Institute for Hygiene and Public Health
WHO Collaborating Centre for Health Promoting Water Management and Risk Communication

Reduction of micro-organisms in combined sewer overflow by passage through vertical-flow constructed wetlands (retention soil filters)

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Introduction

Wastewater contains numerous pathogens from faecal contamination. Usually, it is treated in wastewater treatment plants (WWTPs) before entering the environment. In case of heavy rain events the inflow capacity of the WWTPs is exceeded and combined sewer overflow (CSO) is discharged into the receiving river after presettling in a CSO tank.

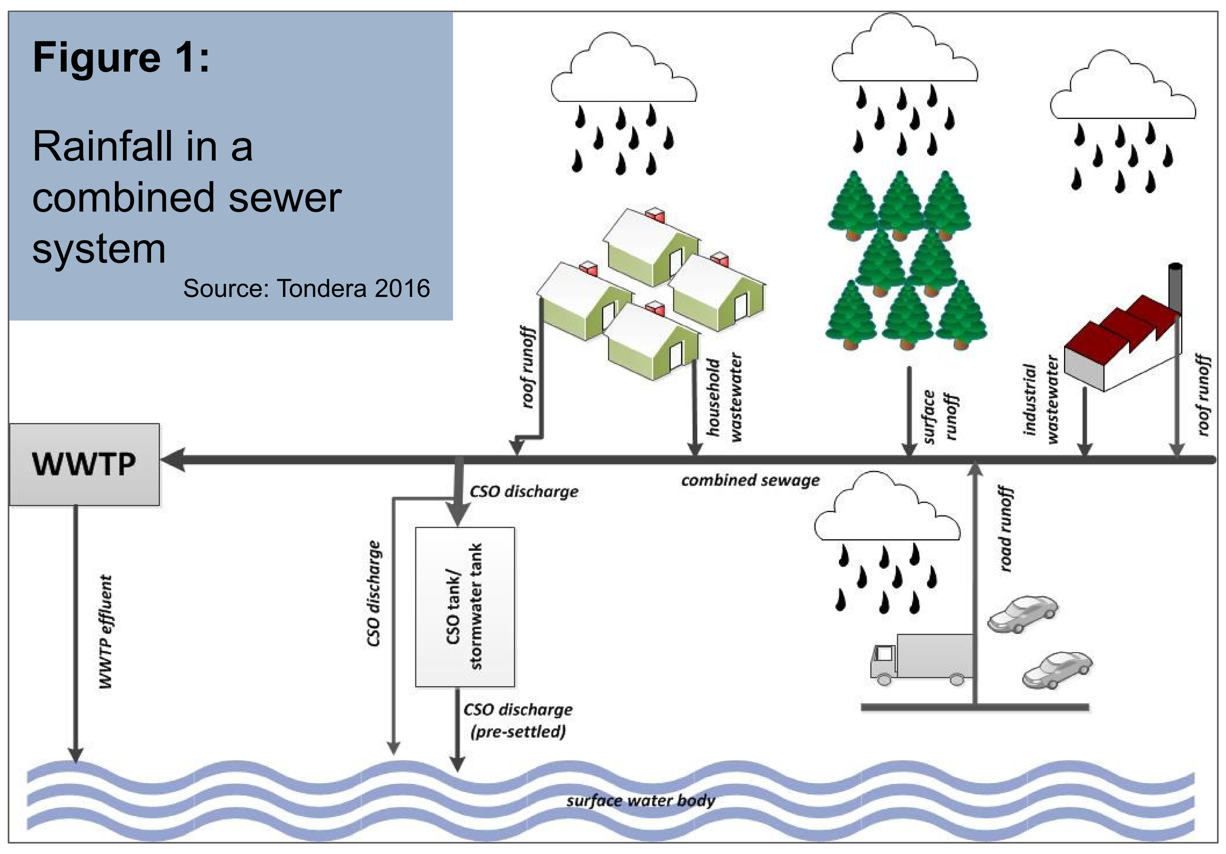

Figure 1:

Rainfall in a combined sewer system

Source: Tondera 2016

Objectives

The main focus of the EU Bathing Water Directive is set on the indicator bacteria *E. coli* (Ec) and intestinal enterococci (IE). However, viruses may pose higher health risk than bacteria to humans using surface waters for recreational purposes [1, 2]. Therefore, we evaluated the reduction of somatic coliphages (sC) as viral indicator in CSO treated by retention soil filters (RSF) at four pilot-scale sites and two full-scale sites. At the pilot-scale sites we tried to evaluate the reduction of micro-organisms depending on preceding dry phases, operation and filter depth under defined conditions. These results were compared to reduction in full-scale treatment under real-live conditions.

Materials & methods

Samples were taken regularly (pilot-scale RSFs) or event-based (full-scale RSFs) in sterile bottles and cooled until processing within 24 h in the laboratory. Bacteria were analysed according to EN ISO 7899-1 and EN ISO 7899-2 (IE), ISO 9308-3 and EN ISO 9308-1 (Ec), EN ISO 10705-2 (sC).

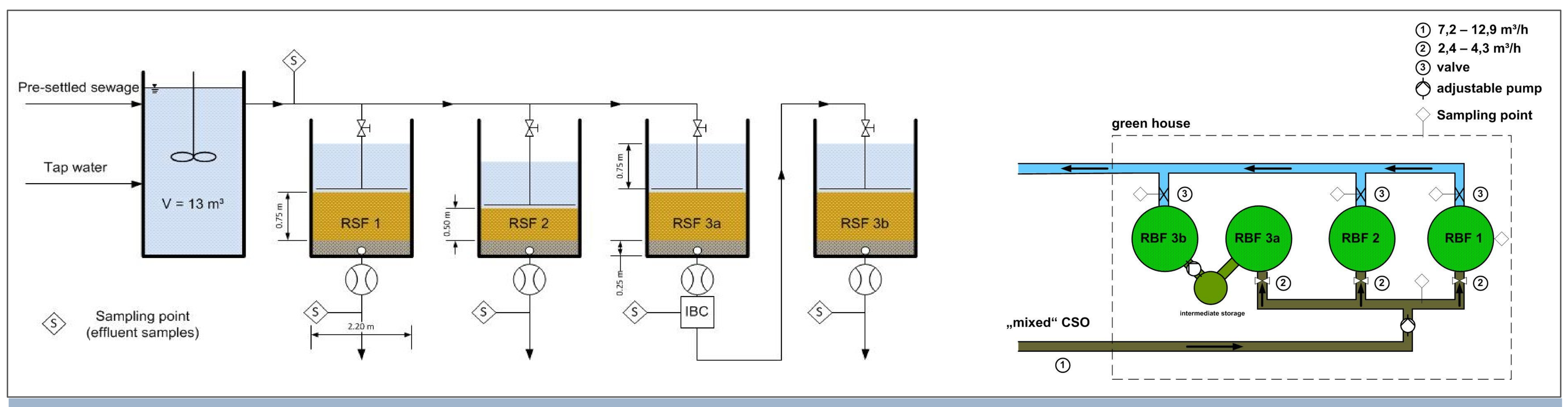

Figure 2:
Pilot-scale RSFs and sampling points : Influent (fabricated combined sewage), supernatant filter 1, effluents filter 1, 2, 3 a+b with effluent 3a = influent 3b. Source: Ruppelt/Tondera

Figure 4:
Large scale RSFs under investigation: RSF A (left, center) and RSF B (right)

Source: IHPH

Results - pilot-scale RSFs

There was no clear correlation between dry phases and removal efficiency in case of the pilot-scale sites. The efficiency for reduction of Ec seems to be at an optimum after 6-7 days without feeding.
The median removal for the indicators investigated was approximately 1 $\log_{10}$. The removal increased at serial operation and is less for 50 cm filter depth than for 75 cm depth.

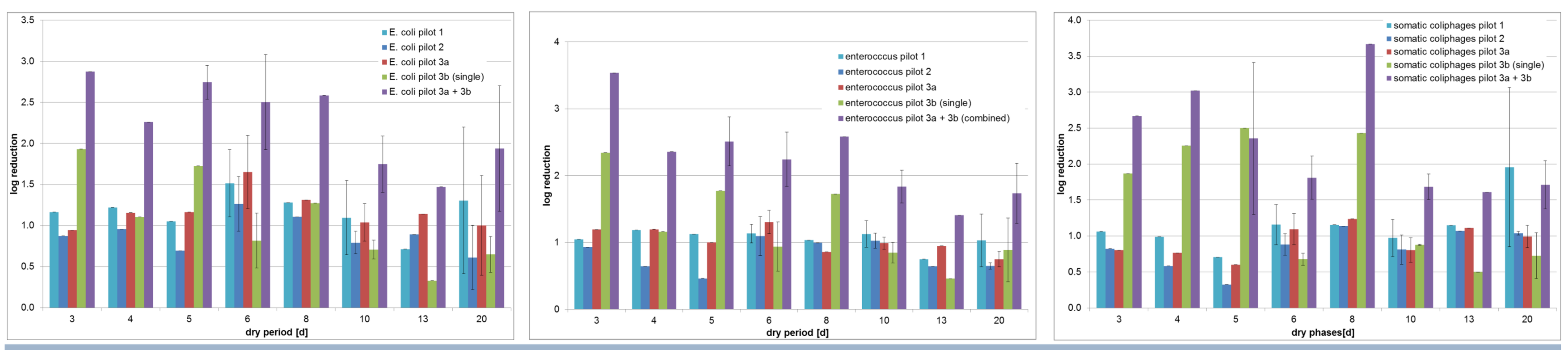

Figure 3:
Microbial reduction ($\log_{10}$-scale) by the pilot-scale RSFs after different dry phase duration: *E. coil* (left), intestinal enterococci (center), somatic coliphages (right)

Results – full scale RSFs

The full scale retention soil filters showed different reduction rates varying by site and parameters. RSF A showed reduction rates up to median 3 $\log_{10}$ [3], while RSF B reduced microorganisms within the range of the test scale sites.

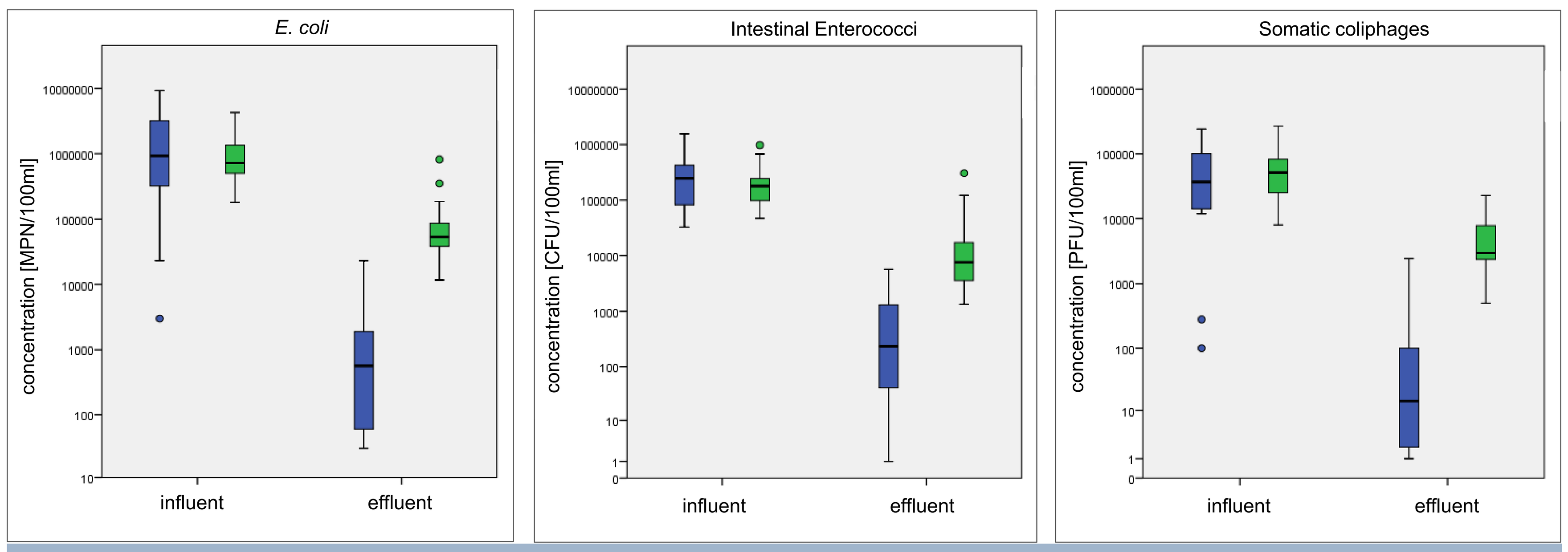

Figure 5:
Microbial reduction by the full-scale RSFs: Detected microorganism concentrations (Ec, IE, sC) in the influents (left) and effluents (right) of the large scale RSFs investigated (blue = A, green = B)

Conclusion

RSFs help to reduce microorganisms considerably in the CSO before entering the river. The results can help to re-design the wastewater system as required due to local circumstances and hygiene requirements for the receiving surface waters and therefore reduce risks for human health.

References
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