Geophysical Research Abstracts
Vol. 13, EGU2011-9344, 2011
EGU General Assembly 2011

Measuring and modelling infiltration losses to groundwater resulting from aquifer exploitation for a stream receiving motorway runoff discharges

Michael Rivett, Mark Cuthbert, and David Simpson

School of Geography, Earth & Environmental Sciences, University of Birmingham, Birmingham, UK
(M.O.Rivett@bham.ac.uk)

The long-term direction of flow through the hyporheic zone underlying streams is often influenced by the presence of groundwater abstractions that may cause a stream receiving groundwater baseflow to become influent to an underlying aquifer. Such conditions are increasingly probable in many parts of the world as aquifers are more heavily exploited. In urban settings surface waters may be polluted and provide a significant loading to the hyporheic zone under stream infiltration conditions. Although the hyporheic zone is often viewed as being a zone of enhanced natural attenuation potential with significant research effort being targeted at its capacity to treat contaminated groundwater baseflow, under influent conditions it is very possible poor urban surface-water quality may overload the natural attenuation capacity of the hyporheic zone and provide poor protection to underlying groundwaters and indeed water supply wells inducing such infiltration. We present field results and supporting modelling from such a case in the UK Midlands involving a peri-urban stream that receives piped discharges from the national motorway network located close to the site since the 1960s and undergoing network expansion through the 1980s. Our study was prompted by rising chloride levels since the 1970s in a nearby public water supply well. A campaign of stream and underlying hyporheic zone sampling through a network of piezometers and supporting logging of electrical conductivity and hydraulic head and flows over the 2009-10 severe winter season has allowed us to track the impact of motorway salting for de-icing on the receiving water environment.

Our data reveal a rapid passage of conservative chloride through the riverbed. A water (and chloride) mass balance - lumped parameter model of the catchment has been developed that incorporates data for the daily application of road salt. The model has successfully reproduced the daily variation of chloride observed in the receiving stream. Further, mass balance calculations on chloride infiltration estimates to the aquifer may reasonably account for the chloride increase observed in the supply well. Although chloride does not pose a major water quality concern, other more hazardous motorway contaminants potentially following might do so. The natural attenuation of the hyporheic zone and underlying unsaturated zone and aquifer, potentially exposed to some 50 years of contamination, is important in this regard and the safeguard of the well supply and wider aquifer. It is also important to consider more widely that an urban impacted influent-flow hyporheic zone and underlying strata may contain a significant accumulation of contamination that may potentially de-sorb and derogate groundwater baseflows should effluent conditions return with groundwater abstraction demise. Groundwater discharge through the urban hyporheic zone may hence not always be beneficial to its water quality. These aspects will be briefly discussed and may form the basis of future research.