Evidence of large-scale deposition of airborne emissions of PFAS near a fluoropolymer production plant in an urban area

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Introduction

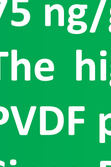
One of the first large-scale applications of PFAS was as processing aids for manufacturing fluoropolymers such as polyvinylidene (PVDF). Consequently, larges quantities of PFAS were released into the environment through wastewater effluents, disposal of industrial waste, but also through airborne emissions.

This study was designed to characterize PFAS contamination in surface soil and outdoor dust following atmospheric deposition of airborne emissions near an industrial park producing PVDF and fluoroelastomers.

Processing aids used

PVDF production unit

- Since 1973, **6:2FTSA**
- From 2003 to 2017, **Surflon® S111**



PFNA 74%, PFUnDA 20%, PFTrDA 5%

Fluoroelastomer production unit:

- From 2002 to 2008, **PFOA**
- Since 2009, **PFHxA**

Materials and Methods

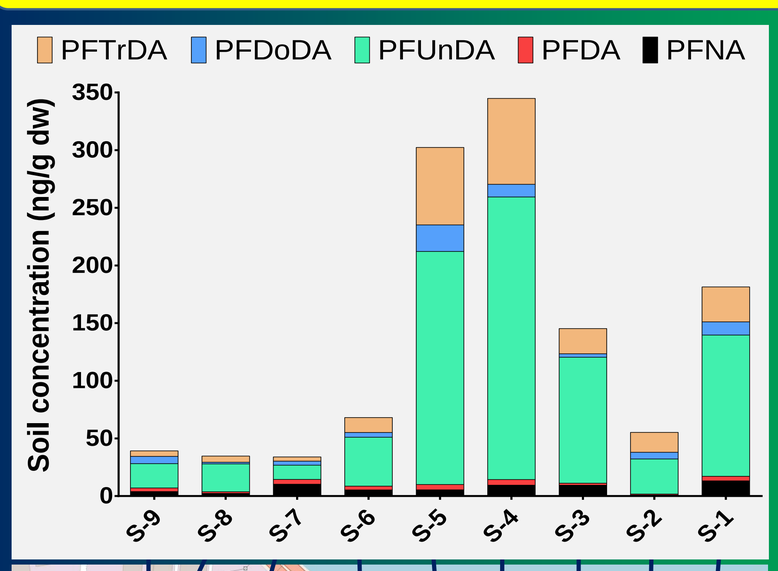
Nine surface soil (S-1 to S-9) and five outdoor dust samples were collected in May 2022 within 200 m of the industrial park's fence.

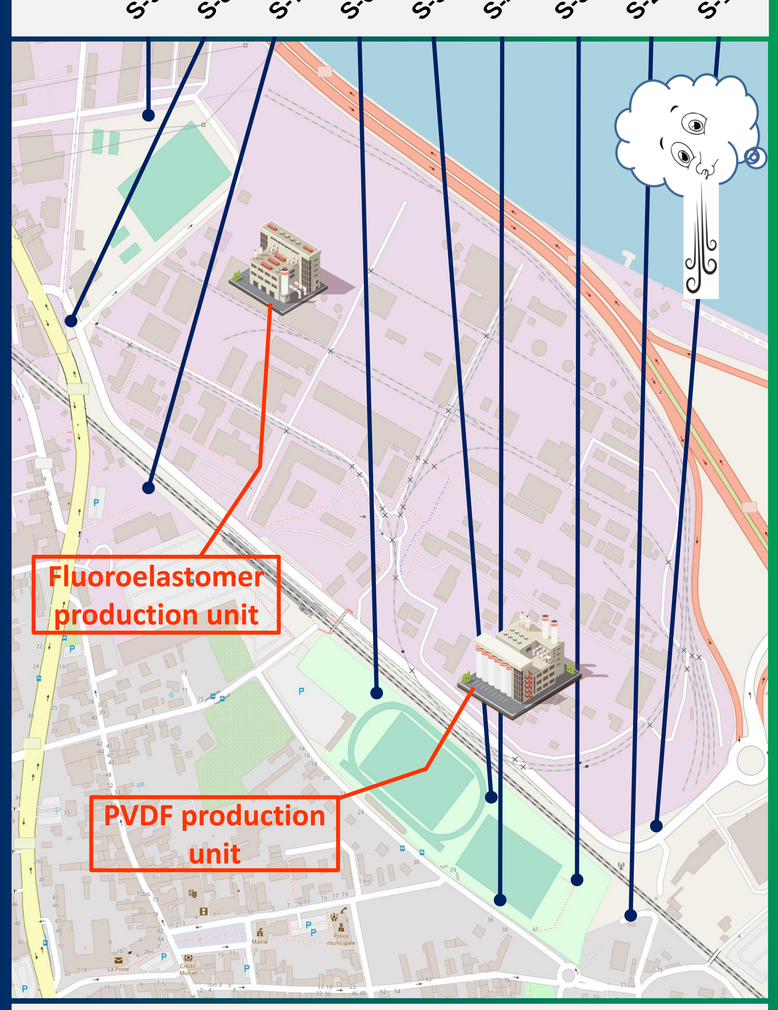
After removing grass, surface soil was sampled to a depth of roughly 0-3 cm. Dust samples were collected on asphalt surfaces (parking spaces and one skate park).

Prevailing wind patterns were taken into account when selecting sample collection sites.

28 PFAS were analyzed with an ultra-performance liquid chromatograph in tandem with a triple quadrupole mass spectrometer.

Results and Discussions



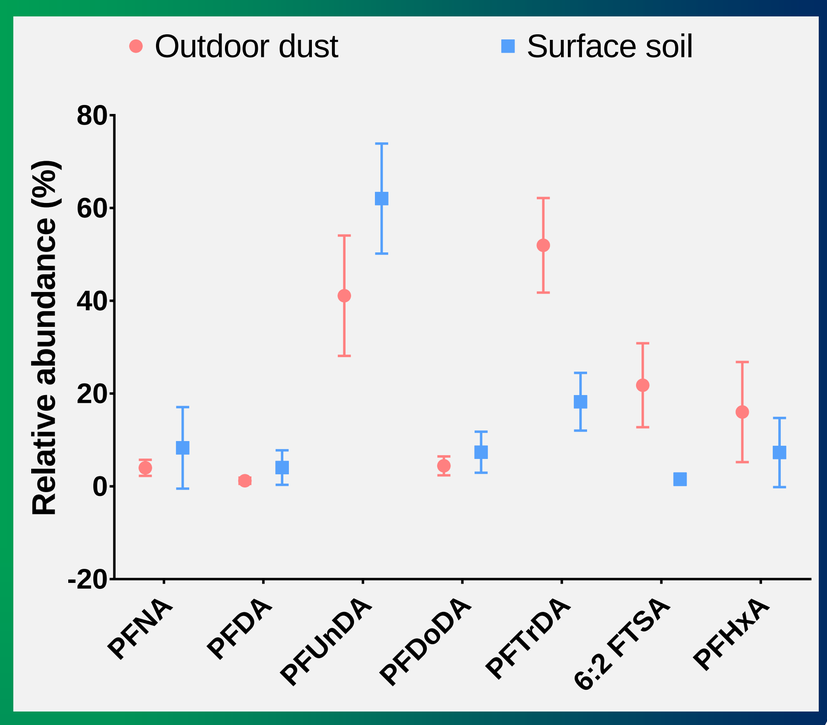


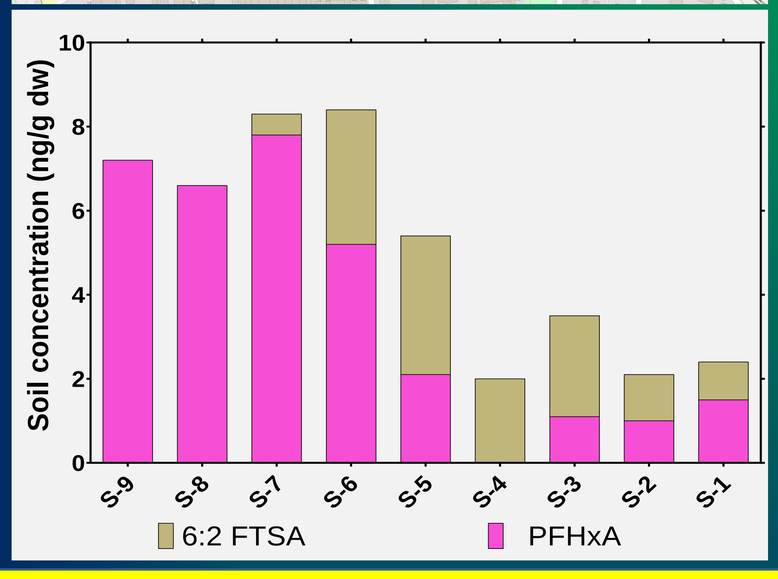
○ **In surface soil samples:**

- **The sum of PFAS ranged from 42 to 347 ng/g dw.**
- **PFCA with chain length between C9 (PFNA) and C13 (PFTrDA) were quantified in all soil samples.**
- **PFUnDA and PFTrDA were the predominant PFAS in soil samples (12-245 and 4-75 ng/g dw, respectively).**
- **The highest concentrations were recorded in samples collected closest to the PVDF production area and in the prevailing wind direction (S-5 and S-6).**
- **Since PFUnDA and PFTrDA are major impurities of Surflon® S111, it is very likely that soil contamination stems from its usage between 2003 and 2017.**

○ **Comparison between soil and outdoor dust samples:**

- **Significant differences of percent distribution in surface soil and outdoor dust samples were observed for PFUnDA ($p<0,05$), PFHxA, PFTrDA and 6:2 FTSA ($p<0,01$).**
- **These differences could be related to the physicochemical properties of PFAS and their temporal-use patterns (long-chain PFCA were not used since 2017, whereas 6:2 FTSA and PFHxA are currently used and thus constantly present in dry deposits released from the facilty stacks).**





○ **In surface soil samples:**

- **Highest 6:2 FTSA concentrations were recorded around the PVDF production area (where it is currently used) and in the prevailing wind direction.**
- **Highest PFHxA concentrations were observed near the fluoroelastomer production area, above those usually reported in background soils.**
- **Why did we observed relatively low concentrations for specific PFAS ?**
  - **PFHxA and PFNA have a much higher mobilty than PFUnDA and PFTrDA and can percholate through the soil with precipitations,**
  - **PFHxA could have a longer atmospheric retention time and a wider dispersion,**
  - **6:2 FTSA could be transformed once on the ground.**

Conclusions & Perspectives

- **One of the ultimate environmental reservoirs for long-chain PFCA such as PFUnDA and PFTrDA is likely to be soil and dust.**
- **The distance and magnitude of atmospheric transport probably depend on the physicochemical properties of each PFAS, as well as their fate and behavior once on the ground.**
- **The competitive rates of soil deposition and losses via leachning may explain our findings and modify human exposure over time. Other environmental matrices (air, vegetables, eggs …) should be monitored to identify the main exposure pathways.**