

Assessing the influence of riverbed heterogeneity on river-aquifer exchange fluxes

Gert Ghysels & Marijke Huysmans

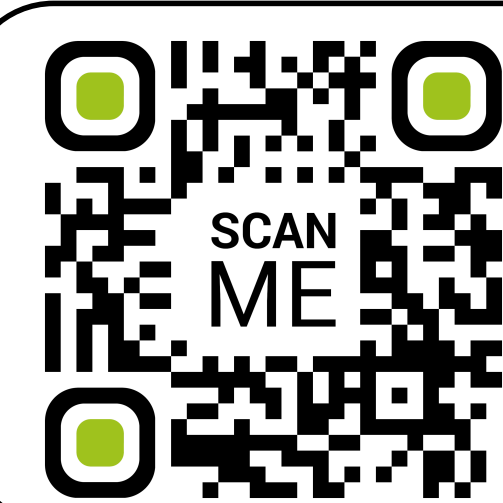
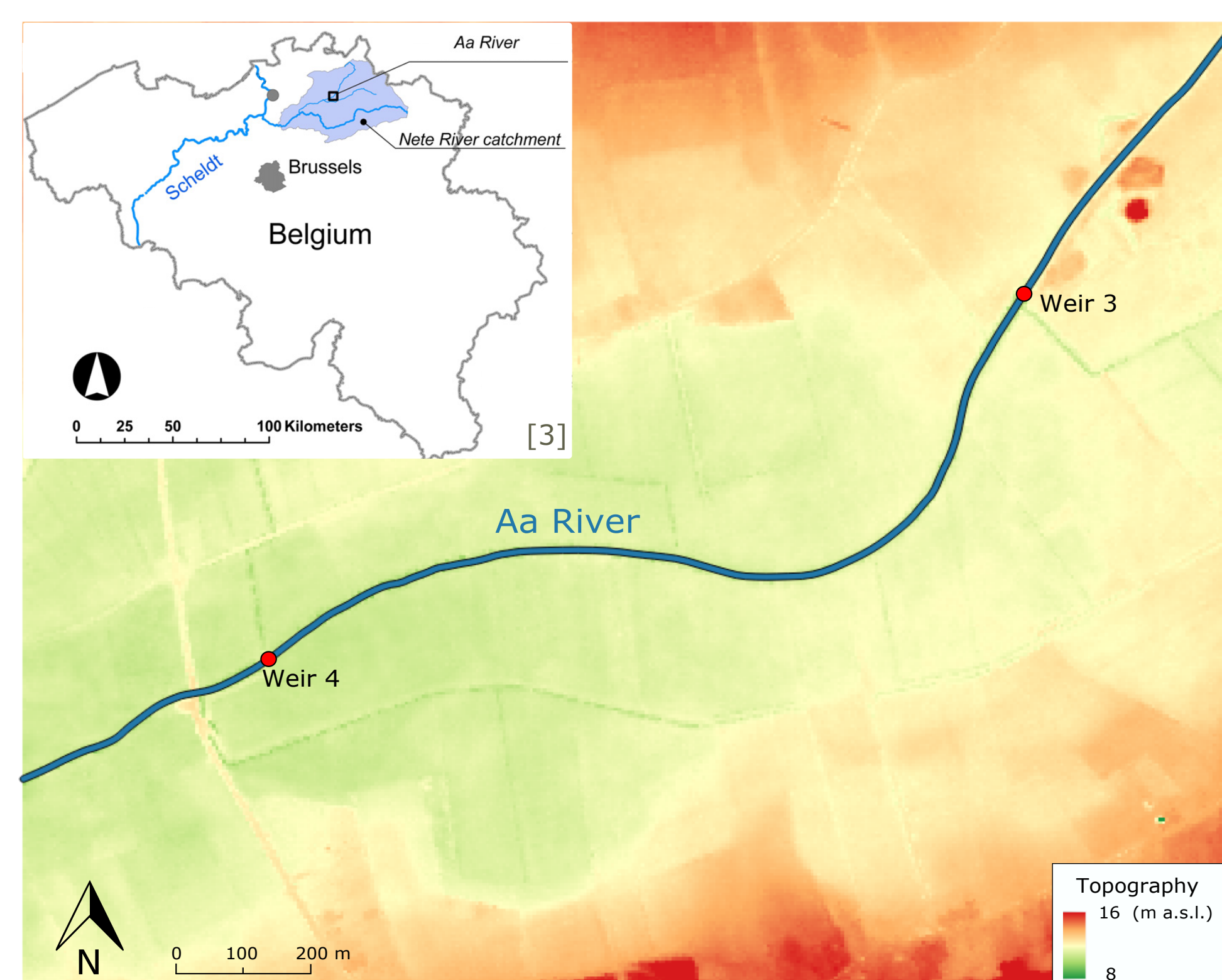
Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel

Why do we study riverbed heterogeneity?

- Characterizing groundwater-surface water interaction is important for assessing riparian ecology, predicting flood peaks and low flows, and assessing river water quality.
- River-aquifer exchange fluxes are mainly dependent on hydraulic gradient and riverbed conductivity.
- In general riverbeds are modelled as homogeneous geological structures HOWEVER riverbed conductivity shows a strong spatial variation and can vary over several orders of magnitude^[1,2].
- What is the influence of riverbed heterogeneity on the magnitude of river-aquifer exchange fluxes?

What is the effect of riverbed heterogeneity on exchange fluxes at the Aa river?

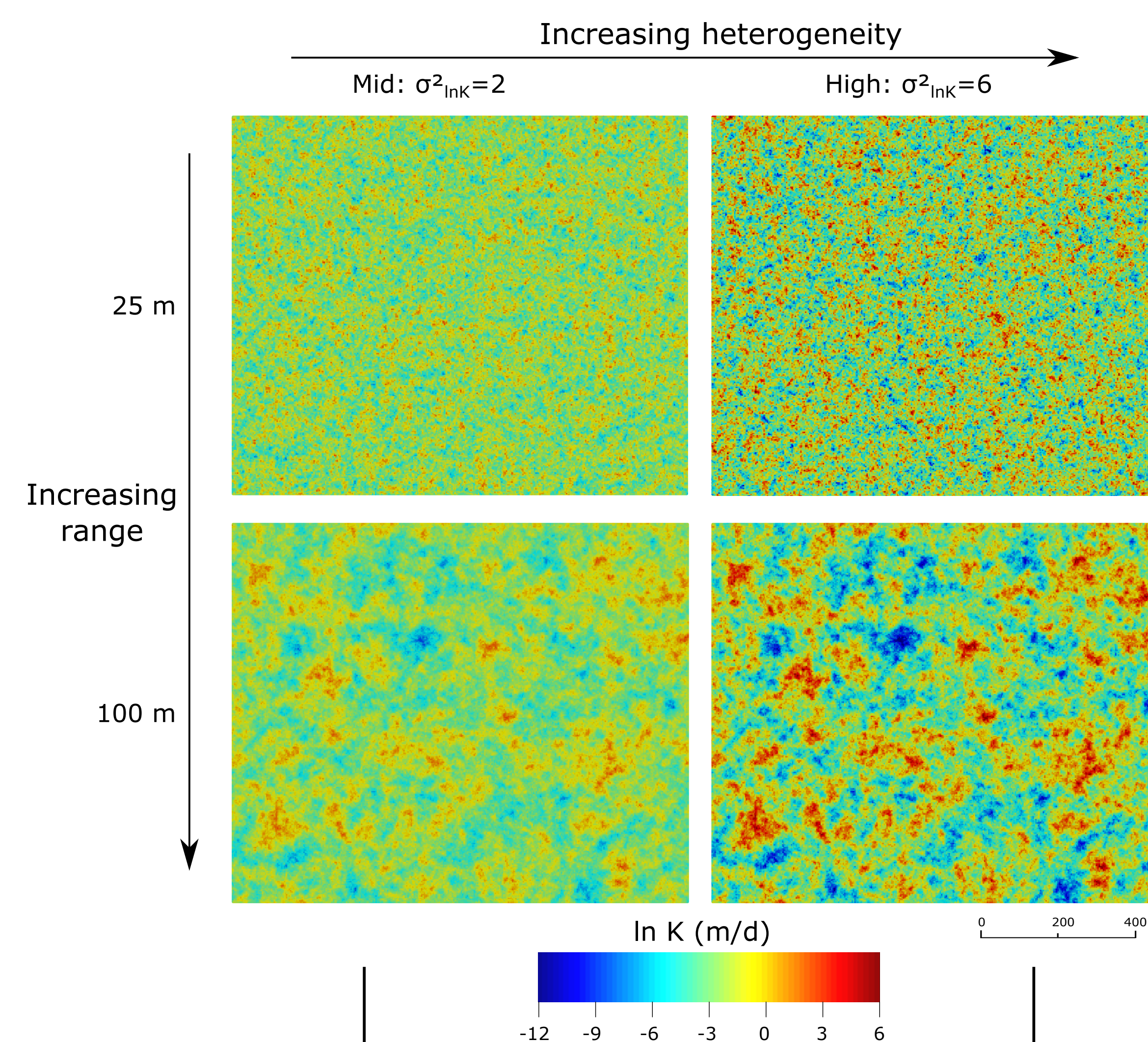
- Study area: a 2 km long stretch of the Aa river, which is a typical Flemish lowland river situated in the Nete River catchment (Belgium).



Scan this QR-code to get extended abstract and poster in PDF-format
(or browse to <http://q-r.to/hydr>)

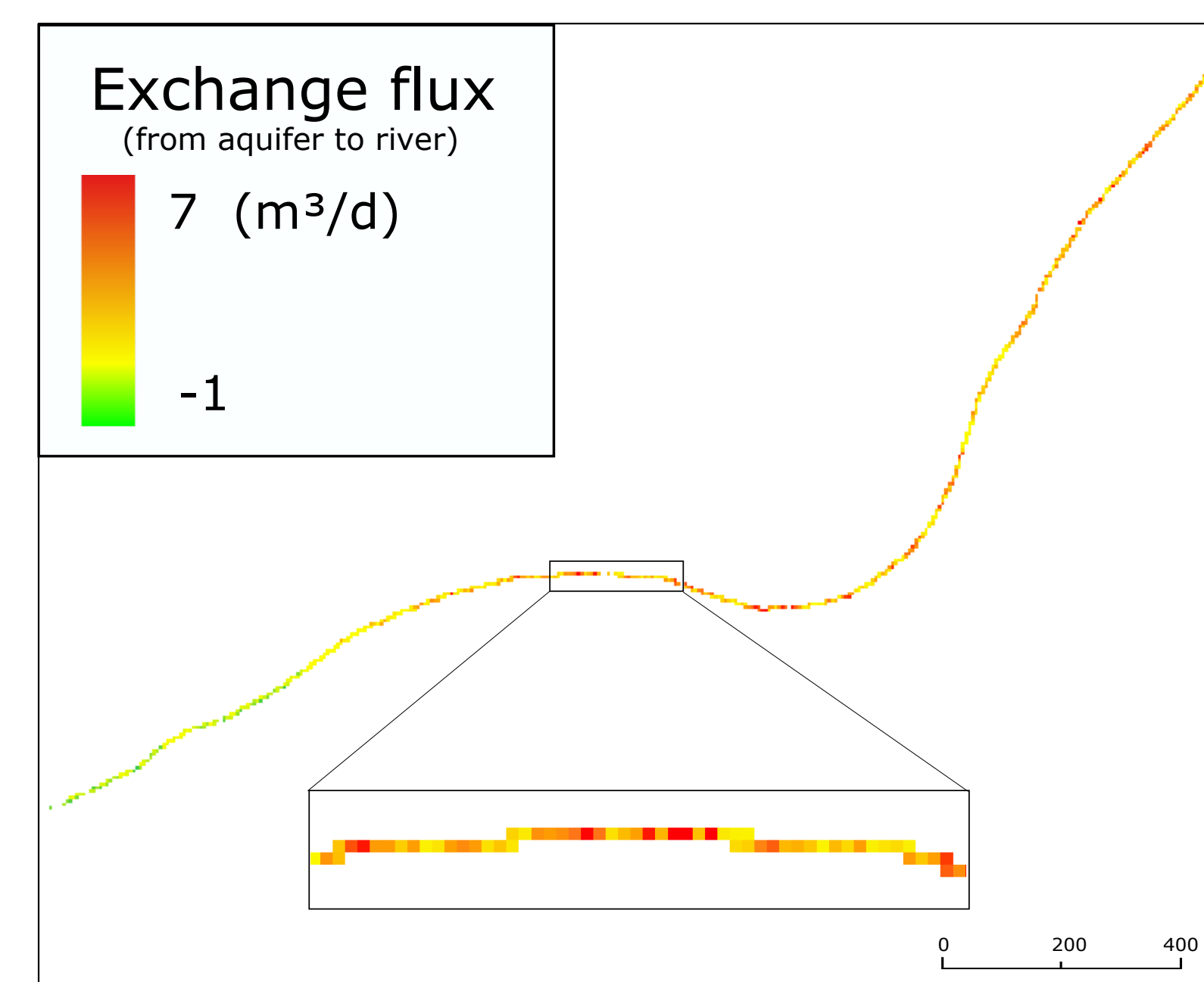
How do we assess the influence of riverbed heterogeneity on exchange fluxes?

- Simulating K for different ranges and degrees of heterogeneity (Sequential Gaussian Simulation).
- Geometric mean of K in all scenarios is equal to K in original homogeneous scenario: $K = 0.1$ m/d.



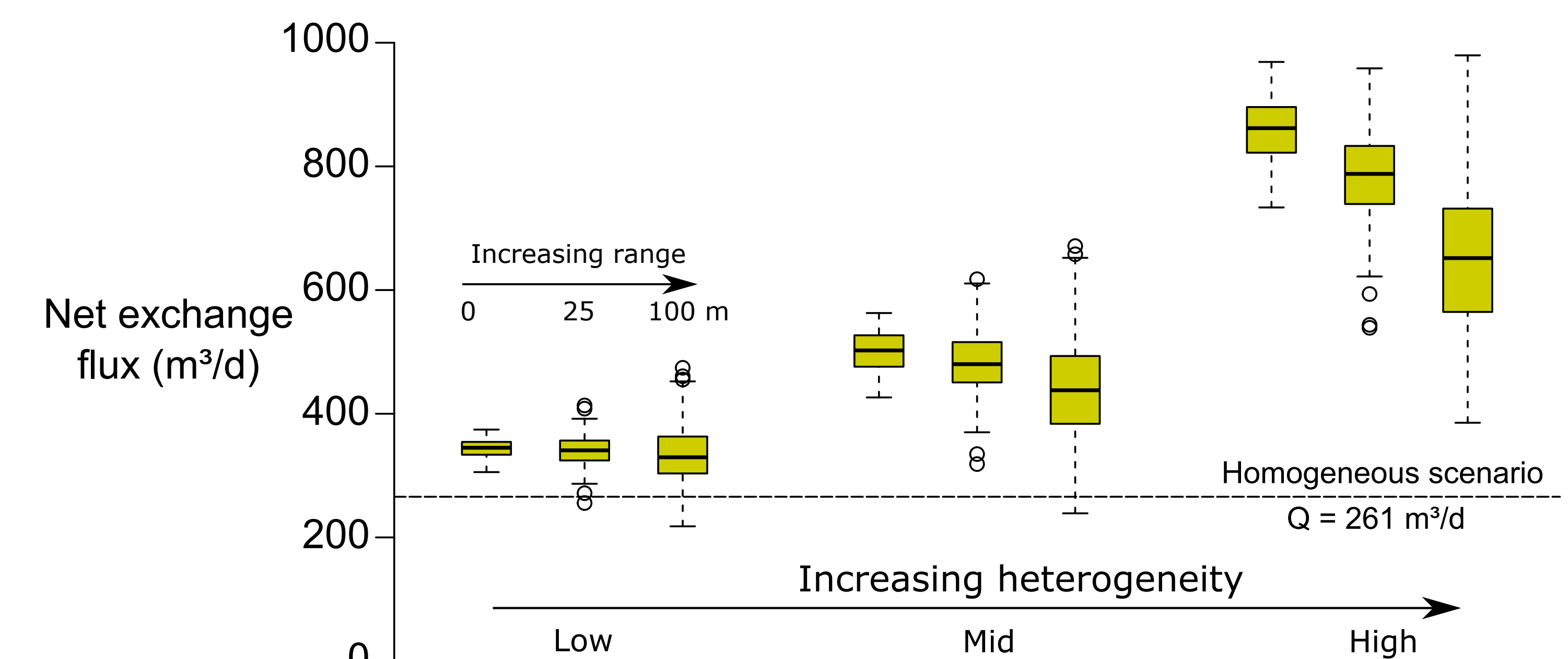
Input for MODFLOW-model

Resulting exchange fluxes:



Exchange fluxes are underestimated significantly when heterogeneity is neglected

Overview of exchange fluxes from aquifer to river for varying degrees of heterogeneity and ranges



Average net exchange flux (in m³/d)

compared to homogeneous scenario ($Q=261$ m³/d)

Range (m)	Low	Mid	High
0	344 +32%	502 +92%	859 +229%
25	341 +30%	481 +84%	779 +198%
100	335 +28%	443 +70%	655 +151%

Outlook

- Development of alternative for River Package which models riverbeds more realistically
- Extensive measurement campaign (K_v , K_h and ΔT) at very dense grid
- Using multiple-point geostatistics for the simulation of realistic fields of riverbed hydraulic conductivity
- Groundwater modeling and incorporating thermal data

Conclusion:

Riverbed heterogeneity has a significant influence on river-aquifer exchange fluxes

[1] Cardenas & Zlotnik (2003). Three-dimensional model of modern channel bend deposits. Water Resources Research 39(6)

[2] Genereux et al. (2008). Spatial and temporal variability of streambed hydraulic conductivity in West Bear Creek, North Carolina, USA. Journal of Hydrology 358:332-353

[3] Anibas et al. (2011). A simple thermal mapping method for seasonal spatial patterns of groundwater-surface water interaction. Journal of Hydrology 397:93-104