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Hydrology and Earth System Sciences
Discussions

Interactive comment on "The impact of elevation and flow dynamics on hydrological drought and wet spell characteristics in semi-arid southeast Arizona" *by* Mengtian Lu et al.

Anonymous Referee #3

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This manuscript deals with a new methodology for assessing hydrological drought with a variable threshold approach in semi-arid catchments and its application on case study catchments in Arizona.

Main comments

The comments will clearly overlap with those of the other referees, emphasizing the main issues found in the manuscript. But before that, it has to be noted that the study is reasonably well conducted and the manuscript generally well written and organised.

However, several major issues can be identified:

1. The study extends some previous work on a generic method for defining a hydrological drought with a variable threshold (Van Huijgevoort et al., 2012), a method that would be applicable to semi-arid catchments with long periods of zero flows. First, the methodological extension presented L165-L198 is not clearly described, and would deserve some more didactic illustration and/or pseudo-algorithm.

2. Second, one wonders about the usefulness of proposing an extension of the variable-threshold hydrological drought definition. Indeed, the basic reasoning of using a variable threshold is to detect streamflow lower than usual. When streamflow is usually zero, what is lower than usual? The conceptual limits of the variable threshold method are here clearly reached. Indeed, what is the point of by all means trying to compute/define a streamflow deficit when there is no streamflow? I guess that defining drought in a non-perennial river may be useful, for example for aquatic biodiversity, but streamflow drought is here not relevant. What could be relevant for example in this case is defining an edaphic drought in the river bed to assess the decline of soil moisture during the dry season, and the state of the corresponding habitat for invertebrates.

3. Third, and in relation to the above comment, the objective of the study is clearly ambiguous. Indeed, the title does not even mention the proposition of a new methodology. Second, the current title suggests some relationships between catchment characteristics and drought characteristics, and the way results are presented – including the poor map of Figure 1 that don't even show the delineation of catchments – do not allow to even extrapolate results in other basins with similar characteristics.

4. Fourth, the interpretation of results in terms of hydrological droughts as computed with the newly proposed method is in my view just that: an interpretation. Indeed,

this is when results are presented that the reader realises that there is no possible assessment of whether the new method is more relevant than another one, because precisely of the questionable relevance of using a variable threshold for zero flows. This method indeed comes down to assess how much the river is not flowing...

As a conclusion, a new methodology to compute hydrological drought – understood as anomalies with respect to a variable threshold – for semi-arid basins has to show a continuity with perennial basins in order to be taken as a serious candidate. This would in my opinion be the only way to assess the underlying computation assumptions. This is what the authors have tried to present, but results are unfortunately unconvincing. And even with such a continuity, I definitely question the overall approach of hydrological drought understood as anomalies when considering non-perennial basins. This study has indeed one merit: to exemplify the irrelevance of considering variable threshold approaches for characterizing hydrological droughts. As an example on the other side of the hydrological spectrum, I am not sure why a slightly-shorter-than-usual several-month-long period with a dry riverbed would be named a wet spell for a given basin.

References

Van Huijgevoort, M. H. J., Hazenberg, P., Van Lanen, H. A. J., and Uijlenhoet, R.: A generic method for hydrological drought identification across different climate regions, Hydrol. Earth Syst. Sci., 16, 2437–2451, https://doi.org/10.5194/hess-16-2437-2012, 2012.

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