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Sewage exfiltration: A risk for soil and groundwater? - Direct measurements at a real world test site

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Introduction

The continuous aging processes of the sewer network as well as improper connections and high traffic volume on the streets lead to a multitude of defects in the sewer network like cracks, shards, joints displacements, etc. Through these defects within the active sewer network, exfiltration of significant amounts of untreated sewage water into the unsaturated zone and into the groundwater occurs. The effect on the one hand is an additional source of groundwater recharge in urban areas. On the other hand raw sewage contaminants are entering directly the unsaturated zone and the groundwater and induce a potential risk for the groundwater as a resource. In order to provide new insights to the poorly understood exfiltration processes of leaky sewers a test site was build in Rastatt, a middle sized city of app. 45,000 inhabitants, 20 km south of Karlsruhe, SW Germany.

Description of the test site Kehler Straße

At the outlet of a catchment area of app. 60 ha an active sewer where mainly domestic sewage is conveyed was cracked to represent real sewer defects. Two artificial leaks (Leak 1: 120 cm^2 and leak 2: 75 cm^2) were milled in a 500 mm sewer. The exfiltrating sewage from leak 1 is collected in a steel tank underneath the pipe and its volume is permanently recorded with a pluviometer. Underneath the second trench, the soil moisture and the matrix potential are recorded at different depths. Chemical analysis is performed for waste water samples, the exfiltrating sewage at leak 1 and soil water at leak 2 in depth from 10-60 cm below the crack. Besides the on-site parameters pH, EC and temperature the major anions and cations are analysed. By the means of sampling

campaigns concentrations of the surface runoff contaminants like zinc, lead, cadmium and copper as well as a range of 40 pharmaceutical substances were monitored in the sewage and after a soil passage of 50 cm.

Results

Maximum exfiltration rates during the initial period (July 04) arrived at 203 l/d and varied significantly depending on the discharge patterns of the sewage. After 6 month (Feb. 05), during which a continuous decrease of the exfiltration had been observed, quasi stable conditions were reached and app. 23 l/d during dry and max. 15 l/d during storm weather days exfiltrated from the sewer. The filling of the crack with sewage sediments and sludge as well as the growing of the microbiological colmation layer in the sewer are responsible for the sealing of the crack.

The analysis of the soil moisture profiles, recorded by the TDR probes in 20, 40 and 60 cm below the leak showed fast reaction on fill level variations. A maximum velocity of the seepage front of 3 cm/min could be monitored during storm flow conditions in the pipe. High seeping velocities induce short interaction time and reduce the effectiveness of the soil passage for the degradation and removal of contaminants. This underscores the vulnerability of the groundwater during storm water events.

40 pharmaceutical substances, including Betablockers, Antibiotiks, Antirheumatiks, Antiepileptics and other pharmaceutical residues were analysed. 15 could be detected in the effluent as well as in the seepage water after soil passage of 50 cm. For the substances Metropolol, Sotalol as well as for Bezabfibrat, Carbamezepine and Gemfibrozil even higher concentrations up to the factor of 2 had been determined after the soil passage. The different concentrations illustrate again the extreme variation of the waste water composition. Sewage samples have been taken over a few minutes, whereas the seepage samples represent an integrated value over one day. The pharmaceutical residues are not yet subject to health guideline limits but were already detected in production wells of water works as well as in the potable water. Due to the persistant behaviour of substances like Carbamazepine, processes of decay or sorption work only at a minor scale. Mainly the effect of dilution actuates the concentrations below the detection limit. Concerns have risen whether interactions with bacteria and microbiological organism can lead to resistances, e.g. against antibiotics.

Further information available at: **www.urbanwater.de**