Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-311-AC1, 2020
© Author(s) 2020. This work is distributed under
the Creative Commons Attribution 4.0 License.

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Catchment-scale drought: capturing the whole drought cycle using multiple indicator" *by* A. J. Gibson et al.

A. J. Gibson et al.

abraham.gibson@uon.edu.au

Received and published: 18 February 2020

Comment 1: The description and application of the NDVI analysis is really quite thin. What is the dominant land cover type in this catchment (forest, shrub, agriculture, etc)? How extensive is human land use (agriculture or pasture)? What is the seasonality of the vegetation, and when in the year is peak productivity and vegetation growth? This is all important information that is required to contextual how drought, and other stress factors, affect vegetation in this catchment. Additionally, the reverb link on line 155 does not work. As I also mention later, I think the NDVI analysis would further benefit from explicit separation of the warm (growing?) vs cold (dormant?) season droughts.

Authors' Response: This has now been included in the revised manuscript; lines 84–

87: "the area is of agricultural significance and sustains grazing and cropping, making up around 75% of each catchment. (Hancock et al., 2015; Rudiger et al., 2007). Vegetation is described as cover grasses with sparse eucalypt forest in the lower and central regions of the catchments, while dense, wet sclerophyll forest dominates the northern slopes (Kunkel et al., 2019). Vegetation cover is generally consistent throughout the year due to an even distribution in rainfall." The separation of warm and cool season droughts is addressed in Comment Three.

Comment 2: Line 193: what are the units on these drought onset/termination rates? Are these changes in the index value (e.g., SPI6) per month?

Authors' Response: These units are index value per month, these have been added.

Comment 3: I found the climate index discussion to be a bit confusing, primarily because the analysis of drought conflates events during both the warm and cold season. The problem, as the authors even admit, is that the influence of climate modes in this region is highly seasonal. Seasonality is mentioned, but it is hand waved away (line 215) for a simplistic statement that Indian ocean and SAM cause drought and El Nino sustains it. Further, the lack of a strong pre-drought signal in indices (especially ENSO) could just be a function of the long-term drought index being used (integrating over 6 months) or the fact that this catchment responds quickly to these modes with little time lag. It would be useful, I think, for the authors to a priori separate cold and warm season drought events and THEN conduct the comparisons with the climate modes. As currently written, I just find this section to be a bit disorganized.

Authors' Response: We acknowledge that some studies examine drought (especially flash drought) as cold or warm season droughts, however this study aimed to look at how meteorological droughts are sustained over multiple seasons and then propagate through to hydrological and agricultural droughts. That is, the drought events studied in this paper tend to span both cool and warms seasons and are hence some of the most impactful. In Figure 5, we identified that across all droughts in the approx. 100-

year record, there is a trend in cool Indian Ocean sea surface temperatures (SSTs) combined with an increasing El Niño Southern Oscillation (ENSO) index leading to drought initiation. Following this, El Niño conditions during the months after drought initiation continue to suppress rainfall, leading to sustained drought. This is indicated by most droughts beginning in summer with the Indian Ocean modes supressing winter and spring rainfall and ENSO further suppressing rainfall (see Figure 1). This combines effect leads. The role of the Indian Ocean modes and ENSO in causing drought in southeast Australia (especially on the east coast) is much debated, and a key finding here is that long-term droughts are caused by the interactions of both, along with the Southern Annular Mode (Lines 199–214). We also acknowledge that the seasonality of the climate modes is a key mechanism in causing long-term drought. When the climate modes are in their “dry-phase” the sequential nature of their suppression of rainfall causes sustained drought (Lines 210–215).

Comment 4: For readers who are not familiar, it would be good for the authors to explicitly define "rainfall-runoff relationship" and why changes in it might matter (or what they would mean).

Authors’ Response: The authors thank the reviewer for this suggestion and have clarified this in Sect. 3.4 (Lines 137–140): “Persistent changes in the rainfall-runoff relationship have been observed after the Millennium Drought by Saft et al. (2015). This relationship is the amount of runoff generated by a given amount of rainfall. Persistent changes in this indicate a change in hydrology in a catchment; indicating that the catchment has undergone a sustained change or has been unable to recover from drought (Saft et al., 2015).”

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-311, 2019.

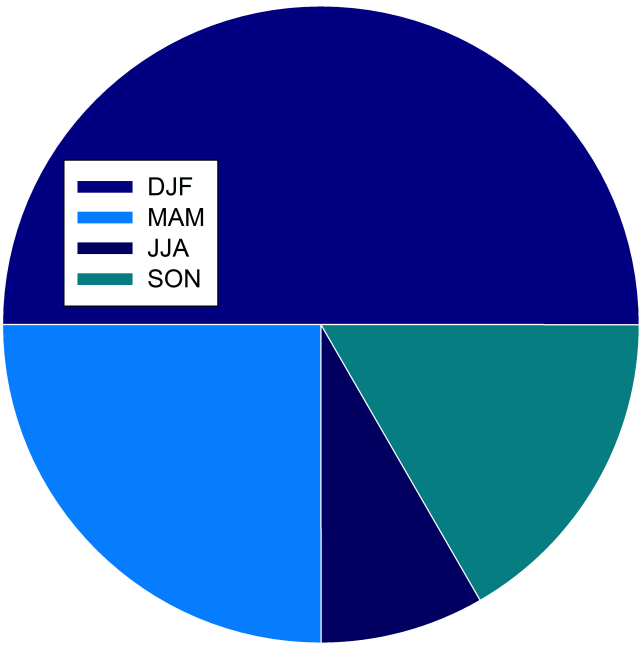

Fig. 1. Figure 1: Onset months of droughts from the SPI6 record grouped by season (data from Table 1 in manuscript).