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Anne Marx, Tobias Juhlke, Michael Mader

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Abstracts

SPP Sea Level: "Groundwater salinization following sea level rise as a societal challenge of climate adaptation - The case of North-Western Germany"

Wencke Appel, Carl von Ossietzky Universität Oldenburg

Abstract:

Enhanced groundwater exploitation and a sea level rise leads to a landward shift of the salt and freshwater mixing zone. The influence of a sea level rise on groundwater salinization is a slow process and is therefore described as a „creeping catastrophe ". Regional investigations of the influence of sea level rise on the German North Sea coast have not been applied in 3D yet. In the superordinate project "SPP sea level" the magnitude of the sea level rise will be ascertained to find application in my model as a boundary condition. Running the model, the reactions of the coastal aquifers of North-West-Germany on this sea level rise will be identified. The aim of my work is the creation and application of a large-scale numerical density dependent flow model of the coastal aquifers of North-West Germany. The current flow conditions and based on various scenarios future flow conditions will be displayed in the model.

Anthropogenic gadolinium as a transient tracer for investigating river bank filtration

Robert Brünjes, Universität Wien

Abstract:

The use of Gadolinium (Gd) complexes as a contrast agent in Magnetic Resonance Imaging (MRI) results in a Gd anomaly in the aquatic environment. Gd complexes are excreted by humans unmetabolized within a few hours after application. Passing the sewage systems with almost no degradation, they successively reach surface waters, which make Gd a capable tracer for river bank filtration (RBF).

The investigated RBF system is located in a sub-alpine river valley in a rural catchment. The river is influenced by a waste water treatment plant (WWTP) from which anthropogenic Gd permanently infiltrates into the glaciofluvial aquifer. The aquifer is characterized by high permeabilities and groundwater flow velocities. The field site was instrumented with ten "Rhizons" (Rhizosphere, The Netherlands) along a transect in groundwater flow direction to allow for a high spatial and temporal monitoring resolution.

Gd and conventional hydrochemical data from 12h composites samples were monitored over a period of ten days. Rare earth element concentrations were measured using an on-line preconcentration system "SeaFAST" (Elemental Scientific Inc., USA), in combination with a QQQ-ICP-MS (Agilent Technologies, Japan). A LOQ of 0.05 ng/L for Gd allowed a robust determination of the geogenic background. Geogenic Gd was estimated with the concentrations of Samarium (Sm) and Terbium (Tb) normalized by the Upper Continental Crust (UCC).

Groundwater residence times within the transect were estimated based on ^{222}Rn measurements to be below seven days. Hydrochemical data indicated that groundwater is recharged exclusively by river water infiltration at all depths and that mixing with ambient groundwater is negligible. Temporal variability in the stream and the groundwater revealed the suitability of anthropogenic Gd to estimate groundwater travel times.

Groundwater dynamics in a discontinuous permafrost environment

Marion Cochand, Université Laval Québec, Canada

Abstract:

With increasing concerns of global warming, the influence of permafrost degradation on groundwater quality is of growing interest. In this context, a detailed field study on groundwater dynamics in a discontinuous permafrost environment is being conducted in a small 2-km2 watershed in northern Québec, Canada. Groundwater origin and evolution, as well as flow dynamics and residence times within the watershed are being investigated using hydrogeochemical tracers such as major ions, water stable isotopes ($\delta^{18}O_{H2O}$ and $\delta^{2}H_{H2O}$), carbon phases (DIC, DOC, POC) and their stable carbon isotopes ($\delta^{13}C$), and dating tools (radiocarbon and tritium-helium methods).

Groundwater types mainly fall into the Ca-HCO3 field. Sample mineralisation is close to the composition of rain and snow, and is likely linked to limited bedrock weathering caused by short residence times, slow reaction rates as well as low levels of dissolved CO_2 in groundwater due to suppressed biological activity in the catchment. Stream-water samples at the watershed outlet had similar hydrochemical composition when compared to groundwaters. Preliminary $\delta^{18}O_{H2O}$ and $\delta^{2}H_{H2O}$ results suggest that ice lenses within the top four meters of permafrost are under the influence of modern water. Moreover, stream water sampled in July appears to be influenced by a snowmelt signature whereas water isotope ratios from thermokarst lakes show an influence of evaporation. Combined with further hydrogeochemical data analyses and numerical modelling, these results will help to provide insight into the groundwater flow dynamics and thermal regime in this watershed of degrading discontinuous permafrost. This will enable assessment of groundwater availability, including for use as a drinking water resource in northern communities.

Impact of groundwater circulation wells for geothermal use on hydrochemical and microbiological processes in Berlin.

Eva Dinkel, Technische Universität Berlin

Abstract:

The climate protection goals issued by the German Government aim at finding new renewable technologies for heating and cooling of buildings. More than 20% of the annual greenhouse emissions in Germany are caused by the energy sector (Umweltbundesamt, 2014). To lower these emissions, the use and impact of low-enthalpy shallow geothermal energy systems is subject of research and development.

A groundwater circulation well (GCW) is an open geothermal system which extracts and injects groundwater in the same well via two filter screens at different depths. The groundwater is extracted at the lower filter screen and pumped to a groundwater heat pump (GWHP) where the thermal energy is utilized for cooling or heating of the building and then reinjected via the upper well screen. The temperature gradient between extracted and injected groundwater is 3K.

To impede clogging, mineral precipitation and dissolution, or physical processes such as particle mobilization, degassing, and flocculation, it is crucial to prevent mixing of different redox zones. Especially the presence of high contents of ferrous iron and manganese are exclusion criteria for the installation of open groundwater systems. A groundwater circulation well could be the appropriate technique to avoid mixing of different redox zones giving the opportunity to use groundwater otherwise not suitable for geothermal use. Furthermore, as the temperature difference between extraction and injection is very low, it remains questionable whether significant hydrochemical, hydraulic or microbiological changes are induced by the operation of GCW for geothermal use at all.

The aim is to ensure long-term economic stability for the energy generation in accordance with groundwater protection applying systematic regulations for site selection and evaluation for GCW. Interactions between the aquifer and the installations are examined at several newly installed and running systems in the North German Basin. Based on the assessment of investigated sites we aim to give prediction tools for users, responsible authorities and investors as a basis for evaluating the annual energy production, aging effects and the influence of GCW on groundwater.

Coupling hydrology and biogeochemistry in riparian wetlands: An interdisciplinary approach

Stefan, Durejka, Universität Bayreuth

Abstract:

The hydrological and biogeochemical responses and dynamics of riparian wetlands play a critical role in the global cycling of Carbon C through the exchange of CO2 with the atmosphere, the emission of CH4, the production and export of dissolved organic carbon (DOC) and the storage of C.

The interactions between hydrology and biogeochemistry are important control mechanisms for wetland ecosystem function and the services they provide. Convoluted positive and negative feedbacks make it difficult to assess the future response of riparian wetlands adjusting to external forces e.g. climate change. The complex coupling between hydrology and biogeochemistry together with the consequent potential influence on biogeochemical hot-spot development, solute transformation and mobilization processes is only poorly understood to date.

Using Rn-222 and DOC as natural flow path tracers we have developed new methods to measure internal runoff generation continuously in-situ with high temporal resolution for long time periods. First results indicate a pronounced opposing diurnal cycle as well as a fast response of the flow path contribution to runoff after precipitation events.

Next, using high spatial resolution information provided by modern geophysical techniques such as electrical resistivity tomography (ERT) areas with rapid processing rates of a number of biogeochemical reactions are identified. Thereafter, the improved process understanding on temporal and spatial scales will be used in further investigations with spatially-explicit, physically-based model structures.

We aim at an integrated understanding of complex riparian wetlands processes and their links to easily accessible hydrological metrics such as water table depth. New robust and autonomous methods can be used in further studies especially in remote locations.

Facing climate change: Development of a participatory water management in urban slums in Jaipur, India

Theresa Frommen, Freie Universität Berlin

Abstract:

Women in urban slums in India are most affected by climate change. The interdisciplinary project "Women's Action towards Climate Resilience for Urban Poor in South Asia" aims at finding solutions especially for this target group. In this frame, a participatory water management based on hydrogeological research is currently being developed in two peri-urban slum areas in Jaipur, Rajasthan. The study sites were chosen to represent typical settings in India, both in a social and in a hydrogeological context. The first area is situated in the northern outskirts of the city on a hill slope. The shallow aquifer is characterized by elevated electrical conductivity (up to 3500 µS/cm) and high nitrate concentrations of up to 500 mg/L. The slum is well established and has a Hindu population of about 1200 people. The second site is located in a lowland area towards the eastern boundary of Jaipur. Insufficient sanitation in this newly emerged slum makes the wells prone to microbial contamination. The electrical conductivity reach values up to 6500 µS/cm while nitrate concentrations remain below 200 mg/L. The slum has a mainly Muslim population of about 3000 people, but is expected to expand rapidly.

In this project, methods which are used in social sciences, especially human-centered-design tools (e.g. interviews, camera-user-studies) were applied to understand the community's point of view and priorities. The main goal is to explore, how communities, represented by women groups, can be enabled to make own reasonable decisions about their water supply, thus creating a sense of ownership and responsibility, which should prevent the relapse in old behavior patterns and guarantee a long-term success. The close cooperation between a hydrogeology research group with a local and experienced NGO, consisting of social scientists, urban planners and health experts, influences both the way of working and the perception of water challenges. It allows developing new and innovative approaches, which are planned to be transferred to similar places throughout South Asia.

Elevated concentrations of sulfur species in an urban aquifer - Berlin, Germany

Babette Gabriel, Freie Universität Berlin

Abstract:

Sulfate concentrations in the groundwater - up to 1000 ppm - can be determined in the catchment area Berlin-Grunewald that contributes to the drinking water supply of Berlin.

To prevent an increase of sulfate concentration in the drinking water, the identification of sulfate sources and sinks as well as the quantification of the input of sulfate into the groundwater is necessary. Potential sources are:

- Debris deposits
- Organogenic sediments
- Oxidation of sulfides and mobilization of geogenic sulfur species
- Emissions from combustion processes (atmospheric input).

Within the catchment area 17 drillings with continuous withdrawal of core samples were driven to a maximum depth of 33 m below surface. In Batch experiments the samples were analyzed for the leachable sulfate content. The results show a sulfate distribution over the depth with two plateaus. The first plateau in between 14 and 17 m below surface (Sulfate 20-45 mg/kg) and the second at the level of the groundwater fluctuation zone (Sulfate >100 mg/kg).

The first plateau can be traced back to atmospheric depositions (SO2). The installation of flue gas desulfurization plants (1989) caused a decrease of SO2 emissions, between 1989 and 1995 of about 50 t. The sulfur deposition has an impact on the sulfate content in the unsaturated zone, by being transported with the percolating water. Hence a characteristic progress of the sulfate distribution over the depth could be detectable. By calculating the transport velocity, the first plateau can be traced back to the atmospheric deposition from the year 1989. For further verification, column experiments were carried out to determine the retardation factor for sulfate.

The second plateau occurs concurrent with high calcium concentrations. A possible source is the precipitation of gypsum. A detailed knowledge of the hydrogeochemical processes in the saturated zone and especially within the groundwater fluctuation zone taking into account the hydraulic situation in the catchment area, is necessary to determine the sources of calcium and sulfate. Thus, experiments for a better understanding of the hydrogeochemical processes within the groundwater fluctuation zone will be included.

Moreover, it is necessary to identify sources and sinks of sulfur species and to quantify the input into the groundwater to develop a catalogue of measures and recommendations for the local water supplier.

Investigation of the recirculation on the beach of Spiekeroog from in- to exfiltration

Nele Grünbaum, Carl von Ossietzky Universität Oldenburg

Abstract:

- Circulation not permitted -

Towards a better understanding of the long term concentration evolution of pesticides and metabolites in groundwater

Simone Hintze, Université de Neuchâtel, Suisse

Abstract:

According to the water protection by-law of Switzerland persistent substances are undesirable in groundwater. Among these substances, pesticides and their metabolites are particularly common, because of their large-scale application in agriculture and their persistence in the environment. Metabolites tend to occur more frequently and at higher concentrations than pesticides due to their higher mobility. To limit the impact of pesticides and metabolites on groundwater quality, pilot projects were initiated in which the application of certain pesticides was stopped (e.g. chloridazon). These projects indicate a high persistence of these substances with no concentration decline in groundwater for extended time periods.

The main aim of this project is the investigation how geological and hydrogeological factors influence the long term persistence of pesticides and their metabolites in landscape characterized by glacial and fluvial deposits. The study is carried out in two small catchments on the Swiss plateau. In the following the two field sites are named after the closest city (Seuzach (ZH) field site and Daillens field site (VD)). The main focus will lie on the pesticide chloridazon and its main metabolites desphenyl chloridazon and methyl desphenyl chloridazon.

We hypothesize that the spatial distribution of lower permeability deposits and their connectivity to the main alluvial aquifer exert control over the long-term concentration evolution in groundwater. To test this hypothesis, we characterize the spatial arrangement of the low permeability deposits and relate them to spatio-temporal patterns of the compounds in soil and groundwater. In addition to the chemical analysis of groundwater and surface water, this hypothesis will be also tested by a numerical model.

Both field sites are small catchments (~ 20 – 30 km2) characterized by glacial and fluvial deposits, predominantly consisting of moraines covering the hillslopes and alluvial deposits in the central valley. Latter usually consist of gravels overlain by more recent finer-grained flood deposits. The Seuzach field site has a distinct drainage (artificial) and surface water system. At the Daillens field site the alluvial aquifer is limited on the western and eastern side by small streams. To locate zones that could act as potential reservoirs for these substances preliminary studies were carried out at both field sites.

In a first sampling campaign under base-flow conditions at the Seuzach field site, elevated concentrations of the two chloridazon metabolites (desphenyl chloridazon: up to ~ 1.3 µg/L; methyl desphenyl chloridazon: up to ~ 0.7 µg/L) were detected in the drainage and surface water although the parent compound is no longer in use since the year 2013. Thus, the less permeable moraine deposits

could represent a reservoir for these substances from which they are slowly but continuously released to the drainage systems and surface water.

Groundwater sampling in the alluvial aquifer at the Daillens field site suggested that a section of the aquifer characterized by clay-rich gravels acts as a reservoir of the compounds. This could lead to still quite high concentrations of chloridazon metabolites in the groundwater even after the termination of the application of chloridazon few years ago.

The connection of surface water and drainage system to the groundwater, the distribution of the compounds in the less permeable parts and other possible origins will be investigated amongst others with new multi-level groundwater measuring stations in the catchment area of a pumping station.

Investigation of stream-aquifer exchange using waterborne spectral induced polarization imaging

Phillip Höhn, Universität Wien

Abstract:

- Circulation not permitted -

Groundwater salinity and vegetation on a juvenile barrier island affected by storm tides and inundation frequency

Tobias Holt, Carl von Ossietzky Universität Oldenburg

Abstract:

- Circulation not permitted -

Investigations on the fate of veterinary pharmaceuticals in the unsaturated zone

Michael Horf, Carl von Ossietzky Universität Oldenburg

Abstract:

Due to the eminently improvement of analytical methods in the last decade there has been a special focus on human and veterinary pharmaceuticals contaminating the environment. In the course of different studies negative impact on humans, animals and the environment like the increasing occurrence of multiresistant pathogens caused by antibiotically active substances have been identified.

Because of the fact that no European law had been passed until 1998 regulating environmental assessment in the accreditation process of pharmaceutic substances, there is a lack of information concerning the degradation of veterinary pharmaceuticals (VP) in the environment, especially in the unsaturated zone. Thus, the main aim of this study is to better understand the behaviour of veterinary pharmaceuticals regarding the degradation and sorption in soils and potential leaching into groundwater. Thereby key parameters, influencing these processes, are supposed to be identified, and the ecological relevance of the investigated substances is said to be elevated.

For this reason, it is intended to work first of all with three unsaturated, undisturbed soil columns in the laboratory to receive degradation constants and sorption coefficients of 10-15 well selected and representative veterinary products (anti-infectives, antiparasitics and endocrine active substances (EAS)) in dependence of temperature and pH-value. Therefore, three kinds of soils with different characteristics in grain size, organic content and pH-value are supposed to be selected (probably a cambisol, podzol and a plaggic anthrosol).

Secondly, it is planned to analyze the seasonable variety of degradation processes of veterinary products by means of a lysimeter study. Thus, it is dedicated to utilize a lysimeter construction which consists of four different disturbed soils (cambisol, luvisol, podzol and a river marsh soil) in duplicate. Again, degradation constants will be obtained and checked against the results of the laboratory.

Furthermore, all results will be utilized to model and predict degradation and transport processes in these scales and to compare them with the outcomes of QSAR methods (quantitative structure activity relationship).

Influences of high reliefs on isotope hydrology and coupled climate proxies

Tobias Juhlke, Friedrich-Alexander Universität Erlangen-Nürnberg

Abstract:

Climate proxies such as tree rings rely on stable isotope ratios for the reconstruction of palaeoclimatic conditions. Such information then allow the calibration of models that evaluate and predict ongoing and future effects of global climate change. According to model predictions, the western Mediterranean is a region that will face severe climatic changes. Therefore, the island of Corsica in that region has been the target for palaeoclimate reconstructions by means of dendrochronology and stable isotopes. However, the oxygen stable isotope results from Corsican pines could not yet be interpreted satisfactorily.

The oxygen stable isotope values (delta18O) of tree rings mainly depend on the oxygen isotope ratio of local precipitation and soil water. The precipitation delta18O values vary according to temperature, altitude and the moisture source area. Such parameters are determined nowadays rather precise but need to be assumed for the past. An important isotope effect is the so-called altitude effect that describes the relation of the delta18O value of precipitation and altitude. The large global network of isotopes in precipitation (GNIP) database of the International Atomic Energy Agency (IAEA) allows for a good regional estimate of isotope effects. However, things become more difficult in regions with high and steep mountain reliefs. Some latest publications suggest that the altitude gradient is absent in such regions during specific seasons. The reason for that observation could be seasonal height variations of the atmospheric planetary boundary layer (PBL).

This isotope hydrology proposal is part of the project package CorsicArchive that also consists of interlinking proposals for climate, dendroisotopes and dendroecology. It is planned to install and regularly sample nine isotope precipitation samplers along an east-west altitudinal transect. This proposal will specifically explore the dynamics of the PBL and the isotope altitude effect. Additional questions relate to moisture source of air masses and the local moisture recycling within the islands hydrologic cycle. Furthermore, soil water and surface water analyses are planned to trace and quantify changes of the delta18O values along the pathway of water to the tree rings. The approach of this proposal aims to fill the gaps in the current knowledge of isotope hydrology of high reliefs and will finally lead to a more robust interpretation of related climate proxies in a climate change sensitive region. With respect to the current climate change it is essential to understand climatic variations and its triggers in the past to better predict future changes.

A new method to detect groundwater via temperature anomalies in a deep lake

Catharina Keim, Universität Bayreuth

Abstract:

Lake Constance is a unique ecosystems, which not only provides habitat for various Flora and Fauna. Furthermore, it supplies more than 4 million people in southwestern Germany with drinking water. The inflows and the lake itself are well monitored. Yet, it is not known where and how much groundwater enters the lake. The research project 'Seezeichen' is interested to identify and quantify the groundwater input into Lake Constance. Generally saying, groundwater is an often neglected component in a lake ecosystem setting. Especially in large, deep lakes hardly any research was conducted to find out how lakes are connected to their surrounding hydrogeological systems. Part of this research project is to test and validate a new method to map areas where groundwater enters a lake. This method is called Thermal Mapper. The Thermal Mapper detects temperature anomalies to find areas of lacustrine groundwater discharge (LGD). Two sets of data were collected. The results identified areas with LGD in certain structures at the lake bottom e.g former gravel pits. The collected data shows temperature anomalies > 0.5 °C. Furthermore, 222-Radon measurements were taken from the bottom of the lake. 222-Radon is used as a groundwater indicator. Elevated 222-Radon concentrations were found at similar locations where the Thermal Mapper detected LGD. These methods to identify groundwater inflows to lakes are part of a tool box, which shall be applied to other lakes as well. The goal is to better understand the groundwater- lake interaction, in order for water resource managers to make good decisions regarding sustainable lake management and drinking water supply.

The role of soil and groundwater storage for flood generation in a Karst catchment, Lauchert river– Swabian Alb

Paul Knöll, Technische Universität Berlin

Abstract:

Flood prediction in Karst catchments is a challenging task. Large scale heterogeneities such as sinkholes and karst conduits lead to a complex system behaviour difficult to forecast. We are working on a new approach to forecast flood events, taking such complexities into account.

The study area is the catchment of the river Lauchert, a tributary of the Danube river in the karstified Swabian Alb. The karst groundwater system is composed of fractured matrix blocks characterised by low flow velocities and large scale karst conduits with high flow velocities (often more than 100 m/h). The conduits in the Lauchert catchment drain the karst system mainly towards springs such as Gallusquelle or Ahlenbergquelle and further smaller springs which feed the Lauchert. Spring discharge can show fast reactions to precipitation events and an important contribution to total runoff. The heterogeneous nature of the system, as well as the extent of groundwater catchment areas that differ from surface catchment areas are usually not included in models for flood prediction. To the authors knowledge there are no published prediction models for the study area.

A flood event in the Lauchert catchment in June 2013 caused large damage. Since then local authorities are longing for a flood warning system in the catchment. The aim of the study is to develop a flood warning system for the Lauchert catchment.

Our current approach is based on modelling soil water balances and groundwater storage. The aim is to simulate the key processes for storage of precipitation and runoff generation. Relevant parameters need to be determined for the use in a flood warning system. In contrast to the models currently in use, we also take subsurface catchments into account. The feasibility of our approach is studied in the catchment of the Gallusquelle spring, the largest karst spring in the Lauchert valley.

In the used soil water balance model, snow storage, interception, land use, and physical soil properties are taken into account as well as the existence of preferential flow paths. Lateral flow within the soil column is not considered.

Storage and transport of groundwater is modelled with a simple, yet efficient approach based on spring hydrograph recession coefficients, considering the fast (conduit) and slow (matrix) flow components of the groundwater system. Modelled recharge from the soil water balance calculations are used as input to determine storage changes and resulting changes in spring discharge.

Disentangling dissolved oxygen sources in shallow riparian groundwater by stable isotope analysis

Michael Mader, Friedrich-Alexander Universität Erlangen-Nürnberg

Abstract:

Dissolved oxygen (DO) is one of the strongest oxidation agents in aquatic environments. Besides gas-water-exchange, mixing and mineral oxidation, it is a key player in fundamental biogeochemical processes such as respiration and photosynthesis. These processes also systematically influence stable isotope ratios of DO and of dissolved inorganic carbon (DIC). Simultaneous measurements of DO and DIC concentrations in conjunction with their stable isotope ratios (δ18ODO and δ13CDIC) can thus provide useful tools to quantify oxygen and carbon sources and sinks in natural waters.

This study focused on the Selke River in the Harz Mountains (Germany) with steep DO gradients between the stream water and the shallow, adjacent groundwater and associated stable isotope shifts. δ13CDIC values decreased from -13 ‰ to -18 ‰ versus the VPDB (Vienna Pee Dee Belemnite) standard from May to November 2016 and indicated the dominant influence of microbial respiration on the observed DO gradients. With such respiration dominance, we have expected a simultaneous enrichment of δ18ODO to values higher than the one of atmospheric O2 (+23.9 ‰ vs Vienna Standard Mean Ocean Water standard - VSMOW). However, our measurements revealed anomalously low δ18ODO values between +22 ‰ and +18 ‰ vs. VSMOW for the same time period. These δ18ODO values were lower than those found in the river. Latter were close to equilibrium with the atmosphere (24.9 ‰ vs. VSMOW). The observed δ18ODO ratios in the shallow groundwater can be explained with DO from the river that is subject to fractionation by microbial respiration with a typical fractionation factor (αr) of 0.995. In addition, mass balances revealed that this oxygen pool receives contributions of up to 25 % by diffused oxygen from the vadose zone. Consequently, isotope shifts by respiration and admixture with surface water are masked by diffusion effects that result in a decoupling of carbon and oxygen isotope systematics in the near river subsurface environment. They also demonstrate that DO in shallow groundwaters has additional sources than admixture from surface waters alone.

Three decades after peak acid deposition: Environmental memories of legacy pollutant sulphate in the northern Czech Republic

Anne Marx, Friedrich-Alexander Universität Erlangen-Nürnberg

Abstract:

A hydrological and physicochemical analysis was conducted in the granitic Uhlirska headwater catchment (1.78 km²) located in the Jizera Mountains in the northern Czech Republic. Due to its location between the northern Czech Republic, southeastern Germany and southwestern Poland an area called the Black Triangle it received among the highest inputs of anthropogenic acid depositions in Europe during the 1980s. An analysis of sulphate distribution in deposition, soil water, stream water and groundwater compartments allowed to establish a sulphate mass-balance (deposition input minus surface water export) and helped to evaluate which changes occurred since the last evaluation of the catchment in 1997. The determined sulphate concentrations decreased in the following order: peatland groundwater > groundwater from 20 m below ground level (bgl) > groundwater from 30 m bgl > stream water > groundwater from10 m bgl > hillslope soil water > peatland soil water > bulk deposition. Our results show that average deposition reductions of 62 % did not result in equal changes of the sulphate mass-balance, which changed by only 47 %. This difference indicates that sulphate must have been stored over decades in the catchment and still originates from internal sources such as the groundwater body and peatland soil. This suggests that the Uhlirska catchment is subject to delayed recovery from anthropogenic acid depositions and remains a net source of stored sulphur even after three decades of declining inputs. Elevated stream water sulphate concentrations after the unusually dry summer 2015 may imply importance of weather patterns for future recovery from acidification.

From Manure to Groundwater – The Fate of Veterinary Pharmaceuticals within the Aquatic Environment

Anne Mehrtens, Carl von Ossietzky Universität Oldenburg

Abstract:

Entry, behavior and fate of pharmaceutical residues in the terrestrial and aquatic environment became focus of various research studies in the field of hydrology and other branches of research. Problematic consequences of pharmaceutical residues in the environment are, amongst others, bacterial resistance and adverse effects on non-target organisms. Pharmaceuticals may enter the environment via different pathways, for example by application of manure from animal farming. Along with the development of intensive livestock farming the consumption of veterinary pharmaceuticals enhanced generally. Still insufficiently investigated are parameters which strongly influence the agents on their way from entering the soil, accumulating in or passing through the unsaturated zone and infiltrating into the groundwater.

Antibiotics, antiparasitics and endocrine active substances are groups of veterinary pharmaceuticals. Many of them found to be environmentally toxic. In the upcoming project 10 to 15 of these compounds will be studied regarding their behavior under saturated and unsaturated conditions. The experimental design is to investigate the transport and degradation behavior on two different scales: Column experiments in the laboratory and sampling of soil water and shallow groundwater in a nearby study area. Column experiments will take place under saturated conditions with aquifer sediments from the study area. Performances under variable settings will result in sorption coefficients and degradation rate constants. The field survey follows the way of the pharmaceuticals from application of the manure to groundwater with a primary focus on determination and mobility of the aim substances, degradation rate constants and infiltration quantity into groundwater.

The results will be compared and analyzed to facilitate the transferability from experimental to field scale. Furthermore reactive modeling will be used to identify key parameters for an improved understanding of the related processes. The ultimate goal is to develop a new fertilizing concept by means of the gained information for a sustainable groundwater management and the transmission into practice.

Understanding the potential of increased contaminant decay in the hyporheic zone.

Sonja Schröter, Technische Universität Hamburg

Abstract:

The area between ground- and surface water seems to have an increased potential of decaying contaminants due to altered biochemical conditions. Several case studies showed that groundwater contaminations close to surface waters are reduced more quickly in comparison to simple groundwater contaminations. As the hyporheic zone is usually only examined from the isolated view of one discipline, a combination of processes such as flow, transport, soil development and microbiological processes is not yet completely understood.

This thesis aims to understand the effects that occur in the hyporheic zone by using various groundwater models such as Visual Modflow and RT3D. Additionally field data will be used and collected to build and calibrate the models. An important step to understand the contaminant fate close to surface waters is also the understanding of small scale flow processes in the transition zone. Planned field investigations are temperature measurements of ground- and surface waters in the transition zone to calculate the flux in that area and mini-piezometer to measure hydraulic head differences in small scales. Data of two case studies is available for this study which includes concentration measurements of contaminants, hydraulic head measurements and partially concentrations of naturally occurring parameters.

First basic models revealed that an important aspect is the colmation layer which is often found below surface waters. This layer consists of fine materials that lead to a reduced hydraulic conductivity. Due to the higher resistivity groundwater tends to flow around that layer, so less amount of groundwater reaches the surface water as expected. Additionally the flow velocity is strongly reduced which leads to a longer residence time. As decay of contaminants is strongly dependent on the time that is available for microorganisms to degrade a substance, the prolonged residence time is very important for protecting the surface water from groundwater contaminations.

The hydrogeochemical evolution of a barrier island freshwater reservoir: Conceptual understanding and identification of key processes

Stephan Seibert, Carl von Ossietzky Universität Oldenburg

Abstract:

- Circulation not permitted -

Direct Push supported geotechnical and hydrogeological characterization of an active sinkhole area

Thomas Tippelt, Helmholtz Centre for Environmental Research UFZ, Leipzig

Abstract:

Sinkholes represent a natural geologic hazard in areas where soluble layers are present in the subsurface. A detailed knowledge of the composition of the subsurface and its hydrogeological and geotechnical properties is essential for the understanding of sinkhole formation and propagation. This serves as base for risk evaluation and the development of an early warning system. However, site models often depend on data from drillings and surface geophysical surveys that in many cases cannot resolve the spatial distribution of relevant hydrogeological and geotechnical parameters sufficiently. Therefore, an active sinkhole area in Münsterdorf, Northern Germany, was investigated in detail using Direct Push technology, a minimally invasive sounding method. The obtained vertical high-resolution profiles of geotechnical and hydrogeological characteristics, in combination with Direct Push based sampling and surface geophysical measurements lead to a strong improvement of the geologic site model. Within the top 18-20m of glacial deposits that overlie water-soluble chalk, layers of fine sand and till reveal a high heterogeneity of the subsurface throughout the profile. Anyway, sedimentological differences appear between the inactive area and the sinkhole zone. Only in the latter evidence for a hydraulically conductive layer directly above the chalk body exists. Though results of the Direct Push and surface geoelectric methods show a high consistency, solely the data from HPT logging (Hydraulic Profiling Tool) clearly describe the upper chalk horizon.

The conceptual site model regarding sinkhole formation and propagation will then be tested based on the gathered data and, if necessary, adapted accordingly. The studies are conducted within the framework of the joint project SIMULTAN (Sinkhole Instability: integrated MULTi-scale monitoring and ANalysis), funded by the German Ministry of Education and Research (BMBF).

Using Precipitation as a Groundwater Tracer – Collection and first Application

Felix Tritschler, Helmholtz Centre for Environmental Research UFZ, Leipzig

Abstract:

When it comes to the question what Tracer to use in a hydrogeological study, precipitation might not be your first response. At the DFG-funded Project Rain as a Groundwater Tracer the UFZ Leipzig and the TU Dresden collaboratively work on the basic feasibility of using the inherent information of natural waters as a tracer in groundwater studies. Those are electrical conductivity, its stable isotopic signature, and the temperature. Given a significant difference of those parameters between on-site collected precipitation and groundwater, one should be able to use these differences as a tracer signal. At the last FH-DGGV-PhD Meeting in Pirna/Dresden 2016 my colleague Martin Binder (TUD) presented the fundamentals of the project and planned experiments.

Collection of Precipitation

In the last summer a transportable collection-facility with a surface of approximately 16 m² was developed, which allows to collect a fairly large amount of precipitation in a short time (ca. 1 m³ in 2-4 weeks). This is crucial for gaining a significantly distinct isotopic signature, as will be shown on a time series of weekly data collected in 2016. More recently about 1 m³ of snowmelt water was collected, which is generally known for heavily depleted isotopic signatures and therefore is a potential tracer water.

Data assessment

To be able to use precipitation as a groundwater tracer one has to know about the parameters of the relevant waters, i.e. groundwater, neighboring surface water and of course groundwater. For that purpose these waters were observed at our test site in Pirna over the course of one year in a weekly resolution. The data clearly shows the opportunity for using precipitation as a groundwater tracer, as its stable isotopic composition is largely different in summer months from that in the groundwater. Also the electrical conductivity has a constant offset in comparison to that of the groundwater.

Field-Application

With the collected water of this summer a first tracer test was conducted at the test site in Pirna as a Push-Pull-Test with Drift. Focusing on the electrical conductivity and comparing it to the well-known tracer Fluorescein (aka Uranin), it could be shown that Rainwater has the promised potential of being a practical field tracer.

Further research has but to clarify what preconditions have to be fulfilled and what boundaries the method has, when applied to several porous systems.

A complexity-reduced, mechanistic model for DOC export from catchments

Benedikt Werner, Helmholtz-Zentrum für Umweltwissenschaften Leipzig

Abstract:

Increasing DOC exports from catchments impact the ecology of downstream waters, pose threats to water supply from drinking water reservoirs (e.g. higher costs for removal, toxic by-products during chlorination) and affect the global carbon cycle (Battin et al. 2009).

First analyses of a large data set on DOC concentration dynamics in catchments draining into German drinking water reservoirs suggest that wet riparian zones are the most likely source zones for instream DOC (Tittel and Kamjunke 2016). Although the importance of riparian zones for DOC export from catchments in humid, temperate climates has generally been acknowledged, the hydrological and biogeochemical controls of mobilization and transport in riparian zones are still elusive. The ubiquitous sources of organic material in catchments from which stream DOC can be derived, together with the complex hydrologic flow paths that may deliver it to the streams have so far impeded "simple" mechanistic models of DOC export from catchments. Apart from the risk of oversimplification, bucket-type models have an inherent rigidity that typically requires them to be recalibrated for each catchment they are applied to, limiting their transferability.

New high frequency, in situ sensing techniques have provided new insights into the dynamics of DOC export and composition (Rode et al. 2016), allowing to identify dominant mobilization processes and source zones of DOC. This in turn provides new opportunities i) to investigate the hydrologic and biogeochemical controls for the mobilization and transport of DOC from riparian soils to the streams and ii) to evaluate how concentration and composition of DOC change during transport to the catchment outlet. Based on the results from i) and ii), this allows iii) to derive an improved mechanistic model of catchment-scale, needed to predict future trends in DOC export.

In a first step the extensive high frequency data set of hydrological and biogeochemical variables from the Rappbode catchment (TALKO 2016), will be systematically analyzed for event-based patterns in DOC mobilization and export. In addition, spectral (e.g. slope ratios in UV-VIS spectra) and analytical (FTICR-MS) characterization of instream as well as riparian DOC will be used to fingerprint sources of instream DOC for a typical spring snow melt and a fall flow event. This will allow to disentangle the spatial and temporal variability of the sources for instream DOC.

Monitoring of riparian groundwater levels will enable an assessment of spatiotemporally variable groundwater-stream transfer processes. Groundwater level dynamics and groundwater flow to the stream segments will be generated using explicitly simulated near-stream groundwater velocity fields. Further simplification will be based on the linearized one-dimensional Boussinesq-equation (e.g. de Rooij 2012, 2013).

DOC loadings will be assessed by extending the RIM concept (riparian flow-concentration model; Seibert et al. 2009) using the observed vertical DOC concentration profiles in the riparian zone. In combination with the 1-D analytical model, this will allow for a mass balance based integration of DOC flux to individual stream segments.

The resulting model will synthesize results into the formulation of a complexity-reduced, mechanistic model of DOC export. Catchment-scale fluxes to the entire stream network can in turn be described via joint probability density functions (PDFs) of the three key model parameters: i) lateral extent of the aquifer, ii) aquifer transmissivity and iii) groundwater recharge, which can be derived from topographic analysis, geologic maps and synoptic weather station data.

The resulting model will be more tractable and transferable than complex process models and at the same time more in line with dominant processes than typical, calibrated bucket-type models.