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# Model based analysis of multi-tracer transport behavior during long-term infiltration of domestic wastewater

In water-scarce regions such as Australia infiltration of wastewater is a common water management option. However, the suitability of the infiltrated water for reuse depends highly on the degree to which naturally occurring attenuation and purification processes contribute to a water quality improvement during subsurface passage. A sound understanding of the various physical and geochemical processes that control the spatial and temporal evolution of the water quality and a robust understanding of attenuation processes are therefore crucial to assess whether a safe reuse is possible.

In this study we investigated the physical attenuation process affecting the fate of a wastewater plume in a shallow aquifer in Mandurah, Western Australia. Long-term hydraulic head data were jointly use with measured concentration snapshots of the wastewater constituents carbamazepine and sucralose as well as water stable isotopes. Existing and newly collected data were used to constrain the development and calibration of a 3D flow and multi-species solute transport model.

The calibrated model successfully replicates the long-term groundwater dynamics and captures the major observed wastewater plume transport characteristics. The model results suggest that multiple factors contribute to the field-observed concentration changes of the wastewater tracers sucralose and carbamazepine. First, some limited mixing and dilution occurs with the ambient groundwater and with groundwater recharge, whereby the groundwater recharge shows to cause the wastewater plume to dip to greater depth. This could have caused the more distal, shallow monitoring bores to leave the plume core uncaptured. Furthermore, the model results suggest that sucralose has undergone a degradation over the 25 year simulation period.

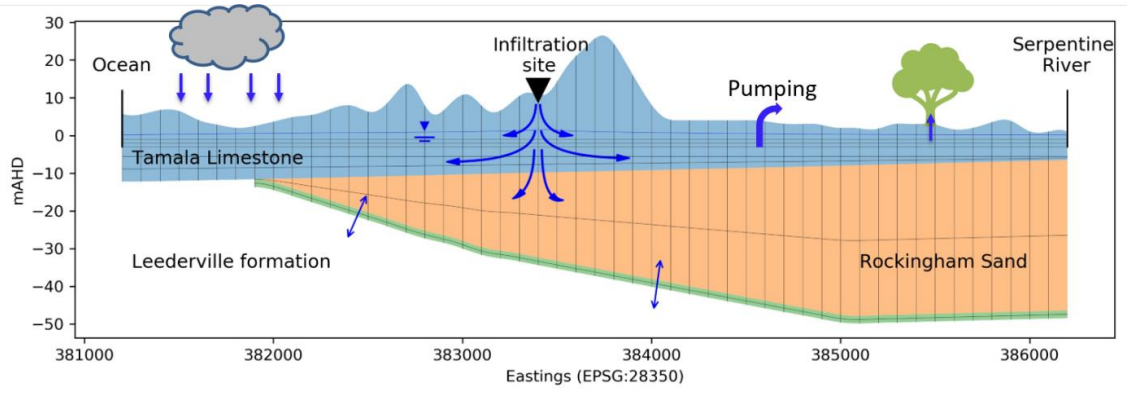


Figure 1: Conceptual model and model discretisation in a West-East cross-section view. The green layer is the fictive layer where boundary conditions between the Leederville formation and the Rockingham Sand are set. Note, there is no interaction below the Tamala Limestone. The wastewater infiltration site is the only source for carbamazepine, sucralose and the wastewater similar isotopic signature in the model.

The model provides good insights but doesn't eliminate the uncertainties associated with the input history and will therefore need further adjustments before it can be used to asses and quantify biogeochemical attenuation processes. It would be very interesting to extend the solute transport modelling to additional resilient drugs and personal care products in order to reduce the overall uncertainties of the model. Finally, installing and monitoring short screened multi-level sampling wells , particularly where the Rockingham Sand is present, would help constraining the extent of the plume which could be missed by the present monitoring pattern.