RSF^{plus}- Removal of micro pollutants and bacteria from combined sewer overflow and wastewater treatment plant effluent

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Introduction

Retention soil filters (RSFs) are vertical flow constructed wetlands with sandy filter material. During the process of percolation, solids and other particles are reduced due to filtration, adsorption and biochemical processes within the filter medium. RSFs are used to treat rainwater from separate sewer systems or combined sewer overflows (CSO) after heavy rain events. They do not only reduce the hydraulic stress of the receiving waterbody but also the pollutant load of the sewage water. Studies on the reduction efficiency of RSFs revealed reduction rates of ≥ 75 % for nutrients (Frechen, 2012). Studies conducted by the Erftverband showed that RSFs are also able to reduce certain micro pollutants (Mertens et al. 2012).

Innovative treatment concept: RSF^{plus}

While conventional RSFs are unoccupied during dry periods, the innovative RSF^{plus} makes optimal use of the free capacities by polishing WWTP effluent during dry periods (Fig. 1). In the course of the research project AquaNES, the Erftverband evaluates the flexible use of RSFs: During dry weather periods the RSF is used for the treatment of waste water treatment plant (WWTP) effluent; during heavy rain events CSO is treated by the RSF.

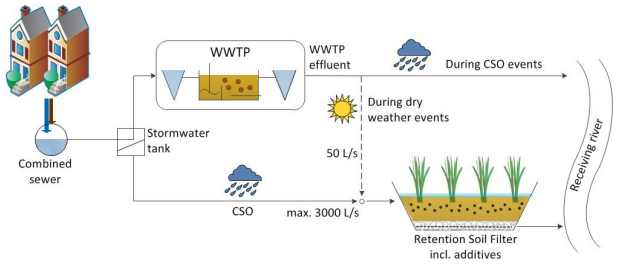

Figure 1: Scheme of the RSF system for the flexible treatment of CSO and WWTP effluent.

New features were adapted to the RSF^{plus} based on experiences with conventional RSFs. To maintain aerobic conditions, the RSF^{plus} is divided into three segments which are fed alternately with WWTP effluent. Two distribution channels in each segment guarantee homogeneous feeding. Besides $CaCO_3$ which is used to stabilize pH conditions within the filter medium, granular activated carbon (GAC) is added in the upper- and lowermost layer to promote pollutant reduction (Fig. 2).

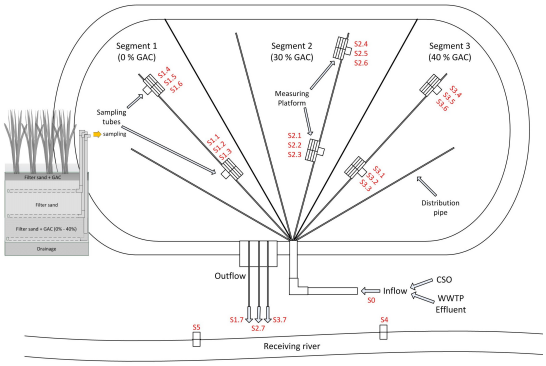

Figure 2: Scheme of the RSF^{plus} including filter design and monitoring system.

Results of the pilot study

A first full-scale RSF^{plus} (5000 m^2) is going to be installed at the Rheinbach WWTP (North Rhine-Westphalia).
First investigations on the polishing of WWTP effluent were conducted on three pilot-RSFs which were installed in 2014. Besides two conventional RSFs (Filter 1 & 2) one RSF with GAC and biochar was researched (Filter 3).

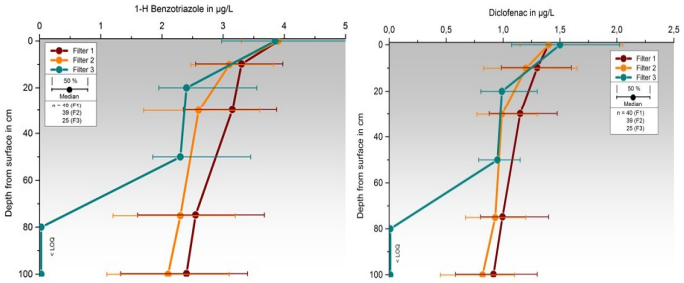

Figure 3: Concentration of 1-Benzotriazol and Diclofenac in relation to filter depths in conventional (Filter 1 & 2) and GAC enhanced filter material (Filter 3).

Numerous micropollutants in the WWTP effluent could be effectively removed by the pilot-RSFs. Conventional RSFs already showed good removal (0 – 79 %) which increased with higher amounts of organic matter in the uppermost filter layer. Best removal was determined in the layer with biochar and GAC of Filter 3 (Fig. 3).
Fecal bacteria could also be removed within the RSFs. The concentration of Coliform bacteria in the WWTP effluent amounts to 10^4 MPN by mean, while E.coli concentrations exceed 10^3 MPN by mean. Both could be removed by 1 to 2 log-stages. With that, the German threshold for bathing water quality of < 10^3 MPN for *E.coli* can be met (Fig. 4 B).
In contrast to most micropollutants, inflow and outflow concentrations of bacteria scattered widely, making an online measurement via a BACTcontrol system of special interest.

A

B

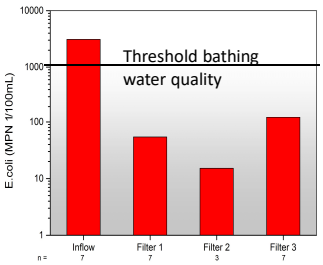

Figure 4A: RSF Pilot plant with controlling unit and BACTcontrol system
Figure 4B: Concentration of E.coli in the inflow and outflow of the pilot RSFs.

The BACTcontrol is an online monitor to check for E.coli and Coliform bacteria. At the site the system will be used to constantly check the levels of bacteria which will be compared with lab testing (MPN results) to also find a correlation factor between the 2 methods.

References:
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