

Hydrol. Earth Syst. Sci. Discuss., referee comment RC3
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Comment on hess-2022-217

Anonymous Referee #3

Referee comment on "Development of a novel daily-scale compound dry and hot index and its application across non-arid regions of China" by Huimin Wang et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-217-RC3>, 2022

The study of Wang et al. proposes a novel daily-scale compound dry and hot index for assessing compound dry and hot events on a daily scale in non-arid regions in China. A standardized temperature based and a standardized soil moisture index are jointly modeled in a copula framework to create an index for short term drought and hot events. The index shows a general good agreement to soil moisture patterns in the study area and can reproduce compound dry and hot events for specific cases. However, in its current form I would recommend to reject the manuscript:

- First, the structure of the study is very similar to a study of Li et al. 2021. In my opinion, the main (technical) difference in the index derived by Li et al. and this study is the calculation of the evaporative demand. Moreover, the evaporative demand is only a constant for each month, divided by the number of days in the proposed index, where the potential evapotranspiration (Penman-Monteith) by Li et al. can be calculated for every day. Thereof, I am not sure if this study has the novelty to be published in HESS.
- Second, I am concerned about the application of copulas in the study. For the application of copulas the iid assumption has to be met. By applying a daily time series of soil moisture and temperature this is not true, as the time series are auto-correlated and the rising temperature over time violates the assumption of stationarity. Pitfalls and good practice for hydroclimatic applications of copulas can be found in e.g. Tootoonchi et al. 2022.

Additional general comments:

- Similar to the application of copulas the iid assumption also has to be met for fitting a uniform distribution to soil moisture data and temperature.
- The evaluation is mainly performed against soil moisture data. Therefore, I suggest to use the term soil moisture drought explicitly throughout the manuscript, or to clearly

define other drought types in dependency to soil moisture.

- The methods section is not very clear to me. I am missing the point which data is used for fitting the distribution for each of the indices (STI, SZI, DCDHI). Is each day fitted separately (as it is proposed by most standardized indices), or is one distribution fitted to the whole time series. Please check the formulas and restructure the methods section to make this more clear.
- One uncertainty for standardized indices as STI and SZI is to find a suitable distribution (Stagge et al. 2015). In case of the STI, I believe that the approximation by a normal distribution will be suitable for most data points. In the case of the SZI, I assume this may be dependent on the applied time-scale and on the geographic region. At least, I suggest to use a goodness of fit test for the log-logistic distribution and dismiss distributions that are not well-fitted to the data, or test other theoretical distributions.

Specific comments and technical corrections

Introduction

Line 36: I could not find Miralles et al. 2019 in the reference list.

Line 37: maybe delete "over global terrestrial regions".

Line 38: Please check the use of the word "invaded" here.

Line 38 – Line 41: These results may be summarized into 1 sentence.

Line 45: I could not find Hao et al. 2013 in the reference list.

Line 51: "con not"

Line 56-59: Please add Li et al. 2021 as citation here.

Line 60: The index was called SAPEI in the study.

Line 63: SCDHI was not introduced.

Line 66: Please rephrase "over global maize areas".

Line 73ff: The end of the introduction would may benefit if the research gap and the addressed research questions could be stated more explicitly. Additionally in the introduction there is no notice, that the indices are evaluated by SPI, SPEI, NDVI and soil moisture data.

Line 75: Please add what the hot index of your study is.

Data

Figure 1: Please check the legend of this figure. I am not sure if it is necessary to use a diverging color ramp, I suggest to at least report the middle threshold. Please check this throughout the whole manuscript.

Line 105 and Line 109: What is the purpose of transforming the soil moisture data and the NDVI?

Methods

Please check all formulas and their definitions.

Line 124ff: I could not find any reference where the data for the surface water balace is from? Please add this to the data section.

Line 149: which is a.

Line 153: Please check the sentence and the following formula.

Formula 10 and Table 1: In my opinion a cold and wet day would also yield a very low DCDHI, how was this approached in this study?

Line 165: What is run theory? Please define or at least add a citation.

Figure 2: The figure is very similar to Figure 3 of Li et al. 2021, either use this one and cite or create a new one. I believe on the y-axis there should be DCDHI and not the index of Li et al. - SCDHI.

Formula 11,12: I could not find any definition for t.

Results

Page 8: I am not quite sure, on which data the Pearson correlation coefficient (?) is calculated, but if it is the whole time series for each data point, then statements as Line185: "indicating SZI can better monitor drought across different climate regions", or Line 189: "In a word, the daily SZI is a reliable indicator in monitoring drought at different time scales, ...", should be avoided. As the Pearson correlation coefficient only gives an impression of the overall correlation between the time series, which also includes medium and wet events.

Figure 3: I could not find a definition of SSMI in the caption. The resolution of the maps may be improved if areas where no results are shown are dismissed. Please check this also in all other figures. Additionally, the panel names ((a1),...) may be also discarded to improve the Figure.

Figure 4: A more informative plot may be the comparison between the different drought indices and dividing the panel by the different time scales.

Figure 5: I could not find a definition of the drought threshold, please clarify.

Line 210 (and 190): I could not find any definition of an agricultural drought. Which time-scales represent agricultural droughts for the soil moisture index? Please clarify.

Line 215: superior to what and how was this evaluated? Please clarify.

Line 218ff: I am not sure of the purpose of this paragraph, as the construction of a copula was to model the dependence between STI and SZI and now test the correlation between the input data (SZI, STI) and the modeled data (DCDHI). Please clarify, why this is necessary and not just report the parameters of the copula function?

Line 242: "with records in some published documents ..." - please be specific, or at least cite the relevant documents.

Section 3.3. Please note my point on stationarity of the STI index. Further, why one period has 29 years and the other 32 years?

Figure 10: How are Duration, Severity, and Intensity defined for this plot – is it an average for each year as for the Frequency?

Literature

Stagge, J.H., Tallaksen, L.M., Gudmundsson, L., Van Loon, A.F. and Stahl, K. (2015), Candidate Distributions for Climatological Drought Indices (SPI and SPEI). *Int. J. Climatol.*, 35: 4027-4040. <https://doi.org/10.1002/joc.4267>.

Tootoonchi, F., Sadegh, M., Haerter, J. O., Rätty, O., Grabs, T., & Teutschbein, C. (2022). Copulas for hydroclimatic analysis: A practice-oriented overview. *Wiley Interdisciplinary Reviews: Water*, 9(2), e1579. <https://doi.org/10.1002/wat2.1579>.

Li, J., Wang, Z., Wu, X., Zscheischler, J., Guo, S., and Chen, X.: A standardized index for

assessing sub-monthly compound dry and hot conditions with application in China, *Hydrol. Earth Syst. Sci.*, 25, 1587–1601, <https://doi.org/10.5194/hess-25-1587-2021>, 2021.