The Selke field site, Central Germany

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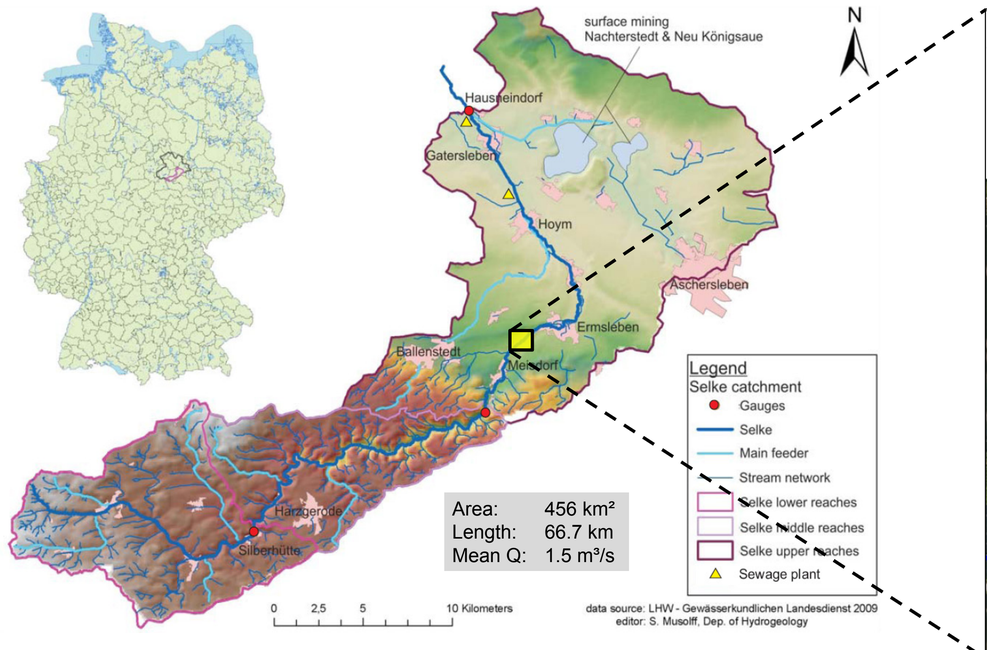
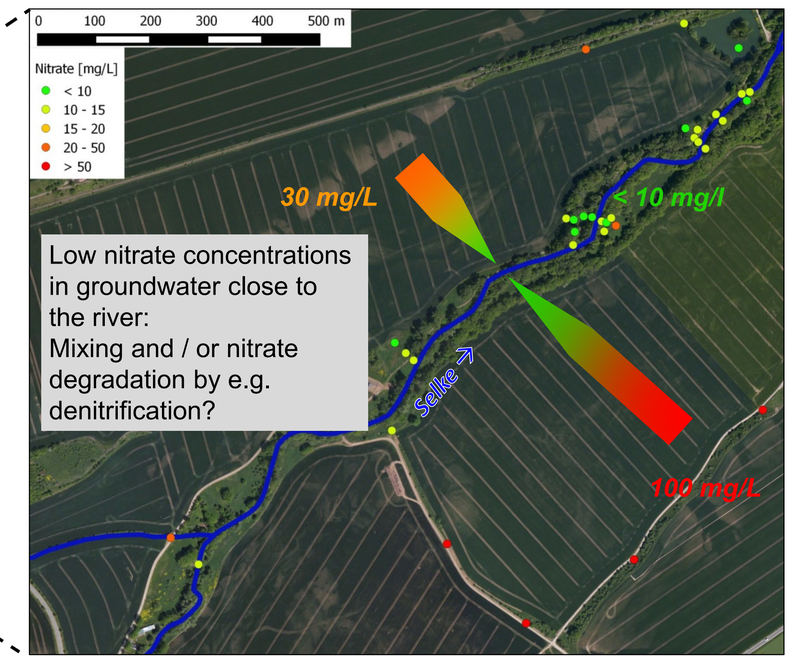
Objectives and Research Questions

- Detailed understanding of groundwater – river water exchange dynamics at the meander to reach scale
- Quantifying water and solute fluxes across this interface
- Delineating controls of turnover of redox-sensitive compounds (carbon, oxygen, nitrate) by aerobic and anaerobic reactions
- Spatial extent and temporal dynamics of water exchange, solute transport and reactive zones

The Selke field site – part of the TERENO observatories

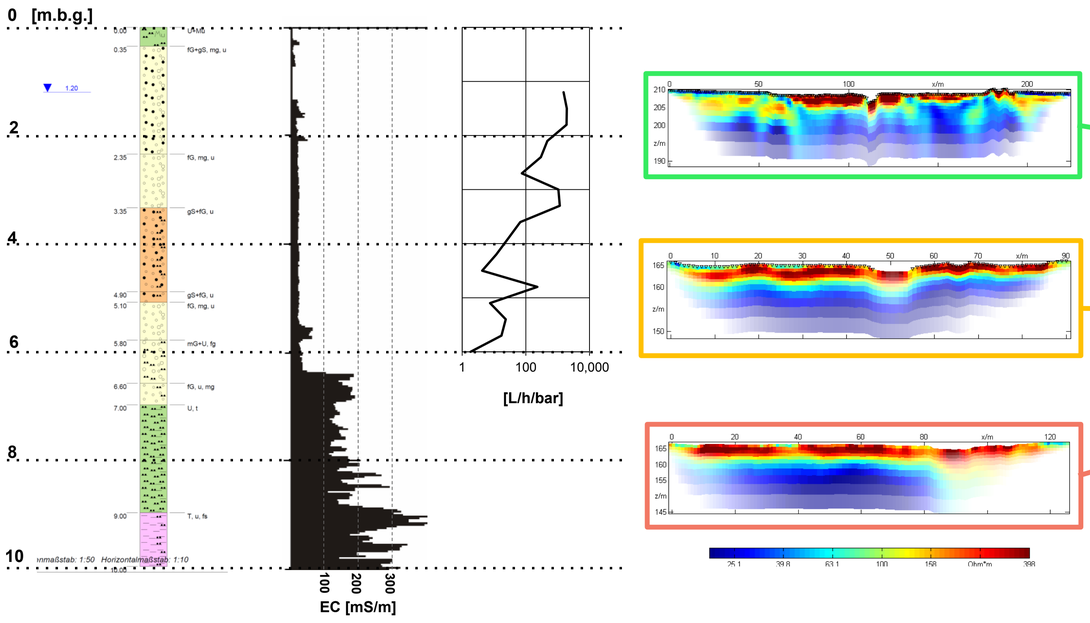


Elevated nitrate concentrations



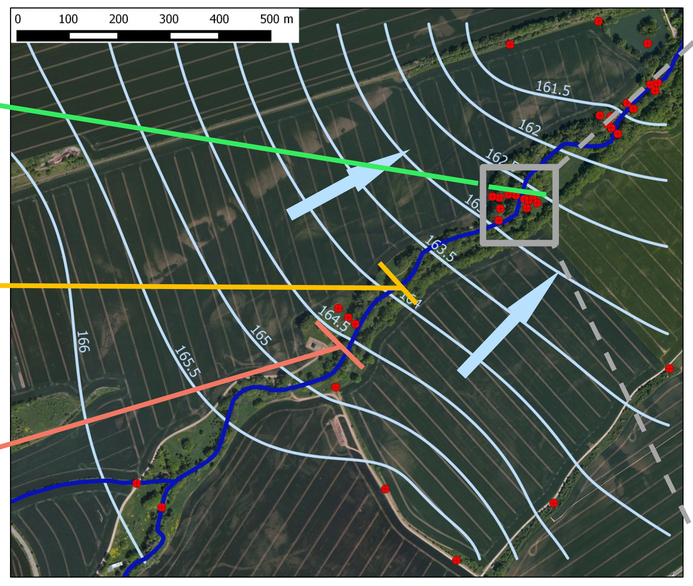
Aquifer characterization

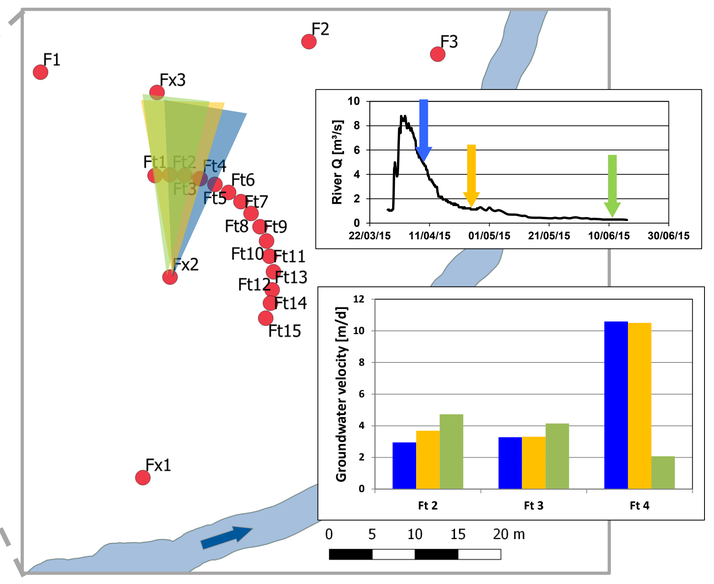
Sediment cores | EC-logs | Inj.-logs | ERT cross-sections



Hydrogeology

Groundwater levels | Natural gradient salt tracer tests

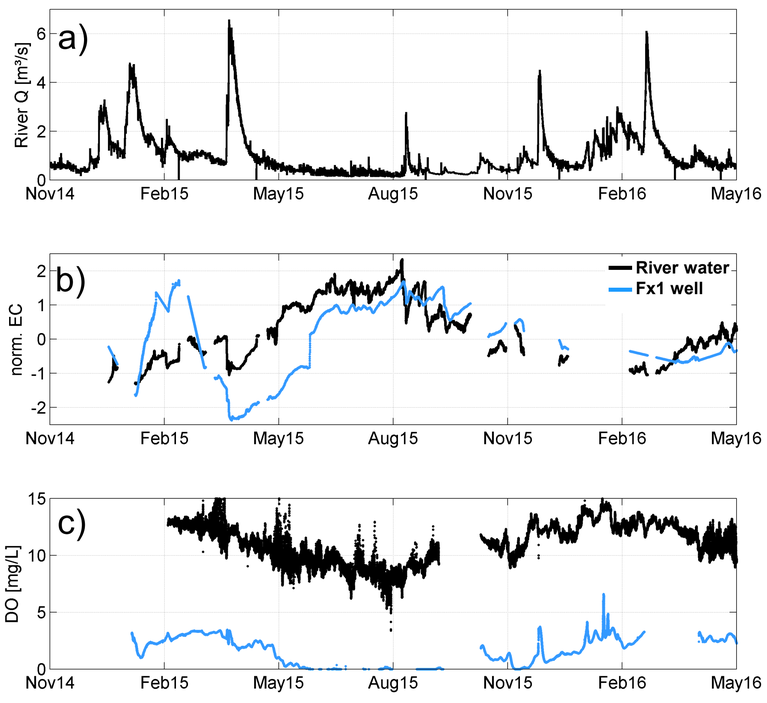




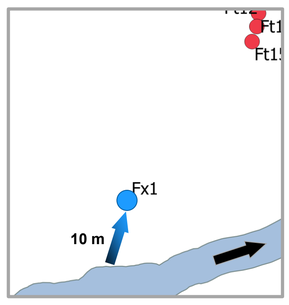
Travel times | Aerobic respiration

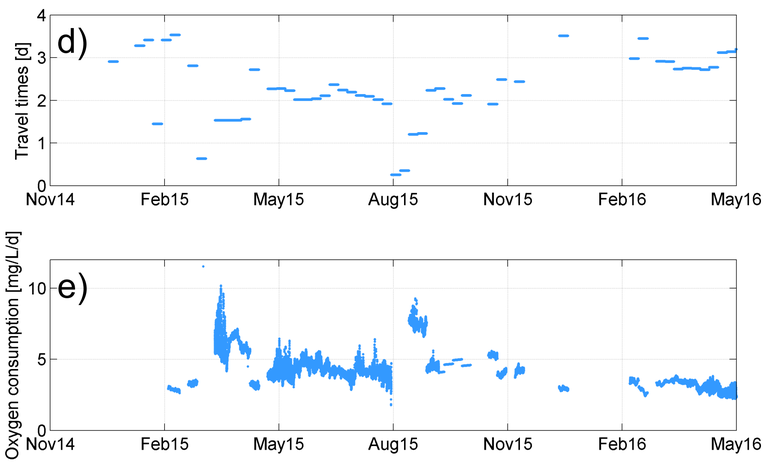
Time series analysis of electrical conductivity and dissolved oxygen

Windowed cross correlation of EC signal
(after Vieweg et al. 2016, JGR-B)



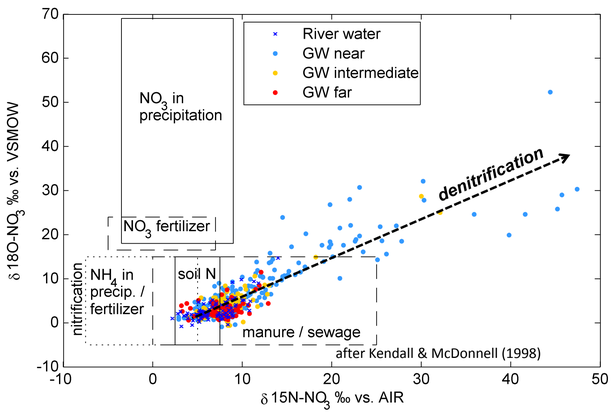
- Average travel time of 2.3 days to well Fx1 over 10 m distance (Fig. d) → 4.3 m/d GW-flow velocity
- Travel time slightly increases with river discharge
- Mean oxygen consumption: 5 mg/L/d (Fig. e)
- Highest oxygen consumption during summer season





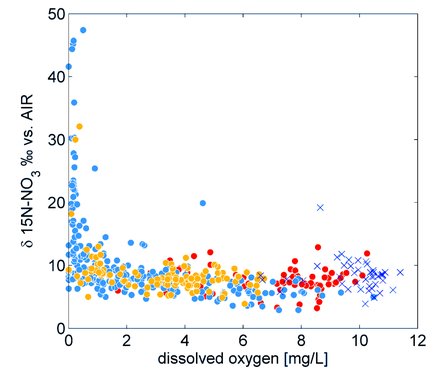
Denitrification

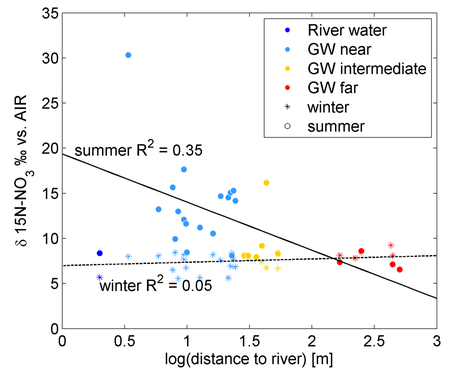
Identification of denitrification by ^{15}N & ^{18}O isotopes



Typical enrichment of ^{15}N and ^{18}O isotopes during denitrification

Favorable conditions:
- Warm season
- Close to the river (<25m) distance
- Low oxygen concentration

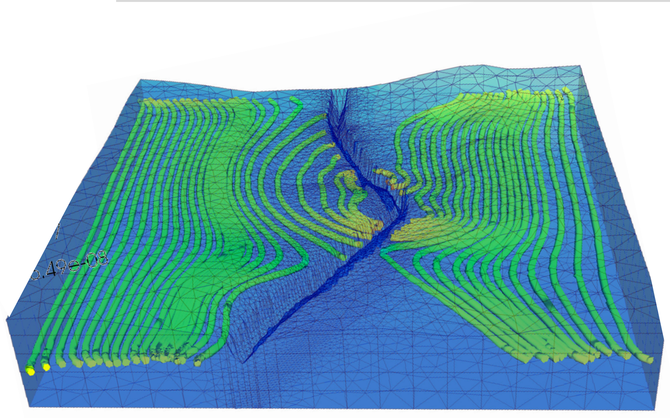


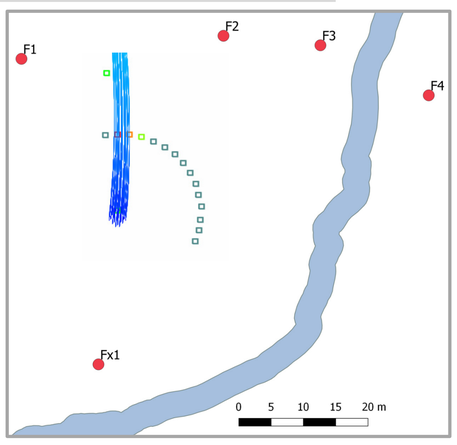


Numerical modeling

Simulation of groundwater flow and solute transport

- Calibration against groundwater levels and salt tracer breakthrough curves





Synthesis and Outlook

Main findings

- Highly conductive riparian aquifer built up of fluvial sediments ($K=3 \cdot 10^{-3}$ m/s)
- Highest permeability in the upper 1-2 m
- Groundwater flow velocities of up to 10 m/d
- Alternating losing and gaining sections along the river reach, depending on river discharge and channel morphology

- Strong seasonal effects on aerobic and anaerobic reactions
- Highest reactivity of the riparian zone in the vicinity of the river, presumably by bioavailable carbon and heat supply of infiltrating river water

Future research

- Linking aquifer heterogeneity, (preferential flow paths), solute transport and reaction (mixing vs. reaction)
- Evaluating sensitivity of discharge events on reaction by e.g. solute mobilization of bioavailable carbon
- Effect of variation of solute concentration over depth
- Reactive transport model of the reach, implementing aquifer texture derived from geophysics
- Effect of riparian vegetation on preferential flow paths and nitrogen transformation

References

pw: selkepaper

Notes: