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Interactive comment on "The Influence of a Prolonged Meteorological Drought on the Catchment Water Storage Capacity: A Hydrological Model Perspective" *by* Zhengke Pan et al.

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Responses to Referee #2:

I read with interest the paper on The Influence of a Prolonged Meteorological Drought on the Catchment 1 Water Storage Capacity: A Hydrological Model Perspective. It's a good piece of work whose findings are useful for water resources management in the light of climate and landuse changes. My major concern however is in the study design and methodology. Most of the steps in the methods section are not adequately

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described. Readers can fully link the methods with the results because certain information is not provided in the methods section.

Reply: Thanks for the comment and suggestions, we will carefully improve the description of the study design and methodology part in the revision. Some examples are described below: B1: Typical examples but not limited to: Which datasets have been used in all the objectives Describe the spatial and temporal variation of these datasets What are the different sources of datasets For examples what is the source of the primary land-use types described in the results section.

Reply: Thanks. More descriptions of the adopted data set will be added in the revised manuscript. The sentences in lines 159-166 in the original manuscript for describing the research data will be modified as follows: The following data have been used in this study: (1) climate variables, include daily rainfall and daily potential evapotranspiration; (2) daily streamflow observation at catchment outlet; (3) land use types at 1 km resolution; (4) soil types at 30 arc-second resolution, and (5) catchment attributes, include catchment area, mean elevation and so on. The detailed lists of the catchment attributes and climate characteristics were presented in Table 2. The data of climate variables, daily runoff, and catchment attributes were obtained from the Australian Water Resources Assessment (AWRA) system, which has been served as a standard publicly available national dataset for hydrological model evaluation (https://publications.csiro.au/rpr/pub?pid=csiro:EP113194, Zhang et al. (2013)). For all catchments, there is no missing data in the rainfall and potential evapotranspiration data while the runoff data in some catchments are missing. The data set of soil types was obtained from the Harmonized World Soil Database by the Food and Agriculture Organization of the United Nations (http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/, Fischer et al. (2008)) and was classified according to the Soil Texture Triangle of USDA (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167). The data set of the land use types was derived from the global land cover map re-

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leased by the University of Maryland (UMD) (Hansen et al., 2000) and was classified according to the UMD Land Cover Classification method (http://app.earth-observer.org/data/basemaps/images/global/LandCover_512/LandCoverUMD_512/LandCoverUMD_512.html).

B2: Authors mention about the catchment physical properties and climate characteristics which influences CWSC. Readers will only get to understand or know these physical properties and climate characteristics when they read the results section. This again has to do with a poor study design.

Reply: Thanks. The list of catchment properties and climate characteristics that might influence CWSC was presented in Table 2. And the illustrations of these potential factors were presented in section 3.4. To facilitate the understanding of this manuscript, the following sentence will be added in section 2.2. of the modified manuscript: The detailed lists of the catchment attributes and climate characteristics were presented in Table 2.

B3: In section 3.4, what do authors mean by '. . ...because of the limitation of available data of catchment attributes, only unique catchment properties are employed. . .'. What are these unique catchment properties? And how were they selected?

Reply: Thanks. (1) The 'unique catchment properties' we meant these data are static values rather than a time series. For example, only one value of the catchment area was used. (2) The unique catchment properties refer to the X1-X9 in Table 2, i.e., catchment area, mean elevation and elevation difference between the maximum and minimum elevations, mean slope, and slope range, forest coverage percentage, saturated hydraulic conductivity of the top soil, available soil water holding capacity of the top soil and sub soil. (3) These catchment attributes were selected because they reflect the physical characteristics of the catchment, and might be related to the shift in the CWSC. (4) To make it clearer, this sentence will be modified as "It should be noted that due to the limitation of available data of catchment attributes, for each catchment, only one static/constant value of the catchment property was employed (X1-X9).".

B4: The authors use the term ‘climate characteristics’ in the abstract and methods section-Upon reading the manuscript (rather the results) one discovers that its only rainfall being referred to. Is rainfall enough to define meteorological characteristics? - what about the influence of other climate characteristics such as Temperature, Evapotranspiration?

Reply: Thanks. (1) The term “climate characteristics” in this manuscript refers to the variables of Y1-Y24 in Table 2, which include rainfall, temperature, potential evapotranspiration, and runoff. It also should be mentioned that the employed climate variables can be divided into four categories, i.e., daily (Y1-Y4), monthly (Y5-Y7), seasonal (Y8-Y16), and annual scale variables (Y17-Y24). Please refer to Table 2. (2) Since rainfall is the most important factor that influences the degree of catchment wetness, the identification of meteorological drought in this manuscript was only based on the annual rainfall data as in other studies (Li et al., 2020; Pan et al., 2019b; Saft et al., 2015; Wong et al., 2013). Furthermore, Saft et al. (2015) indicated that the selected algorithm has been verified as a rigorous method for processing the autocorrelation in regression residuals and testing the global significance. Furthermore, we have the same study region, i.e., catchments in southeastern Australia (but our data sources are different). Thus, the method proposed by Saft et al. (2015) was employed in this study to define the meteorological drought period.

Add reference: Li, Q. F., He, P. F., He, Y. C., Han, X. Y., Zeng, T. S., Lu, G. B., and Wang, H. J.: Investigation to the relation between meteorological drought and hydrological drought in the upper Shaying River Basin using wavelet analysis, Atmos. Res., 234, 10, 10.1016/j.atmosres.2019.104743, 2020. Wong, G., van Lanen, H. A. J., and Torfs, P.: Probabilistic analysis of hydrological drought characteristics using meteorological drought, Hydrol. Sci. J.-J. Sci. Hydrol., 58, 253-270, 10.1080/02626667.2012.753147, 2013.

B5: In section 4.3 authors point out that ‘However, the geographical distribution of catchments with significant and non-significant changes in θ_1 showed no obvious ge-

olocation clustering phenomenon. Which statistical techniques did the authors employ to come up with conclusions on significance in θ_1 Given multiple climate variables and catchment properties-which one significantly affects CWSC?

Reply: Thanks. (1) In order to improve the clarity, this sentence will be deleted in the modified manuscript. (2) The criteria in identifying catchments with a significant/non-significant change in θ_1 were presented in section 3.2.5. As illustrated in lines 312-317, the minimum requirement of significant change in θ_1 was defined as the simulated values of the parameter θ_1 between the two periods should be more than $\pm$20%. In other words, only the catchments with more than $\pm$20% changes in θ_1 would be recognized as changed significantly. After a comparison of several other threshold levels (such as $\pm$5% and $\pm$10%), we found that the value of $\pm$20% can maximally exclude the negative impacts by the heterogeneity of the available parameter sets. (3) As presented in Figures 7 and 9, we used the Pearson Correlation Coefficient to reflect the potential relation between the (%) shift in the CWSC and the catchment properties/climate characteristics. However, no strong association has been found between the shift in the CWSC and the single climate variable/catchment property. Thus, it is really hard to judge the influence of each factor on the CWSC. According to our study, it seems that the final changes in the CWSC are the combined effects of multiple climate variables and catchment properties. Thus, we expected that further studies are still required to confirm which factors played the most important role in the catchment dynamic.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-692/hess-2019-692-AC2-supplement.pdf

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