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Modelling flows from the past to inform flows for the future

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Abstract: The absence of critical low flows is one of the biggest causes of deteriorating catchment health in highly developed areas across South Australia. In response, the Flows for the Future (F4F) program aims to enable low flow releases (LFR) from dams and watercourse extractions (WCE) to support long-term sustainability for communities, industry, and the environment across the Eastern Mount Lofty Ranges (EMLR).

A calibrated rainfall-runoff Source model was developed for the Tookayerta Creek catchment to assess the impact of low flow releases on Environmental Water Provisions (EWP) under the EMLR Water Allocation Plan (WAP). Modelling scenarios included estimating additional flows to the system from LFR under various demand scenarios, including 'Current' and 'Full allocation', which will be used to assess LFR impact to meet EWP targets.

The model covers the hills section of the catchment and was calibrated using functional units of similar hydrological response based on a simplified soil texture classification for the period 2013–2021. Scenario modelling comprised seven demand scenarios for a 36-year period (1971–2006): No Dams, Current, Current BaseWAP, Current WCE LFR only, Full allocation, Full allocation BaseWAP, and Full allocation WCE LFR only.

The No Dams scenario simulates pre-development conditions by removing the impact of farm dams and WCE and was used to provide the baseline conditions for the proposed EWPs. The Current scenario simulates current conditions by including the impact of estimated use from farm dams and WCE. The Full allocation scenario includes current estimated use from farm dams, with WCE demand set to 100% of allocation. Additionally, BaseWAP and WCE LFR variations to Current and Full allocation scenarios were modelled. BaseWAP scenarios incorporated LFR to all licensed dams and non-licensed dams ≥ 5 ML (scope dams) and WCE. WCE LFR scenarios incorporated LFR to WCE only.

Results showed flows at the end of system are reduced by roughly 1300 ML for the Current scenario with no LFR and by 2400 ML for the Full-Allocation scenario with no LFR compared to the pre-development No Dams scenario. Meanwhile, scenarios which included LFRs estimated additional flows under Current and Full-Allocation conditions ranging from 165 ML (Current BaseWAP) to 523 ML (Full-Allocation WCE LFR). A marginal difference of 4 ML, on average, in additional flows between BaseWAP (ie. LFR applied to all 125 scope sites) and WCE LFR (i.e., LFR applied to 63 WCE only) scenarios, indicate that most of additional flow is achieved from LFR applied to WCE. More importantly, results highlight LFR have a greater impact under Full-allocation conditions with additional flows generated at the end of system roughly 3 times higher than under Current-use conditions.

Overall, this study highlights the importance of best-practice modelling technology in ensuring reliable forecasts of demand and water availability, especially in the context of water allocation planning. The modelling approach utilized in this study provides a valuable tool for water resource managers and policymakers to evaluate the impact of programs like F4F on water availability and environmental water provisions. The study's findings suggest that implementing LFR to WCE can significantly increase water availability and ensure flows for the future.

Keywords: *Hydrological modelling, catchment hydrology, water allocation, environmental water provisions*