

Synthesising hydrological knowledge in a semi-dry region with low-permeability unsaturated zone using Modflow-6

Konrad Miotlinski^{a,b} , **Matthias Leopold**^c, **Sally Thompson**^{a,b}

^a*School of Engineering, University of Western Australia, Perth, Australia*

^b*Centre for Water and Spatial Science, University of Western Australia, Perth, Australia*

^c*School of Agriculture and Environment, University of Western Australia, Perth, Australia*

Email: konrad.miotlinski@uwa.edu.au

Abstract: Understanding hydrological budgets in semi-arid regions with low-permeability sediments remains a major challenge, largely due to the episodic nature of recharge and the difficulty of incorporating these dynamics into models. To address this complexity, groundwater recharge is often simplified as a small fraction of precipitation, typically expressed at a monthly scale. In this study, we integrate daily rainfall and potential evapotranspiration data into the MODFLOW-6 framework, explicitly accounting for unsaturated zone flow and storage, overland flow proxies, and stream-routing processes in the UWA research farm in Pingelly, WA. Our results show that short but intense rainfall events can strongly influence the water budget, challenging the conventional assumption of recharge as a fixed fraction of precipitation. Modelled hydrological balances were consistent with eddy covariance observations. Incorporating these refined concepts into groundwater models improves predictive capacity under drying climate conditions and provides new insights into salinity development in semi-arid landscapes.

Keywords: *Groundwater recharge, semi-arid regions, MODFLOW-6, hydrological modelling, salinity*