Department of Hydrology

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Bayreuth Center of Ecology and Environmental Research

UNIVERSITÄT BAYREUTH

Research

The main focus of research at the Department of Hydrology is the investigation of processes at the interface of groundwater and surface water. This interface is of fundamental importance for numerous processes affecting the quality of surface waters (streams, lakes) as well as groundwater as the two aquatic systems possess different chemical and physical properties. This interface offers ideal conditions for an efficient biological degradation of nutrients and contaminants, meaning that processes at the interface between surface and groundwater contribute considerably to nutrient cycling and buffer capacity in aquatic ecosystems.
The department conducts field, lab and modeling investigations that focus on gaining a quantitative process understanding of aquatic systems and address questions of performance and efficiency of matter processing but also vulnerability of aquatic systems, resulting from climate change or anthropogenic influences in general. The overarching goal is to obtain a better understanding of the coupling of physical and biogeochemical processes that control the cycling of matter and energy at the interface of surface waters and groundwater.

Equipment

The Department of Hydrology has modern and extensive facilities. Instruments are available for data logging and on site analytics that allow for e. g. continuous monitoring of water quality parameters or measuring discharge in combination with automatic water sampling equipment. Special equipment is available for sampling of sediments and sediment pore waters. Several analytical instruments allow for the analysis of both aqueous and - after digestion with a microwave digester - also solid phase samples, such as ion chromatography, TOC-analyzer, spectral photometers, FTIR, fluorescence, and AA spectrometry as well as ICP-OES. Moreover, the laboratory has several gas chromatographs to analyze CO_2, CH_4 and H_2. The laboratory is also equipped with HPLC instrumentation with different detectors (UV, DAD, refraction index, fluorescence) as well as a lab for measurement of radioactive labelled isotopes (^{14}C- and ^{35}S). The analytical facilities are completed by an XRD instrument for solid phase analysis. High performance computers and software for the simulation and visualization of flow and transport processes in aquatic and porous systems complement the equipment of the department.

Biogeochemistry / Limnology

Dr. Benjamin Gilfedder

Water is the medium of life while certain vital elements such as C, N, S, and P are intimately and ultimately linked to the water cycle. But where is the water in our streams, rivers and lakes coming from, and what is controlling the availability and distribution of biogeochemically important elements? How are these elements cycled through ecosystems? Such questions are the foundation of what we do in investigating relationships between the water cycle and biogeochemical processes. Of particular interest is coupling between groundwater and surface water systems and the dynamic hydrological and biogeochemical processes at the interface between these reservoirs (e.g. hyporheic zone). This includes water fluxes and residence times, carbon cycling which is dependent on the structure of organic molecules, and redox reactions involving N, S and Fe. We are interesting in long term processes (effects of climate change) and transient events in space and time, e.g. 'hot moments' and 'hot spots'.

Sampling the hyporheic zone in the Mistelbach.

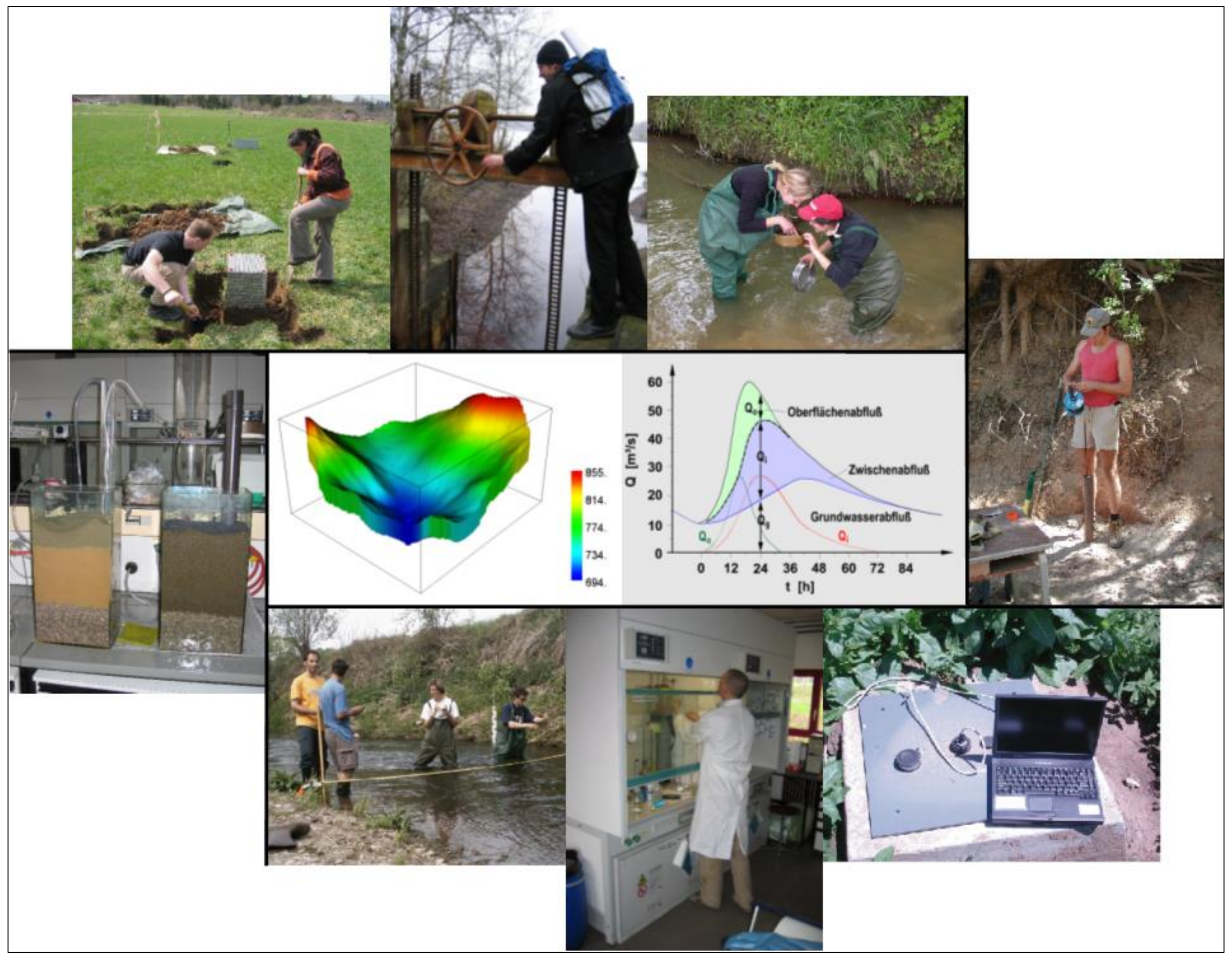
High-resolution measurement of groundwater-surface water exchange.

Hydrogeochemistry

Prof. Dr. Stefan Peiffer

Formation of iron oxide around a spring.

In this field we are asking the question about the role of iron minerals in regulating the chemical composition of aqueous solutions. Surfaces of iron minerals have a strong retention effect for aqueous species on the one side but also accelerate chemical reactions. The understanding of these interactions is of paramount importance for the behavior of pollutants and nutrients as well as for the transformation of organic compounds.
The hydrogeochemical research at the Department of Hydrology focuses on the analysis of reaction kinetics with the aim of resolving the tight coupling between hydrogeochemical, biogeochemical and hydrophysical processes in regard to their effectiveness in processing matter.



Hydrological Modeling

Dr. Sven Frei

Numerical models are important tools to qualitatively and quantitatively understand flow and transport processes in natural systems. The work group "hydrologic modeling" applies numerical models in order to investigate interactions between hydrological and biogeochemical processes at various scales for different ecosystems. Understanding these interactions, together with their potential impact on functions and services of ecosystems, represents an extraordinary interdisciplinary challenge especially considering the effects of climate change. In this context, we investigate couplings between hydrology and biogeochemistry for different types of ecosystems like e.g. river and lake-systems, terrestrial catchments or wetlands. Methodologically, we use established surface/subsurface flow as well as transport models (e.g. MODFLOW, VS2DH, HYDROGEOSPHERE, HYDRUS), complemented by self-developed experimental approaches and a large variety of field methods.

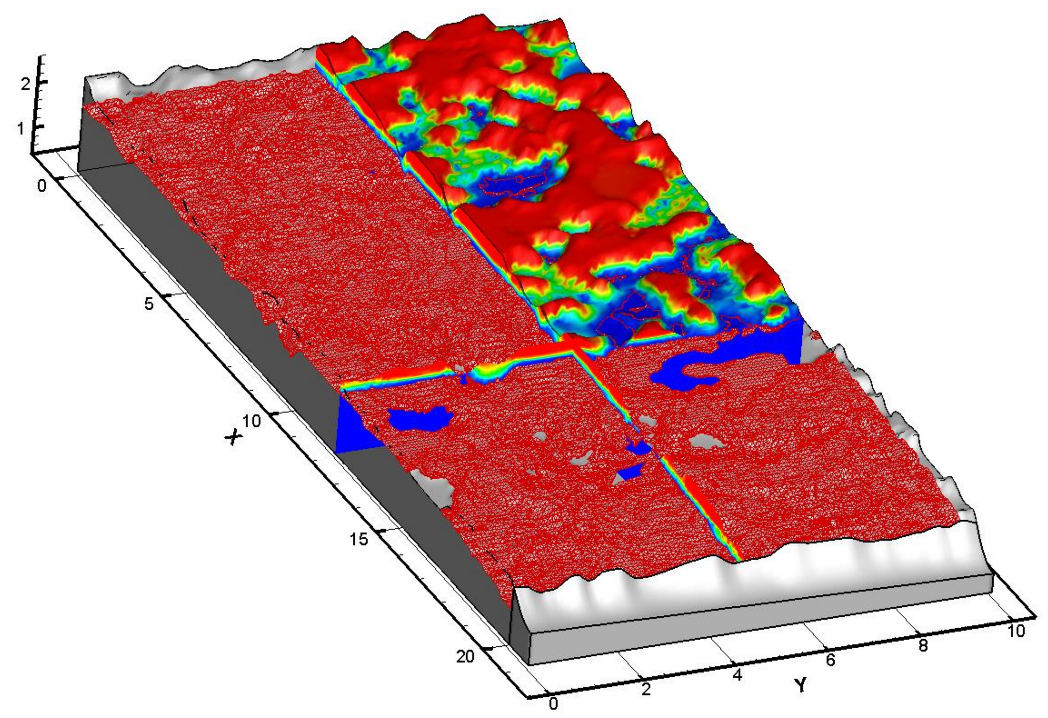
Hydrological Processes

Dr. Luisa Hopp

Subsurface flow collection system.

Stream gauging.

The focus of this research topic are runoff generating processes at the hillslope and small watershed scale, in natural as well as engineered systems (e.g. at former mining sites). We try to answer questions like: Where does water go when it rains? How long does it take infiltrating precipitation to reach the stream? Which flowpaths in the subsurface does water take? Measurements of precipitation, soil moisture, groundwater dynamics and stream runoff allow us to explore how water moves through a landscape. The application of tracers, such as geochemical tracers, stable isotopes of water and temperature, helps us to better understand the mixing of water in the subsurface, the sources of stream water and the mean residence time of water in a hydrological system. These experimental approaches are combined with hydrological modeling to gain a better understanding of the factors controlling runoff generation and to be able to link physical processes to biogeochemical function.



Simulated redox cline in a wetland.

Measuring stream temperature.