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Quantification of Water and Solute Flows between Groundwater and Stream by Combining Integral Pumping Tests and Streambed Temperatures

E. Kalbus (1), C. Schmidt (1), M. Bayer-Raich (1), S. Leschik (1), F. Reinstorf (1), G.U. Balcke (2), M. Schirmer (1)

(1) UFZ - Helmholtz Centre for Environmental Research, Department of Hydrogeology, Leipzig, Germany, (2) Now at Metanomics GmbH, Berlin, Germany

(edda.kalbus@ufz.de / Fax: +49 341 235-2126 / Phone: +49 341 235-3986)

The spatial pattern and magnitude of mass fluxes between contaminated groundwater and surface waters has important implications for the impact of contaminants on floodplain ecology. For quantifying water and solute flows from a contaminated aquifer to a stream, two novel approaches were combined into a new methodology: Streambed temperatures were mapped at multiple depths along a 60 m long stream reach to identify the spatial patterns of groundwater discharge and to quantify water fluxes at the stream-aquifer interface; integral pumping tests were performed to estimate average concentrations and mass flow rates of chlorinated benzenes in the aquifer partially penetrated by the stream. Simple analytical solutions were used for the estimation of both groundwater discharge and average contaminant concentrations that can be applied to typical situations of aquifers connected to streams. The combined interpretation of the results showed average potential contaminant mass fluxes from the aquifer to the stream of 272 μg m^{-2}d^{-1}MCB and 71 μg m^{-2}d^{-1}DCB, respectively. This methodology permits an efficient quantification of the potential mass fluxes and flow rates of contaminants between groundwater and surface water as a basis for further assessments of the environmental impact of large-scale contaminated aquifers on connected stream ecosystems.