aragorn

Achieving Remediation And GOverning
Restoration of contaminated soils Now

Prioritering af miljøfarlige stoffer til monitorering i EU

ATV møde, 27. november
Hvad gemmer der sig i vandet?
DGI byen, København

Xenia Trier, Lektor i analytisk miljøkemi
Sektion for miljøkemi og fysik
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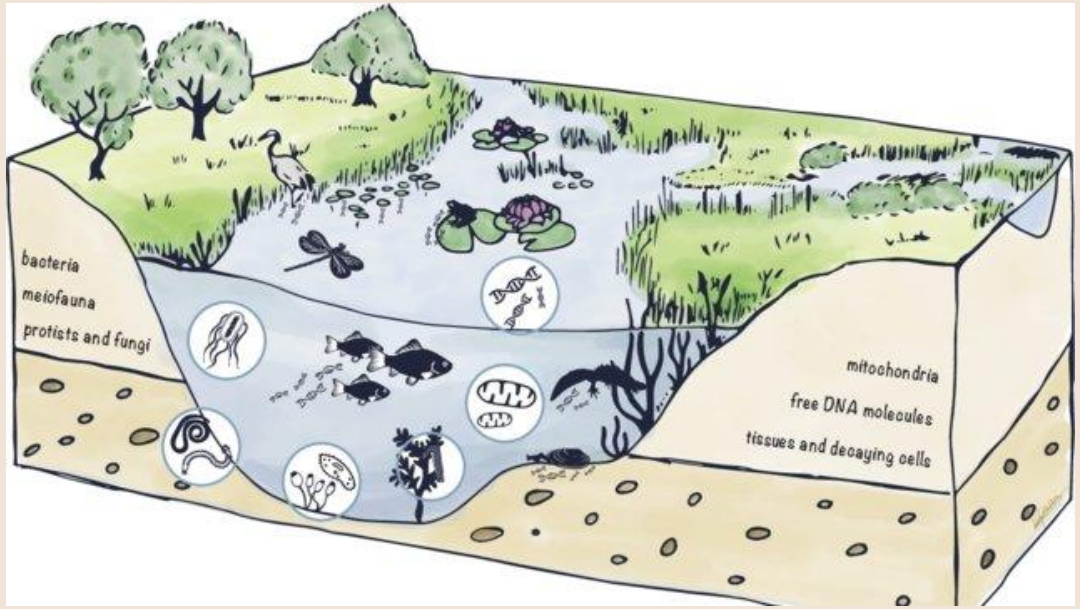
Det Danske PFAS Center – ARAGORN projekt koordinator

Funded by
The European Union

Overvejelser i prioritering af hvad vi måler

- Hvad vil vi beskytte?
  - Mennesker – denne eller næste generation, mod hvilke effekter?
  - Miljø –klima, ozonlag, biodiversitet – hvilke specier, mod hvilke effekter, hvilken beskyttelsesgrad?
  - Land-take
  - Ressourcer (vand, jord, genanvendelser),
  - Virksomheder
  - Omkostninger
  - Retfærdighed
  - Omdømme
- Sammenhæng i reguleringerne?
  - Vand, jord, luft, emissioner, fødevarer, produkter, kemikalie regulering ..



Overvejelser i prioritering af monitorering – hvordan kan man opnå beskyttelsesmålene?

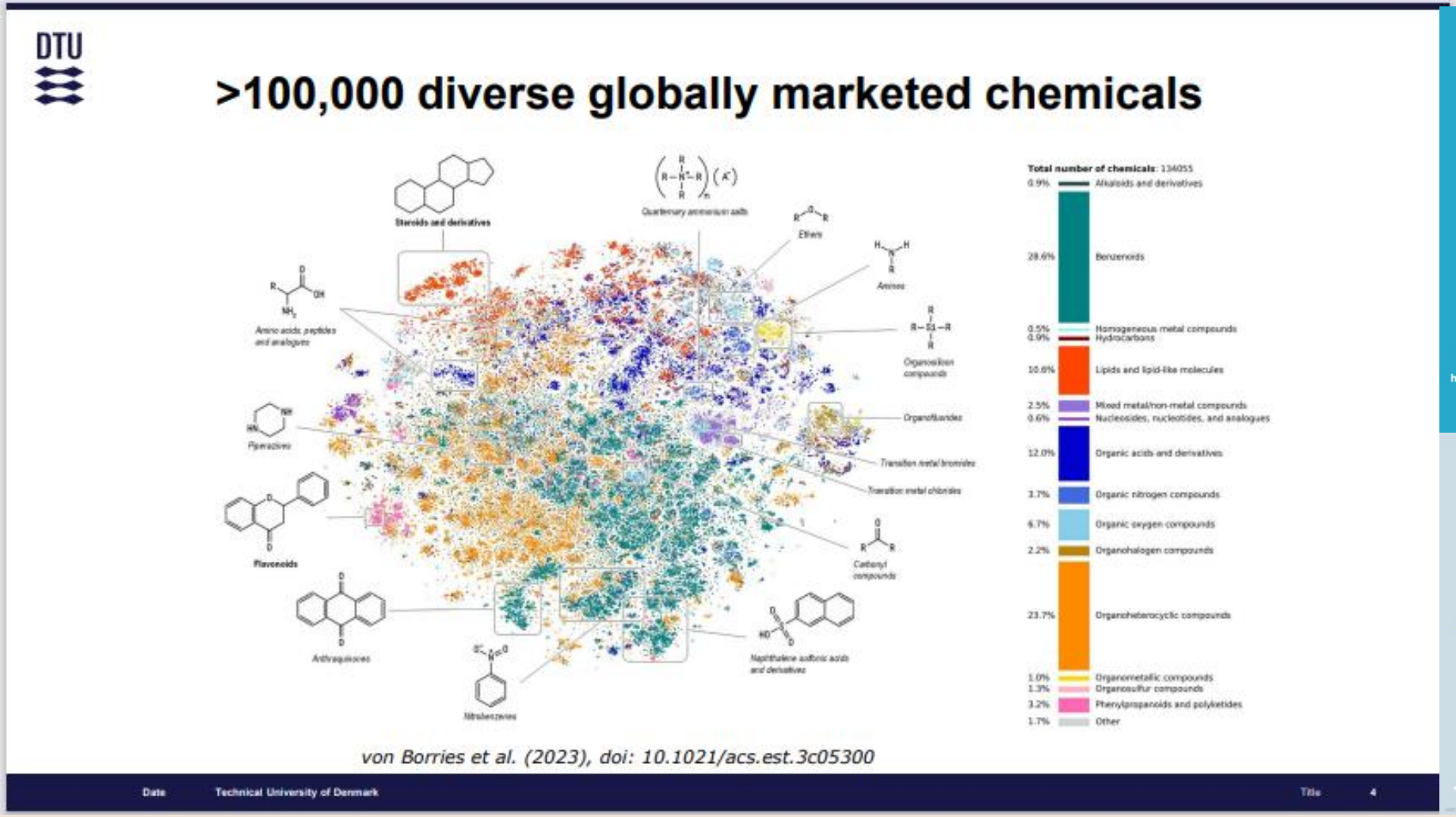
- Risiko = Eksponering x Hazard

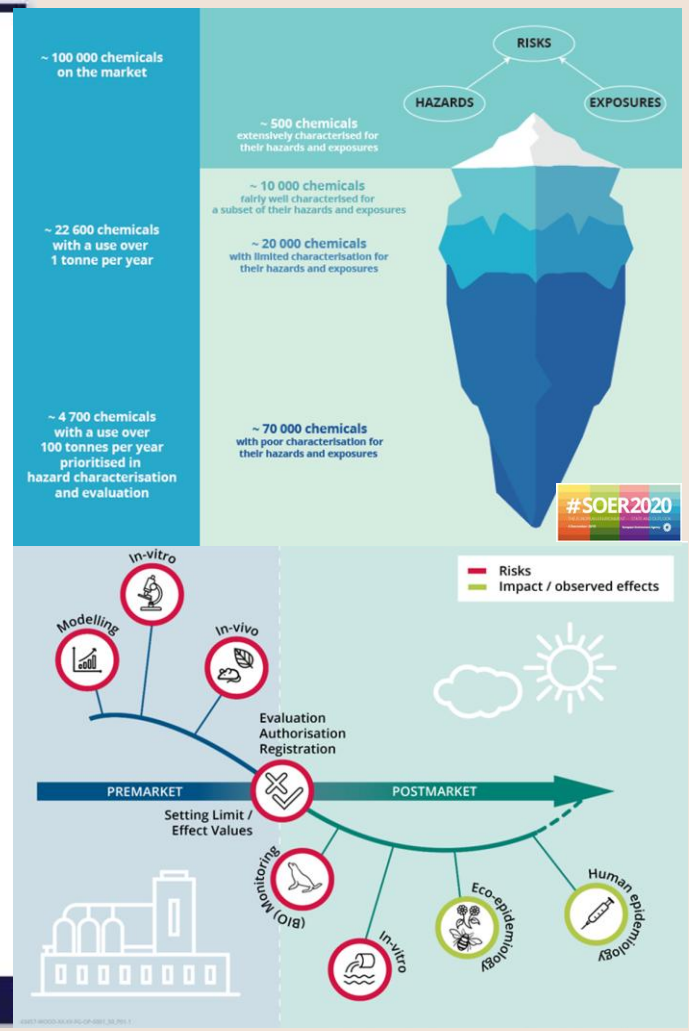
  persistens (fx. vPvB/vM) driver eksponeringen, og dermed risikoen op => **risikobaseret regulering**.

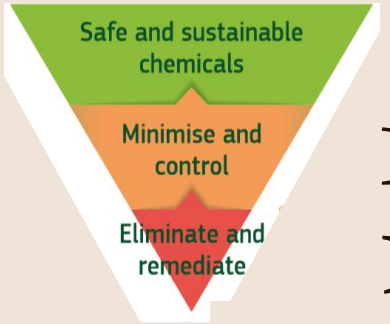
- Risikostyring sker via horizontale reguleringer, fx. REACH, CLP og vertikale reguleringer, fx vandrammedirektivet (WFD), Industriemissioner (IED, EPRTR), Jord (SML), Fødevarelovgivning

Antallet og diversiteten af kemikalier

- i praksis umuligt at risikovurdere og derefter regulere et stof af gangen
- Hvis vi først venter med at begrænse anvendelsen efter vi har malt det i miljøet, er focningen og skaden sket..







EUs Kemikalie strategi (2020)
Preventing harm from chemicals

- **EU Kemikalie Strategi:** En del af den Europæiske Green Deal og Zero Pollution Ambition
  Forebyggelse i stedet for remediering, fokus på **regulering af grupper af kemikalier**
- **Addresere meget persistente kemikalier,** med **særlig fokus på PFAS som en klasse**
- **Foreslå nye fareklasser** og kriterier i CLP reguleringen for at addressere miljømæssig ***toksicitet, persistens, mobilitet og bioakkumulering***
- **Udfase ikke-essentiel brug af mest skadelige kemikalier - industriel transition til *Safe-and-Sustainable-by-Design*.**
- **Opdatere lovgivningen i overensstemmelse med principper og på tværs af reguleringerne**
- **Forøg monitorering og rapportering af** 'chemicals of concern' - mest problematiske kemikalier

Eksempler på regulering af grupper af kemikalier

EU Drinking water directive (DWD)

- **Sum of 20 PFAS**
  C4-C13 PFCA, C4-C13 PFSA
- **Limit:** 100 ppt (0.1 ug/L) for the 'Sum of PFAS'
- **Method**: e.g. LC-MS
- **When**: October 2020***+***
- **Total PFAS (sum/class of PFAS)**
- **Limit**: 0.5 ug organic fluoride/L water
- **Protecion:** Early warning, precaution
- **Method**: e.g. Extractable organic fluorine (EOF-CIC)
- **When**: *After adoption (2020), '....once technical guidelines for monitoring this parameter are developed in accordance with Article 11(6). Member States may then decide to use either one or both of the parameters 'PFAS Total' or 'Sum of PFAS'*

'Commission Notice' adopted by the college,
Technical Guidelines translated in all official EU languages :
EUR-Lex - 52024XC04910 - EN - EUR-Lex (europa.eu)

https://data.consilium.europa.eu/doc/document/ST-5813-2020-INIT/en/pdf

Danish (DVFA): PFAS in food paper & board packaging

Winner of the 2023 Future Policy Award!

- **Total PFAS (class of PFAS)**
- **Where:** intentionally added PFAS in paper and board for food contact. PFAS in recycled products are exempted
- **Protection:** precaution, avoid PFAS in recycled paper (not health based value)
- **Indicator value**:
  20 ug organic fluoride/g paper
  Method: e.g. Total organic fluorine – Combustion ion chromatography (TOF-CIC) or Extractable organic fluorine (EOF-CIC)
- **When**: June 2020

https://www.foedevarestyrelsen.dk/SiteCollectionDocuments/Kemi%20og%20foedevarekvalitet/FKM/Fakta%20ark%20fluorerede%20stoffer.pdf

EFSA opinion: PFAS in food

- **Sum of 4 PFAS**
  PFOA, PFNA, PFHxS, PFOS
- **Tolerable weekly intake (TWI) =**
  4.4 ng PFAS/kg bw/week
- **Protecting**: Children year 0-1, breastfed. Levels set for PFAS levels in mothers
- **Method**: e.g. LC-MS
- **When:** September 2020

https://www.efsa.europa.eu/en/news/pfas-food-efsa-assesses-risks-and-sets-tolerable-intake

EU's vandrammedirektiv:
Risiko for Sum af PFAS og precursors reguleret ved eksponering x hazard

Sum af 24 PFAS
Relative potens faktorer – ganger en faktor på for at korrigere for forskellige toksicitet ifht PFOA og levertoksicitet

PFOA-equivalenter $= PFAS_{individual} * RPF_{individual\ PFAS}$
Sum of $PFAS_{24}$ i PFOA-eq. $= Sum\ (PFAS_{individual} * RPF_{individual\ PFAS})$

PFOS er defineret som → Perfluorooctane sulfonic acid and its derivatives (PFOS)
=> precursors er stadig medtaget

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
[Entry] N°	Name of substance	Category of substances	CAS number (1)	EU number (2)	AA-EQS (3) Inland surface waters (4) [µg/l]	AA-EQS (3) Other surface waters [µg/l]	MAC-EQS (5) Inland surface waters (4) [µg/l]	MAC-EQS (5) Other surface waters [µg/l]	EQS Biota (6) [µg/kg wet weight] or EQS Sediment [µg /kg dry weight] where so indicated	Identified as a priority hazardous substance	Identified as an Ubiquitous Persistent, Bioaccumulative and Toxic (uPBT) substance	Identified as a substance that tends to accumulate in sediment and/or biota
(65)	Per- and ***polyfluoro***alkyl substances (PFAS) – sum of ***25*** (27) (33)	Industrial substances	not applicable	not applicable	Sum of PFOA equivalents 0,0044 (28)	Sum of PFOA equivalents 0,0044 (28)	not applicable	not applicable	Sum of PFOA equivalents 0,077 (28)	X	X	X
(35)	Perfluorooctane sulfonic acid and its derivatives (PFOS)	Industrial substances	1763-23-1	217-179-8	Coverd by substance group 65 (Per- and ***polyfluoro***alkyl substances (PFAS) – sum of 24)							

Council of the European Union

Brussels, 8 October 2025
(OR. en)

13706/25

Interinstitutional File:
2022/0344 (COD)

ENV 980
CLIMA 422
AGRI 474
FORETS 82
ENER 509
TRANS 455
CODEC 1484

OUTCOME OF PROCEEDINGS

From:	General Secretariat of the Council
To:	Delegations
No. prev. doc.:	13321/25
Subject:	Proposal for a Directive of the European Parliament and of the Council amending Directive 2000/60/EC establishing a framework for Community action in the field of water policy, Directive 2006/118/EC on the protection of groundwater against pollution and deterioration and Directive 2008/105/EC on environmental quality standards in the field of water policy - Analysis of the final compromise text with a view to agreement

Delegations will find in the Annex, for information, the text of the final compromise text with a view to an agreement of the abovementioned proposal, approved by COREPER on 8 October 2025.

$RPF_i = BMD_{PFOA} / BMD_i$ (hvor i angiver det enkelte stof)

Det fremgår af ovenstående ligning, at PFOA anvendes som indeksstof, da $RPF_{PFOA} = 1$. Udgangspunktet for beregninger af kvalitetskriterier for biota, sekundær forgiftning og humant indtag, baseret på effekter af PFOA, kan derved udledes som PFOA-ækvivalenter, idet forskelle imellem stofferne inddrages i vurderingerne. Metoden er vist skematisk i figuren herunder (figur 7.3 i JRC-dokumentet).

Figur fra Niegowska et al., 2021

Metoden er beskrevet af Bil et al. [10] (Bil et al., 2021), som har udledt RPF-værdier for 14 per- og polyfluoralkylsyrer (PFAA) og to PFAA-precursor stoffer. Dertil er der for yderligere syv (otte når C6O4 inkluderes) PFAS-stoffer estimeret RPF-værdier ved read-across. Seks af disse er givet ved intervaller for RPF, idet der er antaget sammenlignelighed med henholdsvis PFAS-carboxylsyrer og -sulfonsyrer med kortere eller længere alkylkædelængder.

Ved anvendelse af denne metode, og ved vurdering af de udførte hepatotoksiske studier suppleret med read-across, er der for de 24 PFAS udarbejdet RPF-værdier som vist i nedenstående tabel (tabel 7.12 i JRC-dokumentet).

[10] Bil W, Zeilmaker M, Fragki S, Lijzen J, Verbruggen E, Bokkers B. 2021. Risk Assessment of Per- and Polyfluoroalkyl Substance Mixtures: A Relative Potency Factor Approach. Environmental Toxicology and Chemistry—Volume 40, Number 3, pp. 859–870, 2021.

Relative potens faktorer (RPF)

- Indført i dansk lov: 23. November 2023
- Opdateret August 2025
- Hvad med stoffer der ikke er på listen, fx. PFNS?

- RPF kan ændre sig hvis andre tox-endpoints

Bilag 1 – Relativ potens faktorer for PFOA-ækvivalenter (24 PFAS)

Værdierne af 24 PFAS i overfladevand udregnes som PFOA-ækvivalenter, dvs. at man omregner mængden af den specifikke PFAS, til den tilsvarende mængde af PFOA ved hjælp af "Relative Potency Factor" (Tabel 4). Som det fremgår af tabel 4, er der for nogle PFAS angivet et interval for RPF, for disse anvendes middelværdien angivet i parentes. Et opsat eksempel af omregning ved hjælp af RPF fremgår af Tabel 5.

Tabel 4: 24 PFAS, deres kemikalie identifikationsnummer (Cas nr.), og Relativ Potens faktor (RPF) er angivet.

Akronym	Cas nr.	Relativ Potens Faktor (RPF)
PFBA	375-22-4	0,05
PFPeA	2706-90-3	0,01 ≤ RPF ≤ 0,05* (0,03)
PFHxA	307-24-4	0,01
PFHpA	375-85-9	0,01 ≤ RPF ≤ 1* (0,505)
PFOA	335-67-1	1

Senest opdateret: 05. november 2024

PFNA	375-95-1	10
PFDA	335-76-2	4 ≤ RPF ≤ 10* (7)
PFUnA or PFUnDA	2058-94-8	4
PFDoDA or PFDoA	307-55-1	3
PFTrDA	72629-94-8	0,3 ≤ RPF ≤ 3* (1,65)
PFTeDA	376-06-7	0,3
PFHxDA	67905-19-5	0,02
PFODA	16517-11-6	0,02
PFBS	375-73-5	0,001
PFPeS	2706-91-4	0,001 ≤ RPF ≤ 0,6* (0,3005)
PFHxS	355-46-4	0,6
PFHpS	375-92-8	0,6 ≤ RPF ≤ 2* (1,3)
PFOS	1763-23-1	2
PFDS	335-77-3	2*
6:2 FTOH	647-42-7	0,02
8:2 FTOH	678-39-7	0,04
HFPO-DA (Gen X)	62037-80-3 / 13252-13-6	0,06
ADONA	958445-44-8	0,03
C6O4	1190931-27-1	0,06*

* faktor etableret ved read-across

Udregningseksempel for PFOA-ækvivalenter

Beregning af summen af PFOA-ækvivalenter beregnes ved formlen:

Sum af PFOA-ækvivalenter = $\Sigma (C_i \times RPF_i)$

Miljøministeriet
Miljøstyrelsen

Fastsættelse af kvalitetskriterier for vandmiljøet

- og Polyfluoralkylstoffer (PFAS)

riterier er sat for summen af PFOA-ækvivalenter* med undtagelse af
n kun er bestemt for PFOS. Værdierne er baseret på beregningerne
af PFOA-ækvivalenter (indsat sidst i nærværende datablad).

	$VKK_{ferskvand}$	0,0044 µg/l**
	$VKK_{saltvand}$	0,0044 µg/l**
	$KVKK_{ferskvand}$	Ikke bestemt
	$KVKK_{saltvand}$	Ikke bestemt
	$SKK_{ferskvand}$	13,5 µg/kg tørvægt (5% OC) (PFOS)
		270 µg/kg tørvægt x f_{OC} (PFOS)
	$SKK_{saltvand}$	Ikke bestemt
ır forgiftning,	$BKK_{sek.forgiftn.,ferskvand}$	22,3 µg/kg vådvægt (fisk)
		6,2 µg/kg vådvægt (musling)
ır forgiftning,	$BKK_{sek.forgiftn.,saltvand}$	6,99 µg/kg vådvægt (fisk)
		2 µg/kg vådvægt (musling)
onsum	HKK	0,077 µg/kg vådvægt

orstås at RPF (Relative Potency Factors) er anvendt til at beregne et
et i tabel 1 i JRC (2022).
nd af human konsum af drikkevand (JRC, 2022).

23. november 2023

pfas_miljoekvalitetskriterier.pdf (mim.dk)

https://mst.dk/media/x14n2bsd/graensevaerdier-ved-miljoestyrelsen_18-08-2025.pdf

EUs Jordlov – netop offentliggjort!

Council of the European Union

Brussels, 29 September 2025
(OR. en)

9474/1/25
REV 1

Interinstitutional File:
2023/0232(COD)

ENV 414
CLIMA 174
AGRI 228
FORETS 29
RECH 248
TRANS 210
CODEC 696
PARLNAT

LEGISLATIVE ACTS AND OTHER INSTRUMENTS

Subject: Position of the Council at first reading with a view to the adoption of a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on Soil Monitoring and Resilience (Soil Monitoring Law)
– Adopted by the Council on 29 September 2025

Jordloven: Monitorering + Resiliens

- Beskyttelse af *mennesker* og *miljø*, fremme genanvendelse af jord=> reducere land-take
- Vurderinger baseret på *risici*
- Forventes alignet med andre lovgivninger, fx vandrammedirektivet

- Forureningstyper:
  - Hot-spot : Landene laver selv jordkvalitetskriterier, kontrollerer og risikohåndterer
  - Diffus : EU watchlister til overvågning; *ikke* kontrol værdier i starten
- Harmoniserede europæiske guidelines til prøvetagning, analyser, vurderinger, ..
  - tage højde for naturlige/anthropogene baggrundsniveauer, forskellige beskyttelsesniveauer
- Målinger af enkeltstoffer + total-analyser; varierer for Tier 1/2/3

- Fysisk-kemiske parametre, erosion, kemisk forurening (fx metaller, organiske forureninger; total vs. biotilgængelig mængde), mikrobiel status (fx eDNA)

Jordforurening: PFAS, pesticider og andre kontaminanter

- Hvordan kan/er disse stoffer blevet prioriteret?
- Hvad gør man når der mangler data?

Soil contamination[8]	Concentrations of PFAS-21[9] or concentrations of PFAS-43[10] or selected PFAS set by Member States in accordance with Article 7(4) Concentrations of selected active substances in pesticides and their metabolites set by Member States in accordance with Article 7(4) Optional: – concentrations or presence of a selection of other emerging soil contaminants set by Member States in accordance with Article 7(4)

[8] May be measured on a limited number of sampling points.

[9] 6:2 FTS, PFBA, PFBS, PFDA, PFDoDA, PFDoDS, PFDS, PFHpA, PFHpS, PFHxA, PFHxS, PFNA, PFNS, PFOA, PFOS, PFPeA, PFPeS, PFTrDA, PFTrDS, PFUnDA, PFUnDS or other 21 PFAS, as available in the laboratories.

[10] PFOS, PFOA, PFHxS, PFNA, PFBS, PFPeS, PFHpS, PFNS, PFDS, PFUnDS, PFDoDS, PFTrDS, PFBA, PFPeA, PFHxA, PFHpA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFOSA, N-EtFOSA, N-MeFOSA, FOSAA, N-EtFOSAA, N-MeFOSAA, FHxSA, N-EtFHxSA, N-MeFHxSA, FHxSAA, N-EtFHxSAA, N-MeFHxSAA, FBSA, N-EtFBSA, N-MeFBSA, FBSAA, N-EtFBSAA, N-MeFBSAA, 6:2 FTS, 8:2 FTS, 5:3 FTCA, 7:3 FTCA or other 43 PFAS, as available in the laboratories.

	Basic information					Properties						Scores							
			Price per sample (approximate)	140 €	550 €	Human hazard criteria	Regulatory acceptable concentration [mg/kg]	Halflife in lab [d]	Adsorption Affinity/ leaching	Lipophilicity log Pow	Occurance /monitoring	Human hazard criteria	Regulatory acceptable concentraion [mg/kg]	Halflife in lab [d]	Adsorption Affinity/ leaching	Lipophilicity log Pow	Occurance monitoring	FINAL SCORE
			Required sample amount (g)	100	100														
			Analysis principle	GC-MS/MS	LC -MS/MS														
	Pesticides to monitor			LOQ	LOQ														
No	Active ingredients (AI)	Metabolites	CAS-No..	(ug/kg soil)	(ug/kg soil)	HH	RAC [mg/kg]	DT50	KOC	LOG POW	O	HH	RAC	DT50	KOC	LOG POW	O	-	
1	Cyproconazol		94361-06-5	-	1.0	1	0,3	191	711	3,09	1	1	1	1	1	1	1	1,00	
2	DDT. p.p'-		50-29-3	0.025	0.1	1	0,084	3800	2.00E+05	6	1	1	1	1	1	1	1	1,00	
3	Difenoconazol		119446-68-3	-	1.0	1	0,04	456	3820	4,36	1	1	1	1	1	1	1	1,00	
4	Epoxiconazol		133855-98-8	-	1.0	1	0,51	649	2647	3,3	1	1	1	1	1	1	1	1,00	
5	Propiconazol		60207-90-1	-	1.0	1	0,3	398	612	3,72	1	1	1	1	1	1	1	1,00	
6	Carbendazim and benomyl		10605-21-	-	1.0	1	0,2	180	2805	1,48	1	1	1	1	1	0	1	0,83	
7	Dimethomorph (sum os isomers)		110488-70-5	-	1.0	1	0,2394	599	515	2,68	1	1	1	1	1	0	1	0,83	
8	Dimoxystrobin		149961-52-4	-	1.0	1	0,0096	326	351	3,59	1	1	1	1	0	1	1	0,83	
9	Fluquinconazol		136426-54-5	-	1.0	1		441	1153	3,24	1	1	0	1	1	1	1	0,83	
10	Fluxapyroxad		907204-31-3	-	1.0		0,598	424	1101	3,13	1	0	1	1	1	1	1	0,83	
11	Napropamid (sum of isomers)		15299-99-7	-	1.0	1	3,5	400	1285	3,27	1	1	0	1	1	1	1	0,83	
12	Pendimethalin		40487-42-1	-	1.0	1	6,69	270	20124	5,4	1	1	0	1	1	1	1	0,83	
13	Pirimicarb		23103-98-2	-	1.0	1	0,788	160	3294	1,7	1	1	1	1	1	0	1	0,83	
14	Prochloraz		67747-09-5	-	1.0		0,84	936	16250	3,5	1	0	1	1	1	1	1	0,83	
15		DDE, o,p-	3424-82-6	1.0	-	1		1460	2.00E+05	6	1	1	0	1	1	1	1	0,83	
16		DDE, p,p'-	72-55-9	1.0	-	1		1460	2.00E+05	6,5	1	1	0	1	1	1	1	0,83	
			330-55-2	-	5.0	1					1	1	0	1	1	1	1	0,83	
														0	1	1	1	0,83	

ARAGORN – UBA fast policy response

Case: Prioritering af pesticider / Data 'rich'

- målte værdier, persistens,
- Kow/bioakkumulerbarhed, human toks, økotoks
- mobilitet
- pris af analyser

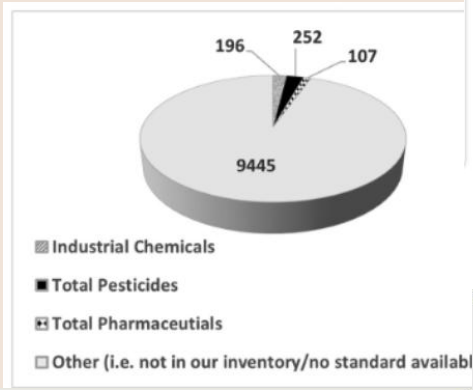
Men hvad hvis der mangler data?

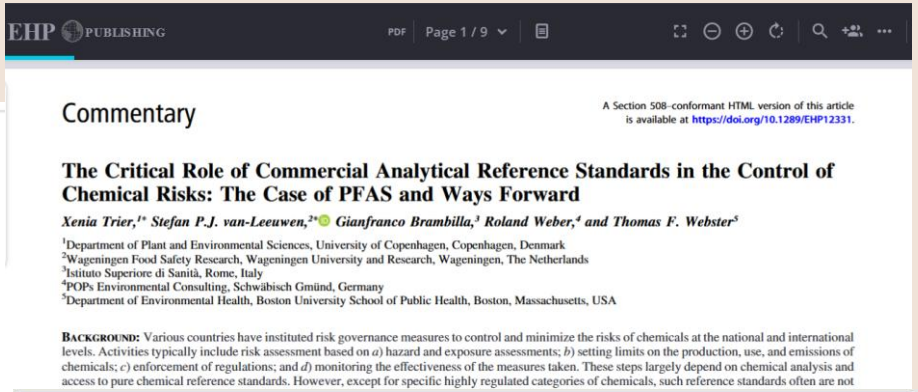
Stor mangel på kemiske rene standarder – fx. kan kun ca. 2% af de industrielle PFAS købes kommercielt

=> Experimentelle data gap, både ifht hazard og kvantitative data

=> behov for prioriteringsmetoder der kan fungere uden sådanne data

=> Test case: ARAGORN PFAS
=> Test case: Norman Network




EHP PUBLISHING PDF Page 1 / 9

Commentary

A Section 508-conformant HTML version of this article is available at https://doi.org/10.1289/EHP12331.

The Critical Role of Commercial Analytical Reference Standards in the Control of Chemical Risks: The Case of PFAS and Ways Forward

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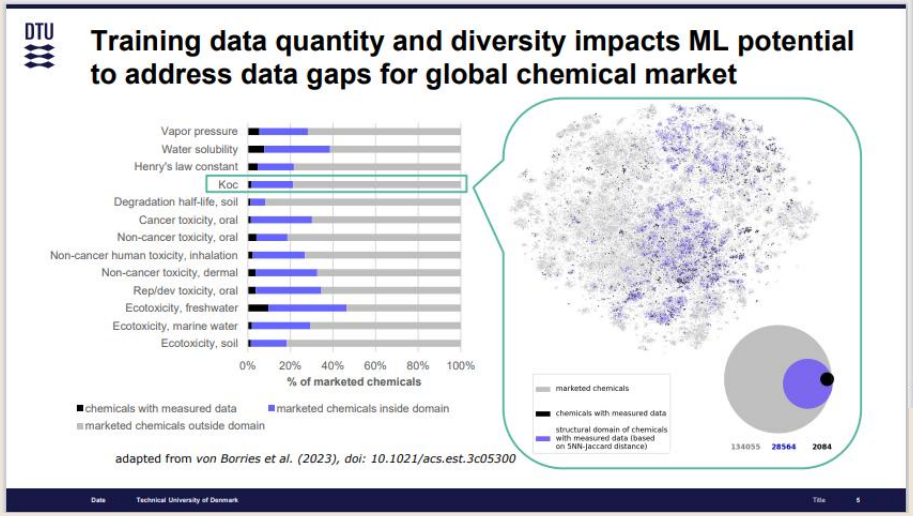
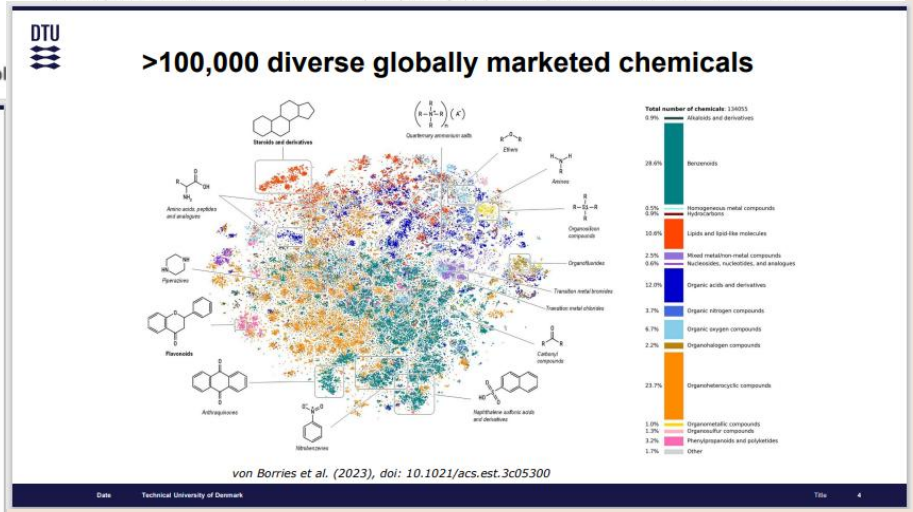
[5]Department of Environmental Health, Boston University School of Public Health, Boston, Massachusetts, USA

BACKGROUND: Various countries have instituted risk governance measures to control and minimize the risks of chemicals at the national and international levels. Activities typically include risk assessment based on *a*) hazard and exposure assessments; *b*) setting limits on the production, use, and emissions of chemicals; *c*) enforcement of regulations; and *d*) monitoring the effectiveness of the measures taken. These steps largely depend on chemical analysis and access to pure chemical reference standards. However, except for specific highly regulated categories of chemicals, such reference standards often are not





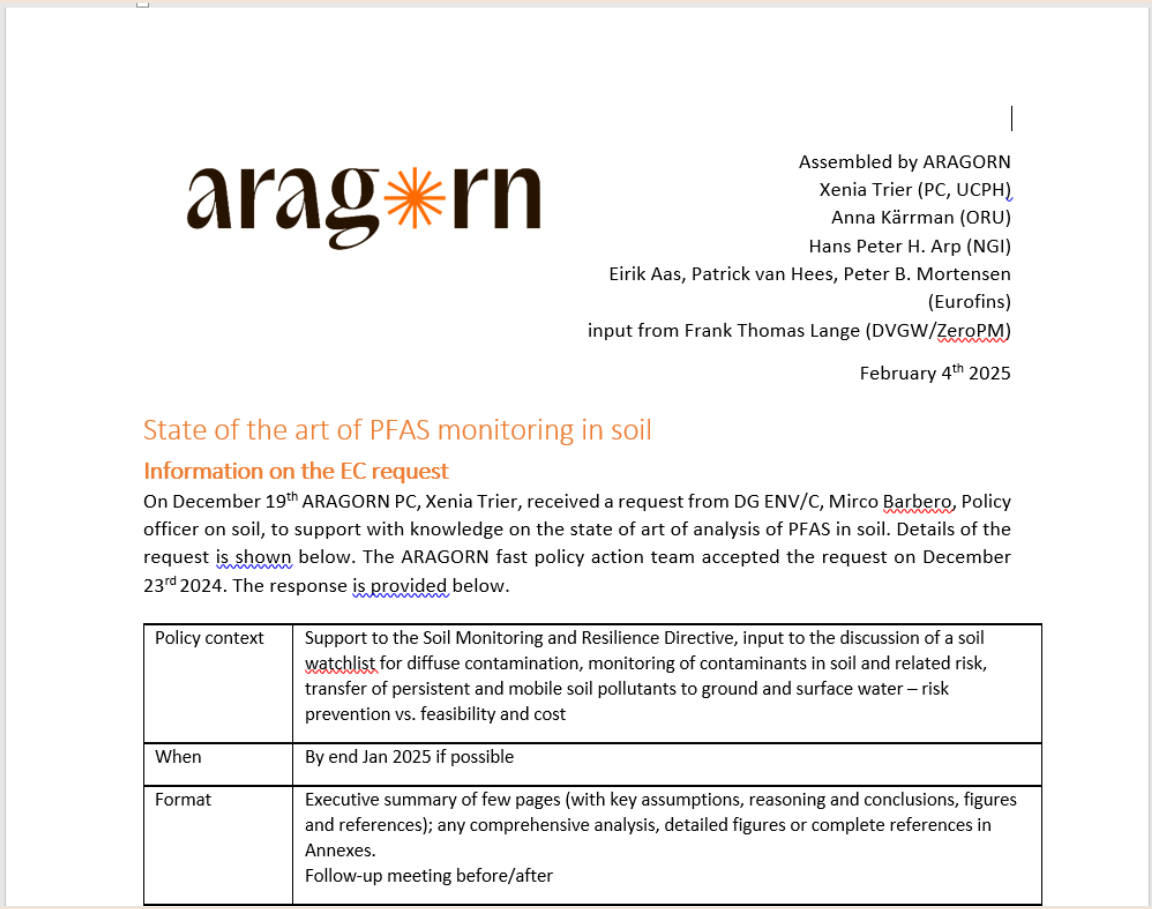
Hvilken type forureningsmålinger?

Rettet mod dels *overvågning*, samt undersøgelse af mistænkt forurenede grunde Tier 1/2/3

ARAGORN fast policy response med vægt på:

- robuste metoder
- kost-effektive metoder: Flest mulige PFAS i én metode
- PFAS udbredt i Europa – ikke kun omkring én fabrik
- forskellige watch lister (og aktioner) rettet mod Tier 1/2/3, evt. baseret på land-uses
- 'typiske' PFAS som repræsentanter for en sub-gruppe; hvis fundet kan man undersøge nærmere
- Binder til jord
- alignment med andre reguleringer - fx WFD

- PFAS målinger:
  - Organic Fluorine (OF) ved EOF-CIC (fleste PFAS)
  - $PFAS_{43}$ ved target analyser
  - En længere PFAS liste typisk for forureningstyper
  - Ikke TFA: mere robust at måle i vand => WFD
  - PFAS pesticider => under pesticider..



aragorn

Assembled by ARAGORN
Xenia Trier (PC, UCPH)
Anna Kärrman (ORU)
Hans Peter H. Arp (NGI)
Eirik Aas, Patrick van Hees, Peter B. Mortensen (Eurofins)
input from Frank Thomas Lange (DVGW/ZeroPM)

February 4th 2025

State of the art of PFAS monitoring in soil

Information on the EC request

On December 19th ARAGORN PC, Xenia Trier, received a request from DG ENV/C, Mirco Barbero, Policy officer on soil, to support with knowledge on the state of art of analysis of PFAS in soil. Details of the request is shown below. The ARAGORN fast policy action team accepted the request on December 23rd 2024. The response is provided below.

Policy context	Support to the Soil Monitoring and Resilience Directive, input to the discussion of a soil watchlist for diffuse contamination, monitoring of contaminants in soil and related risk, transfer of persistent and mobile soil pollutants to ground and surface water – risk prevention vs. feasibility and cost
When	By end Jan 2025 if possible
Format	Executive summary of few pages (with key assumptions, reasoning and conclusions, figures and references); any comprehensive analysis, detailed figures or complete references in Annexes. Follow-up meeting before/after

Jordforurening i jordloven:
PFAS, pesticider, metaller og andre kontaminanter

Soil contamination[8]	Concentrations of PFAS-21[9] or concentrations of PFAS-43[10] or selected PFAS set by Member States in accordance with Article 7(4) Concentrations of selected active substances in pesticides and their metabolites set by Member States in accordance with Article 7(4) Optional: – concentrations or presence of a selection of other emerging soil contaminants set by Member States in accordance with Article 7(4)

[8] May be measured on a limited number of sampling points.

[9] 6:2 FTS, PFBA, PFBS, PFDA, PFDoDA, PFDoDS, PFDS, PFHpA, PFHpS, PFHxA, PFHxS, PFNA, PFNS, PFOA, PFOS, PFPeA, PFPeS, PFTrDA, PFTrDS, PFUnDA, PFUnDS or other 21 PFAS, as available in the laboratories.

[10] PFOS, PFOA, PFHxS, PFNA, PFBS, PFPeS, PFHpS, PFNS, PFDS, PFUnDS, PFDoDS, PFTrDS, PFBA, PFPeA, PFHxA, PFHpA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFOSA, N-EtFOSA, N-MeFOSA, FOSAA, N-EtFOSAA, N-MeFOSAA, FHxSA, N-EtFHxSA, N-MeFHxSA, FHxSAA, N-EtFHxSAA, N-MeFHxSAA, FBSA, N-EtFBSA, N-MeFBSA, FBSAA, N-EtFBSAA, N-MeFBSAA, 6:2 FTS, 8:2 FTS, 5:3 FTCA, 7:3 FTCA or other 43 PFAS, as available in the laboratories.

Nedbrydningsprodukter af flourerede C4 (PFBS), C6 (PFHxS), C8 (PFOS) sulfonamid derivater, anvendt i tekstil, papir, træ og metal coatninger, samt forkromning. Fundet i fisk, sediment, slam, mennesker; stor anvendelse, bioakkumulerbare, toksiske (PFSA derivater / precursors)

Jordforurening: PFAS, pesticider og andre kontaminanter

Soil contamination[8]	Concentrations of PFAS-21[9] or concentrations of PFAS-43[10] or selected PFAS set by Member States in accordance with Article 7(4) Concentrations of selected active substances in pesticides and their metabolites set by Member States in accordance with Article 7(4) Optional: – concentrations or presence of a selection of other emerging soil contaminants set by Member States in accordance with Article 7(4)

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[10] PFOS, PFOA, PFHxS, PFNA, PFBS, PFPeS, PFHpS, PFNS, PFDS, PFUnDS, PFDoDS, PFTrDS, PFBA, PFPeA, PFHxA, PFHpA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFOSA, N-EtFOSA, N-MeFOSA, FOSAA, N-EtFOSAA, N-MeFOSAA, FHxSA, N-EtFHxSA, N-MeFHxSA, FHxSAA, N-EtFHxSAA, N-MeFHxSAA, FBSA, N-EtFBSA, N-MeFBSA, FBSAA, N-EtFBSAA, N-MeFBSAA, 6:2 FTS, 8:2 FTS, 5:3 FTCA, 7:3 FTCA or other 43 PFAS, as available in the laboratories.

Substitutionsstoffer (C6, C8) for PFOS og PFHxS, anvendt især i AFFF brandslukningsskum og forkromning, men også derivater anvendt i papir (og tekstil?) coatninger. Persistente, mobile, stor anvendelse, fundet i vand mm – ECHA: SVHC?

Jordforurening: PFAS, pesticider og andre kontaminanter

Soil contamination[8]	Concentrations of PFAS-21[9] or concentrations of PFAS-43[10] or selected PFAS set by Member States in accordance with Article 7(4) Concentrations of selected active substances in pesticides and their metabolites set by Member States in accordance with Article 7(4) Optional: – concentrations or presence of a selection of other emerging soil contaminants set by Member States in accordance with Article 7(4)

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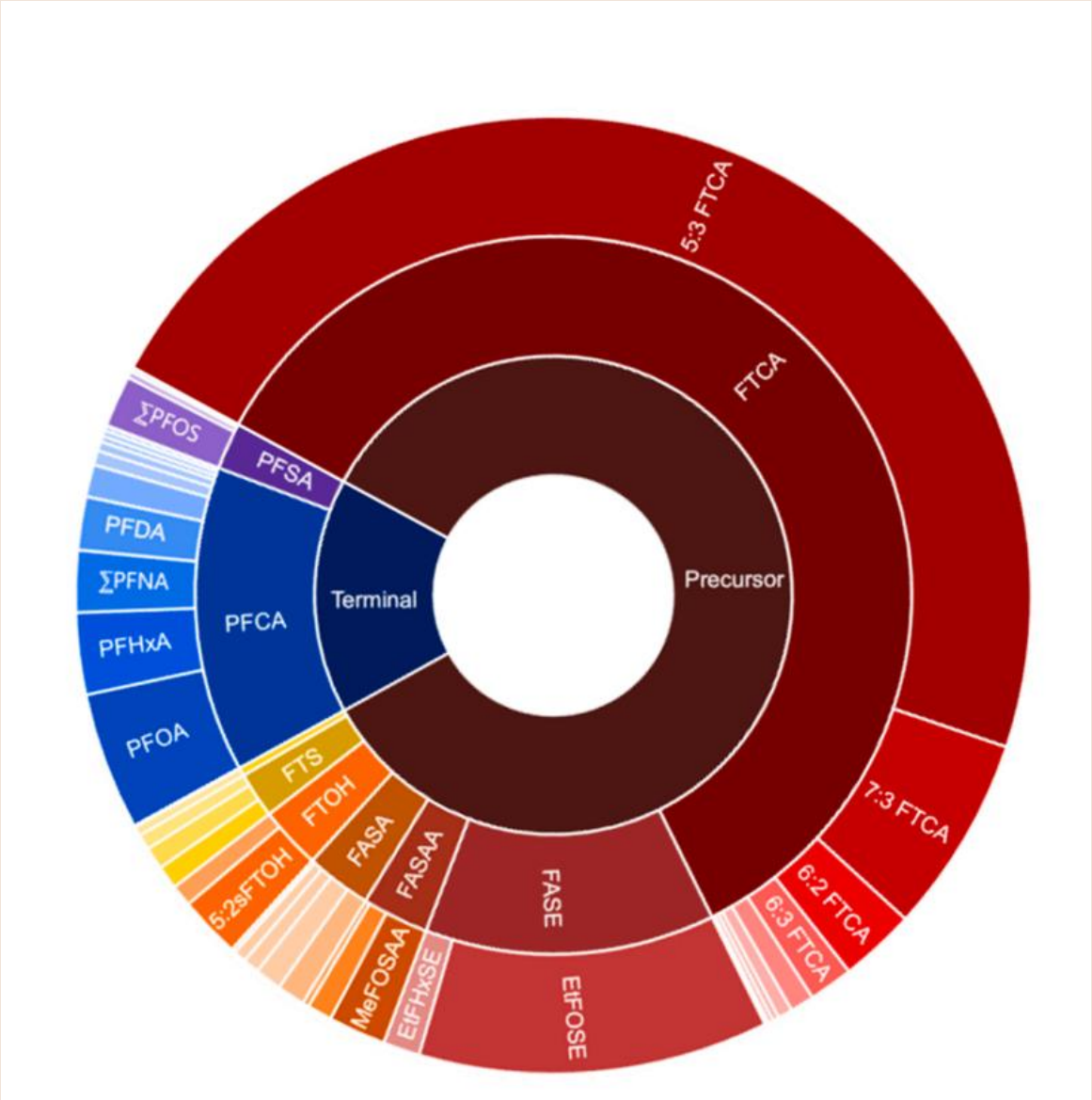
Nedbrydningsprodukter af fluortelomer-derivater, fx. fra tekstil coatninger; i rensningsanlægsslam, sediment, lossepladsperkolat og luft

Losseplads luft emissioner –FTCA, sulfonamider, FTS..

- Fluortelomer alcoholer (FTOH)/acrylater og nedbrydningsprodukter (FTCA)
- Fluoralkyl sulfonamider og ethanoler (FASE, FASA, FASAA)
- Fluortelomer sulfonat syrer (FTS) og derivater
- Perfluoralkylcarboxyl syrer (PFCA)

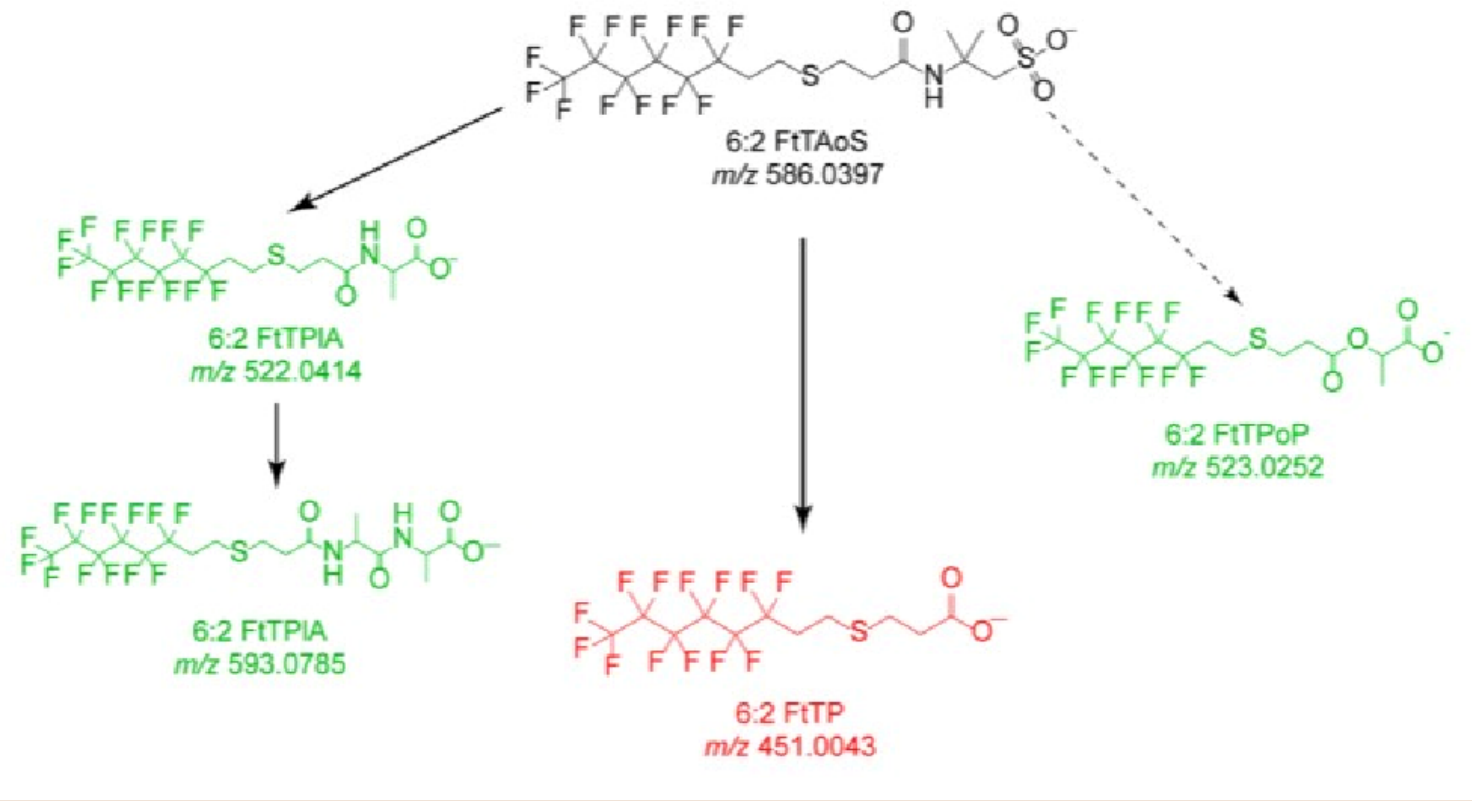


PFAS distribution in landfill gas condensate in US landfills. Only compounds which represented > ~1 % of ∑92PFAS were labelled. Figure by Smallwood et al., 2023.

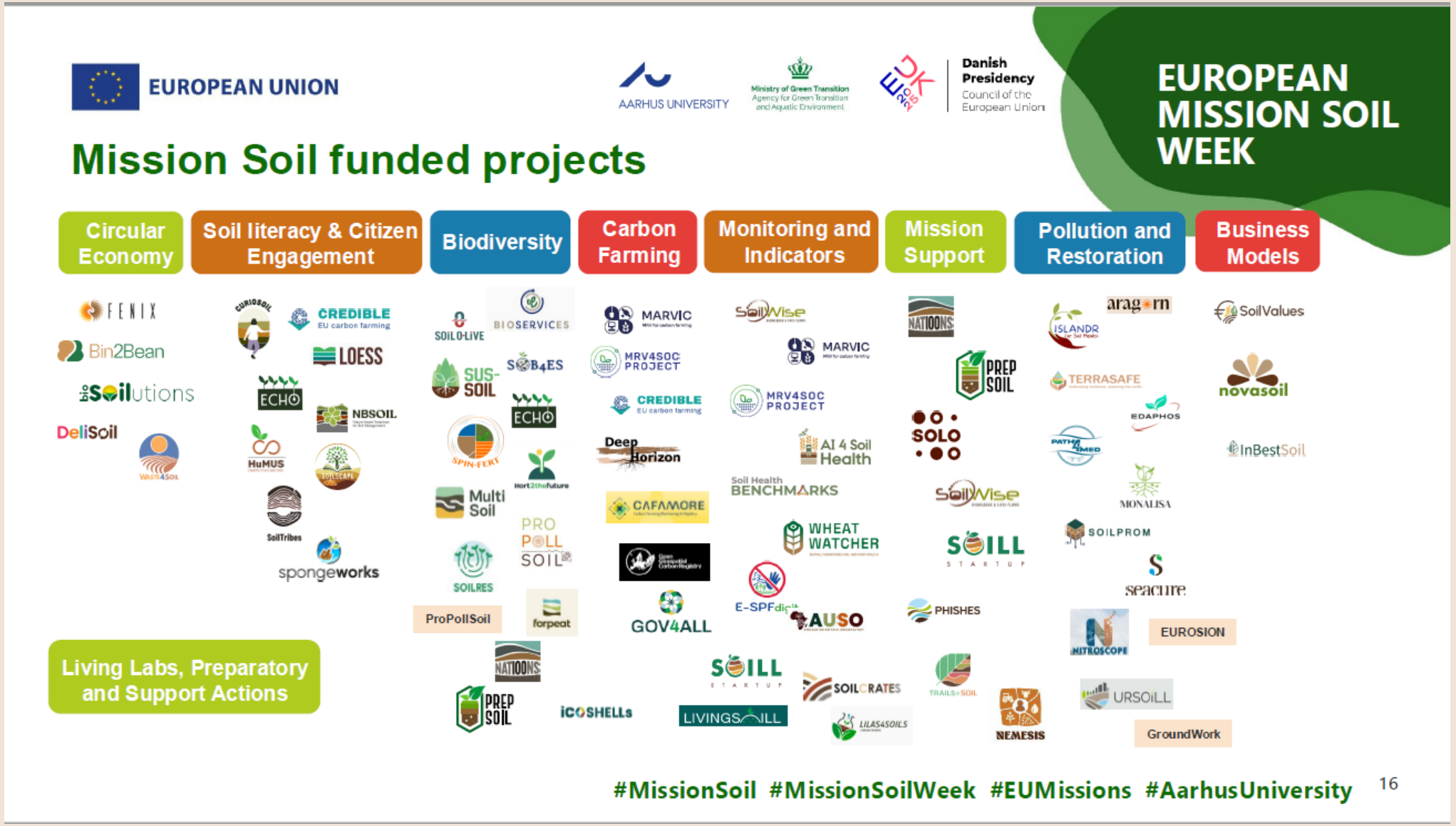
Jordforurening:
PFAS – nedbrydningsprodukter af FTS derivater

Yi, Shan, et al.
"Biotransformation of AFFF component 6: 2 fluorotelomer thioether amido sulfonate generates 6: 2 fluorotelomer thioether carboxylate under sulfate-reducing conditions."

Environmental science & technology letters 5.5 (2018): 283-288. DOI:10.1021/acs.estlett.8b00148



Strategic co-creation with external partners



SETAC 2026 abstract

Prioritisation of contaminants for soil monitoring in Europ

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Email contact: xt@plen.ku.dk

1. Introduction

The European Soil Monitoring Law (SML) introduces a need for a systematic prioritization of contaminants for soil monitoring to address diffuse pollution. With thousands of chemicals regulated by different frameworks in use, prioritization frameworks must balance scientific robustness, regulatory coherence, differing data availability and practical feasibility. This paper s to the development of the prioritization of contaminants for the SML, by comparing prioritisation methodologies applied to soil contaminants from various regulatory frameworks, focusing on their conceptual design, parameter selection, and ability to handle data gaps. The work is a result of collaboration across EU Mission: A Soil Deal for Europe and Horizon Europe funded projects in the newly established Soil Pollution and Remediation cluster.

2. Materials and Methods

Several prioritization methods have been published in recent years, focusing on the whole environment and human health as well as single environmental compartments e.g., water. With this contribution, we analyse four approaches to prioritize soil pollutants:
(i) *risk-based scoring approach* integrating persistence, mobility, bioaccumulation, ecotoxicology and toxicity[1,2]
(ii) *tiered frameworks* combining generic emission models with measured occurrence data in soils[3]
(iii) *multi-criteria decision analysis* (MCDA) approaches, which aggregate hazard for the environment and humans, exposure, and socio-economic indicators[4] and
(iv) *category-based schemes*, which classify substances into "action categories" before ranking[5,6]

A common data set of 20 substances was tested with the four described approaches developed in two Soil Mission projects (ARAGORN, ISLANDR), the Norman Network and by the German Environment Agency (UBA) on pesticides (data-rich)[7], PFAS (data-poor)[8], potentially toxic elements (e.g., metals), and substances of emerging concern, t illustrate how methodological choices influence prioritisation outcomes.

3. Results and Discussion

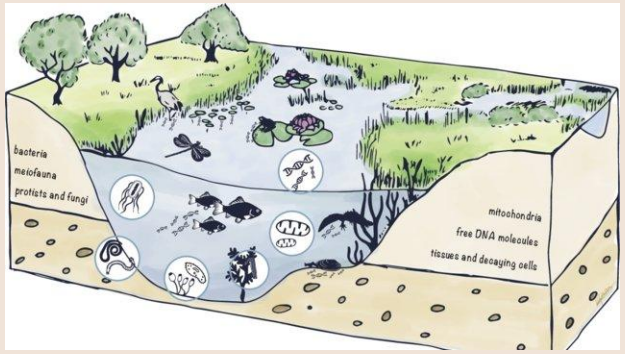
Key differences include reliance on occurrence versus proxy data, treatment of uncertainty, and capacity to int g mixture effects or climate-related stressors[9,10]. Our comparison shows that simple scoring approac es prioritization of substances offer transparency and ease of implementation but may oversimplify com ie

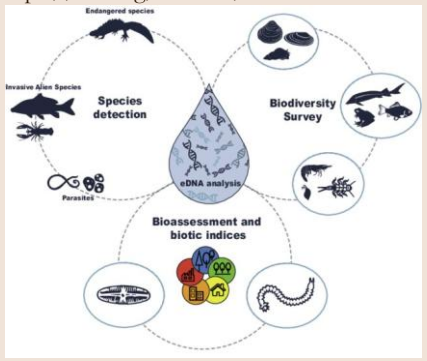
EU Soil Mission: Soil pollution and remediation cluster

- ARAGORN og EDAPHOS projekterne er co-leads af clusteren
- Artikel er ved at blive skrevet
- Test af 4 prioriteringsmetoder på 20 stoffer
  - risikobaseret (UBA- ARAGORN, pesticider)
  - tiered + forekomst (ISLANDR)
  - multicriteria decision analysis (ARAGORN, PFAS)
  - action categories (NORMAN);
    også for detekterede stoffer uden hazard data (NTS)
- => Input til Jordlovens guidelines?

Soil Pollution and Remediation Cluster – 4. nov, Århus
Fokus: Biotilgængelighed – hvornår skal vi måle for hvad?

https://doi.org/10.5167/uzh-187800





Effekt-baserede målinger?

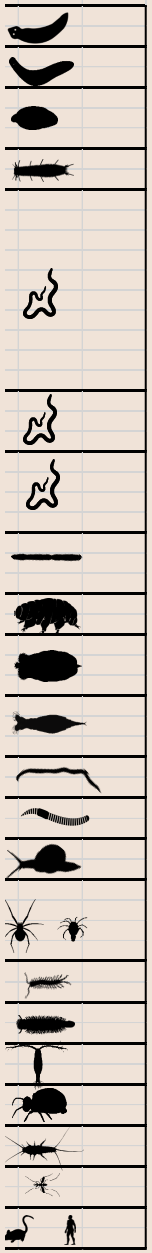
Direkte måling af effekter på organismer
- nævnt for byspildevand og i jord
in-vitro, eDNA mm

Effekten af remediering på jord-organismer i et tidligere mine-område målt med eDNA

- **Kontrol:** Forurenet, ikke oprenset område
- **Treatment:** Tidligere forurenet, nu oprenset område
- **Reference:** Naturligt upåvirket område

	Control area				Treatment area - grassland					Reference area - grassland				
	P1	P2	P4	P5	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Metazoa_(Animalia)														
Tricladida														
Continenticola														
Rhabditophora														
Lecithoepitheliata														
Rhabdocoela														
Dalyellioida														
Neodalyellida														
Gastrotricha														
Chaetonotida														
Chromadorea														
Araeolaimida														
Chromadorida														
Desmodorida														
Diplogasterida														
Monhysterida														
NA														
Oxyurida														
Rhabditida														
Tylenchida														
Dorylaimia														
Dorylaimida														
Trichocephalida														
Enoplia														
Enoplida														
NA														
Triplonchida														
Catenulida														
Catenulidae														
Stenostomidae														
Eutardigrada														
Parachela														
Monogononta														
NA														
Ploimida														
Bdelloidea														
Adinetida														
NA														
Annelida_Incertae_														
Hrabeiella														
Oligochaeta														
Haplotaxida														
Gastropoda														
Heterobranchia														
Arachnida														
Acari														
Araneae														
NA														
Chilopoda														
Pleurostigmophor														
Diplopoda														
Penicillata														
Copepoda														
Harpacticoida														
Ellipura														
Collembola														
Thysanura														
Nicoletiidae														
Neoptera														
Diptera														
Tetrapoda														
Mammalia														

ARAGORN
Unpublished work

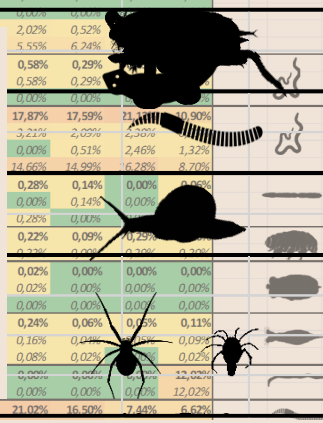


Udvalgte jord-organismer til måling

	Control area				Treatment area - grassland					Reference area - grassland				
	P1	P2	P4	P5	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Annelida_Incertae_Sedis														
Hrabeiella														
Oligochaeta														
Haplotaxida														
Gastropoda														
Heterobranchia														
Arachnida														
Acari														
Araneae														
NA	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,02%	0,00%	0,00%	0,00%	0,00%	0,00%

ARAGORN

Unpublished work



Konklusioner

- **Beskyttelsesmål afgørende for hvad der skal monitoreres:**
  => forskellige reguleringer har forskellige beskyttelsesmål og traditioner
  => forskellig prioritering og vurdering af stoffer
- **God risikostyring kræver sammenhæng mellem reguleringerne**
- **Prioritering af monitorering baseres typisk på risici,**
  men kan kombineres med andre hensyn, fx. fødevaresikkerhed, omkostninger, klima, biodiversitet, omkostninger, gennemførlighed, analysemetoder
- **Vigtigt at overveje hvad data skal bruges til efter!**
  - Vidensopbygning (fx. overvågning, indikatorer) eller aktioner (fx. oprensning, forhindre forurening, og få forureneren til at betale) kræver forskellige typer af målemetoder
- **2025: EUs jordlov (SMRD) og Vandrammedirektivet (WFD) er** *(næsten)* **vedtaget!**
  - Mulighed for at bidrage til udvikling af guidelines for jordloven
    – fx. via Danske Regioner / EU Common Forum

Funded by
The European Union

Funding

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PFAS Center

EU Soil Mission / ARAGORN
EU Horizon / PARC
Danske PFAS Taskforce + PFAS Center

UNIVERSITY OF COPENHAGEN