Geophysical Research Abstracts
Vol. 14, EGU2012-3706, 2012
EGU General Assembly 2012

Nested heat tracer experiments for identifying heterogeneity of aquifer-river exchange at multiple scales

S. Krause (1), D. M. Hannah (1), T. Blume (2), L. Angermann (2), J. Lewandowski (3), and N.J. Cassidy (4)

(1) University of Birmingham, Geography, Earth and Environmental Sciences, Birmingham, United Kingdom (s.krause@esci.keele.ac.uk), (2) GFZ - Helmholtz Centre for Geoscience Research, Potsdam, Germany, (3) IGB - Leibnitz Institute for Freshwater Ecology and Inland Fisheries, Berlin, Germany, (4) Keele University, Dep. for Earth Science and Geography, Dep. for Earth Science and Geography, Keele, Staffordshire, United Kingdom

This study presents the nested application of three heat tracing methods for identifying aquifer-river exchange fluxes at multiple scales ranging from centimeter to stream reach-scale. The investigations focus on a UK lowland river where hotspots of redox-reactivity were found to coincide with locations of increased streambed residence times underneath flow confining streambed peat and clay structures.

In order to identify the spatial extend and patterns of reactivity hot spots associated with these streambed structures, reach-scale patterns of aquifer-river exchange fluxes have been analysed by Fibre-Optic Distributed Temperature Sensing (FO-DTS) along a cable buried in the streambed of a 250 m reach in combination with 2D thermocouple arrays in a 12 m long pool-riffle-pool sequence and small-scale heat pulse injections for tracing shallow hyporheic flow paths within the uppermost 20cm streambed sediments.

FO-DTS observed streambed temperature anomalies caused by the mixing of different temperatures of GW and SW end-members were used to infer information on exchange fluxes at the aquifer-river interface. FO-DTS survey results indicate that patterns of up to 2C colder (Summer) and 3.5C warmer (Winter) temperatures in investigated streambed sediments can be attributed to fast GW up-welling in sandy and gravely sediments. Contrasting conditions were found at locations where streambed temperatures equal SW temperatures and GW-SW exchange was inhibited by the existence of peat or clay lenses within the streambed. FO-DTS observations of regional GW up-welling patterns were complemented by heat pulse injection experiments which provided essential information of the shallow aquifer- river exchange fluxes and confirmed increased SW infiltration and lateral flow in riffle crests and at locations with highly conductive streambed sediments above flow confining low conductivity structures. The propagation of diurnal temperature oscillations from the surface to streambed depths of up to 40cm was observed at thermocouple profiles along a pool-riffle-pool sequence in order to analyse the potential masking of FO-DTS observed temperature patterns by topography induced hyporheic exchange fluxes. The cross-correlation functions based analysis of the depth dampening and offset of diurnal temperature amplitudes revealed that streambed temperature variation due to topography induced hyporheic exchange flow was an order of magnitude lower than the FO-DTS signal strength.

The investigations supported the development of a conceptual model of aquifer-river exchange and hyporheic reactivity in lowland rivers including temperature traceable hyporheic exchange fluxes at multiple scales.