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Investigation of response time and water age

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Utilising flow, isotope and groundwater level data, the downward approach was employed to develop a hydrological model for the Susannah Brook catchment in Western Australia. This model structure was then used to explore internal process variability within the catchment, including (1) the unsaturated zone time delay, between rainfall infiltration and groundwater recharge, (2) lateral flow time delay, between local recharge and catchment discharge, and (3) the difference between the magnitude of these delays and the age of water. Soil depth is found to be the most important factor influencing the magnitude of the delay and the age of water involved. In the deeper soils of the upland region of a catchment, rainfall-recharge delays are large and patterns of temporal variability in rainfall are largely absent from the recharge. In contrast, recharge from the shallow soils in the riparian zone exhibits similar temporal patterns to the rainfall, and rainfall-recharge delays are minimal. The age of water in recharge and catchment discharge was estimated assuming piston flow. In the deeper, upland soils, the age of recharging water is considerably larger than the unsaturated zone delay would suggest; a recharge response 16 days after an infiltration event may involve water as much as 160 days old. The delay, and the age of recharging water, is much lower in the shallow riparian zone. Where the upland zone contributes significantly to discharge, the predicted difference between the rainfall-discharge response time and the average age of discharging water can be significant. The proposed model approach may therefore provide a mechanism for explaining the so-called old water ?new water paradox; further research is necessary to test this hypothesis.