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Uncertainties in simulating river/groundwater exchanges over the Upper Rhine Graben hydrosystem

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The Upper Rhine alluvial aquifer is an important transboundary water resource which is particularly vulnerable to pollution from the rivers due to anthropogenic activities. A realistic simulation of the groundwater-river exchanges is therefore of crucial importance for an effective management of water resources. Characterization of these fluxes in term of quantity and spatio-temporal variability depends on choices made to represent the river water stage in the model as well as on the hydrogeological parameters. Recently, a coupled surface-subsurface model has been applied to the whole aquifer basin (Thierion et al., 2012). The present study aims at improving the estimation of the river/groundwater exchange, and thus, of the hydrodynamic of the alluvial aquifer, and at getting an idea of the associated uncertainty by performing a set of simulations that best take advantage of the different kinds of observed data.

The general modeling strategy is based on the Eau-Dyssée modeling platform which couples existing specialized models to address water resources quantity and quality in small to regional scale river basins. In this study, Eau-Dyssée includes the ISBA surface scheme that estimates the water balance, the RAPID river routing model and the SAM hydrogeological model. In addition, the QtoZ module (Saleh et al., 2011) is used to calculate the river stage from simulated river discharges, which is then used to calculate the exchanges between aquifer units and river, according to three different approaches that are compared: a control experiment with constant river water stage, a rating curves approach derived from observed river discharges and river stages, and the Manning's formula, for which Manning's parameters are defined according to geomorphological parameterizations and topographic data based on Digital Elevation Model (DEM). Supplementary sensitivity tests are also performed by using different hydrogeological parameter datasets (porosity and transmissivity). Two sources of DEM were used for this part. Additionally, sensitivity to the time step of the estimation (daily versus monthly) was studied.

The evaluation is made against observed water levels and river discharges collected both from the french and german riversides of the alluvial plain. A heavy network of water table depth observations is also available to evaluate the simulated piezometric heads. Preliminary results show that the primary source of errors when simulating river stage – and hence groundwater-river interactions – is the uncertainties associated with the topographic data used to define the riverbed elevation. It confirms the need to access to more accurate DEM for estimating riverbed elevation and studying groundwater-river interactions, at least at regional scale.

References

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