Geophysical Research Abstracts
Vol. 12, EGU2010-785-3, 2010
EGU General Assembly 2010

Streambed peat lenses as redox-reactivity hotspots in lowland river hyporheic zones

Emma Naden, Stefan Krause, and Nigel Cassidy
Keele University, Earth Sciences, Crewe, Cheshire, United Kingdom (emma.naden@yahoo.co.uk)

Hyporheic zones, as the direct interfaces between aquifers and rivers, are often characterised by increased redox reactivity and chemical transformation capacity. Depending on redox conditions and reaction types, hyporheic mixing of groundwater and surface water can lead to either attenuation or enrichment of pollutants or nutrients with diametrical implications for in-stream and aquifer hydro-ecological status.
This study combines geophysical methods with distributed temperature sensor networks and nested multi-level sampling and analysis of hyporheic redox conditions and nutrient concentrations to investigate the reactive transport of nitrate at the aquifer-river interface of a UK lowland river.
In stream Electric Resistivity Tomography and Ground Penetrating Radar (including core based ground truthing) have been applied to map the complex spatial patterns of highly conductive sandy and gravely sediments in contrast to semi-confining, low conductivity peat lenses which have been found to be characteristic for most lowland rivers. Reach scale (1km) spatial patterns and temporal dynamics of aquifer-river exchange have been identified by heat tracer experiments based on fibre-optical Distributed Temperature Sensing techniques combined with vertical thermocouple-arrays for tracing hyporheic flow paths. Spatial patterns of hyporheic redox conditions, dissolved oxygen (DO) and organic carbon (DOC) content as well as concentrations of major anions have been monitored in 48 nested multi-level mini-piezometers.
Our investigations indicate that streambed temperature patterns were dominantly controlled by groundwater up-welling, causing cold spots in sandy and gravely sediments with high up-welling rates and low hyporheic residence times and warmer areas at the streambed surface where groundwater – surface water exchange was inhibited by streambed peat lenses.
The flow-inhibiting peat structures have been found to cause semi-confined conditions in the up-welling groundwater, resulting in long residence times and increased redox-reactivity. Anoxic conditions and high DOC contents combined with long residence times underneath peat layers cause highly efficient denitrification rates, reducing nitrate concentrations from > 50mg/l to below the level of detection. In contrast, sandy and gravely areas of fast groundwater up-welling where characterized by only marginal changes in nitrate concentrations.
The investigations lead to the development of a conceptual model of aquifer - river exchange and hyporheic reactivity in lowland rivers including temperature traceable hyporheic reactivity hotspots with high denitrification potential. The results for this exemplary field site highlight the substantial nutrient attenuation capacity of hyporheic zones at lowland rivers and emphasize the great importance of their consideration for river restoration programs and the assessment of water quality and ecological status.