipitation observatories within the basin?, if the latest, how the different stations are weighted to create the regional series?). These issues should be addressed prior explaining how SPI is calculated.

12836. Line 11-20. The authors are using a non-standard procedure to calculate SPI. There are standard guidelines by the WMO to calculate the SPI (http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf) using a 2-parameter Gamma distribution bounded at 0. I think some comparison should be provided (maybe in suppl. Info between SPI following standard guidelines by WMO and the distribution used by the authors). The same is valid for the SSI. It would be useful to know how the proposed Tweedie distribution fits the streamflow data and adapts to the strong seasonal and spatial differences that characterize river regimes. In Vicente-Serrano et al. (2012b) we found strong difficulties to obtain a standard methodology to fit the 1-month streamflow data in a complex basin and finally opted to use different distributions of probability according to different river regime characteristics. If the proposed Tweedie distribution may account for the strong differences in river regimes, it would be a very good contribution to calculate the SSI.

Section 4.1 In general, I find difficult to compare between climate and hydrological droughts. I would find more useful to see in the same graph the drought characteristics for SPI and SSI in the each cluster. In addition, I do not find useful to use time-scales longer than 1 month to quantify hydrological droughts. The different time-scales used to calculate SPI are useful to approximate the times of response of different water uses to precipitation deficits, but long-time scales of SSI have not hydrological meaning neither usefulness for drought monitoring and early warning. I would remove SSI-6 and SSI-18 from analysis in Figs 4 and 5 and I would merge the results on 1-month SSI with different SPI time-scales in Fig 4.

12840. Lines 5-10. I do not find these figures very informative. If any figure should be removed I would recommend 6 and 7 (also same comments that above related to SSI-6 and SSI-18).

12840. Section 4.2. What about possible seasonal differences in the response of hydrological droughts to climate droughts? These differences can be very important (e.g. the time-scales at which hydrological droughts respond to climate droughts can show noticeable seasonal differences, See e.g. Vicente-Serrano and López-Moreno 2005; López-Moreno et al. 2013). Some comments or discussion about these issues would be useful (or maybe to stress this analysis as further research).

A more complete description of the BFI calculation should be provided in page 12835.

Figure 11 caption to include ("climate" drought characteristics)

I find section 4.3 confuse to follow. I would separate the section with different sub-headings, the first relating climate droughts and hydrological droughts characteristics (based on SPI and SSI) with climate and geographical/hydrological variables, and a second subsection analysing the different patterns found on the relationship between SPI and SSI and the different variables. I know all this information is contained in section 4.3 but I think that separating this info in two subsections would be clearer for the potential readers.

12845. Line 20. See a similar example in Vicente-Serrano et al., 2004 Climate Research 26 (1), 5-15) that found very different drought patterns in a small Mediterranean region. I find the explanation in section 5.1 very useful since the authors are merging drought duration-severity with climate characteristics in a region, which are concepts completely different, and they introduce explanations related to atmospheric circulation (e.g. NAO), which also plays a relevant influence to explain this pattern in other regions of Europe (e.g., López-Moreno and Vicente-Serrano, 2008, Journal of Climate

21 (6), 1220-1243; López-Moreno et al., 2008, Water Resources Research 43 (9)). It would be useful to mention the atmospheric mechanisms that govern precipitation in central and south UK, in opposition to long-term variability linked to NAO in the North. I suppose that precipitation in the South is governed by high frequency circulation at the synoptic scale instead to low-frequency circulation patterns. This would explain differences found between drought patterns between North and South regions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 12827, 2015.