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Do vegetation changes necessarily intensify hydrological shifts under multiyear droughts?

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Abstract: Recent observations suggest annual runoff can undergo prolonged shifts, resulting in severe reductions in streamflow generation compared to rainfall generation during and after multiyear droughts. Moreover, these shifts are expected to continue and possibly expand under a future drying climate. Some studies suggest that vegetation may be an important factor driving hydrological shifts under multiyear droughts (Gardiya Weligamage et al., 2023; Peterson et al., 2021). However, this hypothesis is yet to be tested more rigorously over larger areas that experienced rainfall-runoff shifts. Therefore, we investigate how vegetation responded to the Millennium Drought (from 1997 – 2009) in Victoria, Australia at different spatial scales and its relationship with hydrological changes.

The Millennium Drought provides a unique opportunity for studying the impacts of multiyear drought as many catchments suffered during and after this drought (Peterson et al., 2021; Saft et al., 2015). Therefore, we selected 156 unimpaired catchments in Victoria, Australia, with several remotely sensed vegetation indices (AVHRR NDVI and FPAR, and Ku-VOD) spanning pre-drought to the Millennium Drought, and magnitudes of catchment scale rainfall-runoff shifts. Statistical analyses showed increased or maintained vegetation indices during the Millennium Drought compared to the pre-drought (See example in Fig. 1a). Moreover, these catchments with increased or maintained vegetation indices found to be mostly shifted in rainfall-runoff relationship during the Millennium Drought (See Fig 1b). However, there is little statistical match between the spatial distributions of rainfall-runoff change and changes in the vegetation indices, which indicates vegetation may be a contributing factor. This finding supports advancing the current understanding and modelling of the role of vegetation changes on hydrology under a future drying climate.

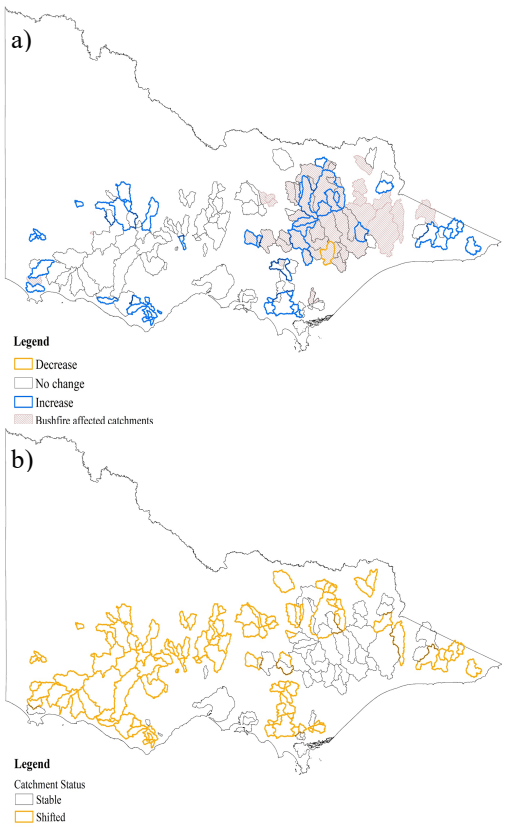

Figure 1. Maps of (a) Mann Whitney difference of median test results in catchments using AVHRR NDVI anomalies between pre-drought and the Millennium Drought; (b) Catchment status during the Millennium Drought. Note that catchments affected by bushfire before 2007 over more than 20% of the catchment area was completely removed from the study, whereas other bushfire-affected regions during major bushfires in 2007 and 2009 were included in the study considering the Millennium Drought analysis period from 1997 March to 2006 November

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