



# Monitoring PFAS in soil and groundwater

Laetitia Six, policy coordinator at OVAM

# Outline of the presentation:



Brief introduction to OVAM



Inventory and mapping of PFAS data



Projects with innovative monitoring techniques

# OVAM in a nutshell



▶ **OVAM** = Public Waste Agency in the region of Flanders

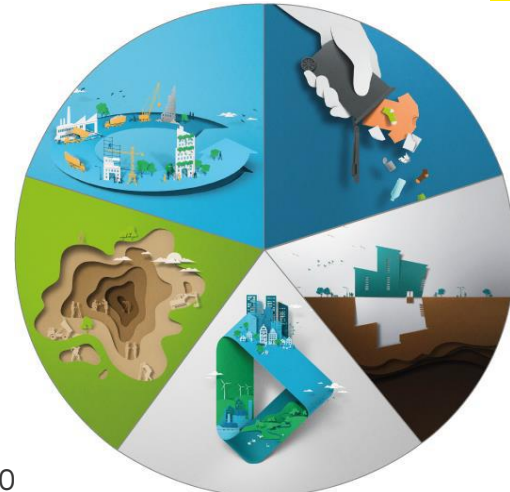
▶ OVAM's overall mission:

We strive for a sustainable waste and materials management, a clean & healthy soil and aim for the transition to a circular economy.

▶ OVAM's soil department focusses on **soil CARE and CURE**

- Monitoring of soil contamination in Flanders
- Protective measures for soil and groundwater
- Soil and ground water remediation

▶ Decree on Soil Remediation and Soil Protection (entry into force 200



# OVAM's track record

## In general

- > 52,000 preliminary soil investigations
- > 14,000 descriptive soil investigations
- > 6,000 soil remediation projects designed
- > 5,500 soil remediation works have been started and about 4 600 have already been finished

## PFAS



- > 4000 locations with potential PFAS risk identified
  - > 700 investigation started
- > 800 fire related sites inventoried
  - ± 90% of those sites preliminary investigated
  - ± 65% of the investigated sites require a descriptive soil investigation and possibly remediation

# Inventory of PFAS data

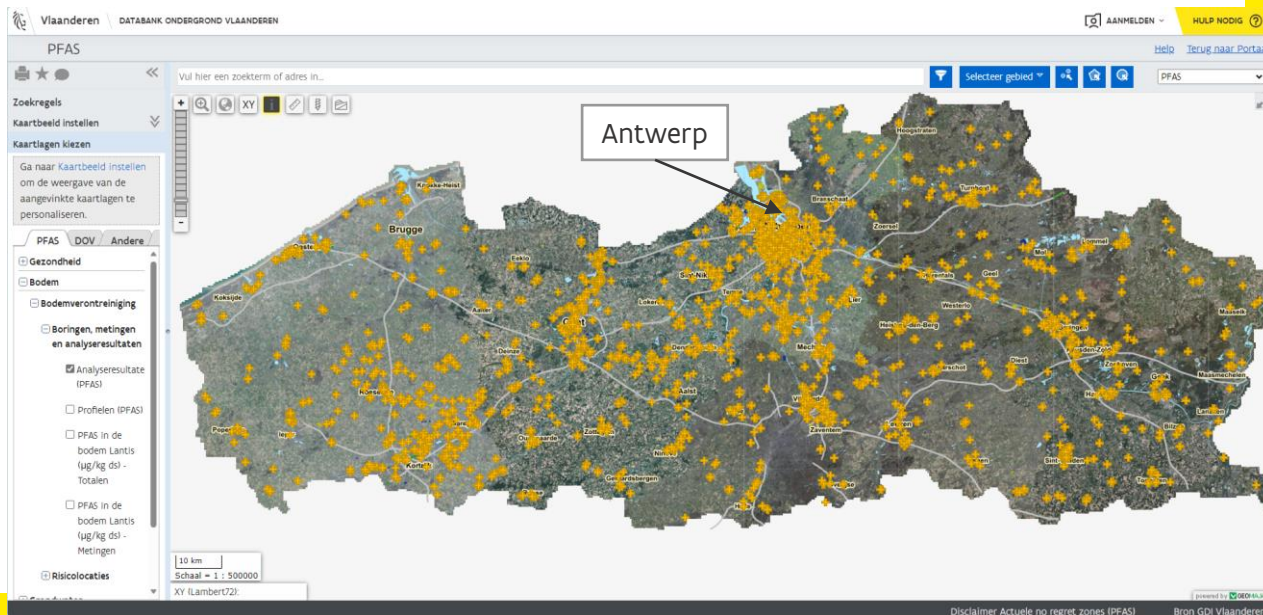


innovative

- The road to full transparency
- Collaboration DOV – Database of subsoil in Flanders

- Map contains PFAS data for:

- Soil
- Groundwater
- Surface water
- Biota
- Sediment
- Emissions
- ...



# Projects with innovative monitoring techniques



# Anthropogenic background levels of PFAS

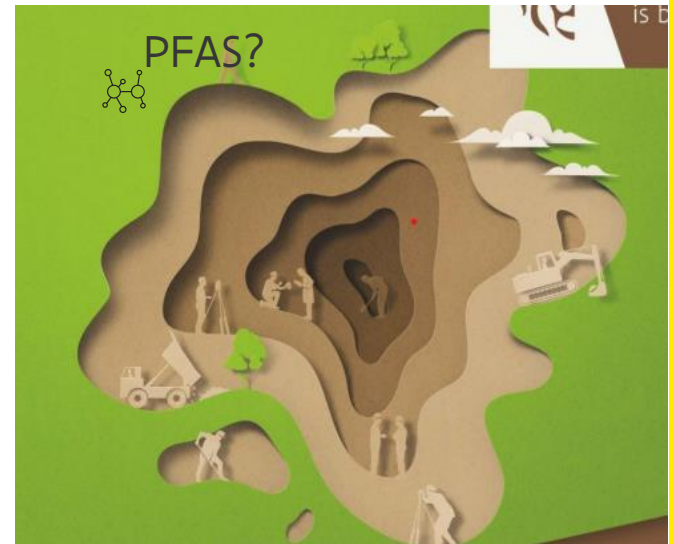


- ▶ Project commissioned by OVAM – carried out by Arcadis & Witteveen+Bos – collab with VMM
- ▶ Decades of PFAS production and use has enriched our soils and groundwater
  - point source vs. regional elevation?

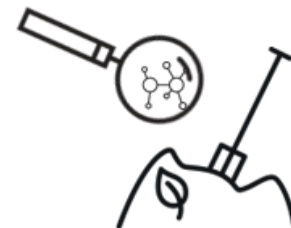


Anthropogenic background levels = PFAS concentration to which we level off

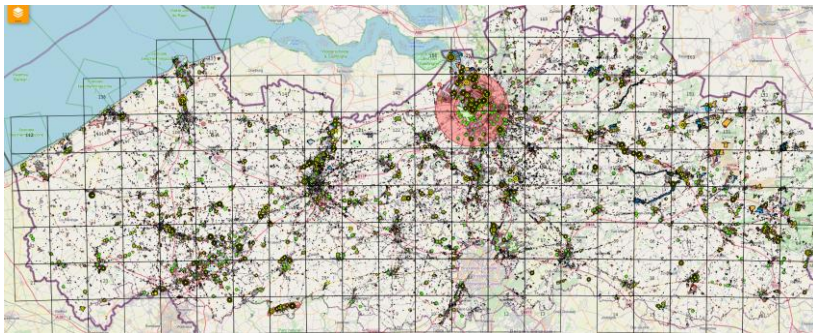
- ▶ Anthropogenic background levels in soil and groundwater



# Anthropogenic background levels of PFAS



- ▶ Selection of sampling sites in green zones



Verification & validation



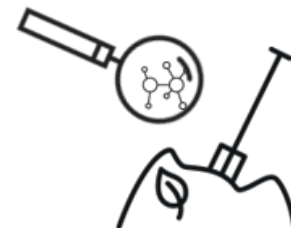
73 soil samples (+ 50 sampled in 2020)  
387 groundwater samples

- ▶ PFAS analysis

- Target analysis: 40 PFAS in soil & 43 PFAS in groundwater
- TOPA on subset of samples



# Anthropogenic background levels of PFAS



► Derivation of anthropogenic background levels in areas not suspected to be close to a PFAS contamination source

→ P90 value of observations and (% > LOQ):

PFAS	groundwater (ng/L)	topsoil (µg/kg dw)
PFBA	21,0 (59%)	0,9 (14%)
PFBS	9,4 (57%)	n.a.
PFOA <sub>total</sub>	8,0 (49%)	0,8 (58%)
PFOA <sub>total</sub>	5,0 (34%)	1,5 (29%)



Comparison with EU WFD proposed EQS 4,4 ng/L PFOA-equivalents?  
- exceeded at 37% of the sites  
- P90 of PFOA and PFOS already exceed this EQS

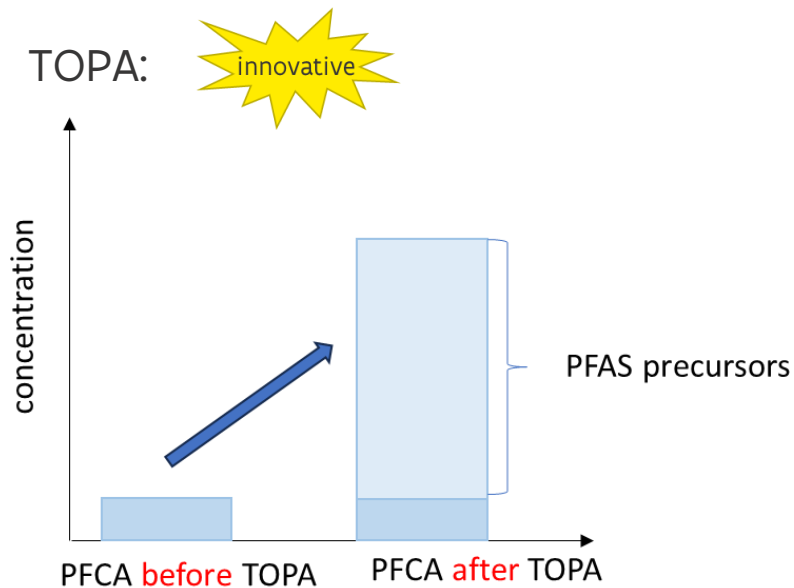
→ Input to the PARC initiative to derive PFAS baseline in Europe



# Anthropogenic background levels of PFAS



- ▶ Selection of samples assessed with TOPA to investigate impact of PFAS precursors

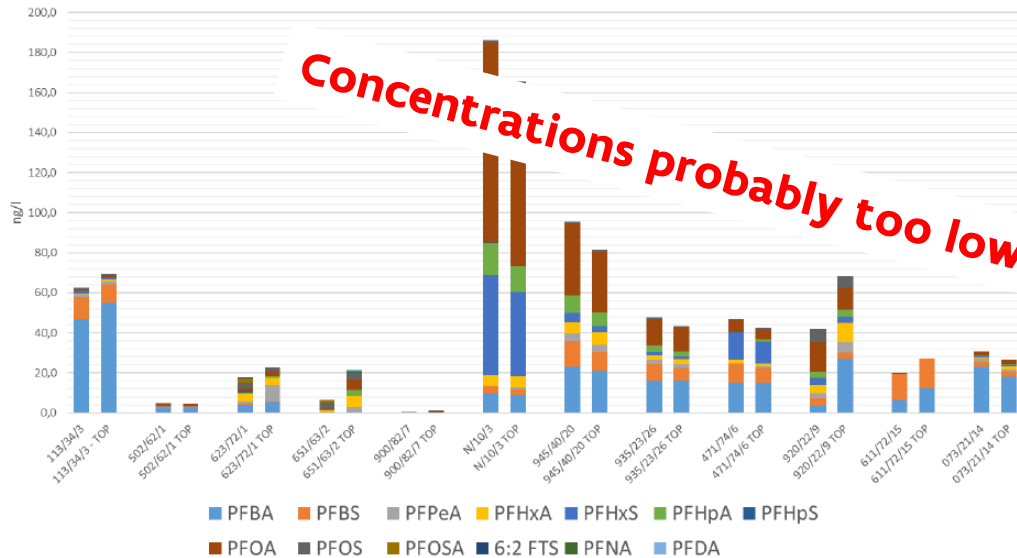


PFCA: Perfluoralkyl carboxylic acids  
TOPA: Total Oxidizable Precursors

# Anthropogenic background levels of PFAS



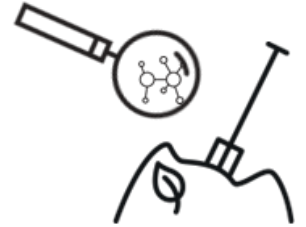
## ► Results TOPA



## ► Variable & unpredictable results:

- Groundwater: Concentration after TOPA > and < before TOPA
- In soil: concentration often < than before TOPA
- In water:
  - tendency to more short-chain PFAS (PFBA, PFPeA and PFHxA) after TOPA.
  - The concentration long-chain PFAS (PFOA) decreases due to TOPA

# PFAS non-target screening in soil and groundwater at PFAS contaminated sites



- ▶ Project commissioned by OVAM – carried out by VITO, University of Antwerp
- ▶ **Aim:** obtain a comprehensive view on the PFAS components, including precursors, at different contaminated sites in Flanders through the use of non-target screening/analysis methods
- ▶ The results will be evaluated against:
  - the PFAS sources, i.e. fingerprinting (especially important for ‘polluter pays’ principle)
  - the fate of PFAS in soil, groundwater and sediment

# PFAS non-target screening in soil and groundwater at PFAS contaminated sites



innovative

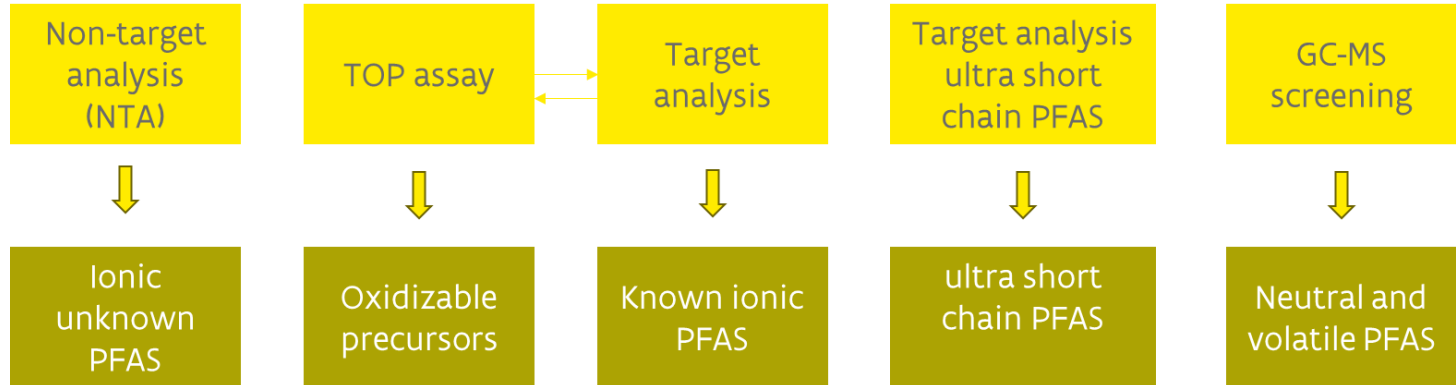
Samples from:

- Former fire fighting training sites
- Textile industry
- Paper manufacturing

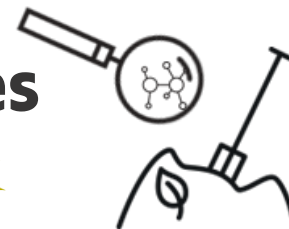
EOF/AOF and  
DART-MS

Promising results with DART-MS

Selection of most promising samples for further analysis



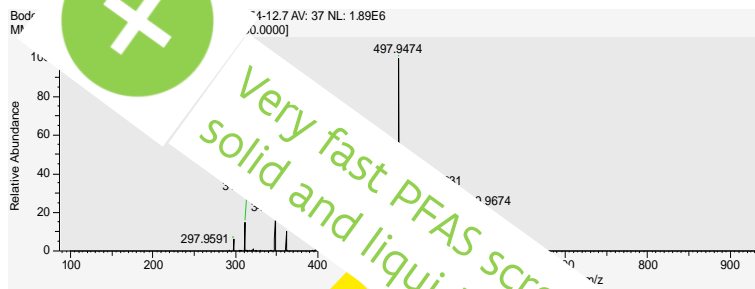
# PFAS non-target screening in soil and groundwater at PFAS contaminated sites



innovative

DART-MS = Direct Analysis in Real Time Mass Spectrometry

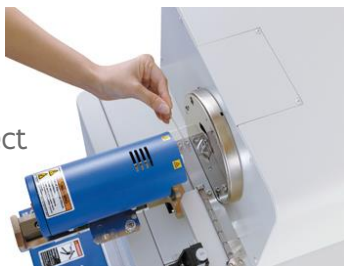
## ▶ DART-MS analysis of soil samples



Very fast PFAS screening in solid and liquid samples

MS data interpretation, database development

Sampling and direct analysis



Specific mass spectrum for each sample

Non-destructive analysis

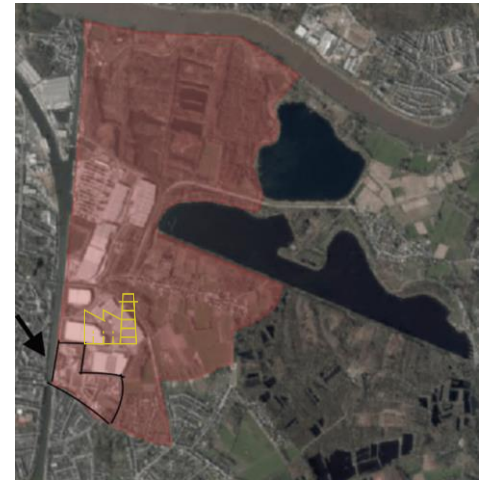
m/z	Rel area	Formula	Compound
497.9473	100.00%	C8H2O2NF17S H-	PFOSA
397.9533	66.88%	C6HO2NF13S H-	PFHxSA
511.9628	33.39%	C8H4O2NF17S H-	MePFOSA
569.9631	18.96%	C8H4O2NF17S H-	MeFOSAA
347.9566	18.96%	C8H4O2NF17S H-	PFPeSA
311.9746	15.20%	C5H3O2NF9S H-	MeFBSA*
411.9690	13.00%	C7H4O2NF13S H-	MePFHxSA
361.9718	10.66%	C6H4O2NF11S H-	MePFPeSA
297.9591	5.74%	C4HO2NF9S H-	FBSA*
412.9672	5.27%	C8HO2F15 H-	PFOA

Challenge

# Suspect screening of PFAS in house dust and soil



- ▶ Project commissioned by OVAM – carried out by VITO, University of Antwerp
- ▶ Investigation at PFAS contaminated site: former paper manufacturing site in Willebroek (De Naeyer)
- ▶ 26 homes at De Naeyer and 1 reference home:
  - house dust (shoe dust, floor dust, ...)
  - air & deposition
  - *Soil data from former investigation*
- ▶ Suspect screening analysis for identification of PFAS + target analysis for quantification



# Target analysis of PFAS in house dust and air deposition – compared to soil



PFAS	Shoe dust	Floor dust	Air deposition	Soil (Abesim 2021)
PFPeA	+	++	++	✓
PFHxA	++	+++	+++	✓
PFHpA	+	++	++	✓
PFOA	++	++	++	✓✓
PFDA	+	++	++	✓✓
PFOS	+++	+++	n.d.	✓✓✓
PFOSA	++	++	+	✓✓✓
EtPFOSAA	+++	+++	++	✓✓✓

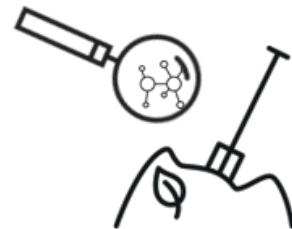
PFAS mostly detected in soil:  
EtPFOSAA, PFOS and PFOSA



+: < 1% of total PFAS  
 ++: 1-10% of total PFAS  
 +++: > 10% of total PFAS



# Suspect screening of PFAS in house dust



	Locations @ De Naeyer										ref
PFAS	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	site
diSAmpAP	+	+	+	+	+	-	+	+	-	+	-
EtPFOSAA	+	+	+	-	-	-	+	+	-	-	-
PFOSAA	+	+	+	-	-	-	+	+	-	-	-
PFOSA	-	-	+	-	-	-	+	-	-	-	-
PFOS	+	+	+	+	+	+	+	+	+	+	+
PFHxA	+	+	+	+	+	+	+	+	+	+	+
PFOA	+	+	+	+	+	+	+	+	+	+	+
PFNA	-	-	-	+	+	+	-	+	+	+	+
6:2 diPAP	+	+	+	+	+	+	+	+	+	+	+

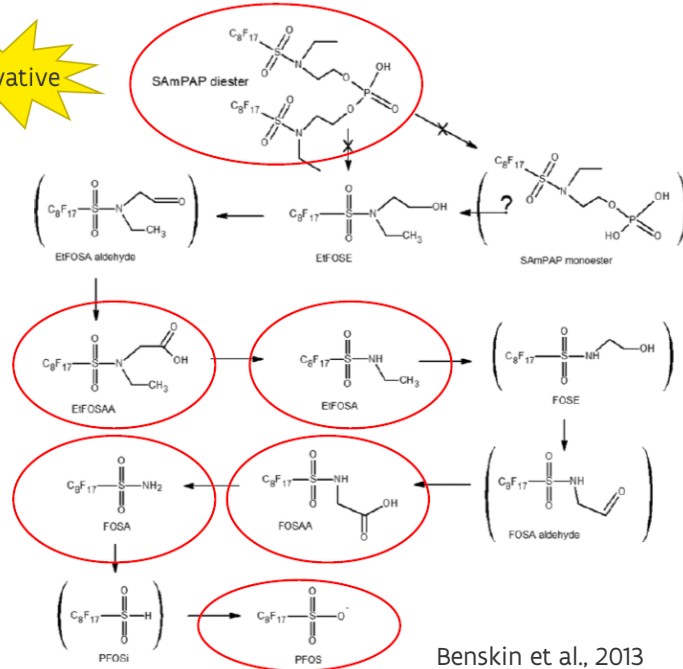
# Suspect screening of PFAS in house dust and soil



► Suspect screening showed contamination with diSAmPAP.

- PFAS compound associated to the paper industry
- Can break down to EtPFOSAA, PFOSAA, PFOSA and PFOS
- Direct link between PFAS found in house dust and the historic activities nearby

innovative



Benskin et al., 2013

# Future?



- ▶ studies including innovative methods of analysis
- ▶ Fingerprinting to better understand fate of PFAS and allow tracing back to the source
- ▶ Explore the possibility of integrating non-target methods (NTA, SS,...) in standard monitoring



**Thank you!!**

Contact: [laetitia.six@ovam.be](mailto:laetitia.six@ovam.be)