Numerical Modelling of Groundwater-Surface Water Hydrogeological and Hydraulic Connectivity in a Floodplain Hyporheic Zone

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Abstract

Transient numerical flow models were developed and calibrated in Processing MODFLOW to quantitatively examine the groundwater-surface water interaction in a floodplain hyporheic zone. Although understanding of groundwater–surface water flux exchange in a hyporheic zone is crucial for effective water management and a variety of scientific purposes, it is a difficult place to study. Our numerical modelling of Danube River and Surány aquifers interaction revealed that there was a strong relationship between the response time lag (of river level change and groundwater level change) and the distance of wells from the river; the response time between a river rise (flooding) and GW level rise increased with increasing distance from the river and vice versa. Further, there were bigger depressions due to pumping in production wells located farther away from the river as a result of decreasing recharge from the river. The water budget from the models showed that the river seepage was the biggest contributor of inflow into the aquifer with over 70% contribution. The analysis of bank filtrate demonstrated that the level of river stage influenced the length of particle travel time; higher river stages led to shorter particle travel times. For the wells closer to the Danube River, the calculated travel times were shorter and increased with wells located farther away from the river. The numerical modelling results imply a strong hydraulic and hydrogeological connection between the permanent river and the adjacent alluvial aquifer. This investigation directly contributes to the implementation of the Danube River basin-wide water resources management and Flood Risk Management Plan developed in 2015 and the European Union Floods Directive requirements. Our models may be used in advancing understanding of the groundwater-surface water hydrogeological and hydraulic connectivity processes and mechanisms in floodplain environments.

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