Assessing phytoremediation integrated in a treatment train for PFAS contaminated groundwater

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Background

Per- and polyfluoralkyl substances (PFAS) are of high concern due to their mobility and persistence in the environment. Therefore, PFAS can contaminate groundwater systems by infiltration. This study is part of the EU LIFE SOuRCE project, which is investigating a treatment train for removal of PFAS in groundwater, combining foam fractionation and electrochemical oxidation to separate and degrade longer chain PFAS, and phytoremediation with incineration of harvested biomass to bind and degrade shorter chain PFAS. This study is a pre-pilot scale test of the phytoremediation unit.

Material and Method

Phytoremediation were tested in a high flow biofilter setup at a landfill with PFAS contaminated groundwater in Uppsala Sweden. A challenge was the high salinity of the water (747 mg/L Cl^-).

The biofilter units consisted of a plant bed contaning 0.48 m^3 of a mixed peat, biochar and LECA filtersubstrate planted with *Salix* Wilhelm and connected to a 300 L recirculation tank.

Contaminated groundwater was continously pumped through the system at an initial rate of 50 L/day, and increased to 100 L/day after 25 days. The test was conducted for 86 days.

PFAS uptake in plant tissue and predicted removal rates

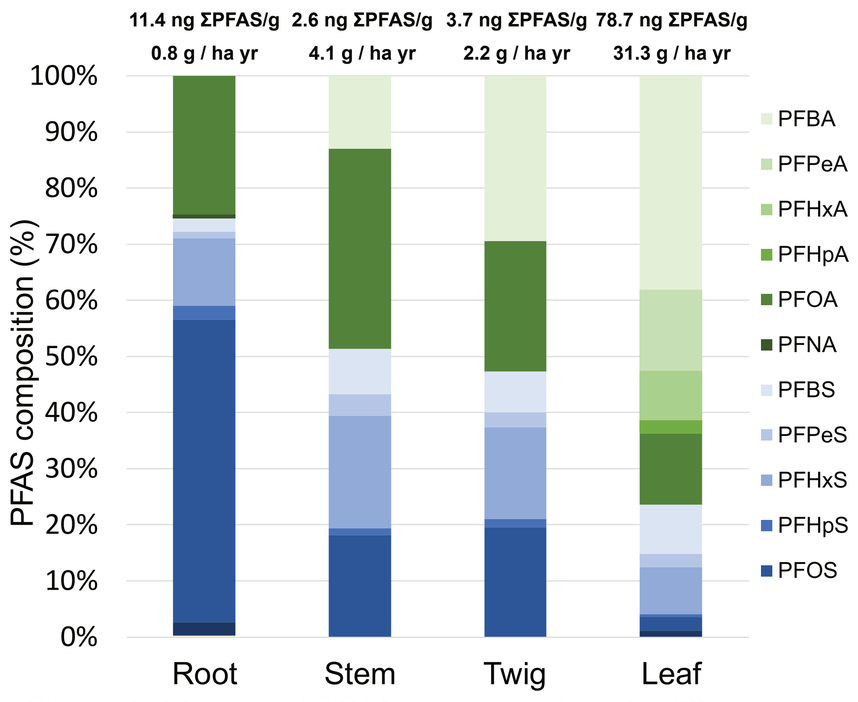


Figure 2. Measured PFAS concentrations in different plant tissues. The predicted romoval rate is based on modeled Salix yields in Sweden of 2.6 t / ha yr for the first cutting cykle (MOLA-YUDEGO & ARONSON 2008).

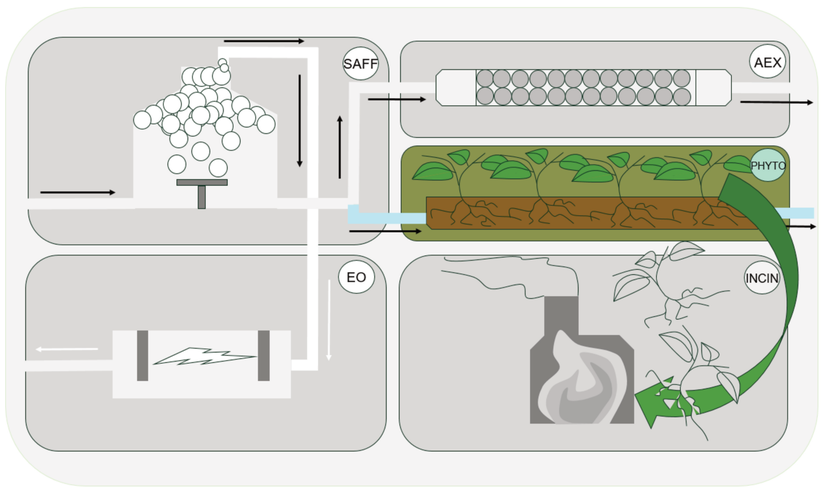
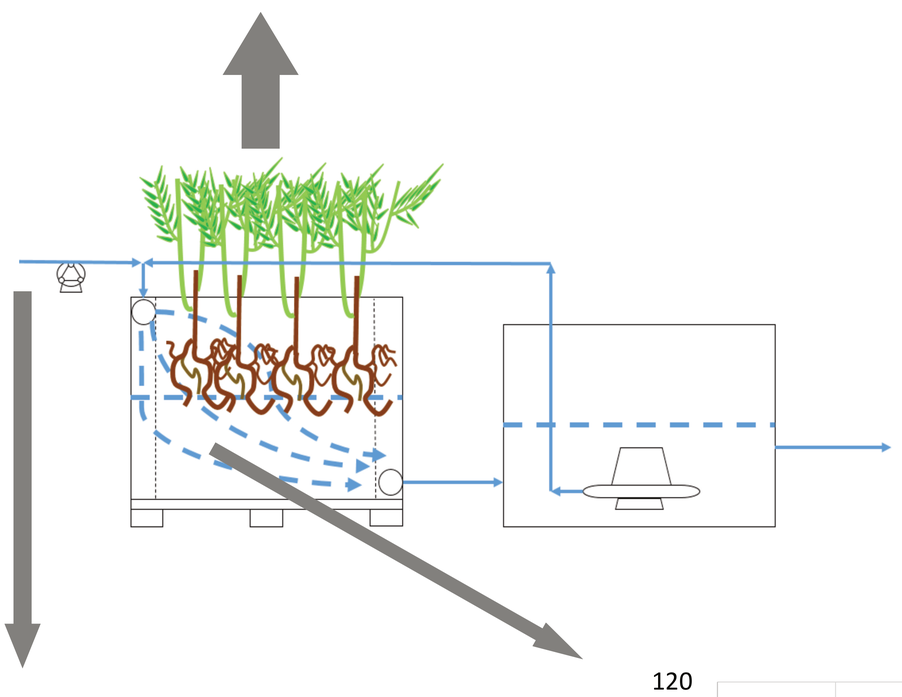


Figure 1. The EU LIFE SOuRCE treatment trains, consisting of surface active foam fractionation (SAFF), anion exchange chromotography (AEX), electrochemical oxidation (EO), phytoremediation (PHYTO) and incineration (INCIN).



Results and Discussion

S. Wilhelm showed a 100% survival rate in the saline groundwater. There was an uptake of PFAS and a clear compartmentalization in different plant tissues with shorter chained PFAS in leaves and longer chained PFAS in the roots. The overall uptake decreased with chain length which would make phytoremediation a good complement to foam fractionation in a treatment train. These data coupled with Salix yield studies for Sweden suggests a potential for removing aproximately 40 g ΣPFAS / ha yr from contaminated groundwater.
Longer chain PFAS were retained to a larger extent by the filter substrate and did not wash out from the system.

PFAS concentration in groundwater

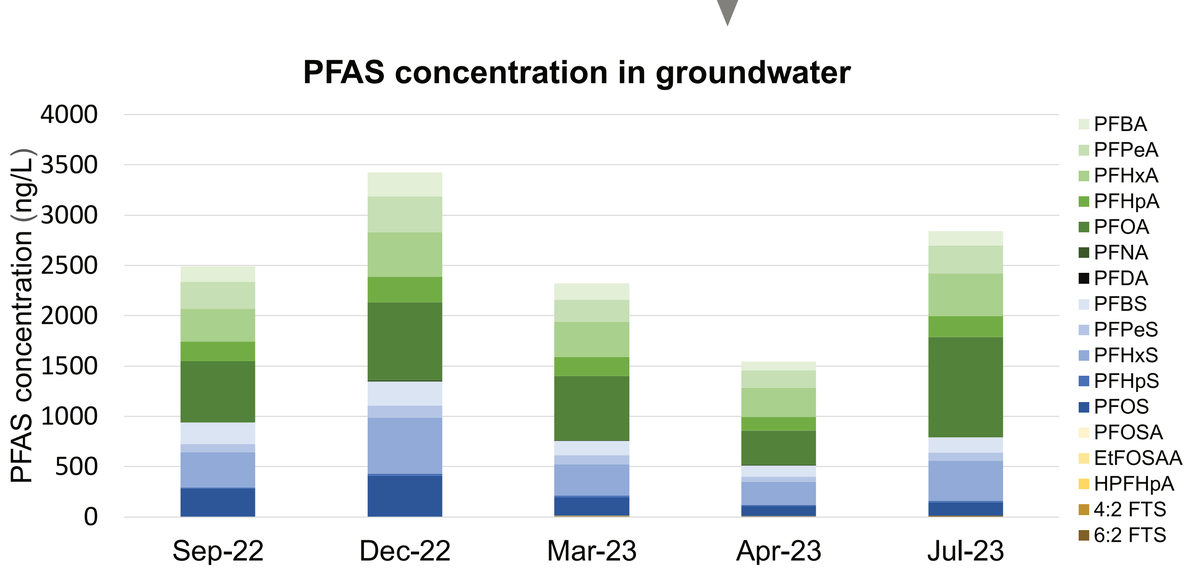


Figure 3. The concentration of PFAS in the groundwater at the site.

PFAS sorbtion to filter substrate

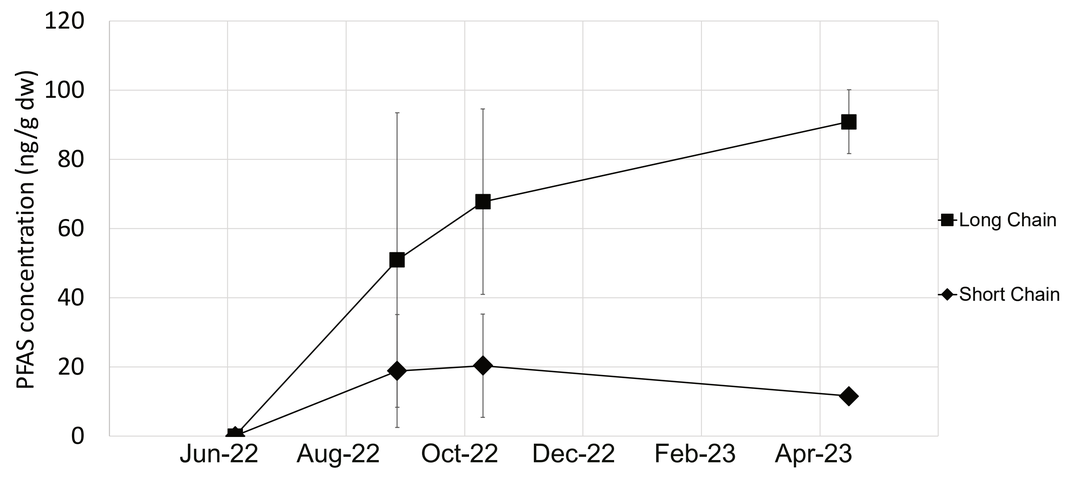


Figure 4. Concentration of PFAS bound to the filter substrate. There was no load on the systems from November 2022 to May 2023. Long chained PFAS detected: PFHxS, PFOA, PFHpS, PFECHS, PFNA, FOSA, PFOS, PFDA, PFUnDA, Et-FOSAA, PFDoDA, 11Cl-PF3Ouds, PFTriDA, PFTeDA. Short chained PFAS detected: PFBA, PFPeA, PFBS, PFHxA, PFPeS, PFHpA.

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