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Discussions

Interactive comment on "Multiscale evaluation of the standardized precipitation index as a groundwater drought indicator" *by* R. Kumar et al.

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Review of "Multiple evaluation of the standardized precipitation index as a groundwater drought indicator". The manuscript analyses the relationship between precipitation and groundwater droughts in South Germany and the Netherlands. The manuscript focusses in knowing on the capacity of the Standardized Precipitation Index as a drought monitoring metric to determine groundwater drought. The article is well-written and structured. The research topic is suitable for HESS and it has great potential given the current interest of moving from the use of climate drought indices (easy to calculate) to drought impacts (difficult to estimate).

I would recommend the acceptance of the manuscript in HESS but I would like to draw attention to different issues that would be interesting that the authors consider or at least mention in the discussion of the results.

Page 7407. Lines 11-13. I agree that drought monitoring based on precipitation data may have advantages regarding data availability. Nevertheless, this approach may have also deficiencies since it does not consider other key variables that affect drought severity, mainly the atmospheric evaporative demand (AED). Although the AED effect could be considered negligible for ground water recharge, we cannot forget that approximately 3/5 parts of the precipitation returns to the atmosphere via evapotranspiration processes. Probably in the Netherlands and Germany the AED is not a relevant stressing variable given high precipitation amounts (although not negligible for drought impacts, e.g., the year 2003) but from sub-humid to arid regions AED is a determining factor that affects water resources availability in a determining manner. Thus, it is expected that AED does not only affect soil moisture and runoff but also water infiltration and ground water since AED is affecting the vegetation respiration and the water exchange between plants and the atmosphere. A comment or discussion about this issue would be welcome.

Page 7407. Line 22. Also the role of AED should be mentioned.

Page 7408. Line 11 Some other references dealing directly with this topic: Climate Research. 58, 117-131; Journal of Hydrology. 477: 175-188; Earth Interactions 16, 1–27.

Page 7408. Line 16. There are previous studies analyzing the relationship between drought indices and groundwater (e.g., Natural Hazards and Earth System Sciences 15: 1381-1397; Hydrology and Earth System Sciences 19: 2353-2375; Water Resources Management 24: pp. 1867-1884). These studies should be cited here.

Page 7409, Line 21. Is there any aquifer exploitation like pumping for water supply and irrigation?, please detail.

Page 7410. Lines 19-22. More details on the filtering analysis are nedded. If only the months with available groundwater are used to select precipitation months, what about previous months needed to obtain longer time-scales?

Page 7411. Lines 4-6. The correct references to support this statement should be McKee et al. 1993 and Guttman 1999.

Page 7411. Line 8. Guttman (1999) suggested the Pearson III distribution based on large study in USA. In any case, the uncertainty associated to the selected distribution should be minimal and there is a standard methodology to calculate the SPI by the World Meteorological Organization (http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf). For this reason, I do not find suitable to use an empirical approach to calculate the SPI when a well-established and widely accepted methodology exists. Empirical approximations to obtain cumulative distribution functions are much more depending of the available sample than the use of pdfs. I understand that groundwater data availability prevents of fitting a a pdf given low data availability in some wells, but given high density of groundwater stations (which are expected to be highly correlated among them), the regional analysis (Hosking, J.R.M., Wallis, J.R., 1997. Regional Frequency Analysis, An Approach Based on L-Moments. Cambridge University Press, Cambridge, UK) could be a better approach to obtain the groundwater drought index. In any case, since the statistical analysis are based on rank correlations, in which the magnitude of the series is not taken into account, the procedure used to standardize of the precipitation and groundwater is secondary. Thus, the authors could have used directly the raw series of ground water and the series of precipitation accumulated on different time-scales for the analysis.

Page 7413. Line 16 and following. I think you could have used better approaches to compare the agreement between groundwater and precipitation drought events (e.g., comparing the duration, maximum intensity, total magnitude and spatial extent of droughts). Really a categorical contingency table is useful but I think that more information could be extracted from the available data, at least for the longest groundwater

series in which individual drought episodes can be identified.

Section 3.2 This stresses the diversity of relationships that are usually recorded between drought time-scales and impacts, and the need of testing initially the best time scale of a drought index to determine possible impacts. This is quite relevant and not specific for groundwater but also for several hydrological and ecological systems (e.g., PNAS 110: 52-57; Climate Research. 58, 117-131; Journal of Hydrology, 386: 13-26; Agricultural and Forest Meteorology. 151: 1800-1811; Journal of Hydrology. 477: 175-188, among others). I think this should be stressed and discussed in more depth (see further discussion about this issue in Journal of Geophysical Research-Atmosphere. 116, D19112, doi:10.1029/2011JD016410).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 7405, 2015.