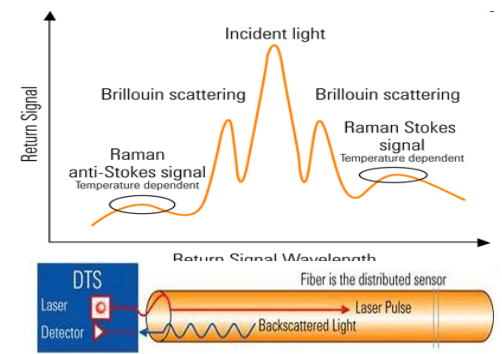
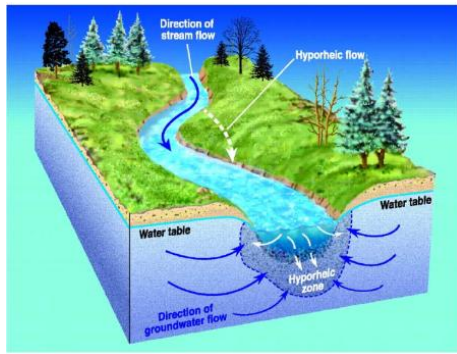


Quantifying *Hot Moments* and *Hot Spots* of contaminant attenuation in streambed hyporheic zones by novel distributed sensor networks, smart tracers and new generations of reactive transport models

Supervisors:

Stefan Krause; John H. Tellam; David M. Hannah; Jan H. Fleckenstein (external, UFZ)



Project description:

Biogeochemical processes in the hyporheic zone, the direct interface between groundwater and surface water in streambeds, can have significant impact on both, aquifers and rivers. Detailed knowledge of exchange flow patterns and flow-path dependent chemical reactivity is crucial for understanding the biogeochemical and ecohydrological functioning of river corridors. Current numerical hydrological models fail to adequately predict the implications of small-scale hyporheic process dynamics at catchment scale, resulting in serious problems for integrated river basin and aquifer management. The main reasons for this shortcoming are a critical lack of adequate experimental monitoring technology as well as the inefficiency of current modelling approaches to reflect and incorporate new types of experimental process information.

This project will focus on investigating the catchment scale implications of locally increased chemical reactivity (hot spots) in hyporheic zones and periods of enhanced turnover rates (hot moments). It will develop novel distributed sensor network technology and smart tracers of pathway dependent chemical reactivity in order to improve the representation of hyporheic zone residence times and chemical reactivity patterns in adaptive models of coupled groundwater and surface water flow and reactive transport. The studentship will deploy novel fibre-optic distributed temperature sensing (FO-DTS) technology for tracing aquifer-river exchange flow patterns in hyporheic streambed environments based on temperature gradients between groundwater and surface water. Current FO-DTS technology will therefore be adapted in collaboration with the leading constructor of fibre-optic tracing equipment. FO-DTS applications will aim to identify the spatial variability of hyporheic exchange fluxes and residence time distributions at multiple spatial and temporal scales. At selected representative locations of high and short residence times, reactive smart tracers will be applied for quantifying the pathway specific chemical reactivity.

The results experimental investigations are not only expected to advance the understanding of hyporheic zone process dynamics but will also be applied to improve model-based quantifications of hyporheic zone reactive uptake at larger scales. The studentship will, therefore, develop strategies for applying the new types of experimental data for advancing the representation of hyporheic zone boundary conditions in coupled groundwater-surface water models at catchment scales. Such modelling strategies will include the implementation of stochastic parameterisation approaches into the process based numerical Hydrogeosphere model.

Training:

The studentship will provide the student with comprehensive training in the design of experimental and lab-analytical research, the development, testing and uncertainty analysis of hydrological models, tracer hydrology, geostatistical data analysis and environmental data processing as well as advanced methods in Geographical Information Systems. The student will be a member of the large, vital graduate research community within the School of Geography, Earth and Environmental Sciences (GEES). The University of Birmingham and GEES provide formal training for PhD students, supporting the development of transferable skills including conference presentation, project design and time management. If required, the student will additionally have the possibility to attend relevant courses from the Hydrogeology MSc programme.

The student will benefit from working in a multidisciplinary international research team including collaborations with international research partners and industrial collaborators as Silixa (UK) the producer of the world's highest performance DTS who provides substantial support to the project.

Relevant Papers by Supervisors and Collaborators:

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Munz M., Krause S., Tecklenburg C., Binley A., (2011) Reducing monitoring gaps at the aquifer-river interface by modelling groundwater-surface water exchange flow patterns. *Hydrological Processes*, 25 (23), 3547–3562.

Krause S., Hannah D.M., Wood P.J., Sadler J. (2011) Hydrology and Ecology interfaces: processes and interactions in wetland, riparian and groundwater-based ecosystems. *Ecohydrol. J.* 4(4), 476-480.

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Fleckenstein J.H., Krause S., Hannah D.M.H., Boano F. (2010) Groundwater-surface water interactions: New methods and models to improve understanding of processes and dynamics. *Advances in Water Resources*. 33 (11), 1291-1295.

Krause S., Hannah DM., Fleckenstein JH. (2009) Hyporheic hydrology: interactions at the groundwater-surface water interface. *Hydrological Processes*. 23 (15), 2103-2107.

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Frei, S., Fleckenstein, J.H., Kollet S. & Maxwell R.M. (2009) Patterns and dynamics of river-aquifer exchange with variably saturated flow using a fully coupled model, *J. of Hydrol.*,375(3-4), 383-393.

Fleckenstein J.H., & Fogg, G.E. (2008) Efficient upscaling of hydraulic conductivity in heterogeneous alluvial aquifers, *Hydrogeology Journal*, 16(7):1239-1250.

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Informal Enquires: Stefan Krause - s.krause@keele.ac.uk; David M. Hannah - d.m.hannah@bham.ac.uk