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Comment on hess-2022-147

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Referee comment on "Explaining changes in rainfall–runoff relationships during and after Australia's Millennium Drought: a community perspective" by Keirnan Fowler et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-147-RC1, 2022

General comments:

The manuscript presents a range of possible process explanations of flow response to the Millennium Drought in Australia, and then evaluates these hypotheses against available evidence. The manuscript is an excellent work to understand the changes in rainfall-runoff relationships after Australia's Millennium Drought. The strength of this work is a large-scale assessment of hydrologic changes and potential drivers. The framework of Hypothesised Process Explanations is also useful to investigate the effects of the drought in other watersheds, and planning more extensive field studies to test predictions of hypotheses.

Specific comments:

In Figure 2, the data of precipitation and runoff from 2011 to 2021 should also be presented to show the hydrological behavior after the Millennium Drought.

Line 234, The manuscript focus on the changes of rainfall-runoff relationships, the annnual runoff coefficient, and those in each season may be necessary to discuss.

The multiple stable states of the watershed may be a potential perspective to explain the change of the behavior of the rainfall-runoff relationship, as mentioned in Line 379, such as that in Peterson et al. (2009). The Millennium Drought is an extreme disturbance that may push the system from one stable state to another. The question is how to quantify the multiple stable states of the watershed. The dry stable state may be seldom presented in the watershed.

Peterson T J, Argent R M, Western A W, Chiew F H S. Multiple stable states in hydrological models: An ecohydrological investigation, Water Resources Research, 2009, 45, W03406, doi:10.1029/2008WR006886.

If the water storage capacity in a watershed is large enough to control all/most of the annual runoff (associated with HPE23), the watershed will be a human-controlled system where the released runoff is regulated by the reservoirs, such as Tarim River basin in China (Liu et al., 2014; Liu et al., 2015). The total water storage capacity of all dams in a watershed may be an important index.

Liu, Y., Tian, F., Hu, H., Sivapalan, M. Socio-hydrologic perspectives of the co-evolution of humans and water in the Tarim River basin, Western China: the Taiji–Tire model[J]. Hydrol. Earth Syst. Sci., 2014, 18, 1289-1303.

Liu D, Tian F, Lin M, Sivapalan M. A conceptual socio-hydrological model of the co-evolution of humans and water: case study of the Tarim River basin, western China[J]. Hydrology and Earth System Sciences, 2015, 19(2): 1035-1054.

Line 570, the spatial distribution of the driving factor should be consistent with the spatial

distribution of shifted versus unshifted catchments. Maybe an example will be helpful to understand it.

Line 600, Of the twenty-four HPEs, three are considered plausible, ten are considered inconsistent with evidence, and eleven are in a category in-between. The strength of this work is a large-scale assessment of hydrologic changes and potential drivers. This information should be stated in abstract.

In Figure 10, Higher AET per mm of rainfall, and it equals aridity index=AET/rainfall.

Technical corrections:

L227 and L240, event rainfall->rainfall events

Line 714, check the citation of Figure 4c. Maybe it is Figure 5d.