A multi-method characterization of river-aquifer interaction at the meter-scale: combining field measurements, heat transport modelling and groundwater modelling

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WHAT IS THE INFLUENCE OF RIVERBED HETEROGENEITY ON RIVER-AQUIFER EXCHANGE FLUXES?

\[ Q_{riv} = f(\Delta h, K_{riv}, ...) \]
OUTLINE

- **Groundwater-surface water interaction** at the Aa River, Belgium

- Characterization of **meter-scale spatial variability** of riverbed hydraulic conductivity

- Estimating **river-aquifer exchange** fluxes from **vertical riverbed temperature profiles** based on the **1D heat transport equation**

- Estimating **river-aquifer exchange** fluxes with a **groundwater flow model (MODFLOW)**
STUDY AREA
AA RIVER

Belgium

0 50 100 km

Aa River Measurement Location
Kleine Nete
Nete catchment
Brussels
Scheldt
Nete

Characterizing River-Aquifer Interaction at the Aa River
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STUDY AREA
AA RIVER

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AA RIVER

Downstream section

Upstream section
METHODOLOGY

RIVERBED HYDRAULIC CONDUCTIVITY ($K_h$ AND $K_v$)

Analyzed with Bouwer & Rice (1976) & Hvorslev (1951)
RESULTS

HORIZONTAL RIVERBED CONDUCTIVITY

Ghysels et al. (2018), J. Hydrol.
RESULTS
VERTICAL RIVERBED CONDUCTIVITY

Upstream section

Ghysels et al. (2018), J. Hydrol.
Analytical solution of Bredehoef特 and Papadopulos (1965) for 1D steady-state, vertical, anisothermal heat transport.
RESULTS

ESTIMATED RIVER-AQUIFER EXCHANGE FLUXES
METHODOLOGY

SIMULATING RIVER-AQUIFER EXCHANGE IN MODFLOW

Ghysels et al. (2019), Hydrogeol. J.
RESULTS

SIMULATED FLUXES IN MODFLOW
RESULTS

SIMULATED FLUXES IN MODFLOW
CONCLUSION

- Riverbed K and flux estimates display **strong spatial variability at meter-scale**

- **No clear correlation** between *riverbed K and vertical flux estimates*

- *Riverbeds* are **complex** structures that are characterized by **complex flow fields**

- **Lateral fluxes** through the river banks and riverbed are an **important contributor** to total river-aquifer exchange fluxes

- **Assumption of strictly vertical fluxes violated near banks**
THANK YOU!

QUESTIONS?

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