**Marie Skłodowska-Curie**

**Innovative Training Network**

**"HypoTRAIN"**

**Hyporheic Zone Processes – A training network for enhancing the understanding of complex physical, chemical and biological process interactions**

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# Deliverable D4.2

## Model validation for identification of hyporheic exchange fluxes at focus sites

**Dissemination Level of Deliverable:**

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|---|---|---|
| **PU** | Public | **X** |
| **CO** | Confidential, only for the members of the consortium (including the Commission Services) | |
| **CI** | Classified, as referred to in Commission Decision 2001/844/EC | |

# Model validation for identification of hyporheic exchange fluxes at focus sites

Especially during the first Joint Field Experiments in June 2016 several groups of ESRs were collecting data on hyporheic flow on different scales at the River Erpe. Those data are currently processed to model flow and solute transport/turnover in order to quantify degradation and retention capacities of the hyporheic zone.

Malte Posselt (ESR 1) and Jonas Schaper (DFG-research training group UWI) work on depth-dependent degradation and retention of pharmaceuticals in the hyporheic zone at the local scale. For this a method for minimally invasive, semi-automated pore water sampling was developed and successfully applied during the Joint Field Experiments. Hyporheic flow as the advective force for compound transport into the hyporheic zone was derived from vertical temperature gradients. With the help of software tools such as VFLUX (Gordon et al., 2012; Irvine et al., 2015) hyporheic fluxes can be modelled from phase and amplitude shifts in temperature time series (Fig. 1).

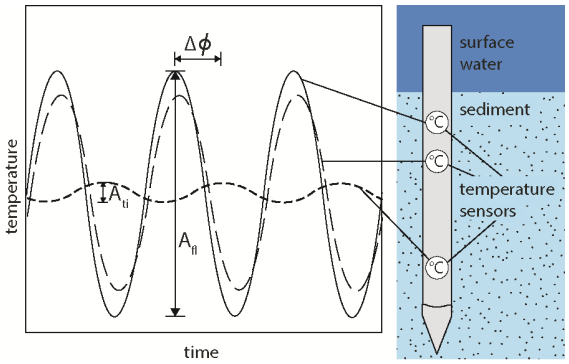


***Figure 1.*** *Shifting and dampening of temperature amplitudes in the sediment (modified from Hatch et al., 2006).*

On the reach scale hydrological modelling shows that surface water at the River Erpe infiltrates into the adjacent aquifer to reenter the river about a hundred meters downstream. Results from piezometer samplings will serve as a basis for biogeochemical modelling to reveal the fate of trace organic compounds during the passage through the aquifer.

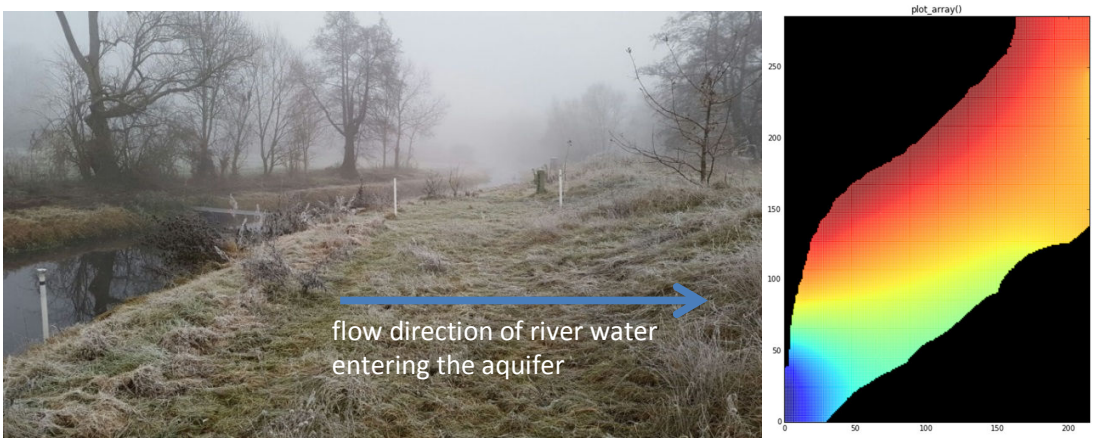


***Figure 2.*** *Right: Well gallery at River Erpe installed for taking alluvial groundwater samples. Left: MODFLOW model of subsurface water flow in alluvial bank (arrows show direction of flow; in black: aquifer boundary; colored grids represent groundwater heads from relatively high, in red, to relatively low, in blue).*

Jason Galloway and Ignacio Peralta-Maraver (ESRs 4 and 9) collaborated in a study on faunal community structure along the sediment depth gradient. It was tested whether community compositions change under different hyporheic flow conditions.

At six different sites sediment-corer samples were collected for meiofauna and macrozoobenthos determination in the hyporheic zone (Fig. 3). Also in this study, vertical streambed fluxes in the sediments of River Erpe were gained from time series analysis of streambed thermal records. For that purpose, vertical temperature lances had been installed in the sediments. Hyporheic fluxes have been modelled from the results using amplitude and phase shifts (Fig. 1). The sampling of sediment cores was repeated 8 times with a time lag of 30 days.

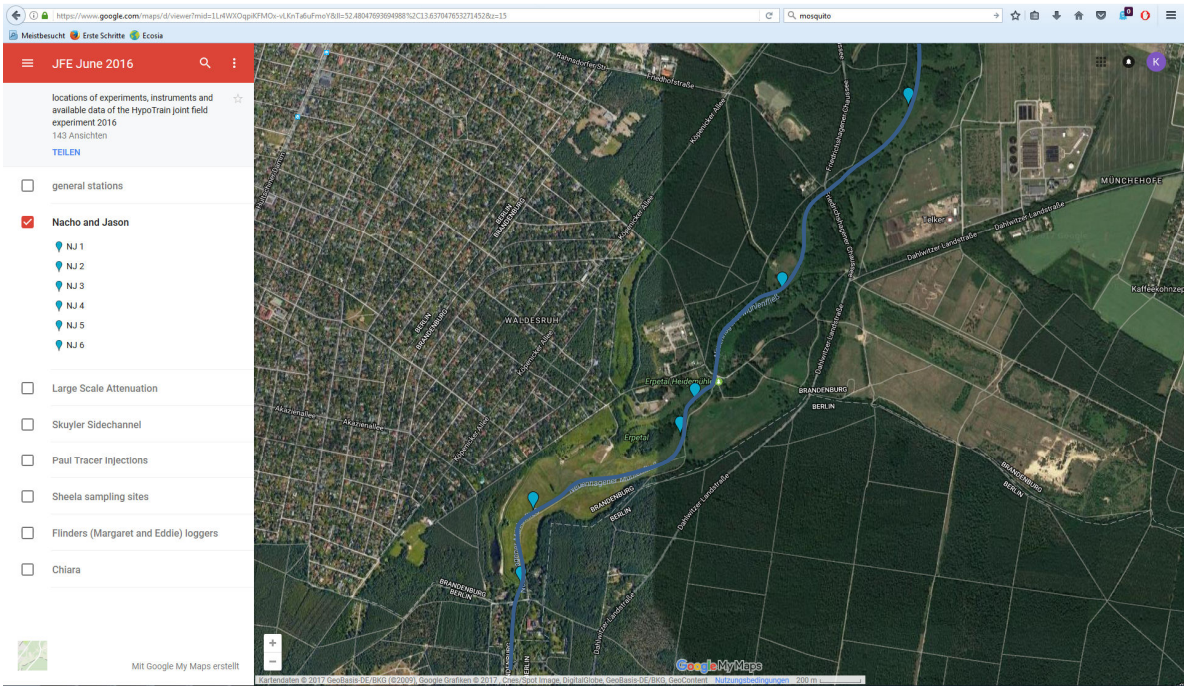


***Figure 3.*** *Investigation sites of ESRs 4 and 9 at River Erpe (river shown as blue line) (https://www.google.com/maps/d/viewer?mid=1Lr4WXOqpiKFMOx-vLKnTa6uFmoY&ll=52.471354246004026%2C13.624173049999968&z=14)*

Besides the examples described above several other sub-projects in HypoTRAIN progressed in modelling surface and hyporheic flow and related turnover/retention of dissolved compounds:

For example, a method was established to estimate residence time distributions and turnover rates in both the river on a reach scale and the aquifer on a cm-scale by using diurnal fluctuations in electric conductivity considering it an intrinsic conservative tracer.

Measurements of another natural trace element (radon from uranium decay chain) were used in combination with temperature measurements of the river sediments in order to analyze the fate and transport of radio nuclide decay chains in groundwater. By this groundwater up-welling zones can be modelled.

Concentration time series of organic trace pollutants and their transformation products will be used to model attenuation also on a reach scale. The turnover rates will be related to hydrological processes, such as transient storage, to identify the influence of these processes on the self-purification capacity of the river.

**References:**

Gordon, R.P., Lautz, L.K., Briggs, M.A., McKenzie, J.M., 2012. Automated calculation of vertical pore-water flux from field temperature time series using the VFLUX method and computer program. Journal of Hydrology, 420–421: 142-158.

Hatch, C.E., Fisher, A.T., Revenaugh, J.S., Constantz, J., Ruehl, C., 2006. Quantifying surface water-groundwater interactions using time series analysis of streambed thermal records: Method development. Water Resour. Res., 42(10).

Irvine, D.J., Lautz, L.K., Briggs, M.A., Gordon, R.P., McKenzie, J.M., 2015. Experimental evaluation of the applicability of phase, amplitude, and combined methods to determine water flux and thermal diffusivity from temperature time series using VFLUX 2. Journal of Hydrology, 531, Part 3: 728-737.