



## Quantification of exchange rates between groundwater and surface water applying pharmaceutical compounds – the Nuthegraben case

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The main source of pharmaceuticals from human medical care is excretion and disposal into the sewage water, and discharge of treated and untreated sewage water into surface water. In the area of the Nuthegraben south of Berlin (Germany) sewage water has been irrigated until the early 1990s. Today, treated sewage water is discharged from the sewage treatment plant (STP) Waßmannsdorf directly into the stream Nuthegraben. The objective of this study is to evaluate the possibility to use different human pharmaceutical compounds as tracers for the characterization and quantification of sewage influence on groundwater and surface water.

Groundwater and surface water was sampled several times and analyzed for the main ions, for organic carbon applying LC-OCD technique and the pharmaceutical substances clofibric acid, bezafibrate (blood lipid regulators), diclofenac (anti-inflammatory), carbamazepine and primidone (both antiepileptic drugs). The pharmaceutically active substances and metabolites were found at concentrations up to the  $\mu\text{g L}^{-1}$ -level in groundwater and surface water samples from the Nuthegraben lowland area and from the former irrigation farms. Among the compounds detected in groundwater are clofibric acid, diclofenac, carbamazepine and primidone. Additionally, pharmaceuticals are measured up to the  $\mu\text{g L}^{-1}$ -level in surface water from this area. However, concentrations detected in groundwater are generally much lower and there is significant variation in the distribution of pharmaceutical concentrations in groundwater. Groundwater influenced by the irrigation of sewage water shows higher primidone and clofibric acid concentrations. The groundwater influenced by the recent discharge of treated sewage water to the Nuthegraben shows high carbamazepine concentrations while concentrations of primidone are low.

Hydraulic measurements have shown that the flow conditions along the Nuthegraben change from influent conditions near the STP Waßmannsdorf to effluent conditions further downstream. The distribution of the pharmaceuticals (e.g. clofibric acid) in groundwater and surface water confirmed these results. It was possible to show that surface water infiltrates in the aquifer at the upper part of the Nuthegraben and vice versa at the downstream area.