PFAS Phytoscreening for Rapid, ad-hoc Detection of PFAS Groundwater Impacts: Initial Results from the Rastatt / Baden-Baden Site, Germany

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Background/Objectives. Groundwater monitoring well networks are essential for the delineation of per- and polyfluoroalkyl substances (PFAS) groundwater impacts. However, these networks typically require dedicating significant time and resources to be established. A new, alternative approach for detecting and monitoring environmental contamination is phytoscreening, as plant uptake of contaminants via the root system can be a tool to understand groundwater contaminant hydrology. Sampling tree cores and leaves is quick, simple, and cost-effective. Moreover, within a short period of time, a great number of samples across large areas can be collected and analyzed. As such, there are potential benefits over traditional site investigations when being supplemented with phytoscreening.

The aim of this study was to perform a PFAS phytoscreening in the district of Rastatt and Baden-Baden, Germany, to investigate the applicability of this sampling technology to detect and delineate PFAS groundwater impacts.

Approach/Activities. For the PFAS phytoscreening, leaves of three species, namely white willow (Salix alba L.), black poplar, (Populus nigra L.), and black alder (Alnus glutinosa L.) were sampled in October 2020 and July / October 2021. The purpose was to (i) evaluate plant uptake, and (ii) assess potential seasonal and annual variations in 23 PFAS concentrations in foliage. Plant uptake of PFAS was compared to soil and groundwater PFAS concentrations obtained from previous sampling studies at the site. Furthermore, a spatial interpolation of PFAS in foliage and groundwater was performed to assess phytoscreening applicability in terms of groundwater plume detection.

Results/Lessons Learned. Phytoscreening results indicated tree species-specific differences with the highest total PFAS concentrations observed in October for white willow (0–1,800 µg kg-1), followed by black poplar (6.7–32 µg kg-1), and black alder (0–13 µg kg-1). The bulk substances in leaves were highly mobile short-chain perfluoroalkyl carboxylic acids (PFCA). In contrast, the PFAS composition in soil was dominated by long-chain PFCA, PFOA, and PFDA due to their lower mobility with total PFAS concentrations ranging between 0.18–26 µg/L (eluate) and 66–420 µg/kg (solid). The PFAS composition in groundwater, however, was comparable to the spectrum observed in leaves. Calculated spatial interpolations of PFAS compounds in groundwater and foliage showed a good correlation and demonstrated the potential of phytoscreening to detect and delineate the site's PFAS groundwater impacts.