Numerical modelling of surface water and groundwater flow and solute interactions between a river and a saline floodplain in a semi-arid region

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Abstract

The Murray River is one of Australia's longest rivers but in South Australia it has become degraded through river regulation, water extraction and adjacent highland irrigation. These have decreased the natural flood frequency and increased rates of floodplain salinization. Concerns have been raised about the quality of water extracted from the Murray River for industrial, agricultural and potable uses, including for metropolitan Adelaide's water supply. Hence, this research is aimed at developing a better understanding of surface water (SW) and groundwater (GW) flow and solute interactions in a semi-arid river-floodplain system using a numerical modelling approach. The HydroGeoSphere model was selected for this research because it is a 3D physically-based fully integrated surface-subsurface numerical model with variable saturation and solute transport simulation capabilities. A calibrated model was developed and a number of scenarios were designed to investigate the impacts of different drivers on the river-floodplain system processes such as groundwater-table dynamics, evapotranspiration (ET), bank storage, regional groundwater recharge and floodplain salinization. The identified drivers include floodplain vegetation cover, groundwater lowering, river stage manipulation, and artificial flooding and water injection to the saline floodplain aquifer. Results show that all of these salt interception measures are limited spatially and temporally. Indeed, none of these measures are able to permanently change the natural condition of the floodplain groundwater salinity and flow regime. Hence, the interventions should be considered only as short term management techniques. However, if longer term strategies are required, it may be possible to implement these salt interception measures periodically. This research also provides knowledge regarding the ecological implications of SW-GW flow and solute interactions in a semi-arid river-floodplain system, with a particular focus on the Lower Murray River region.