Geophysical Research Abstracts
Vol. 21, EGU2019-14533, 2019
EGU General Assembly 2019

Transport of pharmaceuticals in different aquifer sediments

Christine Stumpp (1,2), Aleksandra Kiecak (1,3), Friederike Breuer (1), and Marleen Schübl (1)

(1) Institute of Groundwater Ecology, Helmholtz Zentrum München, München, Germany, (2) Institute of Hydraulics and Rural Water Management, University of Natural Ressources and Life Sciences (BOKU), Wien, Austria (christine.stumpp@boku.ac.at), (3) Chair of Hydrogeology, Technical University Munich, München, Germany

The presence of pharmaceuticals in the environment has been recognized as a great environmental concern. Improving the understanding of pharmaceutical transport in heterogeneous and dynamic hydrogeological settings requires the knowledge of transport processes, which are, however, difficult to determine at complex field sites. Therefore, we investigated the transport of selected pharmaceuticals (antipyrine, atenolol, carbamazepine, caffeine, diclofenac, ketoprofen, and sulfamethoxazole) in laboratory column experiments using three sediments: 1) medium sand, 2) coarse sand, and 3) sandy loam. Additionally, the influence of three different water flow velocities on sorption and degradation rates was tested. Column experiments were carried out in saturated conditions by applying conservative (KBr) and reactive tracers (pharmaceuticals). Both, instantaneous and continuous injections of tracer solution were studied. An analytical transport model was used to determine transport parameters from the obtained experimental results.

In medium sand, lowest concentrations were observed for atenolol and clofibrate due to sorption and degradation. Degradation of clofibrate was also confirmed by its conversion to clofibric acid. Diclofenac, caffeine and carbamazepine were also affected by sorption and degradation but to a lesser extent than atenolol and clofibrate, whereas sulfamethoxazole, ketoprofen and antipyrine showed almost conservative transport behavior. Atenolol revealed the greatest retardation factors (5.6-7.1) and greatest degradation rates (7.3-10.8 d-1). For sulfamethoxazole, in contrast, low degradation rates (0.1-0.6 d-1) and no sorption was observed. Retardation was independent on flow velocity, except for atenolol. In coarse sand retardation factors were low for all the compounds and independent on flow velocity. The greatest retardation factors were observed for atenolol. Biodegradation was not observed for any of the compounds. In sandy loam most of the compounds little impacted by sorption. Again, Atenolol showed the greatest retardation factors (2.57-5.33) and degradation rates (1.28-6.02 d-1). Low biodegradation was observed for diclofenac and ketoprofen in the experiment with the fastest flow velocity. In general, biodegradation did not influence the transport of selected compounds in coarse sand. Findings from instantaneous and continuous injection experiments were similar; except for caffeine. Here, increased biodegradation was observed after an adaption period; particularly under oxic conditions and in the absence of sulfamethoxazole. The study showed that degradation and sorption rates were generally independent on water flow velocities. The type of sediment influenced the extent of sorption or degradation for individual tested pharmaceuticals. Therefore, sorption or degradation were sediment specific and not only depended on the properties of the sediment and compounds but also on redox conditions and presence of other compounds.