Identification of PFAS Hotspots in German Rivers: Target Analysis vs. the Direct Total Oxidizable Precursor Assay

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Introduction

The extensive production and use of PFAS has caused global environmental contamination. Today, thousands of different substances are known to belong to the group of PFAS. One analytical approach to overcome this complexity is the total oxidizable precursor (TOP) assay. In this study, a spatial monitoring of the PFAS burden in rivers and lakes in Germany and The Netherlands was conducted. More than 210 suspended particulate matter (SPM) and sediment samples from 171 riverine sampling sites and lakes across Germany and five sites in Dutch rivers were analyzed .

Methodology

SPM and sediment samples were provided by authorities of the German federal states, the German Federal Institute of Hydrology (BfG), the German Environmental Specimen Bank and the Dutch Authority Rijkswaterstaat.

All samples were taken in 2021, preferably in April or May, and were analyzed with both, an extended target analysis with 41 analytes as well as a modified approach of the TOP assay, the so-called direct TOP (dTOP) assay. Both methods are described below in Figure 2.

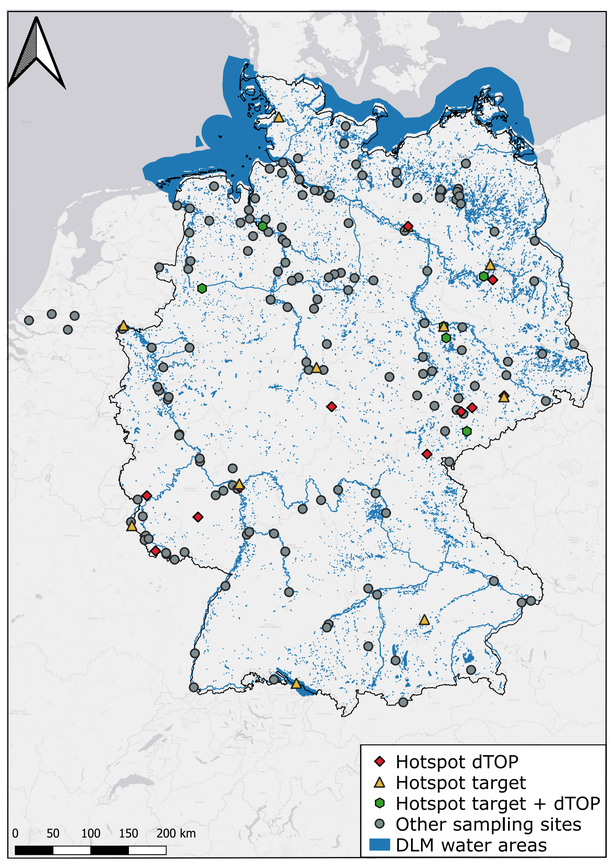

Figure 1: Location of sampling sites and hotspots identified with each methods

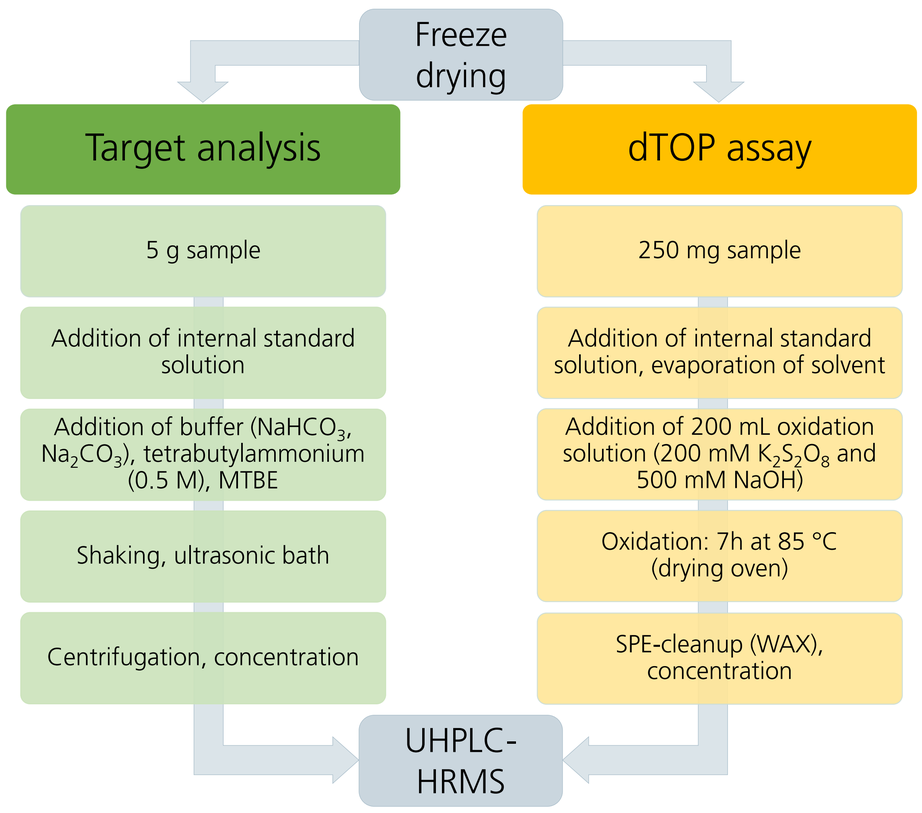

Figure 2: Method descriptions for target analysis and dTOP assay

Results

- PFAS were detected in nearly every sample at levels above the LOQs
- $\sum PFAS_{dTOP}$ levels were higher than $\sum PFAS_{Target}$ levels by a factor of 1.1 to 346

Table 1: Analytical key values of target analysis and dTOP assay

Method	Min	Max	P50	P90	%(>LOQ)
Target	<0.5	53.1	1.41	7.11	94%
dTOP	<1.0	336.8	23.5	79.1	92%

- $PFAS_{Target}$ patterns by were dominated by PFOS, but also long-chain PFCA, diPAPs, short-chain PFCA, sulfonamides and FTS, while $PFAS_{dTOP}$ patterns were clearly dominated by precursors of short-chain PFCA and PFOS
- For hotspot identification, the P90 values for $\sum PFAS_{dTOP}$ and $\sum PFAS_{Target}$, respectively, were chosen as trigger thresholds (see Table 1)
- Both methods identified 17 hotspots, but there were only six overlaps (see Figure 1 and Figure 3)
- Identified hotspots covered both, big streams as well as smaller river systems
- Increased ∑PFAS levels were correlated to the proximity to built-up areas and known sites where PFAS are or were likely used, e.g. galvanic industries, paper industries or (military) airports
- For some of the hotspots, however, contamination could not be explained by known sources, thus emphasizing the need for future elucidation to prevent further discharge to the environment

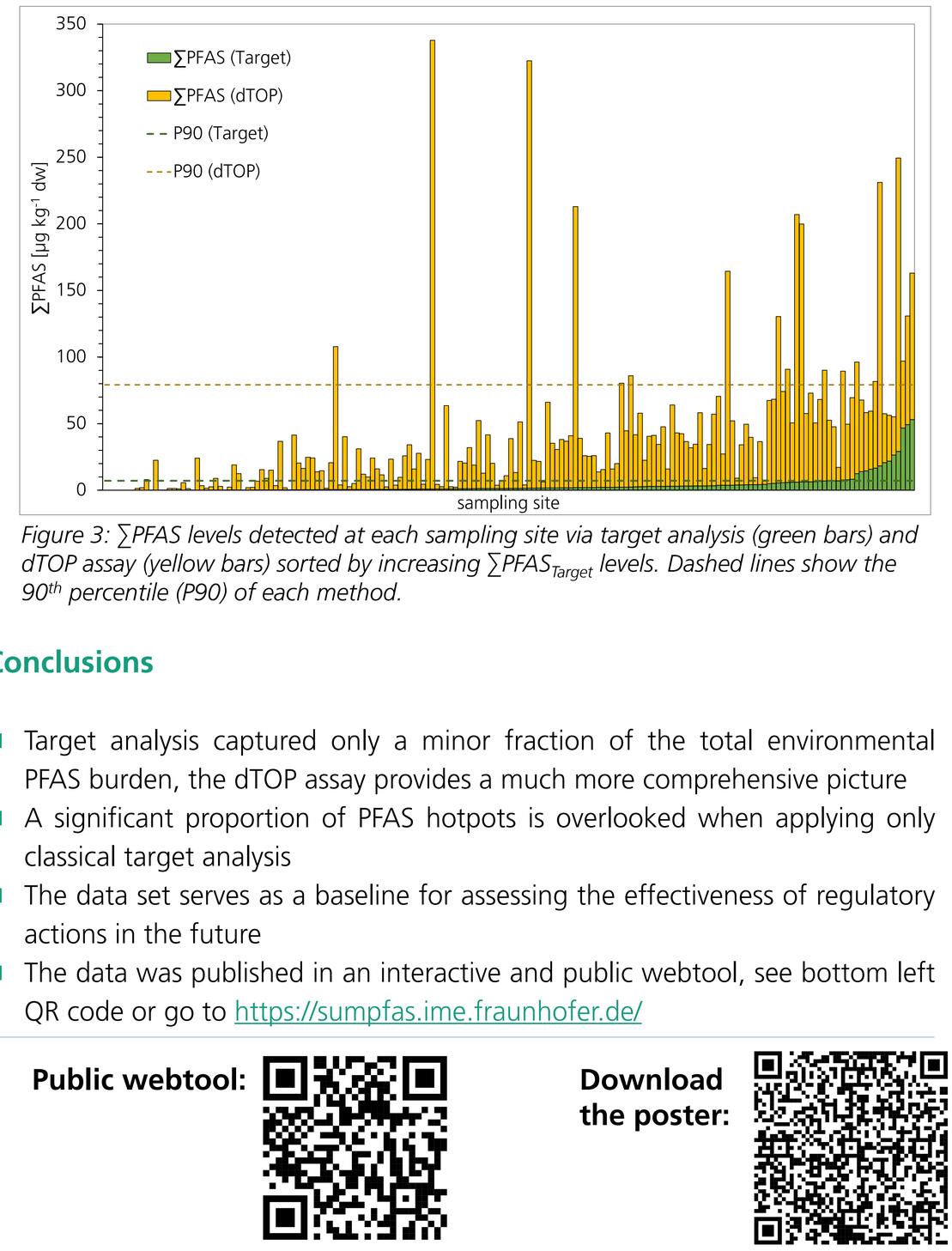

Figure 3: $\sum PFAS$ levels detected at each sampling site via target analysis (green bars) and dTOP assay (yellow bars) sorted by increasing $\sum PFAS_{Target}$ levels. Dashed lines show the 90th percentile (P90) of each method.

Conclusions

- Target analysis captured only a minor fraction of the total environmental PFAS burden, the dTOP assay provides a much more comprehensive picture
- A significant proportion of PFAS hotpots is overlooked when applying only classical target analysis
- The data set serves as a baseline for assessing the effectiveness of regulatory actions in the future
- The data was published in an interactive and public webtool, see bottom left QR code or go to https://sumpfas.ime.fraunhofer.de/

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Public webtool:

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