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EmConSoil
a Multi-stakeholder Network for Emerging Soil Contaminants

Antropogenic background levels of PFAS in soil and groundwater

Dorien Gorteman, Arcadis, Projectleader, Karen Van Geert, Arcadis, Project Manager and Sigrid Willems, Witteveen+Bos, team Manager

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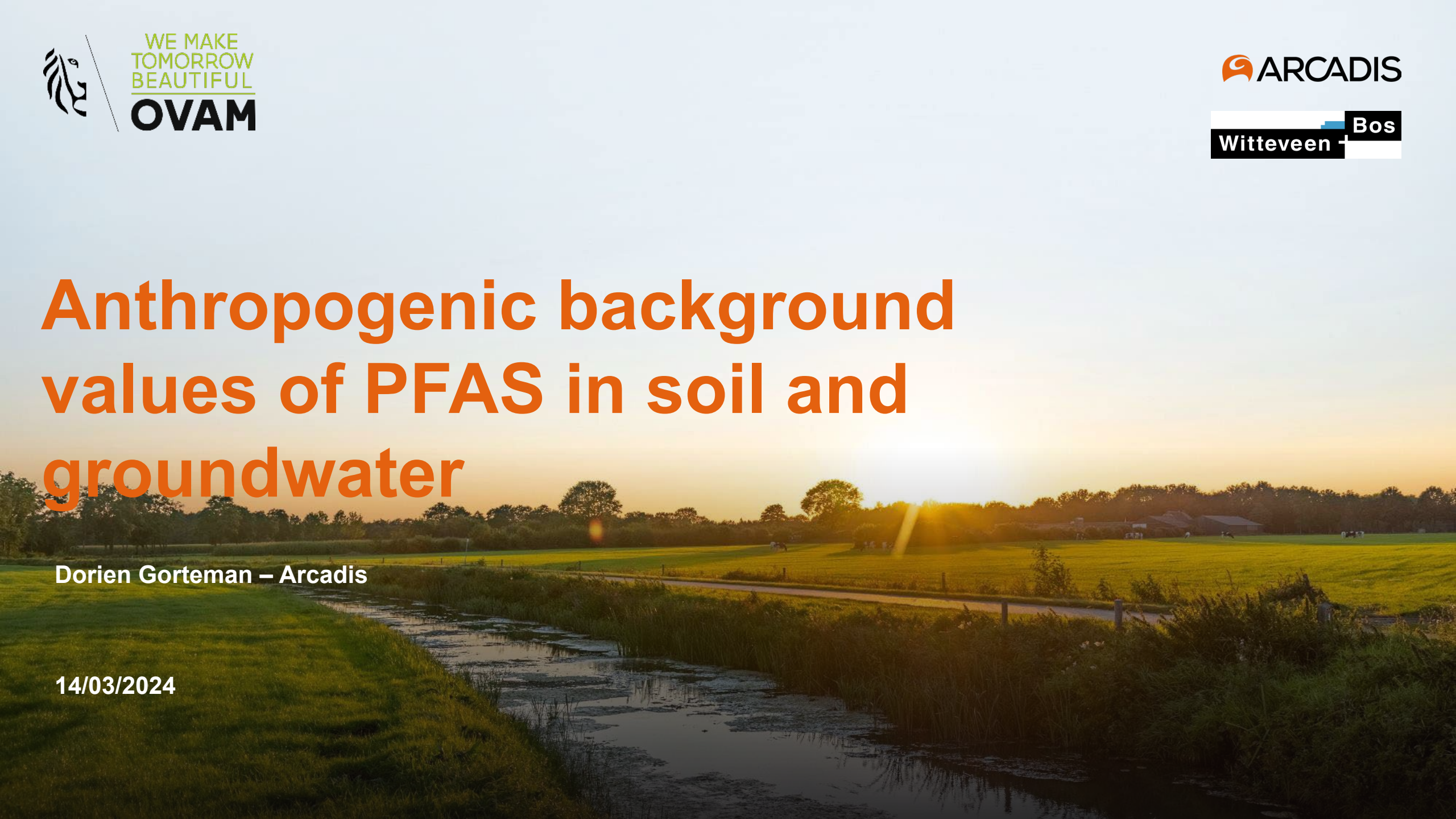
Witteveen+Bos

Anthropogenic background values of PFAS in soil and groundwater



Dorien Gorteman – Arcadis

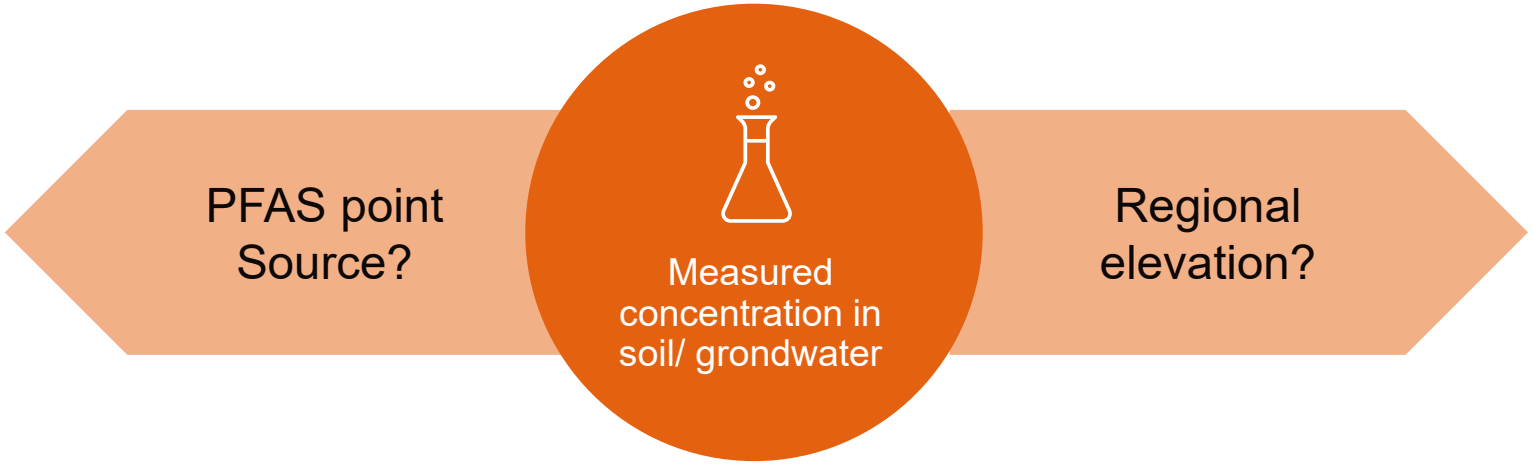
14/03/2024

Anthropogenic background values of PFAS in soil and groundwater

1. Introduction

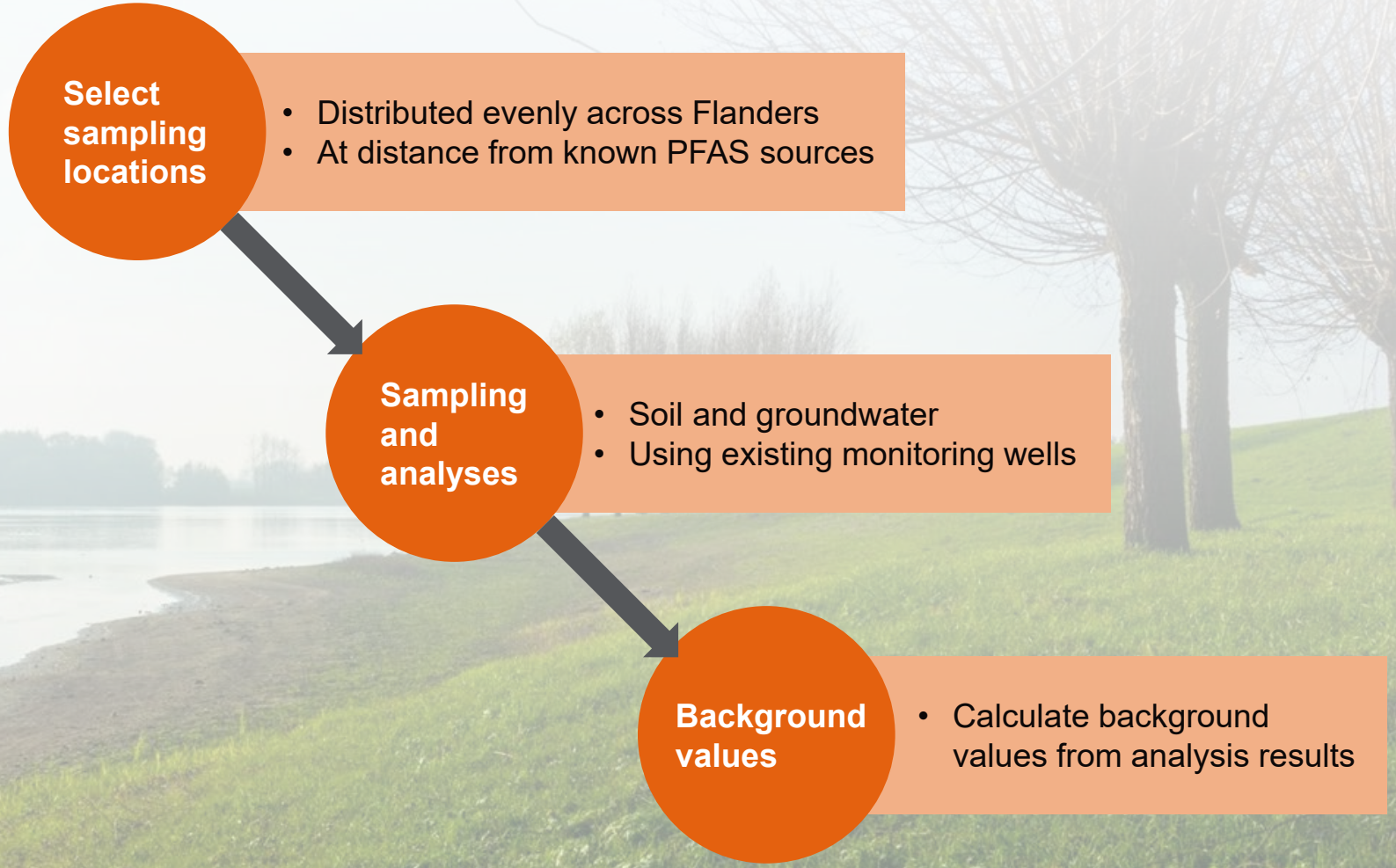
PFAS

- Extensive plumes
- Groundwater might be diffusely enriched
- Difficult to delineate a contamination



→ Need to determine background values in soil and groundwater in Flanders

2. Methodology



3. Sampling locations

Green zones

- Known PFAS contaminations
- Activities using PFAS (point sources)
- Inventory of fire fighting sites
- Inventory of known fires
- Sites discharging PFAS in waste water
- Known landfills
- Other sites with known soil contaminations
- Waste water treatment plants

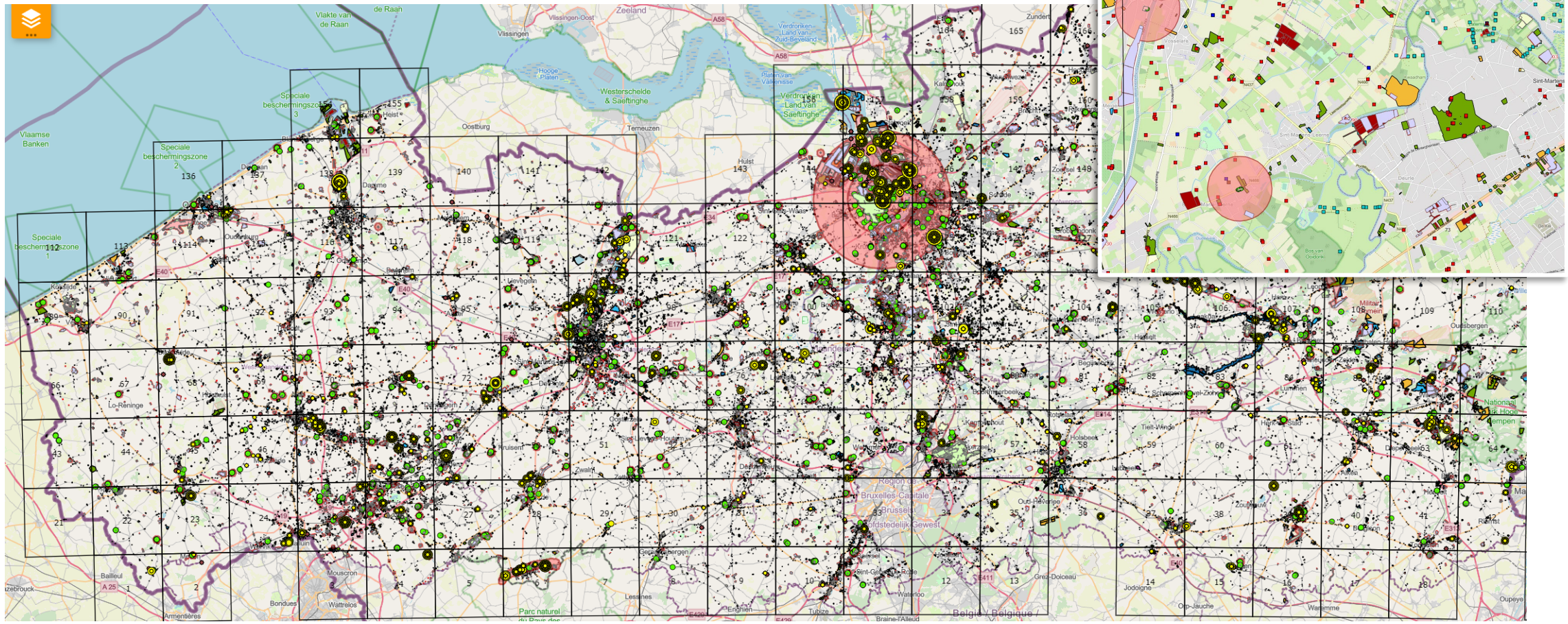
Evenly distributed

- Ca. 150 groundwater samples
- 75 soil samples
  - Complementary to existing DB of 50 samples
- Grid 10 x 10 km

Existing network of monitoring wells

- Network of wells in phreatic groundwater:
  - Ca. 3000 wells
  - Active wells
  - Recently used
  - Mostly in nature areas and agricultural areas

3. Sampling locations



4. Sampling and analyses

Groundwater

- Eurofins
- Sampling method
  - low flow, in accordance with procedure for soil investigation
  - high flow, diffuse dispersion commissioned by Flanders Environment Agency for their study

Soil

- Witteveen + Bos
- Sampling method
  - Complementary to existing study
    - top 20 cm-mv
    - for proper comparison
- Visual inspection of the area for signs of possible sources/contamination

Checklist prevention PFAS-contamination by field sampling

Quality control sampling

- By Witteveen + Bos
- By OVAM

In case the monitoring well was sampled for both groundwater and soil, the efforts were made to be present at the same time for monitoring.

4. Sampling and analyses

PFAS analyses were conducted by Eurofins Analytico

- Determined by LC-MS/MS analysis
  - Soil cf. CMA/3/D. (PFAS 40, 31 quantitively, 9 indicatively)
  - Groundwater cf. WAC/IV/A/025 (PFAS 43, 34 quantitively, 9 indicatively)
- Lab results were preliminarily checked
  - When values were above LOQ, samples were preserved for possible further analyses such as Total Oxidizable Precursors

5. Results - Groundwater

Groundwater

- 147 samples
- 4 compounds with 50 % detects > LOQ

Analytes	LOQ	NumObs	#> LOQ	#<LOQ	Minimum	Maximum	Median	90%ile	95%ile
					ng/l				
PFBA	1	147	92	55	1,07	201,0	2,3	23,5	42,6
PFBS	1	147	86	61	1,01	48,4	1,2	7,8	11,5
PFOAtot	1	147	82	65	1,02	112,9	1,2	6,5	9,6
PFOStot	1	147	77	70	1,03	18,4	1,0	4,7	7,1

- Combined with 240 samples Flanders environmental agency (VMM)
- 3 compounds with ca. 50 % detects > LOQ

Analytes	LOQ	NumObs	#> LOQ	#<LOQ	Minimum	Maximum	Median	90%ile	95%ile
							ng/l		
PFBA	1	370	220	150	1,0	201,0	3,0	21,1	34,5
PFBS	1	385	220	165	1,0	74,0	2,0	9,5	13,8
PFOAtot	1	387	191	196	1,0	112,9	< KL	8,1	13,2
PFOStot	1	387	132	255	1,0	26,0	< KL	5,0	8,0

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ng/l

0 - 1
2 - 5
6 - 10
11 - 20
21 - 50
101 - 500

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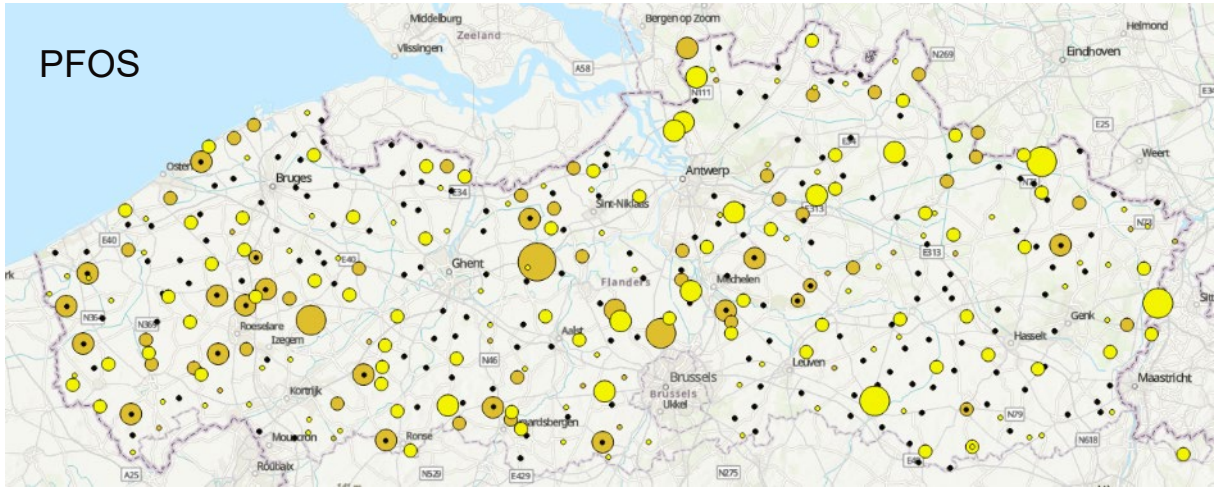
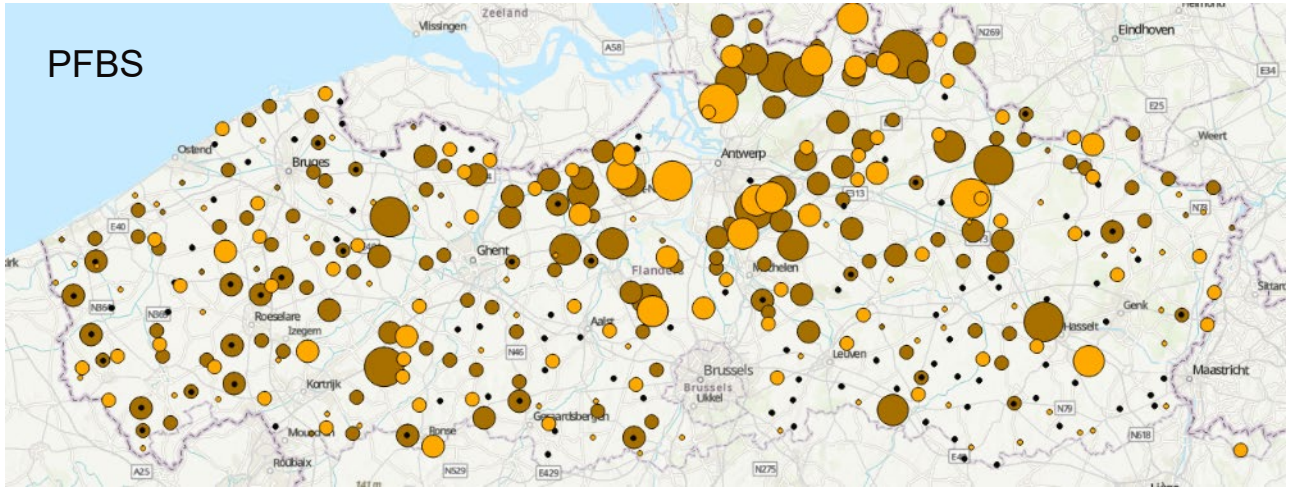
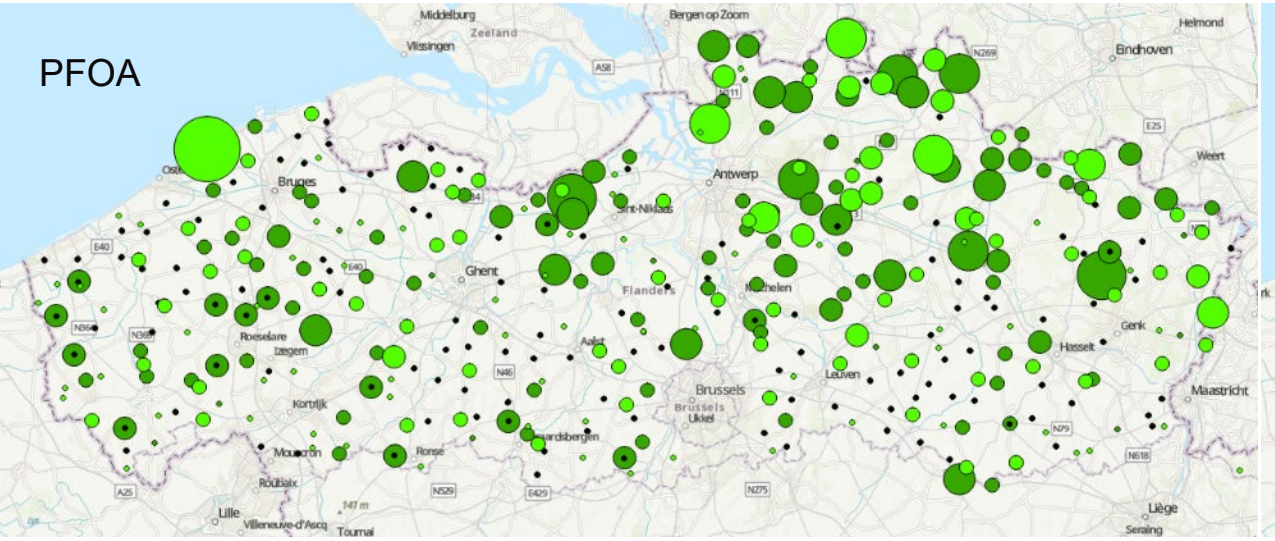
PFOS



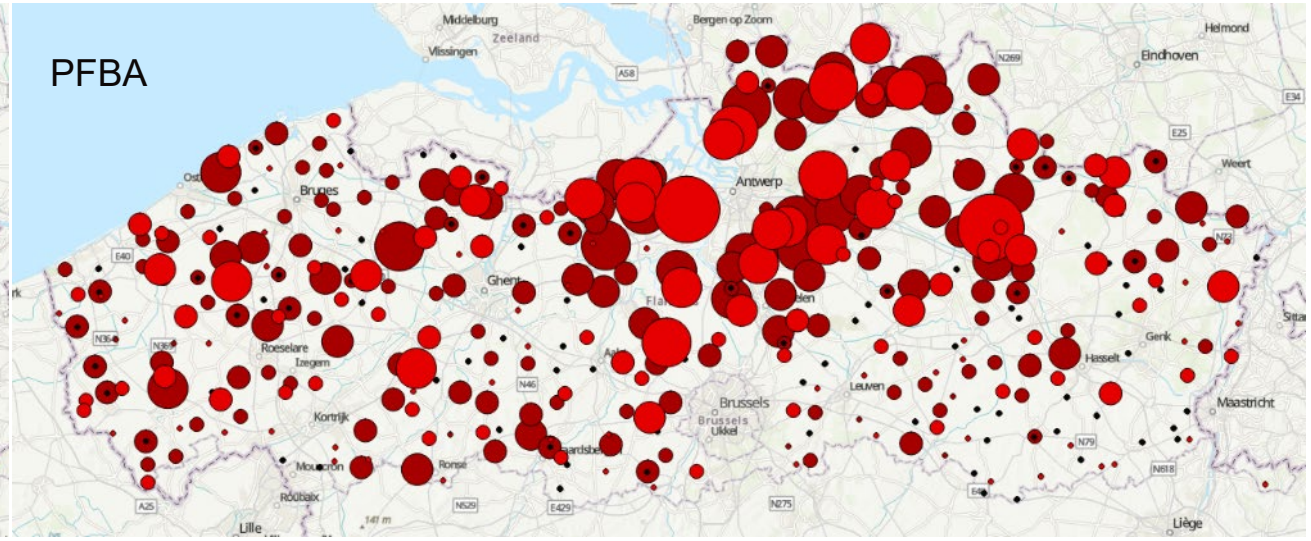
PFBS



PFOA



PFBA



5. Results

Soil

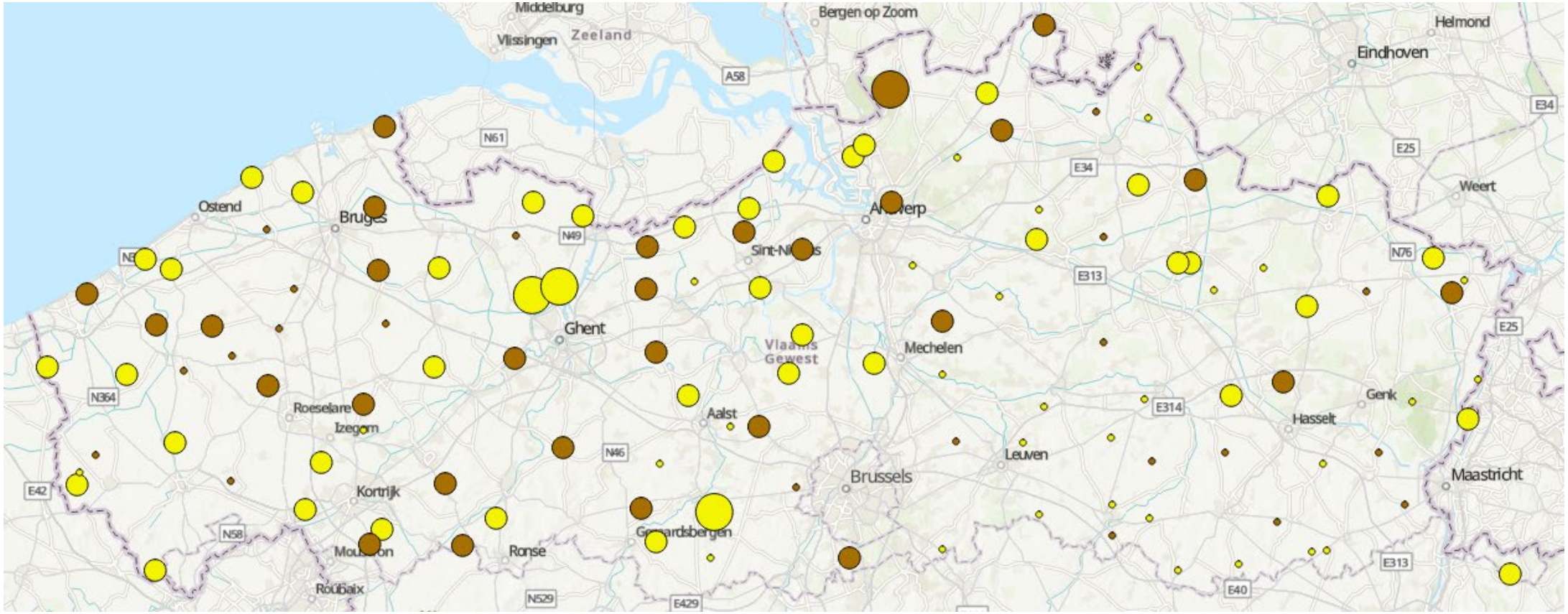
- 73 samples
- Only PFOS (total) > 50% detects:

Analytes	LOQ	NumObs	# > LOQ	# < LOQ	Minimum	Maximum	Median	90%ile	95%ile
				µg/kg ds					
PFOS total	0,5	73	42	31	0,5	2,6	0,6	**1,4**	1,8

- 90%ile in line with current background value of 1,5 µg/kg dm

- Combined with 50 existing samples
- Only PFOS (total) > 50% detects:

Analytes	LOQ	NumObs	# > LOQ	# < LOQ	Minimum	Maximum	Median	90%ile	95%ile
				µg/kg ds					
PFOS total	0,2/0,5	123	89	34	0,2	2,6	0,6	**1,5**	1,7



PFOS totaal - vaste deel van de aarde - dataset 2 (µg/kg ds)

- < 0,5
- 0,5 - 2
- 2 - 3

PFOS totaal - vaste deel van de aarde - dataset 1 (µg/kg ds)

- < 0,5
- 0,5 - 2,0
- 2,0 - 3,0

5. Results

- Outlier analysis
- Proposed antropogenic background value: P90 after removal of outliers

analyte	Proposed antropogenic background value	
	Groundwater (ng/l)	Soil (µg/kg dm)
PFBA	**21,0**	/
PFBS	**9,4**	/
PFOAtot	**8,0**	1,0
PFOStot	*(5,0)*	1,5

6. Conclusions (1/2)

- **Sampling campaign to calculate background values for PFAS in soil and groundwater:**
  - 147 groundwater samples OVAM+ 240 samples Flemisch Environmental Agency (VMM)
  - 73 new soil samples + 50 results from existing database
  - PFAS-unsuspected sampling locations

Groundwater

- In 341/387 locations at least 1 PFAS component was detected above LOQ (used in this study)
- Reported values are mostly below required LOQ for soil investigation (10 ng/l)
- PFBA, PFBS and PFOA were found in ca. 50% of sampling locations
- A significant part of the current standard from the EU - DWD (100 ng/l for the sum of 20 PFAS) has already been filled by the anthropogenic background value of PFBA (21%)
- The antropogenic background value for PFBA exceeds the discharge standard in Flanders of 20 ng/l

6. Conclusions (2/2)

- **Soil**
  - High percentage of non-detects
  - Results for PFOS in soil similar to previous studies
  - No new anthropogenic background values were proposed.

- **Additional recommendations**
  - Samples were taken from rural and nature areas, additional research is required to determine the anthropogenic background in urban and industrial areas
  - The background values can be used in soil investigation- to motivate wether or not a measured concentration can be assigned with high probability to the investigated source

Partners

Griet Van Gestel

Laetitia Six

Karen Van Geert

Dorien Gorteman

Sigrid Willems

Joachim Jacobs

Brent Gomand

Arjan Veldhuizen

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