AquaNES

Demonstrating Synergies in Combined Natural and Engineered Processes for Water Treatment Systems

RSF*plus*: a flexible concept to reduce the micropollutant and microbial load from WWTPs

Challenge

Pressures on small river systems

- High wastewater loads during dry weather
- High hydraulic load and with combined sewer systems additional pollutant loads during strom events

Applied Solution

Conventional retention soil filter (RSFs):

- Specific configuration of vertical flow constructed wetlands
- Treatment of rainwater from separate sewer systems
- Treatment of combined sewer overflows (CSO)
- Reduction of hydraulic stress and pollutant load of the receiving waterbody
- Reduction of Nutrients, Total Suspended Solids, Metals, Pathogens

The innovative RSF*plus*:

- Combined treatment of CSO during storm events
- Wastewater treatment plant (WWTP) effluent polishing during dry weather periods (Fig. 1).
- Reduction of organic micropollutants (OMP) due to addition of granular activated carbon (GAC) to the upper- and lowermost layer
- Innovative distribution system (segmentation and distribution channels) (Fig. 3)

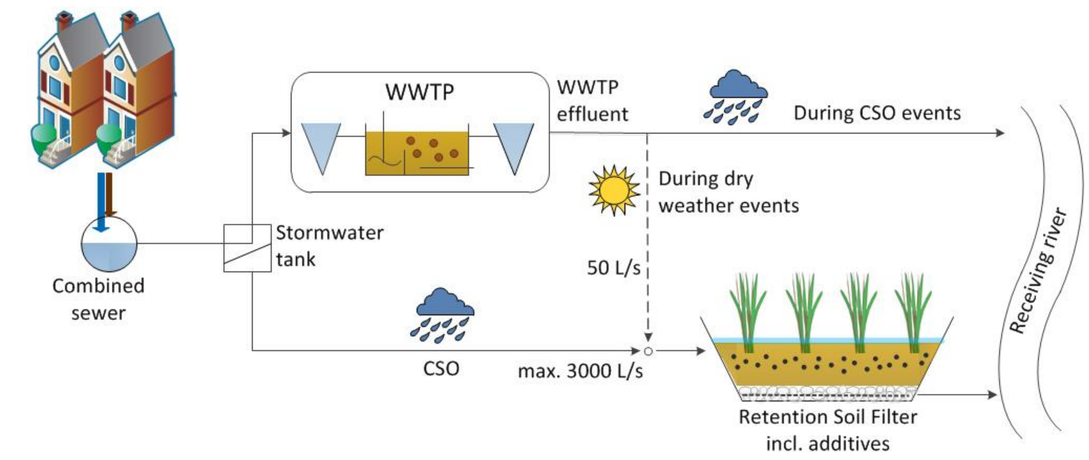


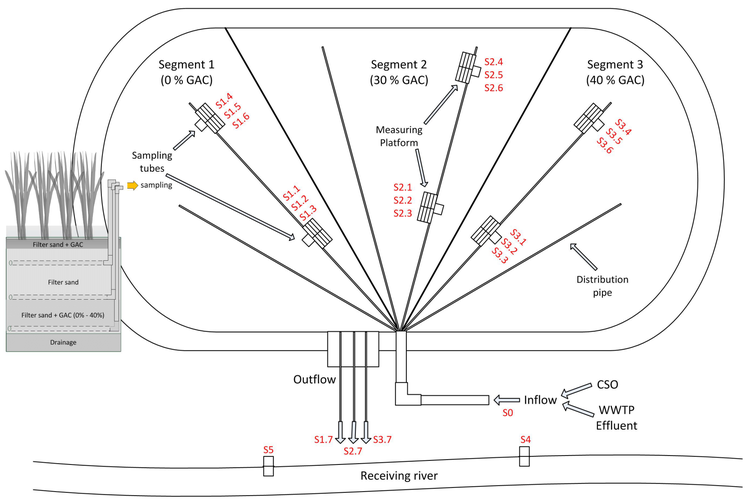
Fig. 1: Scheme of the RSF system for flexible treatment of CSO and WWTP effluent.

Technical Demonstration

Three pilot scale RSFs (1.5 m² filter area) (Fig. 2) for long-term testing of WWTP effluent polishing and tests on operational conditions:

- Two conventional RSF (Filter 1 & 2)
- One RSF with biochar and GAC (Filter 3)

Fig. 2: Three pilot RSFs



A first full-scale RSF*plus* (5000 m²) is installed at the Rheinbach WWTP of Erftverband in North Rhine-Westphalia, DE. Operation starts 2019.

Fig 3: Scheme of the RSF*plus* including sampling locations.

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Results

WWTP effluent treatment

Effective removal of various micropollutants present in WWTP effluent.

Conventional RSFs:

- Show good removal (0 – 78%) (Fig. 4)
- Best removal in the uppermost filter layer with higher amounts of organic matter (Fig. 6)

RSF with GAC and biochar

- Clear enhancement of removal for all measured compounds (Fig. 5 + 6)
- Only slight decrease in DOC removal in the GAC layer (> 88% to 60 %) over the first 2.5 operational years
- No total breakthrough of any of the investigated OMP

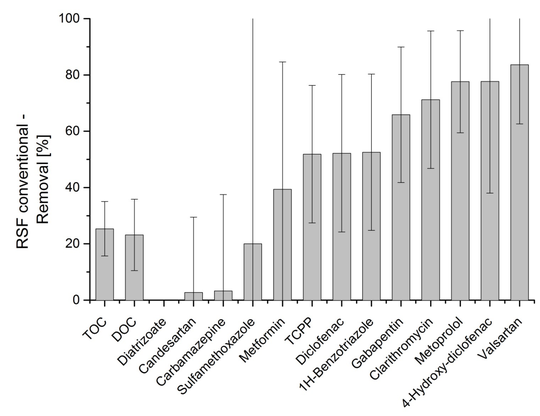

Fig. 4: Removal (Median with stand. deviation) of DOC, TOC and OMP in conventional RSF

n = 27 – 85, Sept. 2014 – Nov. 2018, values < LOQ = LOQ

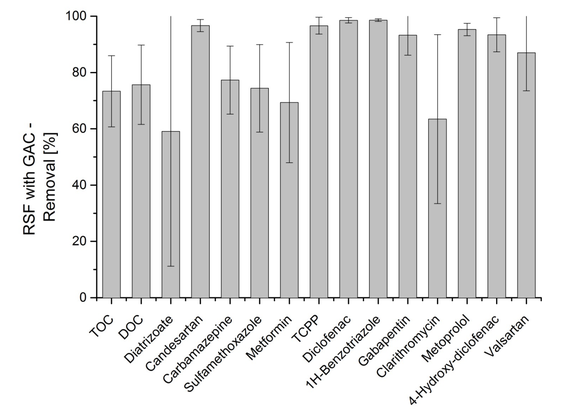

Fig. 5: Removal (Median with stand. deviation) of DOC, TOC and OMP in RSF with GAC

n = 14 – 56, Apr. 2015 – Nov. 2018, values < LOQ = LOQ

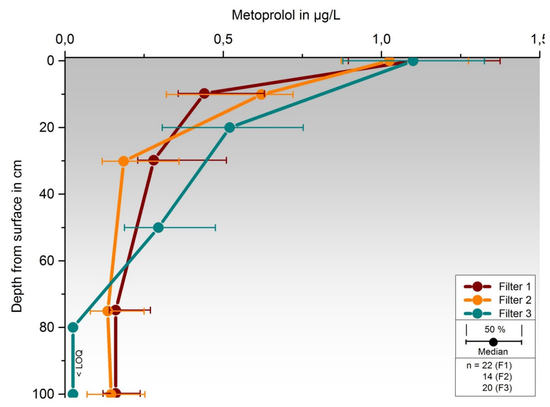

Fig. 6: Concentrations of metoprolol in the vertical profile of the three pilot RSF

Jan. 2016 – Nov. 2018, values < LOQ = LOQ

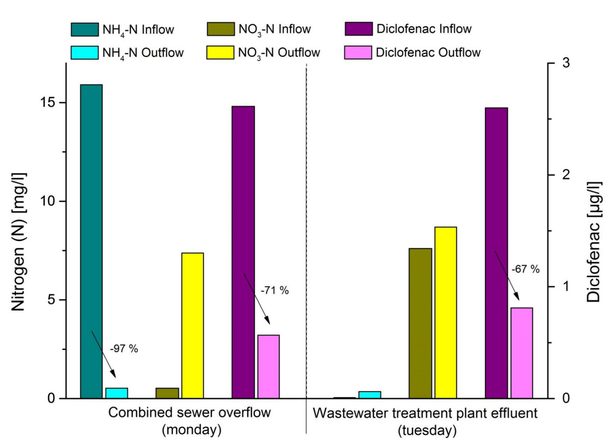

Fig. 7: Concentrations of Nitrogen and Diclofenac during CSO and WWTP effluent feeding in conventional RSF.

n = 4, May. – Aug. 2018, values < LOQ = LOQ

Dual use of RSF

Both, combined sewer overflow and WWTP effluent was treated in one conventional RSF. Results (Fig. 7) show that:

- The CSO derived NH_4-N was almost completely transformed to NO_3-N Removal of OMP was comparable in both treatments A dry period of 18 hours between CSO and WWTP effluent treatment is effective

Additional Benefits:

- Hygienically improved effluents compliant with Bathing Water Directive
- Long lifetime due to only little accumulation of micropollutants in filter material
- Improved reduction efficiency due to combination of several reduction mechanisms such as sorption and microbiological degradation
- Little maintenance due to self-sustaining natural system

Erft Verband

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