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Changes to wet and dry spell characteristics in Australian catchments

S. Thomas[a], C. Wasko[b], D. Guo[c,d], U. Bende-Michl[e] and M. Peel[a]

[a] *Department of Infrastructure Engineering, The University of Melbourne, Parkville, Victoria, Australia*
[b] *School of Civil Engineering, The University of Sydney, Sydney, NSW, Australia.*
[c] *School of Engineering, ANU College of Engineering, Computing and Cybernetics, Australian National University, Australian Capital Territory, Australia*
[d] *Institute for Water Futures, The Australian National University, Canberra, ACT, Australia*
[e] *Australia Bureau of Meteorology, Canberra, Australia*

Email: steven.thomas.1@unimelb.edu.au

Abstract: Hydroclimate variability plays a crucial role in Australia's water resources and how they are managed. Australia is no stranger to the extremes of this variability, with widespread and persistent periods of drought and flooding that have significantly impacted the many sectors that rely on water. Recent trends have highlighted that Australia's hydroclimate variability, particularly rainfall variability, will be increasing with climate change. This poses a new challenge to water managers around Australia: how are changes in rainfall dynamics impacting water resources?

One way to understand changes in rainfall variability is through the investigation of rainfall intermittency. Here, intermittency refers to the sequencing of wet and dry spells, which are periods of consecutive wet or dry days. Previous analysis of wet and dry spells in Australia has highlighted trends towards shorter and more frequent wet spells across southern and eastern Australia, whilst northern Australia has trends towards longer and more intense wet spells. Much of the literature on wet and dry spells in Australia is either restricted to regional analyses or only investigates a focused set of metrics that do not provide a complete picture of how these spells are changing. Furthermore, there is no nationally consistent approach applied at the catchment scale to understand how intermittency is changing. This catchment-level understanding is crucial to providing insights into how catchment hydrology and water resources may change into the future.

In this study, we apply an event-based approach using catchment aggregated rainfall data for 467 HRS catchments around Australia from 1950-2022. We identify wet and dry spells from the rainfall timeseries and use a 1mm daily rainfall threshold to define a wet day. The characteristics of these spells are then investigated at the annual and seasonal timescales to provide a regional understanding of change in intermittency characteristics and how these changes can impact Australian catchments.

We find that the intermittency of rainfall is increasing across much of Australia, i.e. there are more transitions between wet and dry spells. This increase in intermittency comes with an increase in the number of dry days per which appears to be driving a decline in the mean wet spell length across almost all southern and eastern Australia. This aligns with declining trends in the rainfall depth during wet spells alongside the declines in annual rainfall in these regions. We see the opposite trends in northern and northwestern Australia, where rainfall totals are increasing alongside mean wet spell lengths. Despite the widespread increases in the number of dry days per year, there are no robust changes in the mean dry spell lengths as might be expected. The average daily rainfall during wet spells is increasing across Australia, suggesting that whilst events are becoming shorter, they are more intense. We find that wet spells in southern and eastern Australia are primarily impacted during winter, whilst in the north and northwest, spells are impacted during spring and summer, aligning with the summer monsoon. The changes in intermittency characteristics align with the changes in the driving mechanisms of rainfall in these regions.

Overall, our results show Australia is experiencing more variable climatic conditions with more frequent rainfall events that are shorter and more intense. Such changes have potentially large implications for runoff generation dynamics across Australia, impacting flash flood risk, and decreasing total runoff and water availability. We conclude that changes in intermittency and how the characteristics of wet and dry spells will continue to change into the future have the potential to significantly impact water resources across Australia.