

# Review of “Multiscale evaluation of the standardized precipitation index as a groundwater drought indicator” by Kumar et al. HESSD 2015

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## **General comments**

Kumar et al investigate the suitability of a version of the standard precipitation index (SPI) to characterise groundwater droughts, as defined by standardised groundwater level hydrographs (SGI), at point and regional scales. This is done using monthly groundwater level data from ~2000 relatively shallow wells from southern Germany and central Netherlands. The study first characterises the relationships between SPI and SGI for a variety of SPI accumulation periods, including identification of optimal SPI accumulation periods, and then assesses the skill of SPI in predicting groundwater droughts using an assessment of the hit rate and false alarm ratios. The authors find that in the absence of prior information about the hydrogeology of a point or region SPI is a poor indicator of groundwater drought at both scales.

The paper is well written, with a clear description of the aims and methods. The results and discussion are combined in a single section. Although generally this is not to be recommended, because the combined results and discussion section is well structured the combined presentation does not detract from the central arguments of the paper.

The papers main finding is essentially a negative one, i.e. that SPI when used in isolation is a poor indicator of groundwater drought, and consequently the authors should be applauded on reporting this based on a systematic and well argued analysis. Although the authors emphasise that the study focuses on the statistical skill of SPI in predicting groundwater droughts (P7409, L1-4), given the negative findings it would have been interesting to see what effect additional prior information may have had on the correlations between SPI and SGI. For example, information about the geology or aquifer type of each site and some equivalent averaged descriptor for each 0.5 degree grid cell should be available based on even relatively coarse-scale mapping. Would bringing this sort of information into the analysis improve the SPI/SGI correlations, and if so by how much?

## **Specific comments**

1. P7408, L12: re-order Peters et al references to 2003, 2005, 2006
2. Section 2.1 states that the study was performed using monthly groundwater observations. Are these averaged from more dense observations or are all observations on the same day of each month? Is there any missing data in the time series, if so how has this been handled, e.g. left missing, or infilled and if so how? If there is missing data how much is acceptable?
3. P7412, L15-25 describes the method used to produce monthly estimates of SPI and SGI at 0.5 degree grid scales. What analysis has been undertaken to investigate the effect of sample size on the relative confidence of estimated mean gridded SPI and SGI values and the consequent implications for calculated hit rates and false alarms (Figs.6 and 7)? For example, some of the grid cells for the Dutch study area contain only 2 or 3 sites, whereas some grids cells in Germany appear to have many 10s of sites. Also, it appears that the better hit rates for Optimal SPI in Fig. 6 are associated with grid cells with the most sites. Is this correct? If so, what are the implications for the analysis?

4. P7413, L5 it is stated that “we consider the entire spectrum [0,1] of the SPI and the SGI, without distinguishing between dry or wet regimes”. It would be helpful to add a brief discussion of the implications of this statement. Also note a slight contradiction with the statement at P7422, L24-25 that “here we specifically aimed at analyzing the ability of the SPI to predict groundwater drought conditions at different levels”. Consider a short clarification to reconcile these statements.
5. P7419, L9-12. This is describing the well known phenomenon of drought attenuation in the groundwater compartment of the terrestrial water cycle. It may be helpful to explicitly acknowledge this here with a suitable reference.
6. P7421, L12 should read “on the basis of this data-based exploratory analysis”
7. Please check all references. For example, a number have missing volume or page numbers, e.g. AghaKouchak et al.; Hao et al; Li et al; Samaniego et al; Teuling et al; and Weider and Boutt.