Response to the comments of Anonymous Referee 1:

Review of: Human influences on streamflow drought characteristics in England and Wales. This study analyses the impact of human perturbation of hydrological drought occurrence using streamflow and precipitation data. The manuscript is very well written and organized, and introduction and discussion sections are really very sound. I consider the manuscript's topic is also highly suitable for HESS and it contains some novel issues, including the methodology applied to identify anthropogenic modifications of streamflow.

We thank the reviewer for the positive and constructive feedback on the manuscript and are grateful for the valuable input. Below we respond (in blue) to the reviewer comments (which are in black).

Page 2. 12. See also Vicente-Serrano et al. (2017) Journal of Hydrology: Regional Studies 12: 13-32, which is covering a similar topic.

Thank you for making us aware of this publication, which we had missed.

Page 5.3 How were the monthly streamflow series created? Averaging the available daily records in a month?

Monthly streamflow time series were created by calculating the monthly average of all daily flows. We will clarify this in the revised version of the manuscript.

Page 5.8 I understand the existing problems for data gap filling but the existence of gaps also limit calculation of drought indices. If I understand well, all the selected stations showed less than five days of missing data in all months between 1974-2013, so the entire monthly series were complete. If this is correct it should be stated in the manuscript.

Streamflow records that had at least one month with more than five days of missing data were excluded from the analyses (so a record could have several months with a few days of missing data). We will clarify this in the revised version of the manuscript.

Page 6.12-15. Why standardized streamflow and precipitation indices are not used instead of real precipitation and streamflow magnitudes? These indices are comparable spatially and seasonally. Note that streamflow and precipitation distributions are usually biased so this could have some impact on average precipitation and streamflow but also on total magnitude anomalies. The selection of this approach would be justified in some depth.

For the correlation based screening approach (Results in section 4.2), we use rank correlation (Spearman's Rho). Thus, the strength of the correlation will be the same, regardless whether standardized or not. The other two screening approaches (results in section 4.1 and 4.3) are based on drought characteristics derived from a threshold based approach (20^{th} percentile threshold). This is the classic, most used method to determine below-threshold characteristics and we think it an advantage to use such a threshold based approach on raw precipitation and streamflow data as it assures that the 20^{th} percentile threshold is exceeded the expected 20 percent of the time for each station and calendar month.
This is not necessarily the case when streamflow data would be transformed to the Standardized Streamflow Index. An SSI record computed with for example the GEV distribution exceeds the 20^{th} percentile (corresponding to an SSI value of -0.84) between 7.5 and 37.5 percent of the time, due to an imperfect distribution fit. Therefore, standardizing streamflow in combination with a threshold based approach reaches the opposite of having a fair comparison of a number of threshold exceedances over space and time.

Arguably, better results (a closer approximation of the 20th percentile of threshold exceedance) should be obtained using the best fitting distribution for each calendar month or station (as is done in Vicente-Serrano et al., 2012). However, even the "best fitting" distribution is likely not perfect and will result in a variability in threshold exceedances between stations and calendar months. This is especially the case for heavily influenced streamflow records that could have less standard distributions (e.g., bimodal in case of changes in outflow from a reservoir during the period of record). Concluding, we did consider using SSI, but decided against it as it adds unnecessary complexity to the interpretation effort due to the effects of distribution fitting, which would distract from the main topic.

Page 9.21. It would be also quite interesting not only to analyse the magnitude of correlations but also the time-scales of precipitation accumulation that better correlates with streamflow. Maybe it could provide some relevant differences between natural and perturbed basins.

For natural catchments in the UK, this has been done in (Barker et al., 2016); catchments with a high BFIHOST have a stronger correlation with the precipitation accumulated over longer timescales, as is also shown in Figure 1A of this reply. Similar patterns were observed for the subset of catchments for which groundwater abstractions (FAR=G) or reservoirs (FAR=S) are indicated (Figure 1B and 1C of this reply). However, some of the streamflow records for which groundwater abstractions have been indicated that have a lower BFIHOST show on average a stronger correlation with precipitation records accumulated over longer timescales (Figure 1B). The observed (non-linear) pattern looks very similar to the relation between BFIHOST and drought duration (Figure 4 of the manuscript); more persistent streamflow droughts of higher average durations goes together with a stronger correlation between streamflow and precipitation accumulated over longer time periods. For catchments for which storage or impoundment reservoirs have been indicated (FAR=S), there are a few stations with a low BFIHOST that have a stronger correlation with precipitation accumulated over longer time periods (Figure 1C).

Although interesting, we feel like that this analysis does not fit in within the current version of the manuscript but rather in a follow up study that explores these relations in more detail (more focused on drought propagation / drought monitoring and early warning).

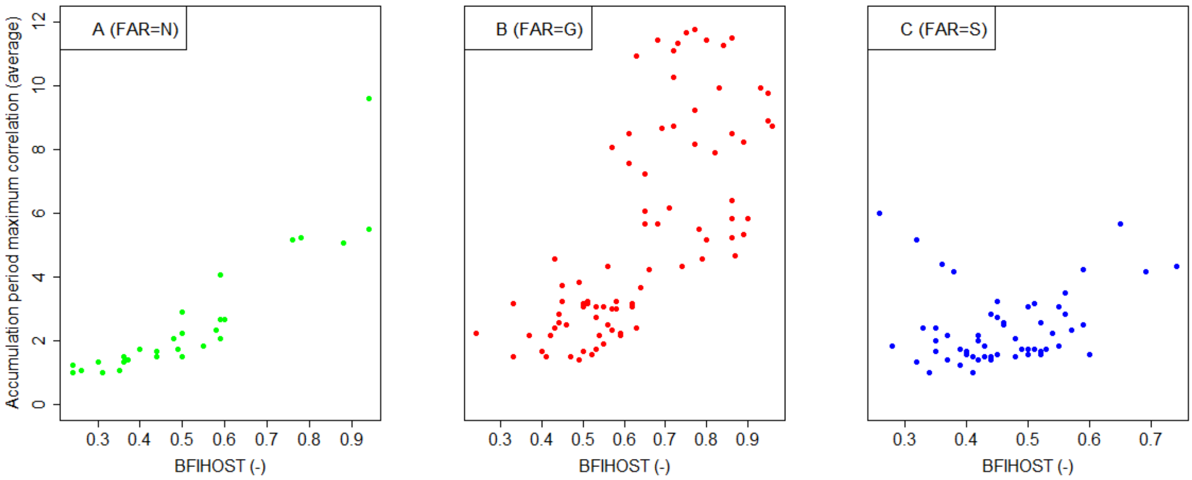

Figure 1. Average accumulation period (in months) of the precipitation signal that has the strongest rank correlation with streamflow for all calendar months.

Page10.27. See also Vicente-Serrano et al. (2017) four further example

Thanks for this suggestion.

References:

Barker, L.J. et al., 2016. From meteorological to hydrological drought using standardised indicators. *Hydrol. Earth Syst. Sci.*, 20(6), pp.2483–2505. Available at: http://www.hydrol-earth-syst-sci-discuss.net/12/12827/2015/.

Vicente-Serrano, S.M. et al., 2012. Accurate Computation of a Streamflow Drought Index. *Journal of Hydrologic Engineering*, 17(2), pp.318–332.