Spatio-Temporal Data Analysis as a Tool for Understanding Complex PFAS Plumes

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Background. The omnipresence of per- and polyfluorinated compounds (PFAS) in the environment has raised concerns among researchers and authorities regarding the fate and transport of PFAS in the environment. More recently, municipal and military firefighting training sites have been identified as point sources of PFAS to groundwater and potentially drinking water posing a threat to humans and biota. The present study investigates the fate and transport of PFAS from a former Fire Protection Training Area (FPTA) located in the vicinity of an airport. In 2013, this FPTA was found to be contaminated by the intensive use of PFAS containing aqueous film-forming foams (AFFFs) during fire training between the late 1970s and the early 1990s. Recent groundwater results from monitoring wells near the FPTA showed concentrations of perfluororoctanoic sulfonic acid (PFOS) as high as 2.3 mg/L. In combination with the magnitudes of other PFAS compounds detected in groundwater, these concentrations were alarming in both national and international measures. As an example, a PFOS concentration of 2.3 mg/L exceeds the preliminary Swedish groundwater guideline value of 45 ng/L more than 50,000 times.

Approach. Authority concerns about PFAS contaminants reaching a nearby lake, used as a drinking water source, has led to several investigations of the contaminant situation. Starting in 2013, field activities included installation of approximately 30 groundwater monitoring wells at and around the former FPTA. Soil auger drilling and cone penetration tests were conducted in order to obtain an enhanced image on the geological situation. Soil and groundwater samples were collected and analyzed for 22 different PFAS compounds as well as linear and branched isomers of PFOS, perfluorohexanic sulfonic acid (PFHxS), perfluorooctanoic acid (PFOA) and perfluorooctanesulfonamide (PFOSA). After an assessment of the analytical results for PFAS in soil and groundwater, 16 further groundwater monitoring wells were installed, covering the contaminant situation in multiple aquifers. The results of groundwater gauging and contaminant concentrations were compiled and analyzed separately for each aquifer by a Spatio-Temporal Data Analysis Tool, giving a detailed picture on fate and behavior of the plume at different depths.

Results/Lessons learned. This paper will present methods used for characterizing the lateral and horizontal transport of PFAS in multiple groundwater plumes in a complex environment. In order to handle a geologically and hydrologically variegated environment, consisting of trenches, brooks and agricultural land, groundwater results were analyzed separately from multiple theoretical aquifers and thereafter combined. Spatio-temporal data analysis results and graphical PFAS fingerprint pattern variations over time and space, as well as the behavior of the PFAS plume, influenced by hydrogeological conditions will be presented. Lessons learned from the in-depth assessment of multiple aquifers will be discussed along with recommended actions for preventing the plume to reach drinking water bodies.