Quality of greywater from a city district: influent and treated effluent after treatment in a green wall

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Study description

The study aimed to evaluate the performance of a green wall in treating greywater. Five natural filter materials (pumice, biochar, hemp fiber, spent coffee ground (SCG), and composted fiber soil (CFS)) were used in the green wall and tested for three hydraulic loading rates (54, 108, and 216 $l/m^2/d$). The dataset presented here consists of raw data on the quality of influent greywater generated from a city district with 800 PE and the effluent quality of greywater after treatment using a green wall. The influent and effluent samples were taken manually between November 2021 and March 2022 and analyzed for organic material, nutrients, pathogens, anionic surfactants, and salt. Supporting parameters e.g. suspended solids and pH, are also included. In addition, pumice, biochar, hemp fiber, and CFS were investigated for their retention capacity of microplastics polymers. The results from blank samples prepared during microplastics sampling are also included in the dataset.

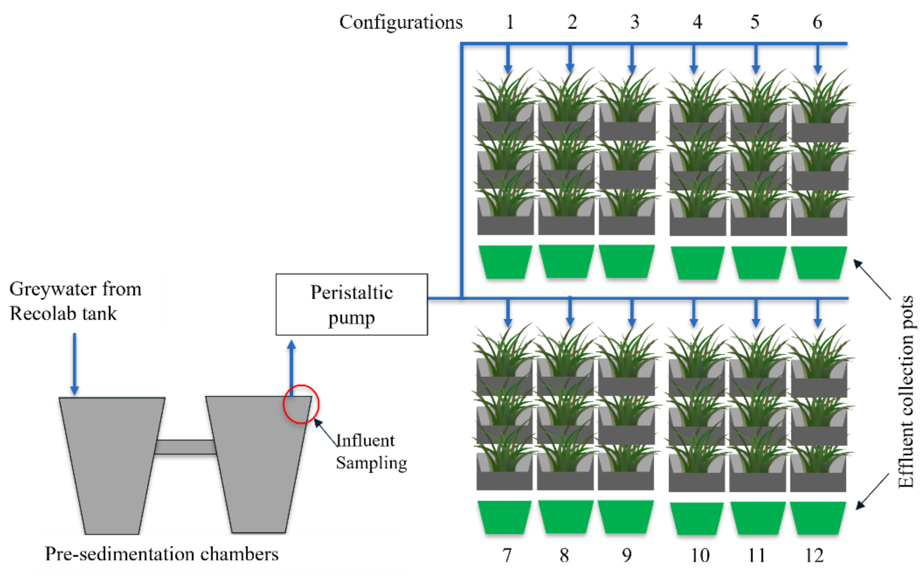

Figure 1: Experimental setup of the green wall. The red circle indicates the influent sampling point.

Methods

The green wall was made of 12 configurations (C) and each configuration consisted of three pots. Each configuration with respective filter materials was replicated three times and their placement in the wall was randomized. Hence, configurations C1, C9, and C11 were filled with hemp fiber, C2, C4, and C6 were filled with biochar, C3, C5, and C7 were filled pumice. Initially, SCG was filled in C8, C10, and C12 but after unsatisfactory treatment performance, the configurations were replaced with CFS. SCG and CFS were only tested for a low hydraulic loading rate of 54 $l/m^2/d$. The green wall was loaded with greywater on the top pots of each configuration using a 12-channel peristaltic pump and effluents from the configurations were collected in 20 l HD-PE containers (Figure 1). However, during the sampling for microplastics, 80 l stainless-steel containers were used to collect 13, 14, and 15-day composite effluents. Influent greywater was sampled near the outlet of the pre-sedimentation tank septic tank (Figure 1) using a Ruttner sampler. The pH, turbidity, and conductivity of the samples were measured on-site. For analysis of the other parameters (Table 1), samples were sent to external accredited laboratories, SGS Analytics Sweden and ALS Scandinavia.

The investigation of microplastics in greywater and the retention capacity of the filter materials was a 15-day study. Three 1 l influent samples were taken on the 1st, 14^{th}, and 15^{th} day. The composite effluent samples were filtered on-site using 10 µm stainless-steel filters which were transported to the laboratory at Luleå University of Technology (LTU) for rinsing and sonicating before preparing a 250 ml sample for microplastics analysis. The samples were analyzed at the external laboratory SGS Analytics Sweden. The influent samples were filtered at LTU, and similar to effluent, 250 ml samples were prepared for analysis. In addition, blanks were prepared, one using tap water to determine potential contamination by the filtration system used for filtering the effluents (system blank), and one air blank sample to determine airborne microplastic contamination during sampling and filtration (dry blank). For further details about the sample preparation and microplastics analysis refer to the article in the publication section. The microplastics data presented here are in total mass in µg.

Analyses

Standard analytical methods were used for the analysis of the different parameters (Table 1). The pH was measured using a WTW pH3110 pH meter and SenTix®41 electrode. Turbidity was measured using the Hach 2100Qis turbidimeter and conductivity was measured using the WTW Cond 3110 meter with TetraCon®325 electrode. Samples for the analysis of dissolved organic carbon (DOC) and dissolved phosphorus (disP) were filtered through 0.45 µm filters and analyzed as TOC and TP

For the microplastics analyses, the thermal extraction desorption gas chromatography-mass spectrometry (TED-GCMS) technique was used for the quantification of nine polymers: polyvinylchloride (PVC), polystyrene (PS), poly-ethylene-terephthalate (PET), polyethylene (PE), polycarbonate (PC), natural rubber/gum (NG), poly-methyl methacrylate (PMMA), polypropylene (PP), and polyamide 6 (PA6).

Table 1: Standards and methods used for analyzing greywater quality parameters.

Parameter	Methods
Total suspended solids, TSS (mg/l)	SS-EN 872 (modified)
Biological oxygen demand, BOD_7 (mg/l)	SS-EN ISO 5815-1:2019
Chemical oxygen demand, $COD_{(Cr)}$ (mg/l)	ISO 15705:2002
Total organic carbon, TOC (mg/l)	SS-EN 1484 utg 1
Total nitrogen, TN (mg/l)	SS-EN 12260:2004
Total phosphorus, TP (mg/l)	SS-EN ISO 15681-2:2018
Ammonium nitrogen, NH_4-N (mg/l)	ISO 15923-1:2013
Sodium, Na (mg/l)	ISO 11885 (acid digested)
Chloride, Cl (mg/l)	SS-EN ISO 10304-1:2009
E.coli (cfu/100 ml)	SS028167-2
Enterococci (cfu/100 ml)	SS-EN ISO 7899-2
Surfactants, (LAS) (mg/l)	CSN ISO 16265
Microplastics (µg)	*TED-GCMS analysis based on* Duemichen et al. (2019)

Legends:

INF = Influent

GW-C1 – GW-C12 = Effluents from configurations

H = Hemp fiber

P = Pumice

B = Biochar

SCG = Spent coffee grounds

CFS = Composted fiber soil

Numbers after materials represent hydraulic loading rates:

1 & 4 = 54 $l/m^2/d$,

2 = 216 $l/m^2/d$,

3 = 108 $l/m^2/d$,

ND = Not Detected

N/A = Not Applicable

References

Duemichen, E., Eisentraut, P., Celina, M., & Braun, U. (2019). Automated thermal extraction-desorption gas chromatography mass spectrometry: A multifunctional tool for comprehensive characterization of polymers and their degradation products. *J. Chromatogr. A*, *1592*, 133–142.