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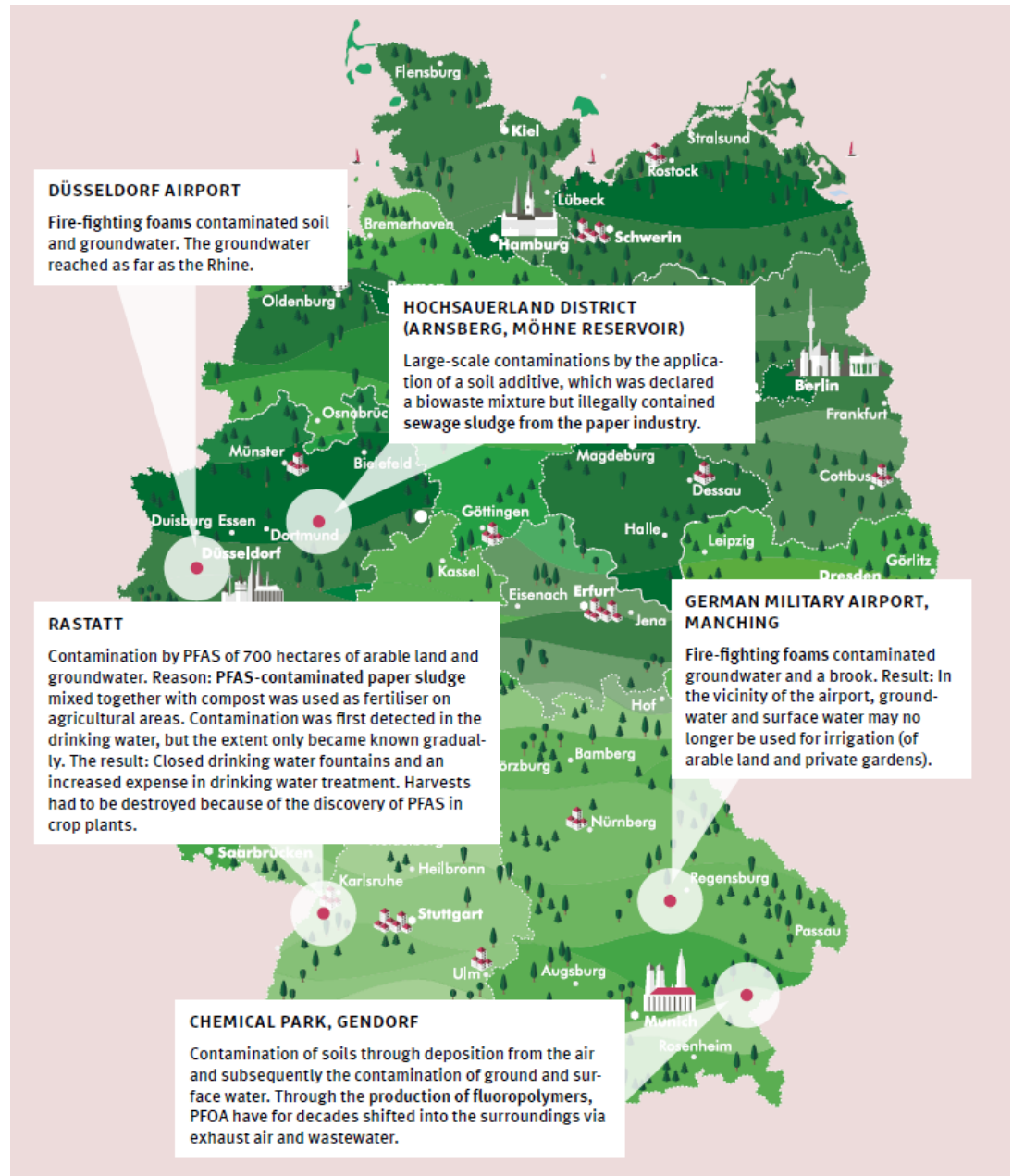
International workshop on Emerging policy challenges
on New SOil contaminants (ENSOr)
March 14-15 2024

PFAS in Soil and Groundwater – Progress and Comprehensive Challenges in Germany

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PFAS Hotspots in Germany

- Airports
- (former) Military sites
- Fluorochemical industry
- Agricultural areas



<https://www.umweltbundesamt.de/publikationen/what-matters-1-2020-pfas-came-to-stay>

The Rastatt Case in Germany

- Water provider detected PFAS in drinking water in 2012
- 1105 ha contaminated agricultural area (ca 1500 soccer pitches);
- 58 km² contaminated groundwater (180 Mio m³)

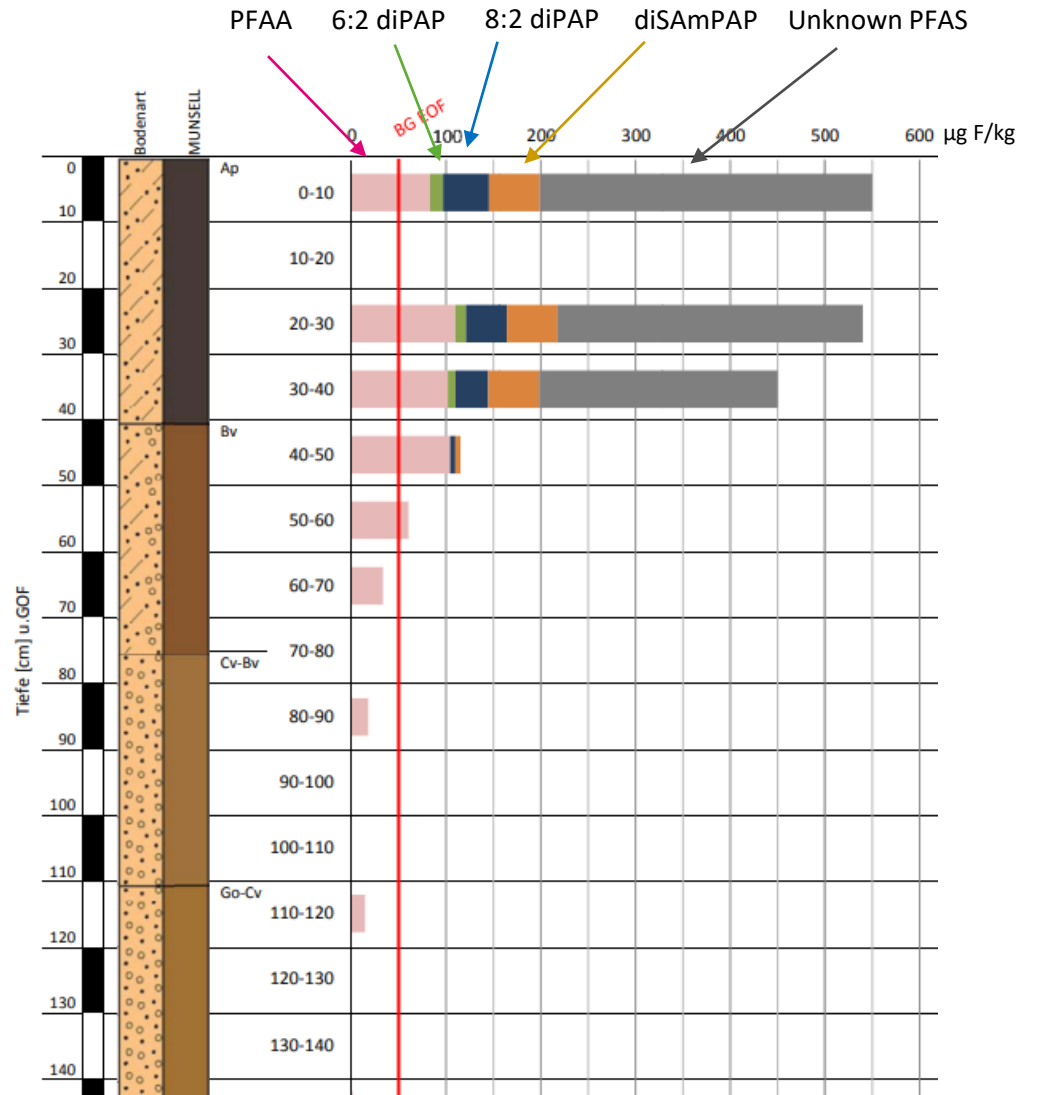
Source: most probably compost mixed with paper sludge from 2006 on

Concern: Human exposure via drinking water, feed and/or food



Rastatt Case: PFAS Composition in Soil

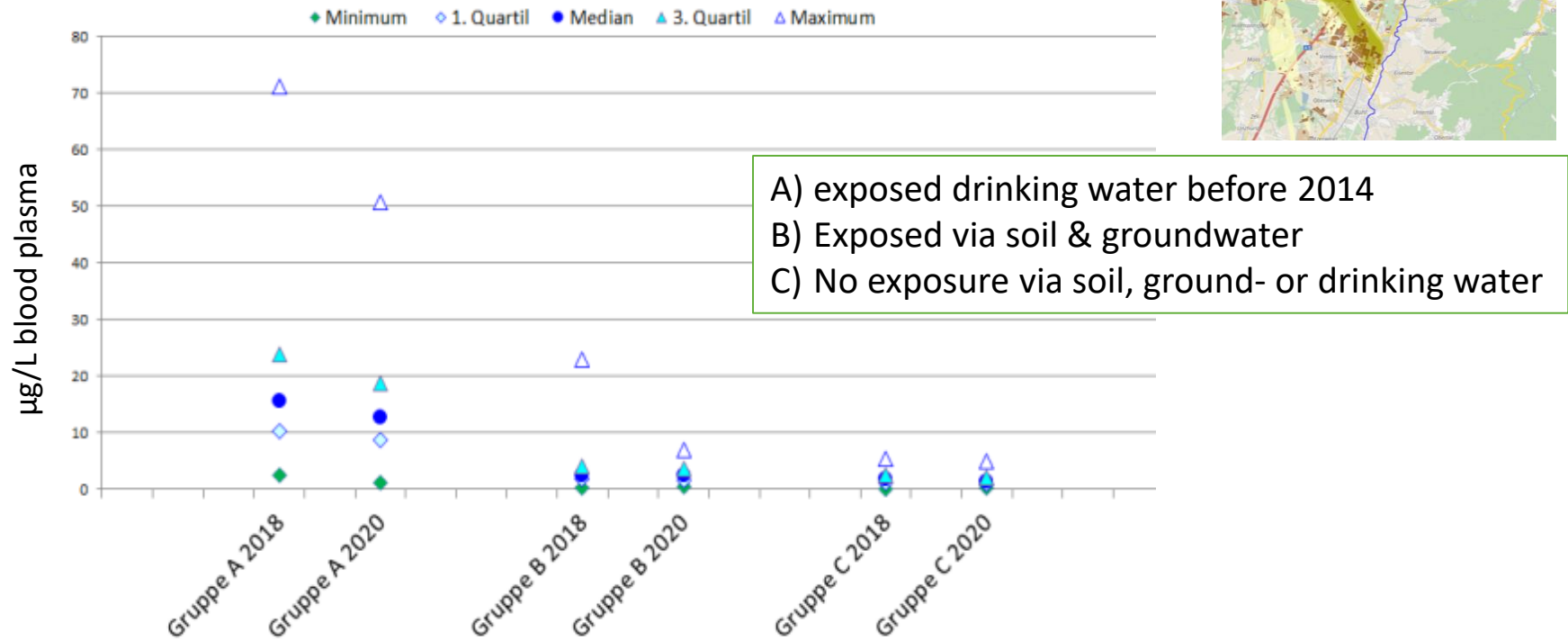
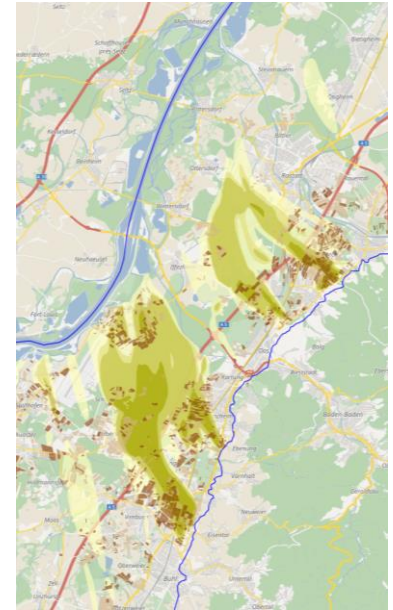
Top soil contains widely varying PFAS contents of up to 1000 µg/kg total PFAS (individual cases above this).



Source: Bericht Tiefenverlagerung EOF

Rastatt Case: Impact for Residents

- Blood of residents showed elevated PFOA levels
- Decrease by ~20 % within 2 years



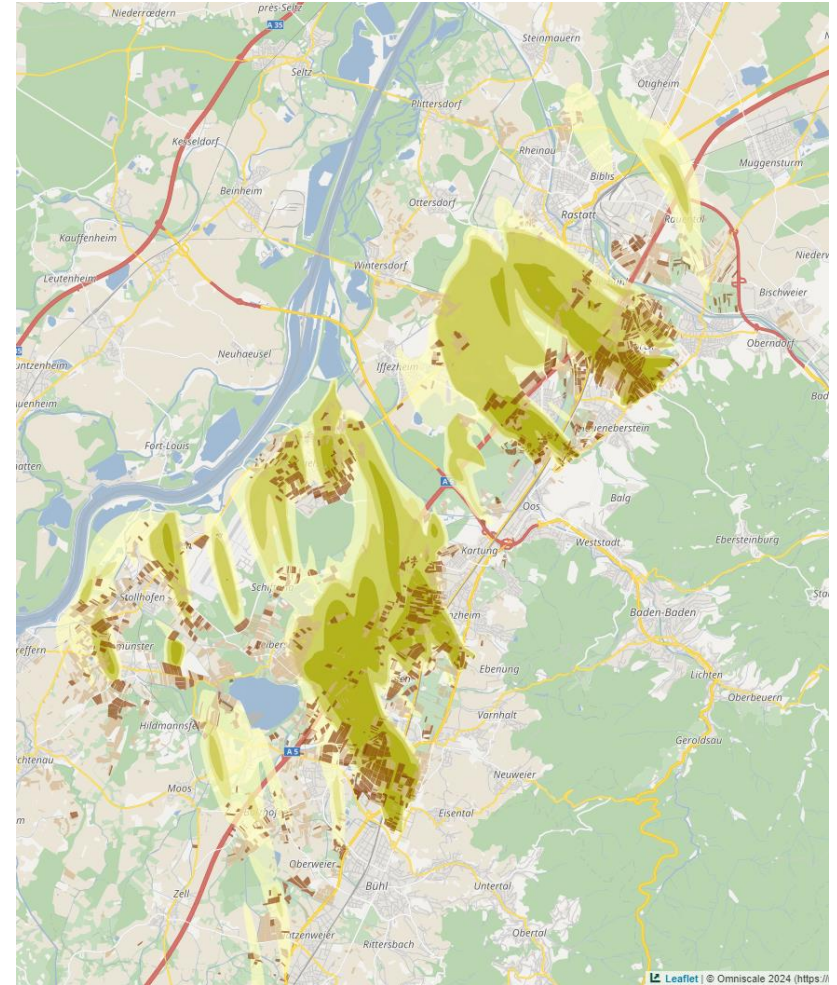
Solutions

For farmers

- Pre-harvest-monitoring and cultivation recommendations for farmers
- Activated carbon filters for irrigation water
- Strictly controlled wells and agricultural products

Water provider

- Closed wells and installation of new wells
- Water purification (i.e. with activated carbon filters)



National Harmonized Guidance in Germany

- Guidance for the analysis of PFAS in soil, including precursors
- Use significant thresholds for assessing the groundwater contamination and soil eluates
- Pre-harvest monitoring may be considered
- Guidance on handling soil material containing PFAS;

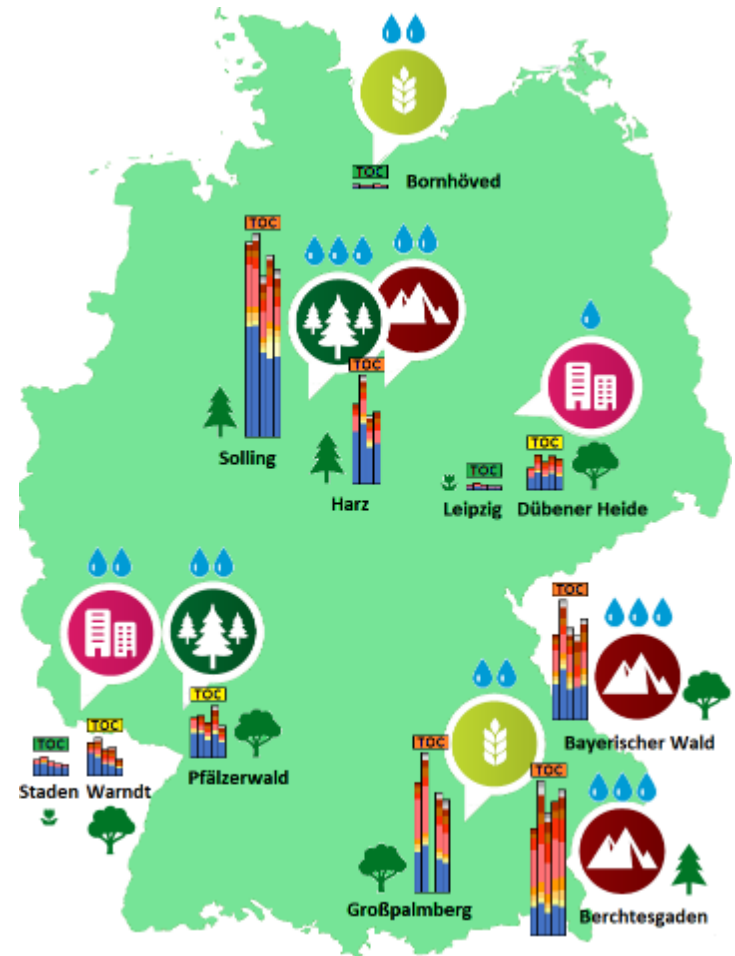
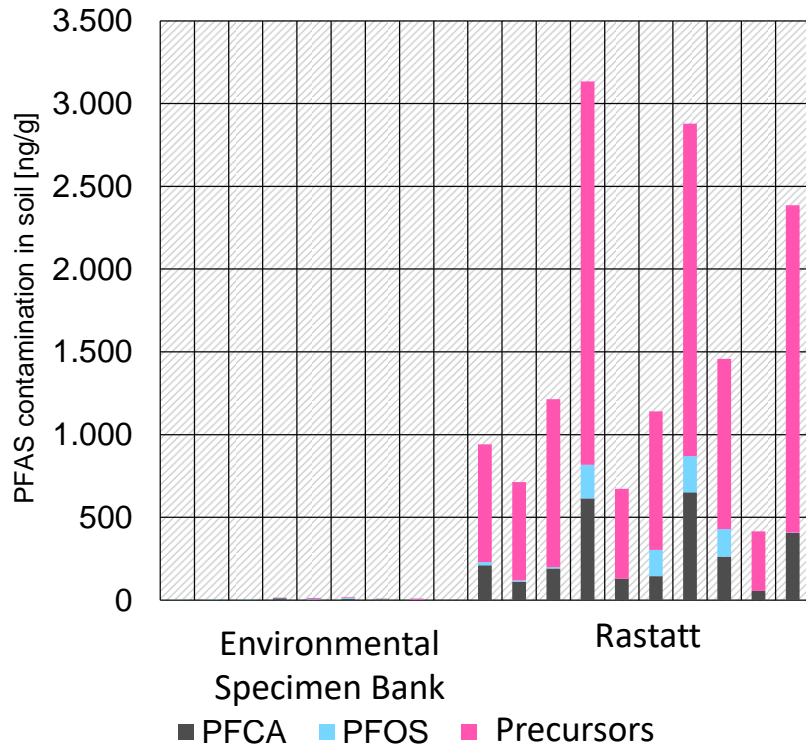
MAIN IDEA:

PFAS CONTAMINATED SOIL SHOULD NOT BE LANDFILLED, BACKFILLED OR USED AT PLACES WITH NO OR A LOWER PFAS POLLUTION.

| Substance | Significant thresholds for groundwater [$\mu\text{g/L}$] | Precautionary health-related indication value [$\mu\text{g/L}$] |
|--|--|---|
| PFBA | 10 | |
| PFPeA | | 3.0 |
| PFHxA | 6.0 | |
| PFHpA | | 0.3 |
| PFOA | 0.1 | |
| PFNA | 0.06 | |
| PFDA | | 0.1 |
| PFBS | 6.0 | |
| PFHxS | 0.1 | |
| PFHpS | | 0.3 |
| PFOS | 0.1 | |
| H4PFOS | | 0.1 |
| PFOSA | | 0.1 |
| other PFAS with R1-(CF ₂) _n -R ₂ , n>3 | | 0.1 |

Von der Trenck et al., Environ Sci Eur (2018) 30, 19; Significant thresholds for the assessment of contaminated groundwater; perfluorinated and polyfluorinated chemicals

Hotspots vs Background

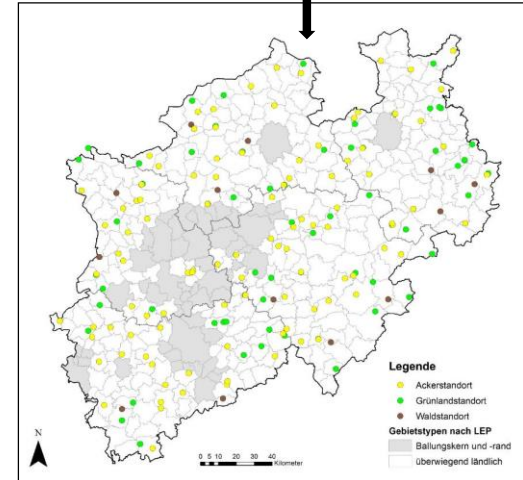


Kotthoff et al. (2020); Science of The Total Environment, 740
<https://doi.org/10.1016/j.scitotenv.2020.140116>

Wellmitz, Bandow, Koschorreck (2023); Science of The Total Environment, 893
<https://doi.org/10.1016/j.scitotenv.2023.164586>

PFAS Background Concentration in North-Rhine-Westphalia (NRW)

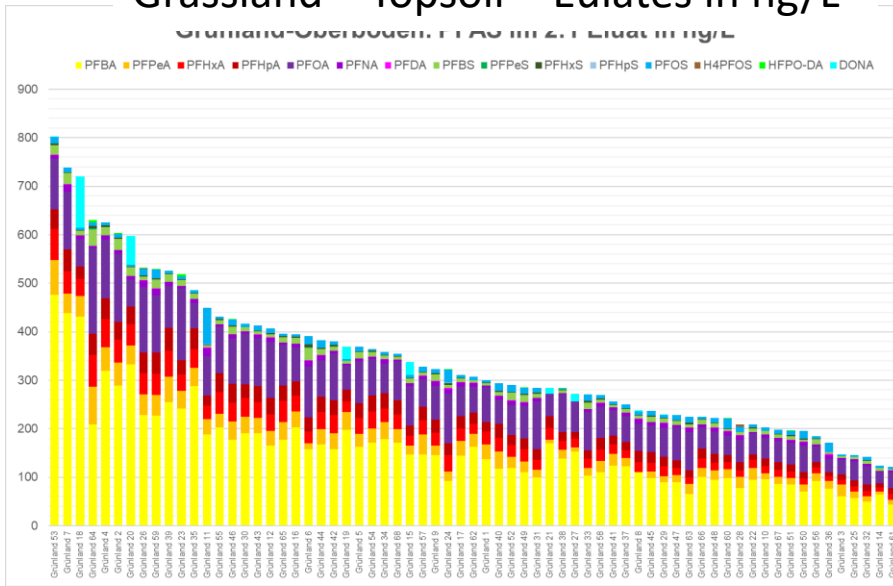
| Use | Sites | Sampling depth | Number of samples |
|-----------|-------|-------------------------|-------------------|
| Cropland | 107 | Topsoil (0 – 30 cm) | 107 |
| | | Subsoil (30 - 60 cm) | 40 |
| Grassland | 68 | Topsoil (0 – 10 cm) | 68 |
| | | Subsoil (10 – 30 cm) | 27 |
| Forest | 13 | Topsoil (0 – 10 cm) | 13 |
| | | Subsoil (10 – 30 cm) | 13 |
| | | Organic layer | 18 |



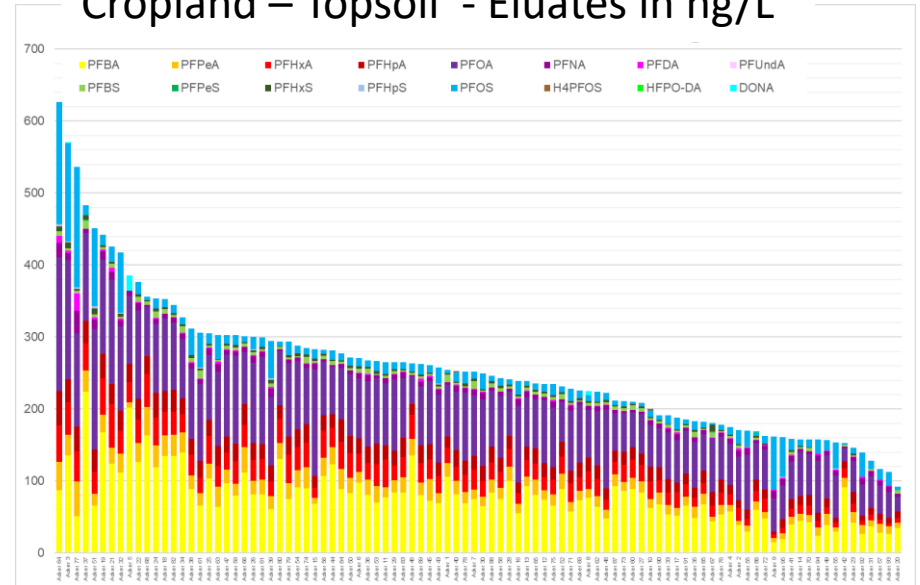
https://www.lanuv.nrw.de/fileadmin/lanuvpubl/3_fachberichte/LANUV-Fachbericht_150.pdf

Results: PFAS Background – Topsoil (Soil Eluates)

Grassland – Topsoil - Eluates in ng/L



Cropland – Topsoil - Eluates in ng/L



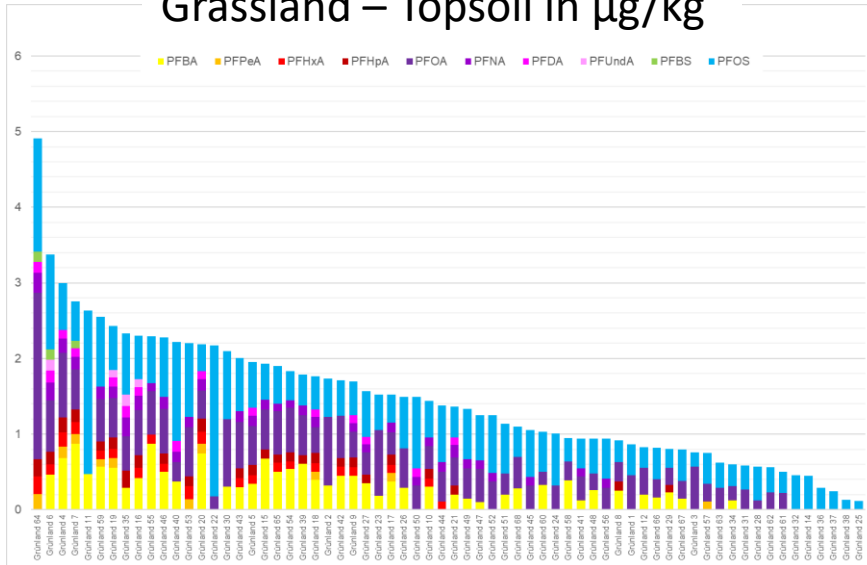
| Use | PFBA | PFPeA | PFHxA | PFHpA | PFOA | PFNA | PFBS | PFHxS | PFOS |
|-----------|------|-------|-------|-------|------|------|------|-------|------|
| Grassland | 288 | 42 | 44 | 42 | 118 | 9 | 18 | 3 | 16 |
| Cropland | 126 | 29 | 38 | 29 | 113 | 9 | 7 | 3 | 19 |

90th Percentile; ng/L

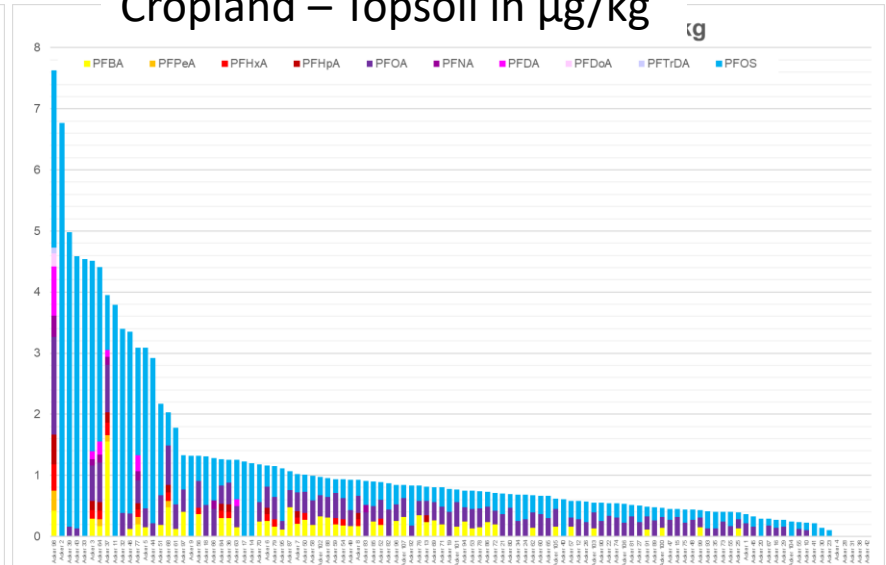
https://www.lanuv.nrw.de/fileadmin/lanuvpubl/3_fachberichte/LANUV-Fachbericht_150.pdf

Results: PFAS Background – Topsoil (solid matter)

Grassland – Topsoil in µg/kg



Cropland – Topsoil in µg/kg

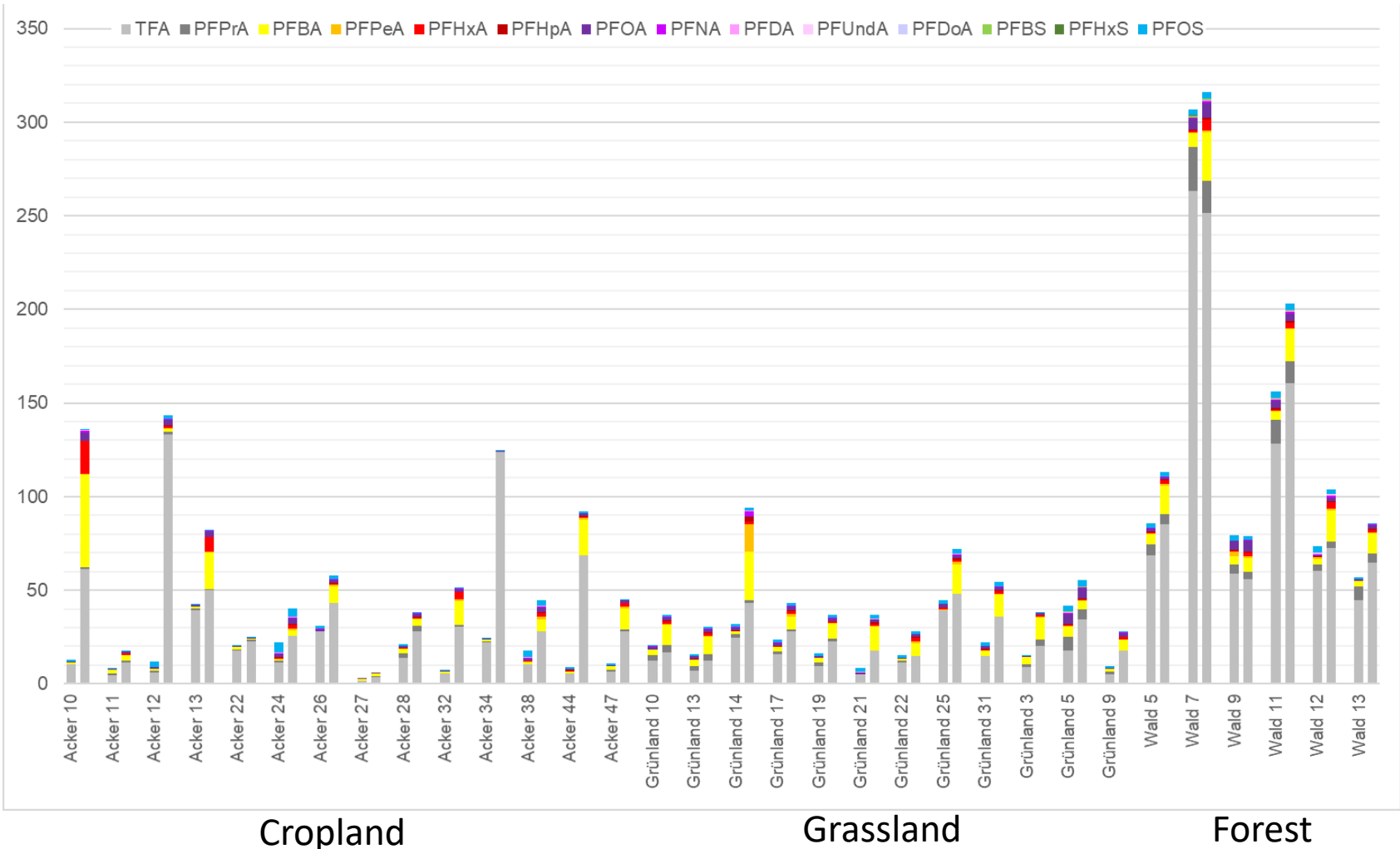


| Use | PFBA (µg/kg) | PFOA (µg/kg) | PFOS (µg/kg) |
|-----------|-----------------|-----------------|-----------------|
| Grassland | 0.62* | 0.62* | 0.91* |
| Cropland | 0.30* | 0.42* | 0.73* |

* 90th Percentile

https://www.lanuv.nrw.de/fileadmin/lanuvpubl/3_fachberichte/LANUV-Fachbericht_150.pdf

PFAS in Topsoil Before and After TOP Assay in nmol F/kg (Methanol Extract)



https://www.lanuv.nrw.de/fileadmin/lanuvpubl/3_fachberichte/LANUV-Fachbericht_150.pdf

Further Progress – UBA Research Activities

- Standardization Top Assay (DIN)

Verification of the robustness and implementation of a ring test for the quantification of Total Oxidizable Precursor (TOP-Assay) in soil eluates for the pathway soil-groundwater" [Project report](#)

- Determination of background levels of PFAS

Background levels of PFAS and (micro)plastics - nationwide representative sampling of agricultural soils (FKZ 3720 72 288 0; duration 2021 - 2025).

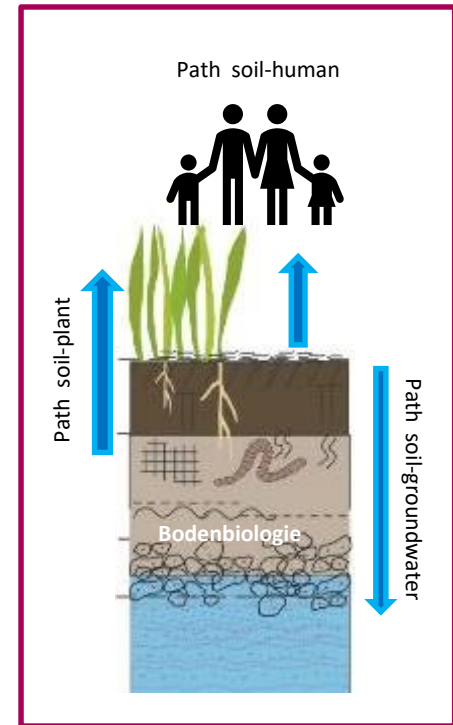
- Derivation of soil values of PFAS

UBA in-house research; duration: 2021-2025

→ Screening values for the direct path soil-human

→ Screening values for the path soil-plant

- Characterisation of the contamination of soils with PFAS in urban areas, in selected contamination cases as well as nationwide background values for forest soils in Germany (2024-2026)



[Digging deep—implementation, standardisation and interpretation of a total oxidisable precursor \(TOP\) assay within the regulatory context of per- and polyfluoroalkyl substances \(PFASs\) in soil | Environmental Sciences Europe](#)

Thank you!

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