

Reply on RC3

Huimin Wang et al.

Author 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-AC4>, 2022

We express our great appreciation for your constructive comments on improving the manuscript. We will revise our manuscript according to your comments. The answers to your concerns are as follows:

First, the structure of the study is very similar to the 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.

Response: In the current study, we first extended the monthly SIZI to a daily scale and then combined it with daily STI to monitor short-term compound dry and hot events. Although SIZI is an existing drought index with good performance in drought monitoring across different climatic regions, we don't know whether it can monitor short-term drought events, which occur more frequently in recent years due to climate change. Therefore, we should develop the daily SIZI and verify its applicability. Li et al. (2021) developed a short-term compound dry and hot events by combining SPEI and STI. We agree that SPEI is also a commonly used drought index, however, some studies (Ayantobo et al. 2020; Zhang et al. 2015, 2019, 2021) have reported that it always overestimates drought, especially across non-humid regions. The SPEI measures climatic water balance anomalies by incorporating the difference between precipitation (P ; available water supply) and potential evapotranspiration (PET ; atmospheric water demand). While PET is a good indicator for characterizing climate aridity, using it as a measure of atmospheric water demand for drought analysis leads to misrepresentation of droughts, especially over water-limited (non-humid) regions where the actual evapotranspiration is primarily dominated by water availability rather than energy (or PET) (Zhang et al., 2019). Compared to SPEI, SIZI, using climatically appropriate precipitation for existing conditions (P^*) as the atmospheric water demand metric, is physically more reasonable in reflecting

surface water-energy balance over both humid and non-humid regions and can monitor different types of droughts in different climatic regions (Ayantobo et al. 2020; Zhang et al. 2015, 2019, 2021). In addition, we will extend our research regions from non-arid regions of China to the whole regions of China and verify the applicability of daily SZI in drought monitoring across different climatic regions of China.

Thanks for your suggestion about the application of copulas, we have read the reference carefully. Yes, we should test the iid assumption of variables before coupling them using copulas. We will test the iid assumption of the daily STI and SZI before using copulas when revising. If the variables are stationary and independent, we will join them using copulas, otherwise, we will first remove the autocorrelation using AR or ARMA models and then couple residuals using non-stationary (e.g., time-dependent parameter) copulas.

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.

Response: We will use the term 'soil moisture drought' throughout the main text.

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.

Response: We fitted the daily temperature and SWD to normal and log-logistic distributions for each day. We will explain the procedure and restructure the methods when revising.

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.

Response: Yes, we agree that geophysical locations or time scales may affect distribution types that WSD is subject to. We will compare and test different distributions for selecting the optimal distribution for SZI in different climatic regions and for various time scales.

We will revise the manuscript according to all your comments which are very helpful for improving our research. Thanks.