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Characterization of riverbed heterogeneity for a better assessment of river-aquifer interactions

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Characterization of river-aquifer exchange fluxes is important for assessing riparian ecology, determining quantity and quality of pumped groundwater close to rivers, modeling groundwater flow, predicting flood peaks and low flows, and assessing river water quality. The exchange fluxes between river and aquifer are strongly influenced by the hydraulic conductivity of the riverbed which can vary several orders of magnitude and shows a strong spatial variation. Direct measurement of riverbed hydraulic conductivity is cumbersome and therefore often indirect data such as temperature data or calibration of groundwater models are used to constrain riverbed hydraulic conductivity. In these approaches, the riverbed is usually represented as a homogeneous geological structure and the spatial variation of riverbed hydraulic conductivity is thus neglected. However, neglecting this spatial variation can lead to systematic underestimation of net river-aquifer exchange fluxes and may have important implications for the estimation of peak mass flows, for the hydrochemistry of streambed sediments, nutrient cycling and biogeochemical gradients.

In this study, riverbed conductivities are measured on a fine-scale measurement grid at a stretch of the Aa river, a typical Flemish lowland river in the Nete catchment, Belgium. Both horizontal and vertical riverbed conductivities are measured, with respectively pneumatic rising-head slug tests and falling-head standpipe tests. Moreover, at the same measurement locations temperature profiles are measured with a ‘T-lance’. These are converted into vertical advective fluxes by inverse modelling of the one-dimensional heat transport equation.

First results show that the riverbed conductivity at this site varies over more than two orders of magnitude and that it shows a strong spatial variation. Moreover, patterns of riverbed conductivity are identified with higher values in the middle compared to the sides. Furthermore, the correlation between river-aquifer exchange fluxes and the riverbed conductivity dataset is assessed.