Overview of the outputs and outcomes of the UNEP/GEF POPs GMP project

Experts Presentations – Day 1

Final meeting of the UNEP/GEF POPs GMP projects
in the Africa region

Casablanca, Morocco 28-30 November 2023

Facts and figures of dl-POPs and PFAS monitoring in air, national samples, human milk and water

ÖREBRO UNIVERSITY

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PAS/PUFs

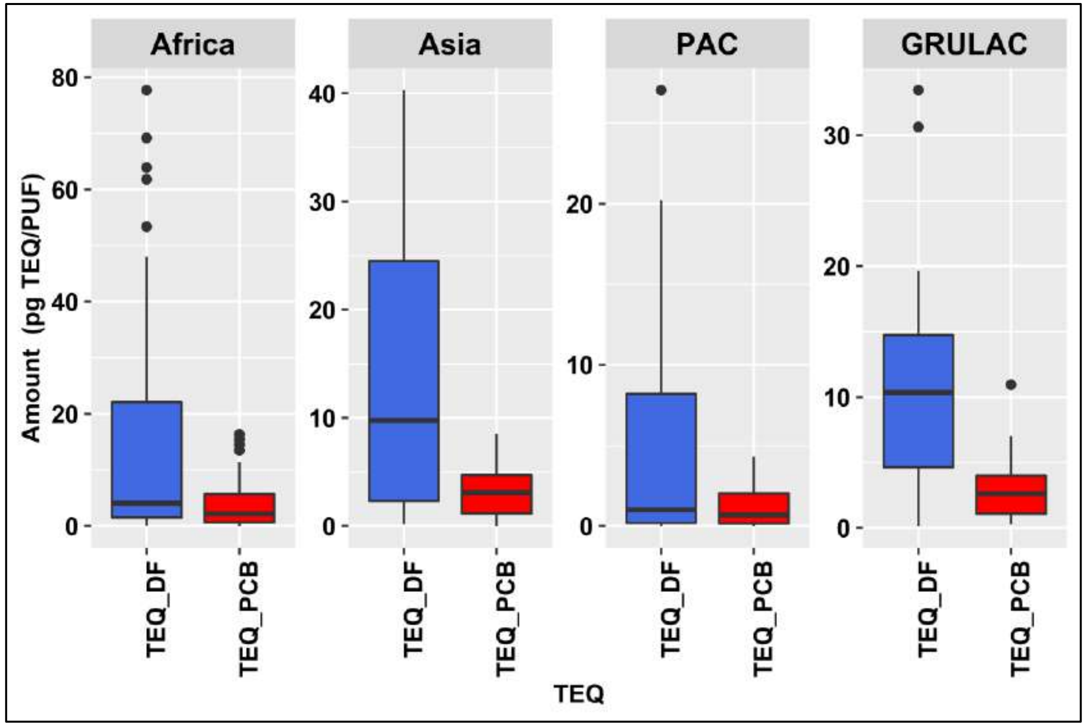
1. dl-POPs (analyzed by CSIC, Barcelona)

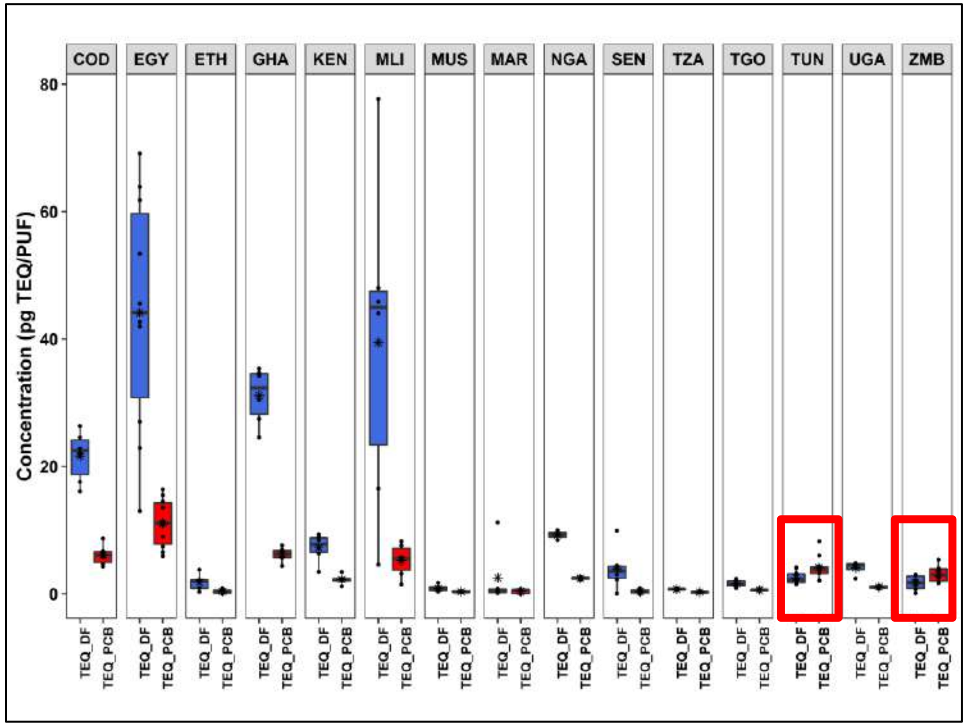
2. PFAS

- Results were sent to national coordinators (and UNEP) for dl-POPs on 30 August 2020 and for PFAS on 30/31 August 2020
- Results for air were presented at on-line regional workshop in October 2020
- The PAS/PUF and AAS air results are contained in the UNEP regional report for Africa
  (HF sent to UNEP in March 2023, not yet published)
- A global report, summarizing air results (PAS/PUFs and active sampler) from four regional GMP2 projects are contained in a global report for air
  (HF sent to UNEP in December 2022, not yet published)
- A report presenting the results for all POPs of the UNEP/GEF GMP1 project was prepared and sent to UNEP in May 2020, not published
- The results are only partially contained in the dwh and not reflected in the global report for the COP.

Summary: dl-POPs in PAS/PUFs global

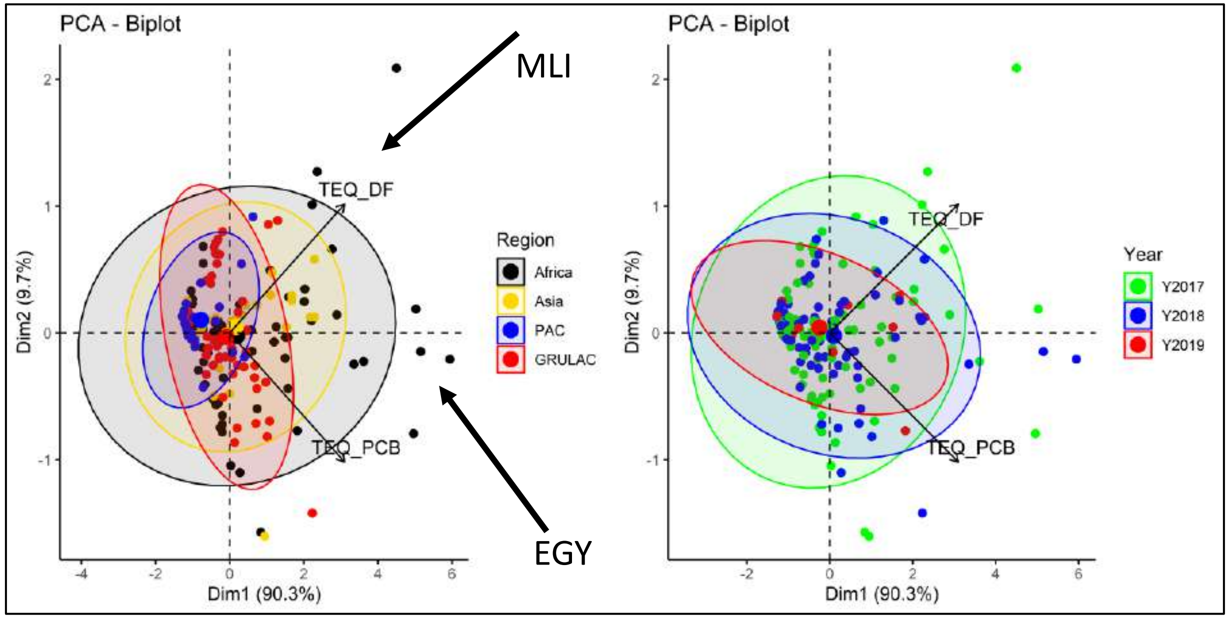
	Africa (N=89)	Asia (N=30)	PAC (N=23)	GRULAC (N=53)	Overall (N=195)
TEQ_DF (pg TEQ/PUF)					
Mean (SD)	13.3 (18.3)	13.6 (12.6)	4.79 (7.34)	10.4 (6.98)	11.5 (14.2)
Median [Min, Max]	4.07 [0.055, 77.7]	9.80 [0.162, 40.3]	1.01 [0.0005, 27.0]	10.4 [0.141, 33.5]	6.41 [0.0005, 77.7]
TEQ_PCB (pg TEQ/PUF)					
Mean (SD)	3.53 (3.78)	3.30 (2.55)	1.15 (1.23)	2.94 (2.16)	3.05 (3.07)
Median [Min, Max]	2.17 [0.0004, 16.4]	3.10 [0.003, 8.57]	0.675 [0.002, 4.32]	2.62 [0.253, 11.0]	2.34 [0.0004, 16.4]

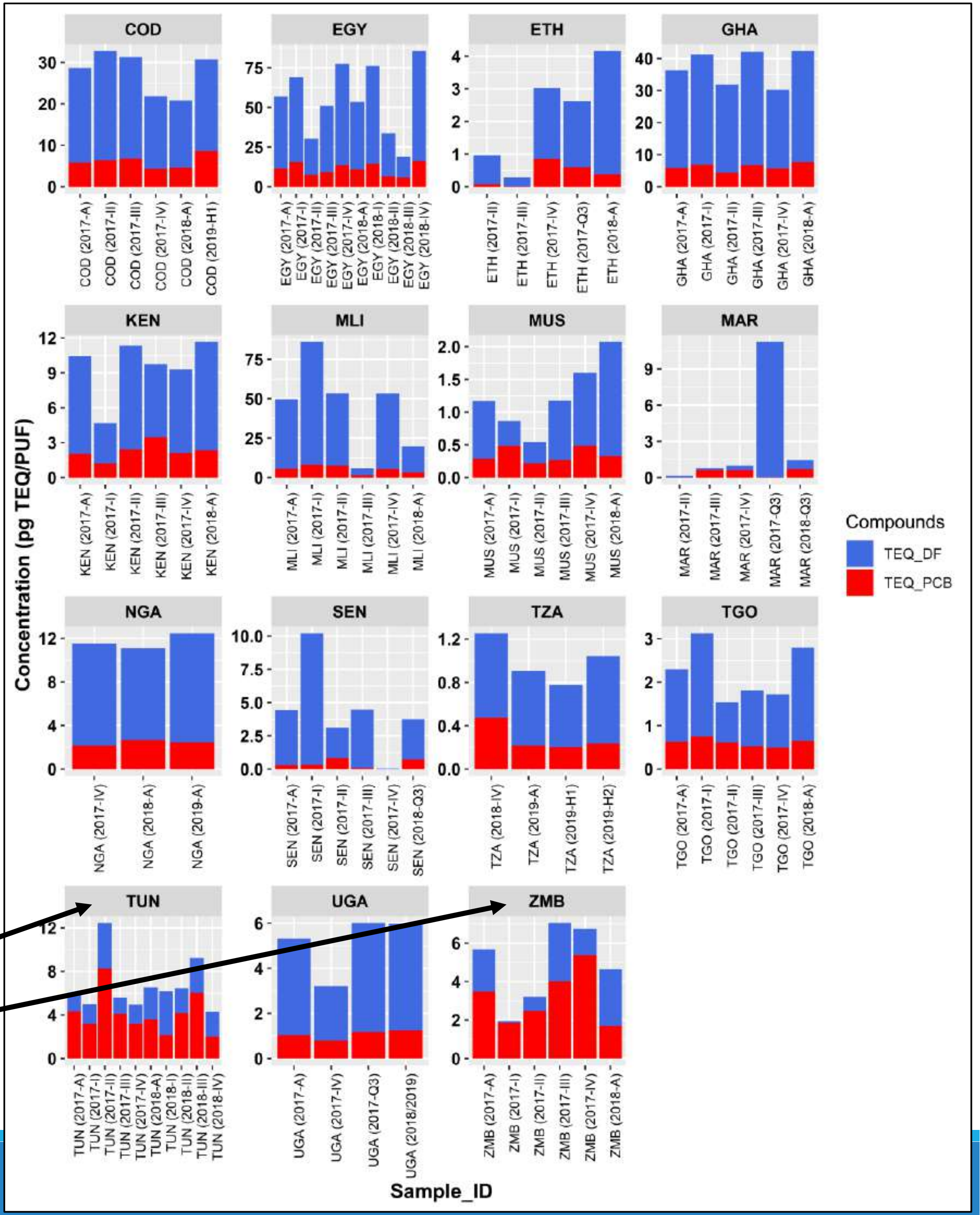




At low level,
TEQ_PCB>TEQ_DF

dl-POPs results by sample (n=89)





African samples have the widest range on regional basis
Maximum for TEQ_DF in Mali (77.7 pg TEQ/PUF),
Maximum for TEQ_PCB in Egypt (16.4 pg TEQ/PUF)

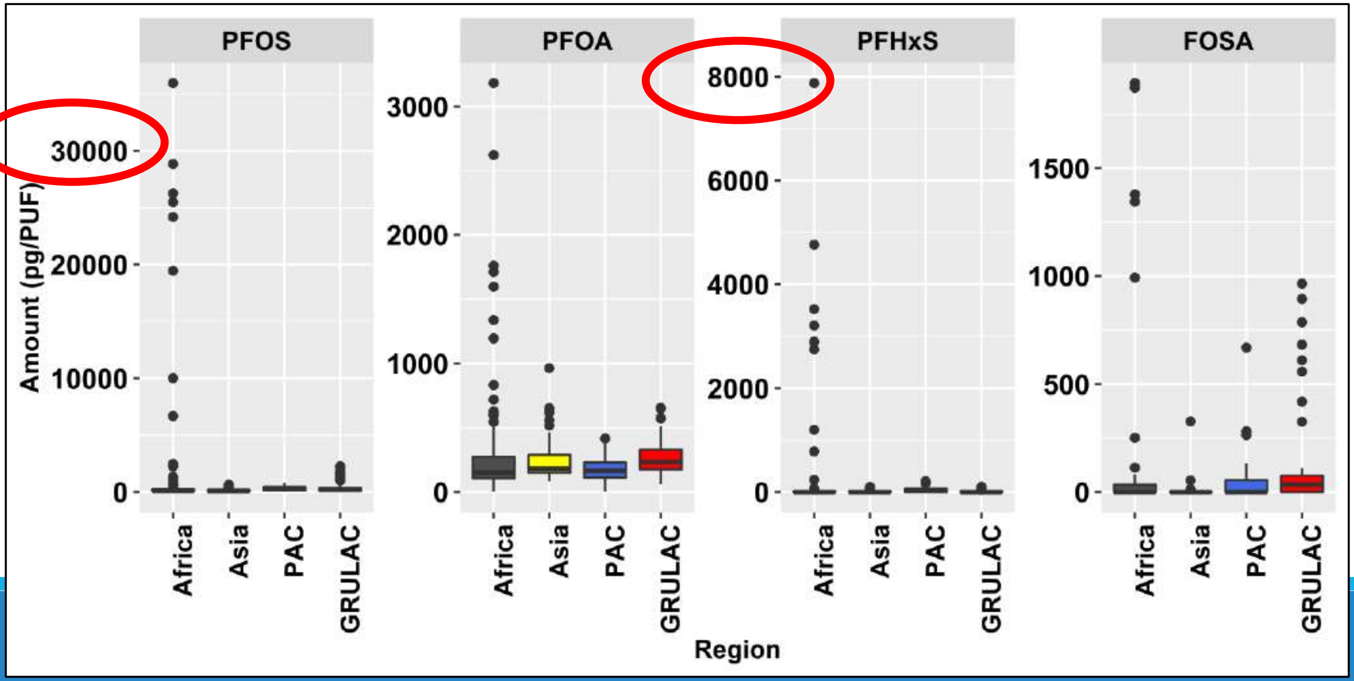
Tunisia and Zambia have high shares of dl-PCB

PAS/PUFs: PFAS

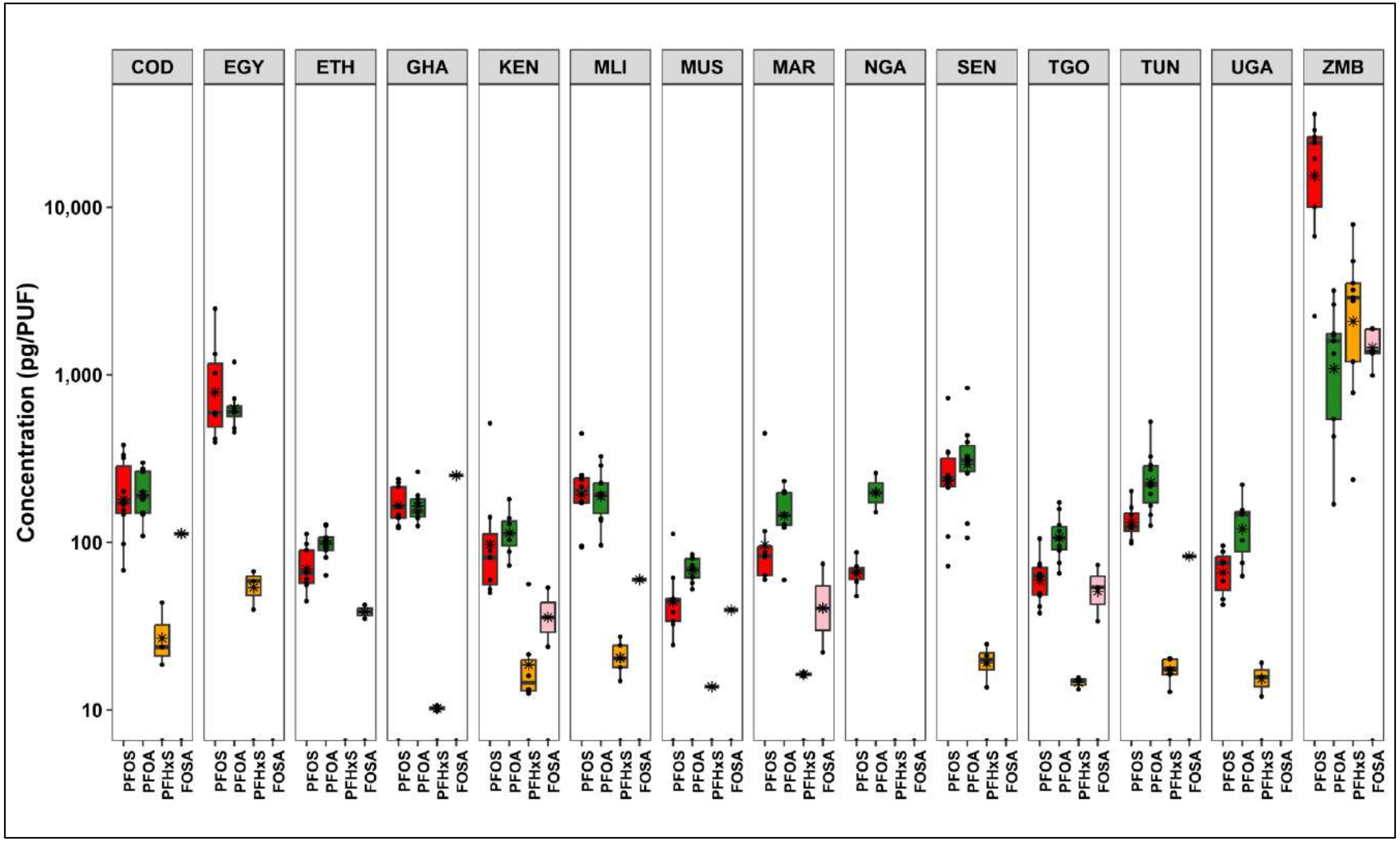
(n=317 global, 127 in Africa)

	Africa (N=127)	Asia (N=46)	PAC (N=43)	GRULAC (N=101)	Overall (N=317)
PFOS					
Mean (SD)	1640 (5940)	139 (122)	297 (219)	376 (497)	847 (3860)
Median [Min, Max]	110 [0, 36000]	101 [27.3, 634]	266 [0, 827]	192 [0, 2260]	136 [0, 36000]
PFOA					
Mean (SD)	305 (464)	271 (194)	181 (86.5)	257 (125)	268 (313)
Median [Min, Max]	153 [0, 3180]	183 [83.1, 965]	165 [0, 417]	233 [58.9, 655]	192 [0, 3180]
PFHxS					
Mean (SD)	224 (980)	13.4 (20.7)	41.6 (48.5)	9.72 (18.6)	101 (628)
Median [Min, Max]	0 [0, 7880]	0 [0, 96.1]	34.7 [0, 206]	0 [0, 101]	0 [0, 7880]
FOSA					
Mean (SD)	132 (414)	24.6 (81.8)	68.5 (155)	138 (260)	112 (315)
Median [Min, Max]	0 [0, 1890]	0 [0, 327]	0 [0, 669]	34.9 [0, 964]	0 [0, 1890]

- PFAS in 38 PUFs could not be reported due to deterioration of the sample matrix (across all projects)
- FOSA could not be quantified in about 50% of the samples
- NMe-/NEtFOSA and NMe-/NEtFOSE are not reported due to only very few occurrences



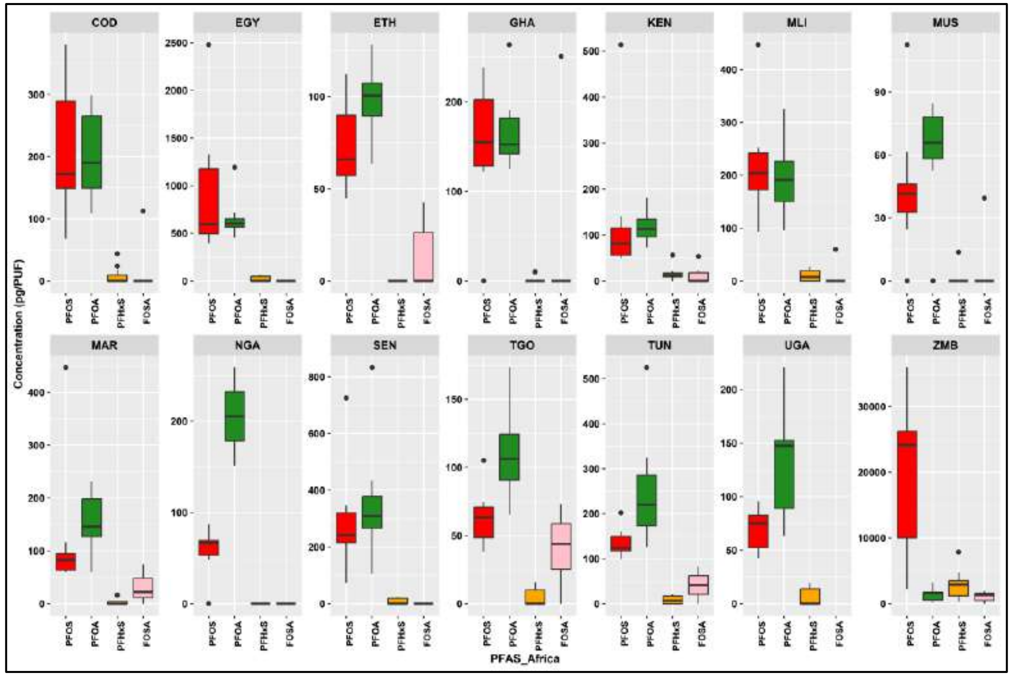
Presence of PFAS by country in Africa (n=317)

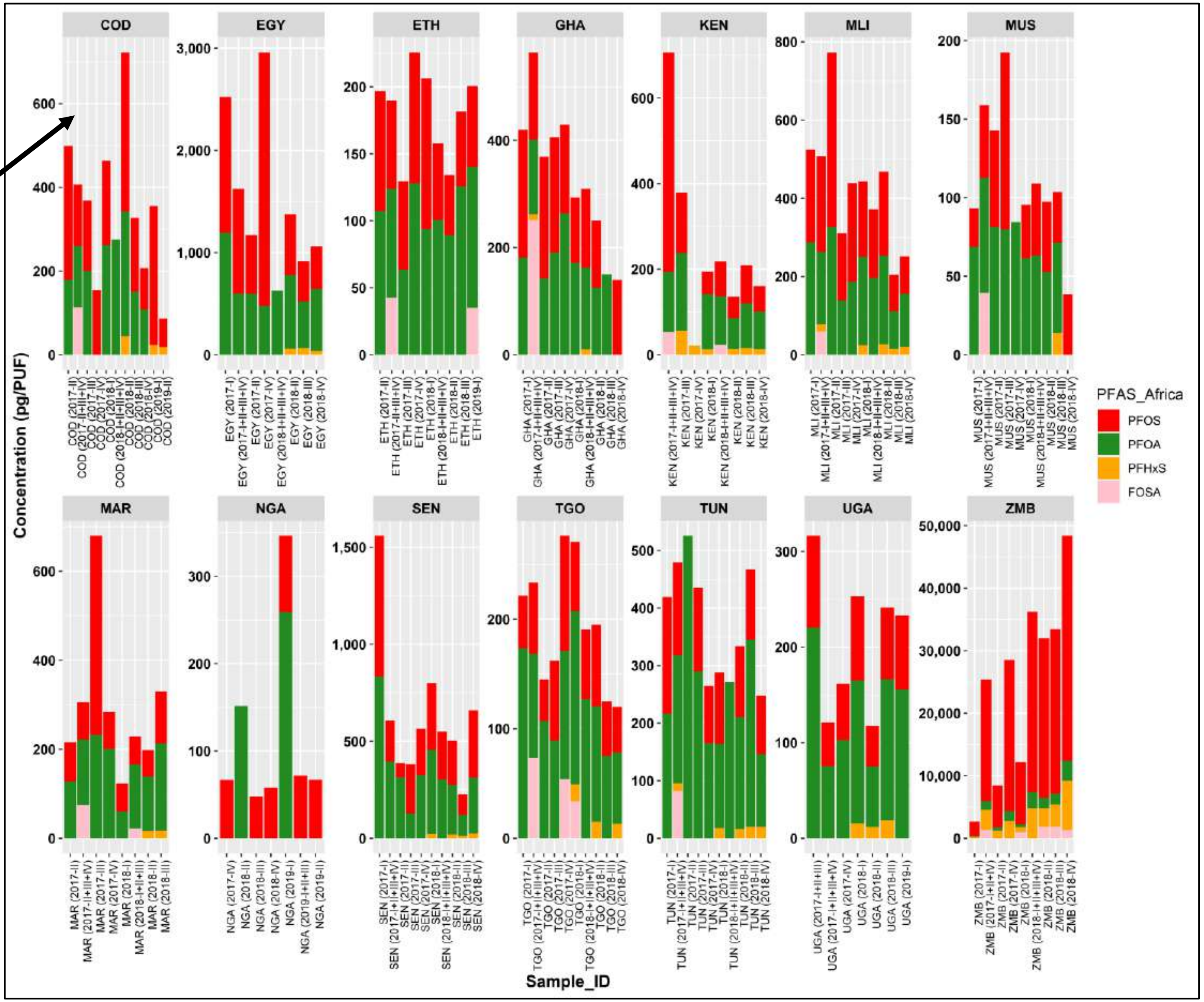


- Extremely high values found in Zambia (point source = excavation work at Lusaka airport)
- Question: where to locate sampling stations in case of deviation from guidance document?
- PFOS, PFHxS, and FOSA order of magnitude higher in ZMB
- PFOA high but to lesser extend
- Tanzania did not send any PUF for PFAS analysis (reason: no MeOH-pretreated PUFs exposed)

PFAS4 by country

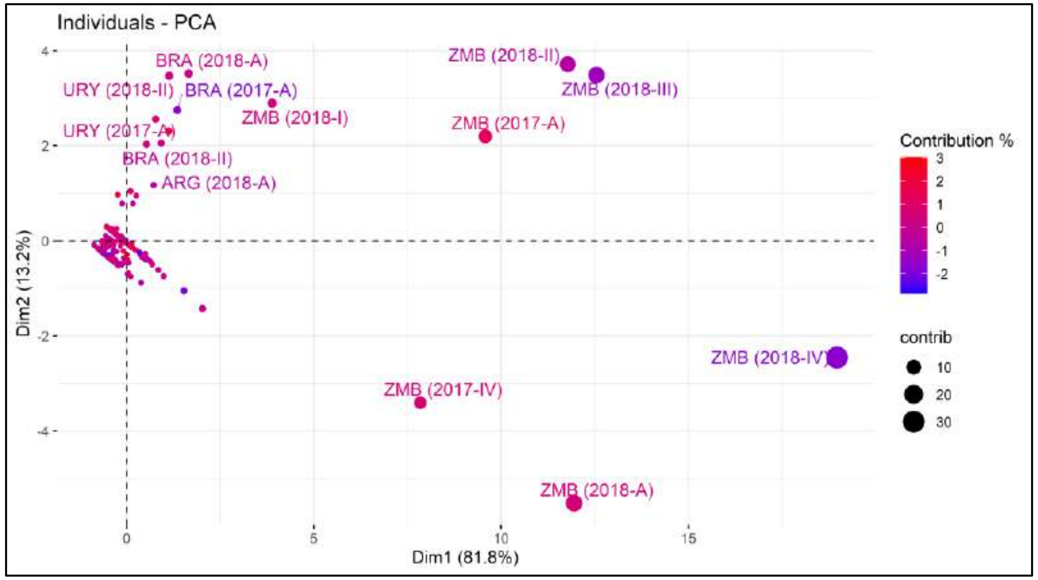
Diverse picture:
FOSA not frequently quantified
PFOA>PFOS (median) in COD, ETH, MUS, MAR, NGA, SEN, TGO, TUN, UGA
Ratio PFOS:PFOA varied; sometimes between measurements in the sample country

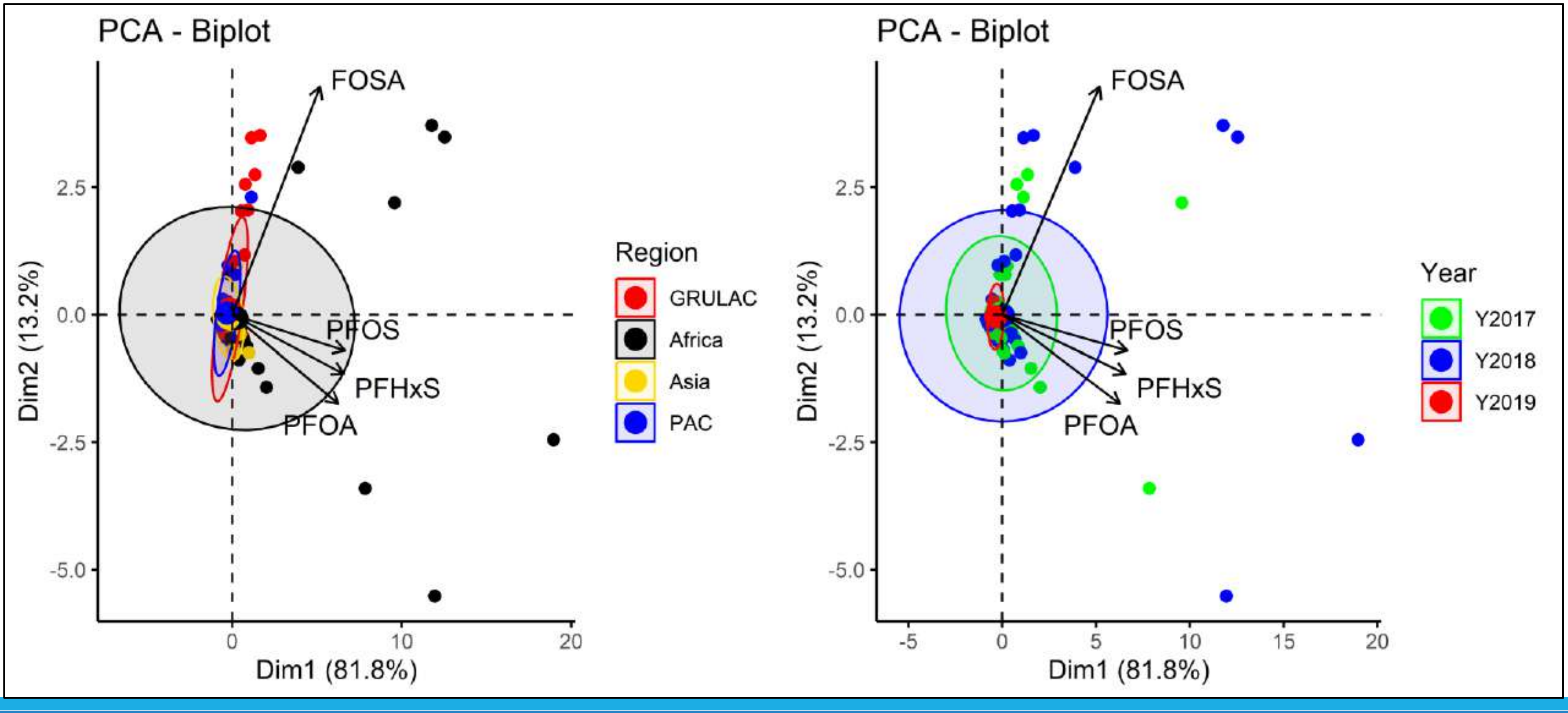




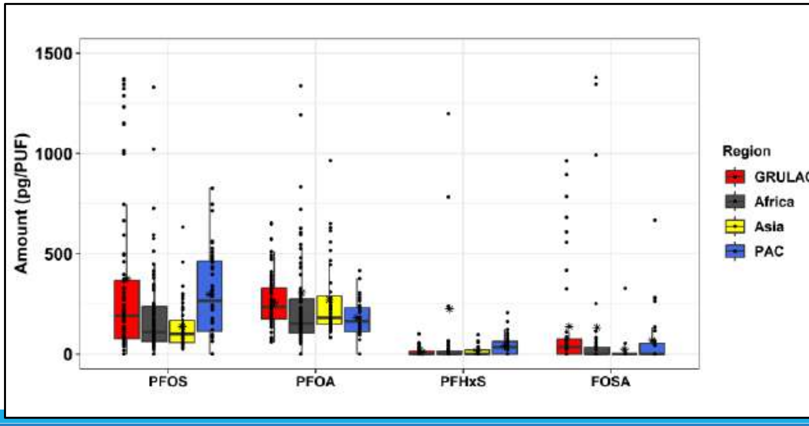
PFAS4 in air

- 355 polyurethane foam disks analyzed for PFOS and precursors, PFOA and PFHxS
- PFOS (with wide range of values) and PFOA dominated over PFHxS and other PFAS
- Low sorption capacity of PUFs hampered analysis and quantification of PFAS

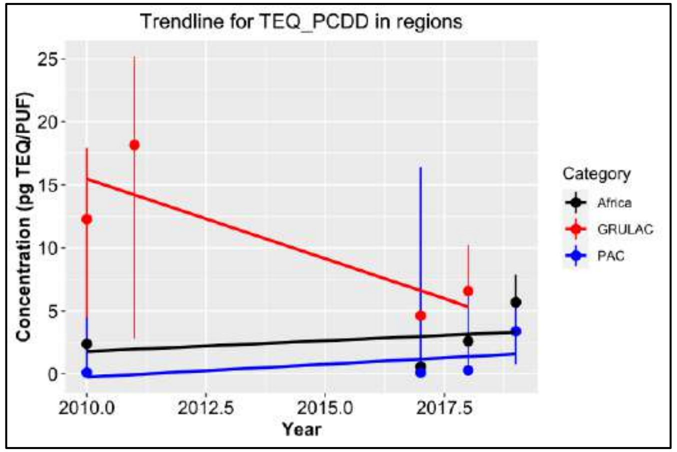


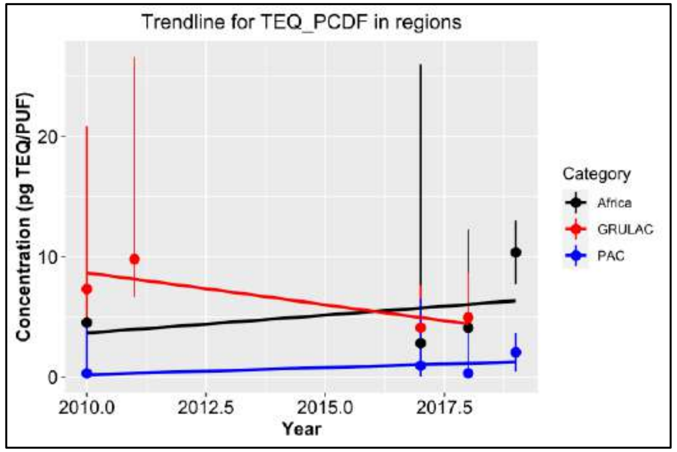


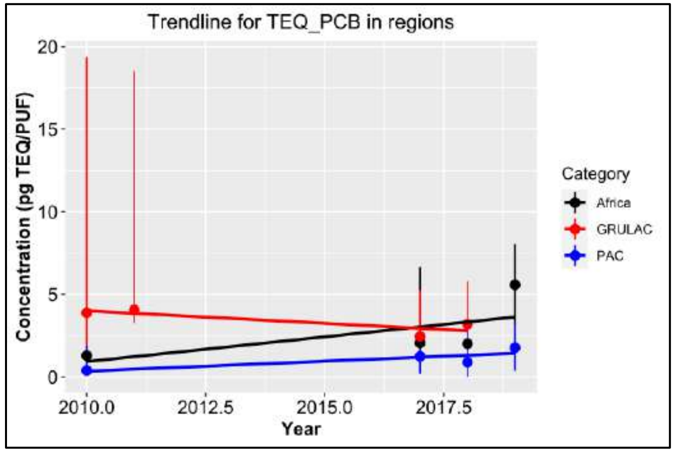
- Highest single PFAS values found in Africa;
- Driving high mean values;
- Median values were highest in GRULAC and not in Africa

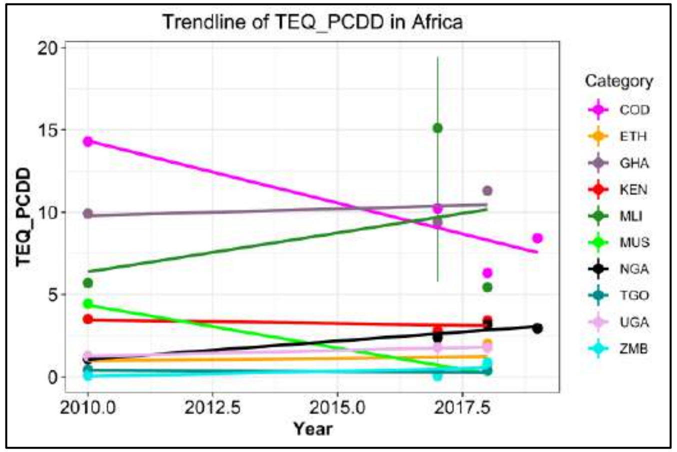


Trends for dl-POPs in air samples (PAS/PUFs) GMP1 vs. GMP2 (2010/2011 *vs.* 2017-2019)









- Trend analysis with 8-9 year interval could be made for PCDD, PCDF, and dl-PCB
- Global trends hardly seen since trends within the regions were different, and trends for countries within the same region were different.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ELSEVIER

Preliminary trends over ten years of persistent organic pollutants in air - Comparison of two sets of data in the same countries

Heidelore Fiedler [a,*], Esteban Abad [b], Jacob de Boer [c]

National samples

1. dl-POPs (analyzed by commercial laboratories)
2. PFAS

- Results were sent to national coordinators (and UNEP) for dl-POPs on 26 October 2020 and for PFAS on 14 November 2020
- Results for national samples and human milk were presented at on-line regional workshop in November 2021
- These results are not yet summarized, made available by UNEP

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Dioxin-like POPs in national samples from global monitoring plan projects (2017–2019)

Heidelore Fiedler[a,*], Manuela Ábalos[b], Jordi Parera[b], Esteban Abad[b], Nina Lohmann[c], Frank Neugebauer[c], Horst Rottler[d], Michael Horstmann[c]

Chemosphere 307 (2022) 136038
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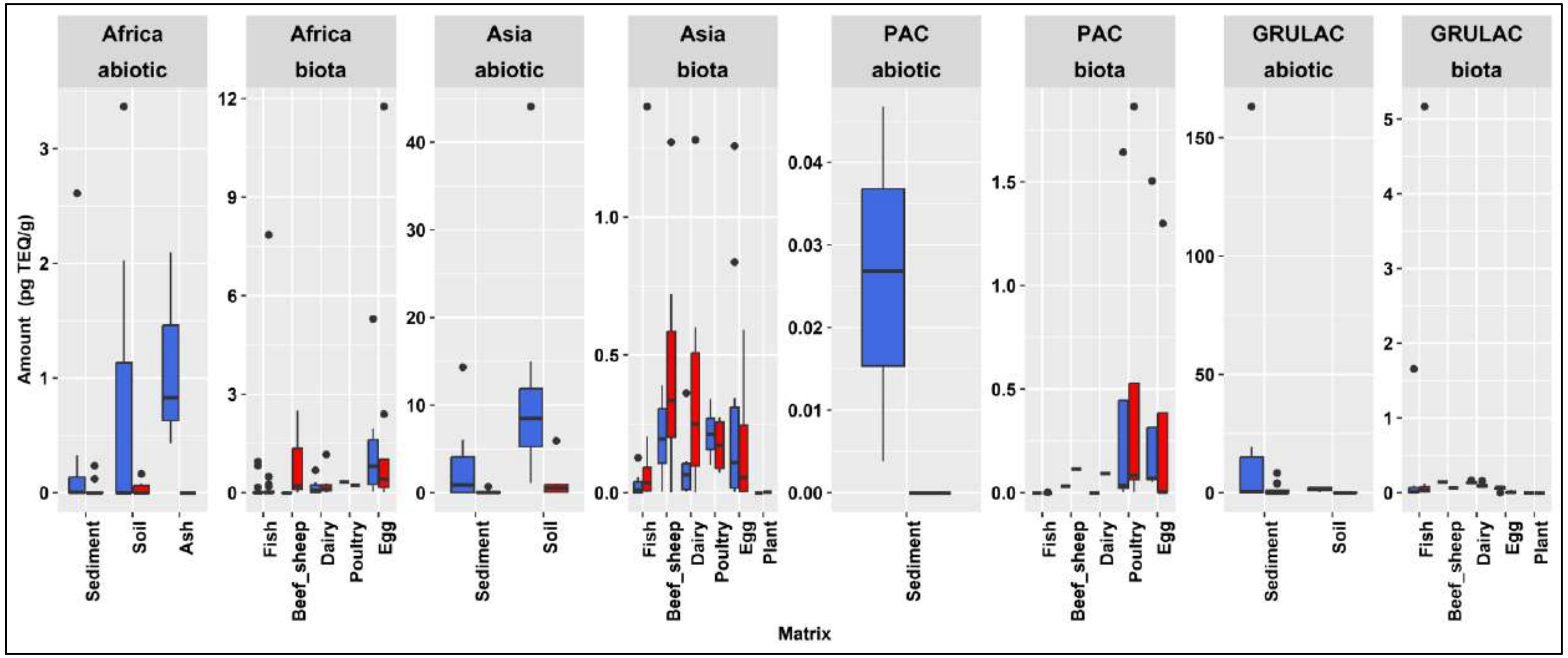
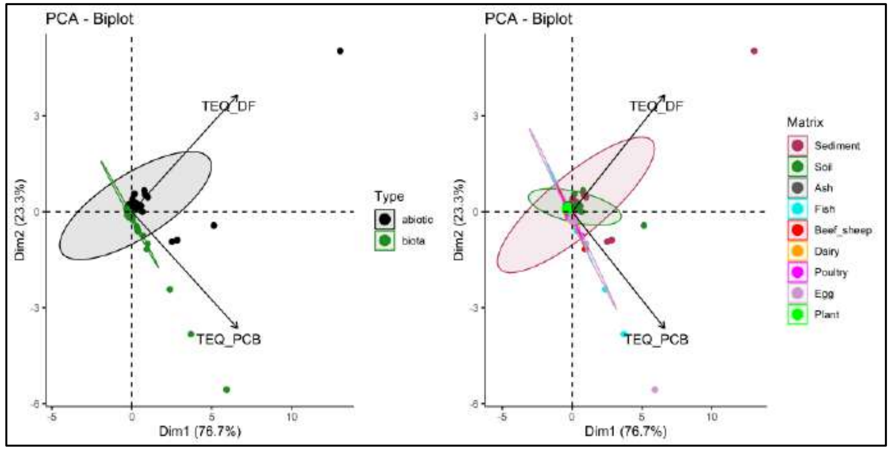
Perfluoroalkane substances in national samples from global monitoring plan projects (2017–2019)

Heidelore Fiedler[a,*], Mohammad Sadia[a,b], Abeer Baabish[a], Siamak Sobhanei[a]

Summary dl-POPs in national samples (global)

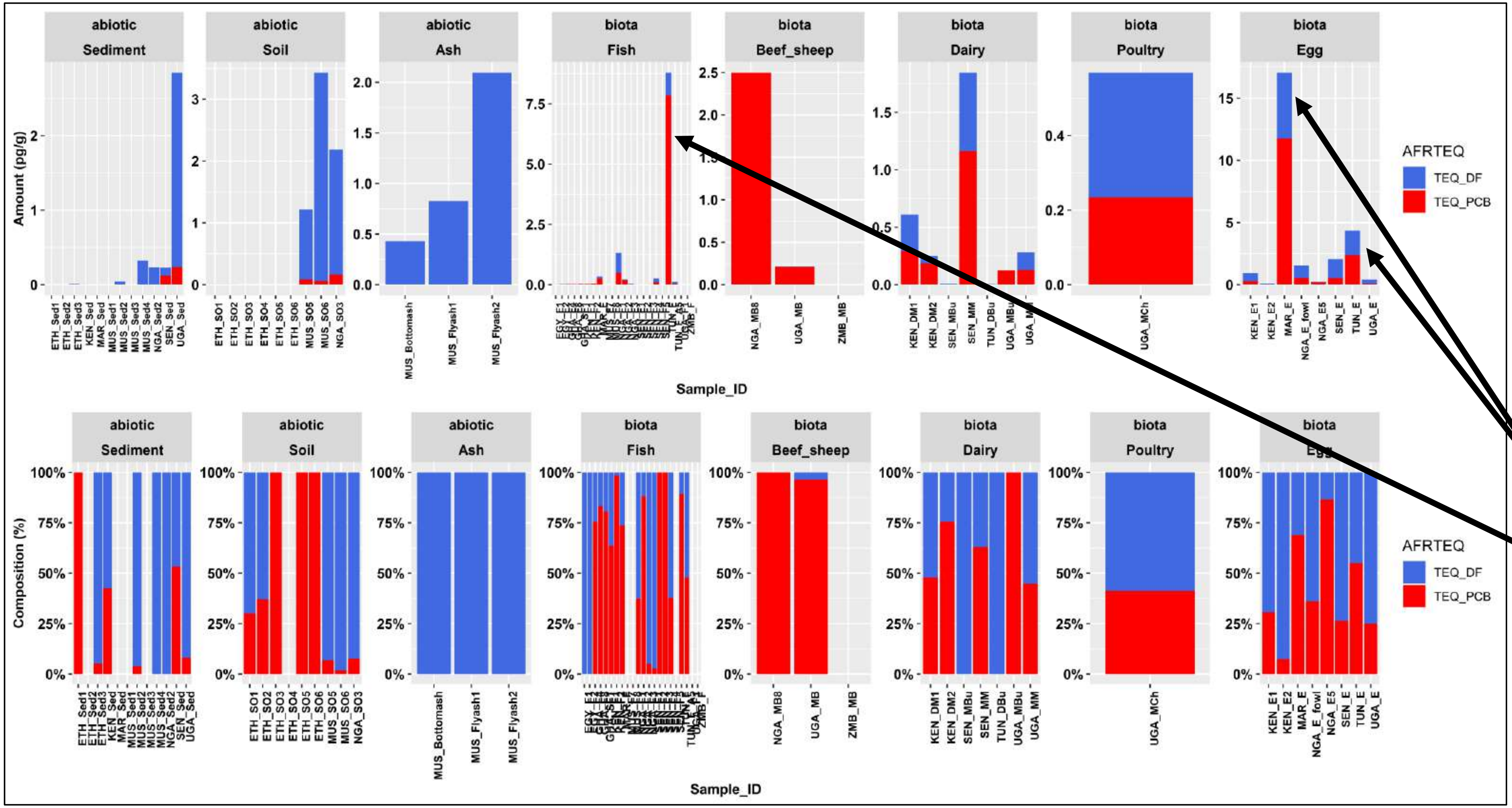
	Africa		Asia		PAC		GRULAC	
	abiotic (N=24)	biota (N=41)	abiotic (N=18)	biota (N=40)	abiotic (N=3)	biota (N=22)	abiotic (N=16)	biota (N=21)
TEQ_DF								
Mean (SD)	0.550 (0.971)	0.356 (0.904)	6.71 (10.5)	0.155 (0.245)	0.026 (0.022)	0.171 (0.460)	13.9 (40.3)	0.137 (0.352)
Median [Min, Max]	0.005 [0, 3.37]	0.023 [0, 5.29]	2.75 [0.011, 44.1]	0.059 [0, 1.26]	0.027 [0.004, 0.047]	0 [0, 1.64]	0.576 [0.012, 163]	0.065 [0.00002, 1.66]
TEQ_PCB								
Mean (SD)	0.028 (0.062)	0.725 (2.20)	0.541 (1.38)	0.254 (0.360)	0 (0)	0.179 (0.470)	1.10 (2.34)	0.292 (1.12)
Median [Min, Max]	0.0004 [0, 0.235]	0.054 [0, 11.8]	0.081 [0, 5.91]	0.111 [0, 1.40]	0 [0, 0]	0.002 [0, 1.86]	0.022 [0.0007, 8.32]	0.039 [0.0001, 5.17]





Sediments as abiotic and fish/eggs have highest concentrations

National samples – dl-POPs by sample



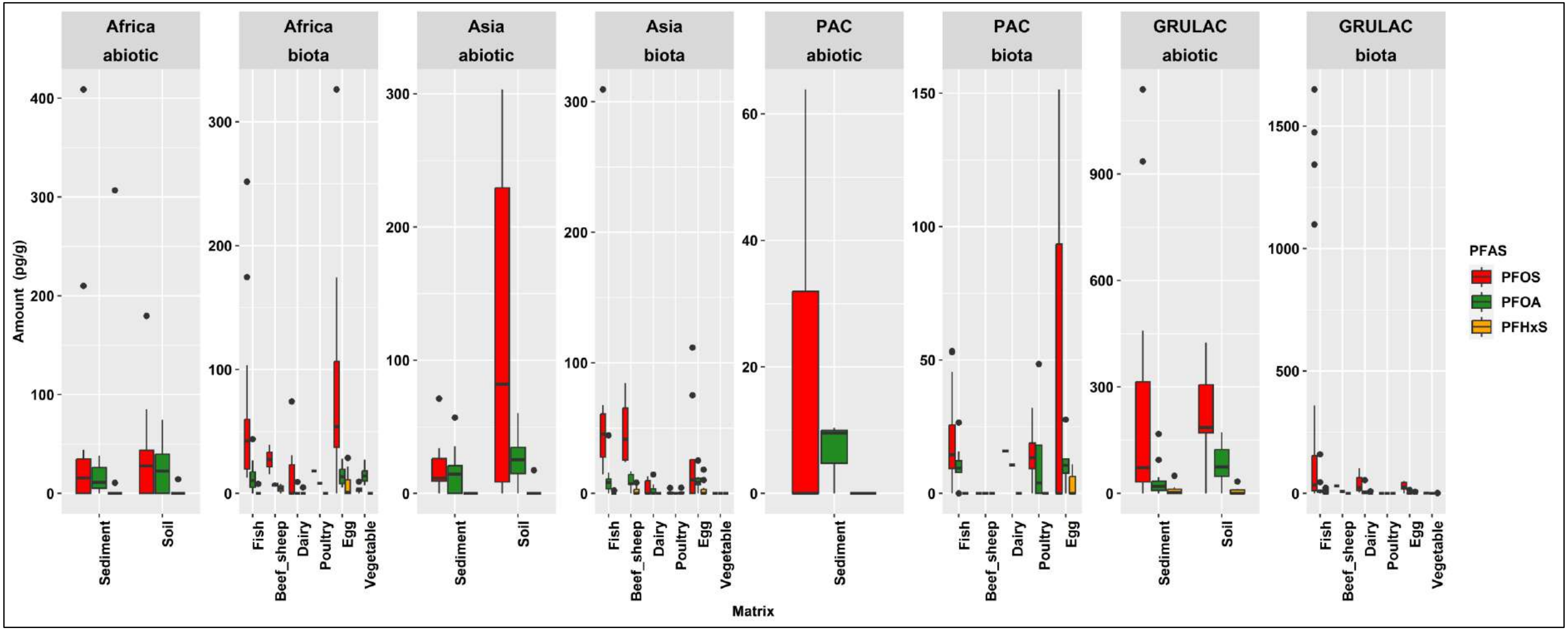
- TEQ_DF dominate in abiotic samples
- TEQ_PCB in most biota samples
- Egg samples may be impacted by abiotic material (higher PCDD/PCDF contribution)
- High concentrations found in:
- Egg from Morocco (and Tunisia)
- Fish from Tunisia

National samples analyzed for PFAS

- Total of 238 national samples; of these: 71 abiotic samples and 167 biota samples
  - abiotic without air samples (317 PAS/PUFs, 18 from active air samplers) and without 144 samples from water network
  - biota without 44 human milk samples
- 76 samples (32% of total) were fish, 36 (15%) were egg (new matrix for PFAS)
- Africa contributed with 68 samples (29% of total)

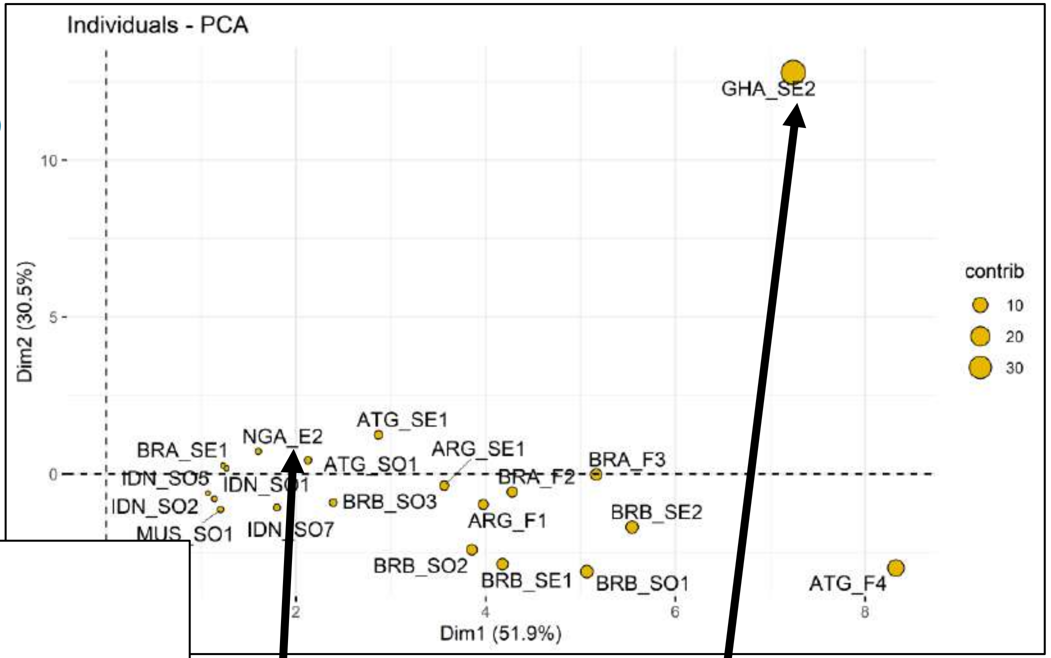
	Africa		Asia		PAC		GRULAC	
	abiotic (N=25)	biota (N=43)	abiotic (N=21)	biota (N=41)	abiotic (N=3)	biota (N=27)	abiotic (N=22)	biota (N=56)
PFOS (pg/g f.w.)								
Mean (SD)	49.0 (91.8)	50.0 (67.5)	68.1 (98.7)	33.9 (52.6)	21.3 (36.9)	23.7 (33.5)	238 (297)	139 (360)
Median [Min, Max]	15.9 [0, 409]	30.8 [0, 326]	22.4 [0, 303]	21.2 [0, 309]	0 [0, 63.9]	12.4 [0, 151]	173 [0, **1140**]	25.3 [0, **1650**]
PFOA (pg/g f.w.)								
Mean (SD)	18.6 (18.7)	11.2 (9.50)	20.9 (18.7)	7.48 (8.64)	6.63 (5.76)	10.4 (10.5)	46.9 (52.6)	9.26 (22.8)
Median [Min, Max]	12.4 [0, 74.5]	8.74 [0, 43.9]	19.9 [0, 60.3]	6.92 [0, 44.4]	9.55 [0, 10.4]	9.36 [0, 48.5]	28.8 [0, **172**]	4.15 [0, **160**]
PFHxS (pg/g f.w.)								
Mean (SD)	13.3 (61.2)	1.87 (5.67)	0.827 (3.79)	1.31 (3.58)	0 (0)	0.641 (2.40)	7.80 (12.6)	1.64 (4.37)
Median [Min, Max]	0 [0, **307**]	0 [0, **28.7**]	0 [0, 17.4]	0 [0, 18.2]	0 [0, 0]	0 [0, 11.0]	0 [0, 49.5]	0 [0, 22.9]

Scale of PFAS in national samples (global)

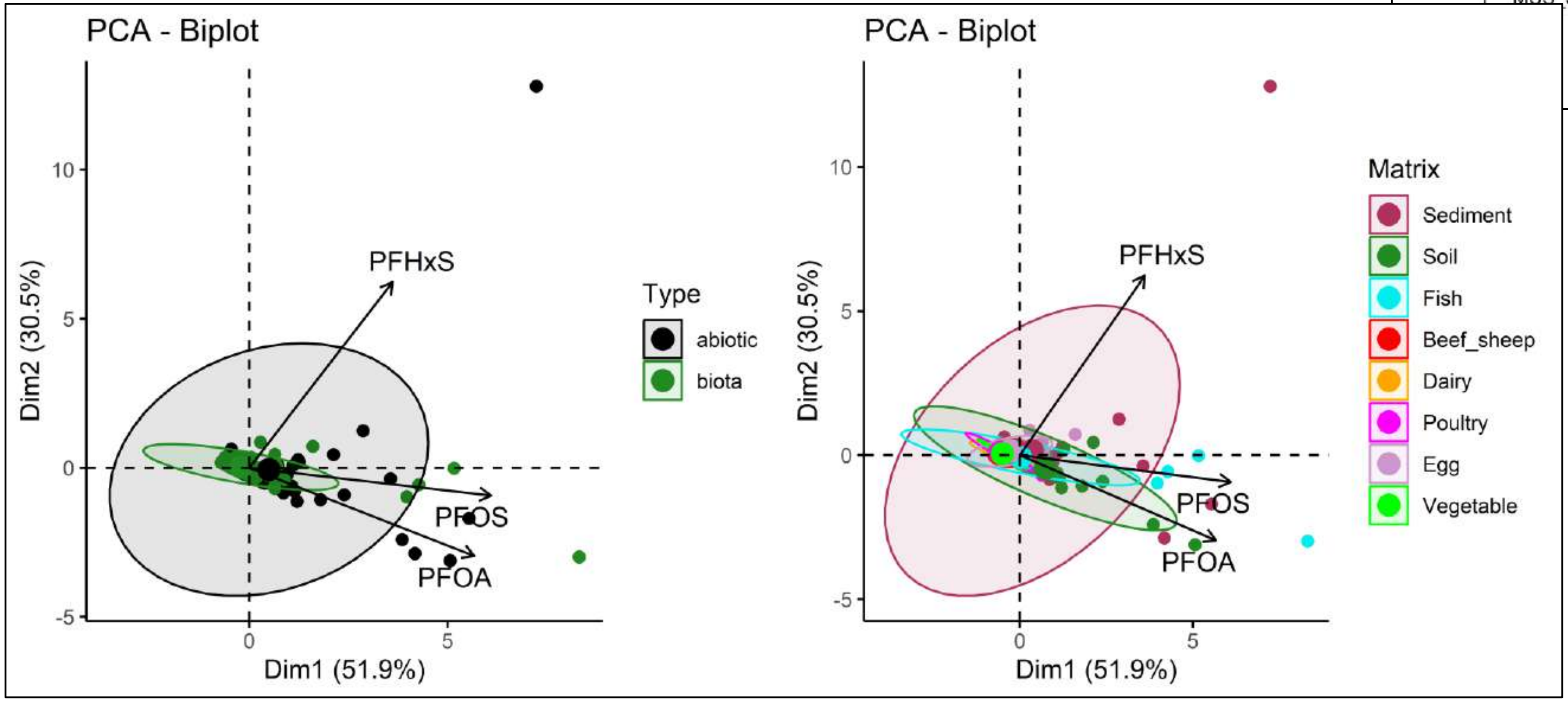


All values in pg/g f.w.)

PCA PFAS in national samples

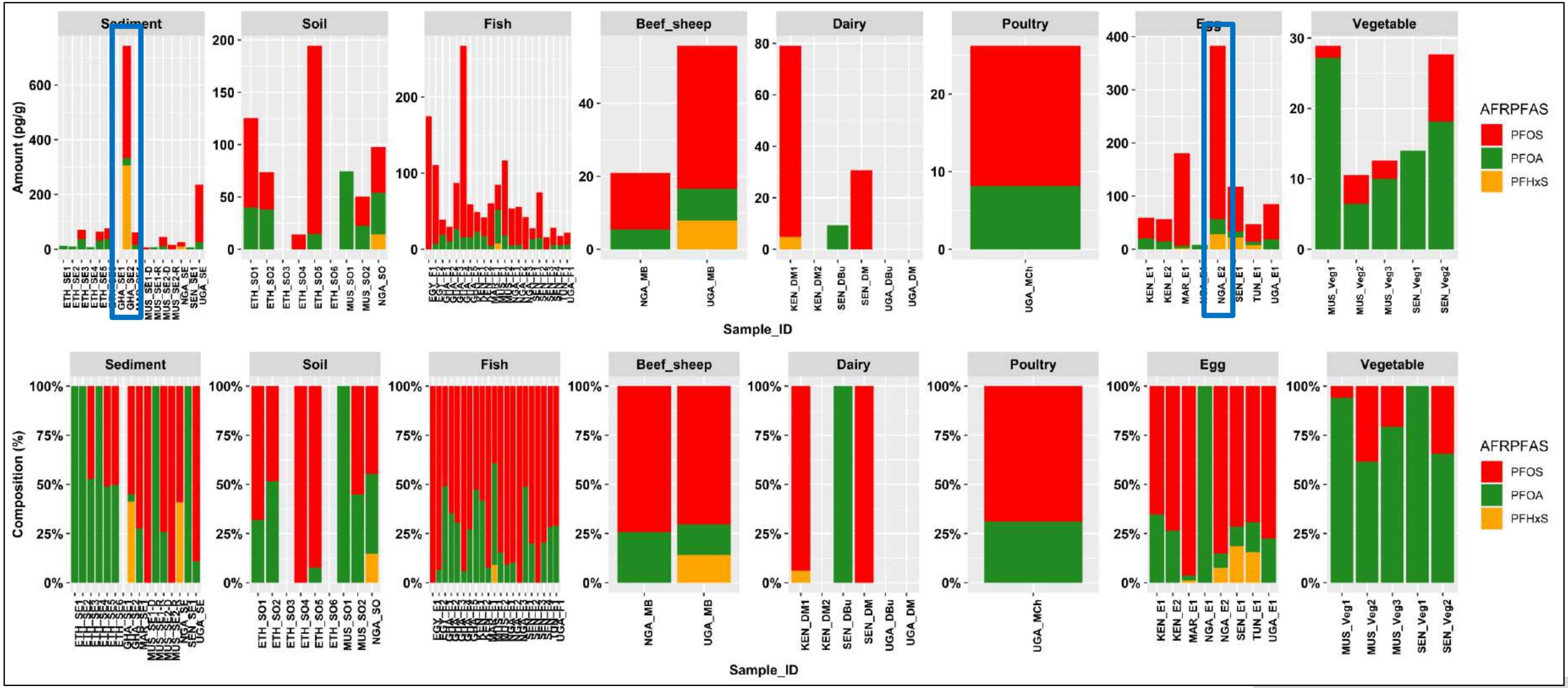


- Sediment and fish had the highest concentrations
- Outliers with high concentrations (see concentration ellipses) found for abiotic (sediment Ghana) and biota (fish Antigua and Barbuda) samples



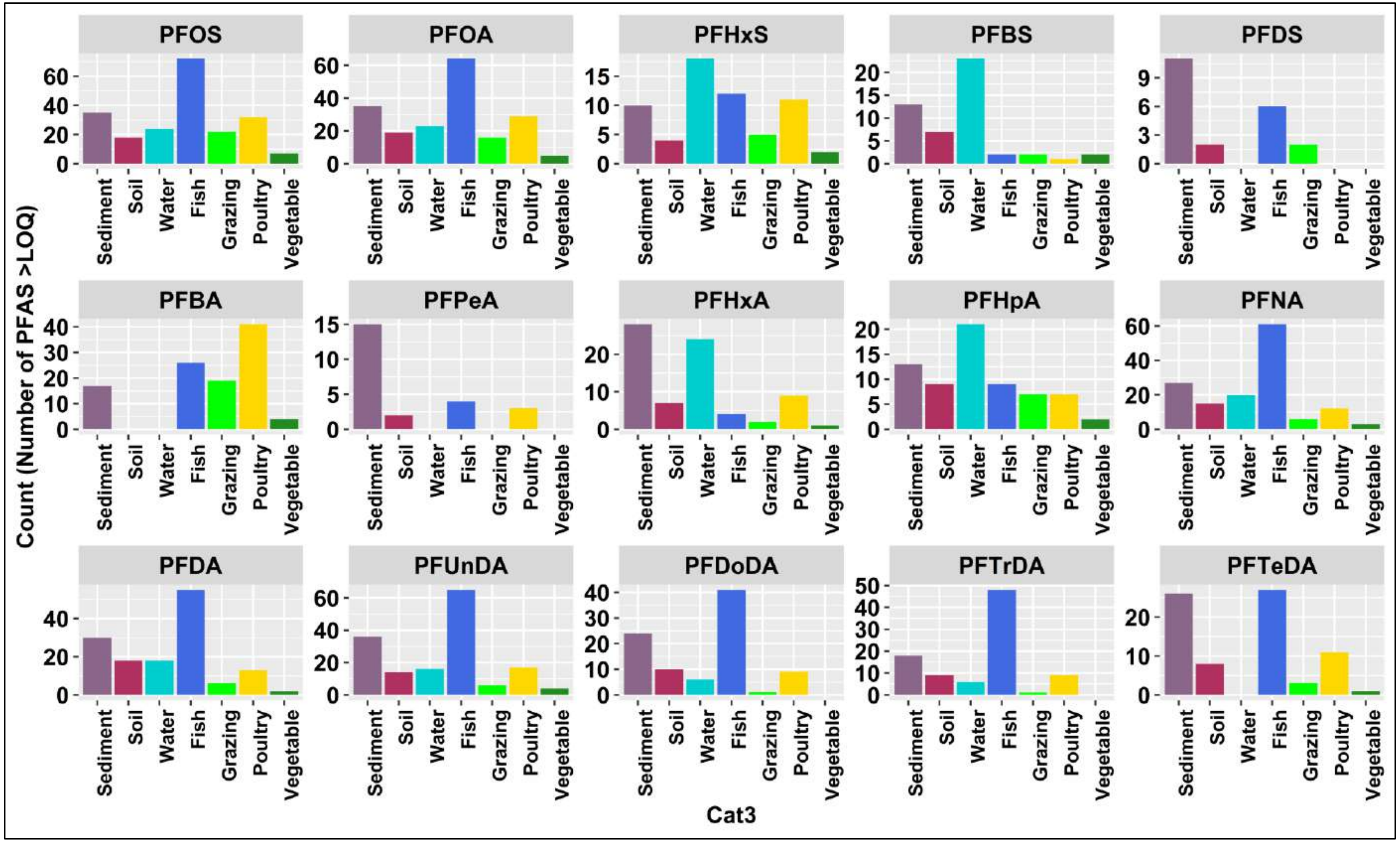
Samples to note:
- Sediment from Ghana
- Soil from Ethiopia
- Fish from Ghana
- Egg from Nigeria (fowl)
- Cow's milk from Kenya (low level)

Africa national samples: PFAS by sample



All values in pg/g f.w.)

Occurrence of other PFAS in national samples



38% of the results had PFAS >LOQ

Detection frequencies:

- PFOS = 80%
- PFOA = 73%
- PFHxS =24%
- PFNA = 55%

These informations, as well as results for air and water samples, have not been taken into considerations in other groups such as POPRC or inventories (include POPs under evaluation for listing; PFOA-2019, PFHxS-2022, LC_PFAS-2023ff)

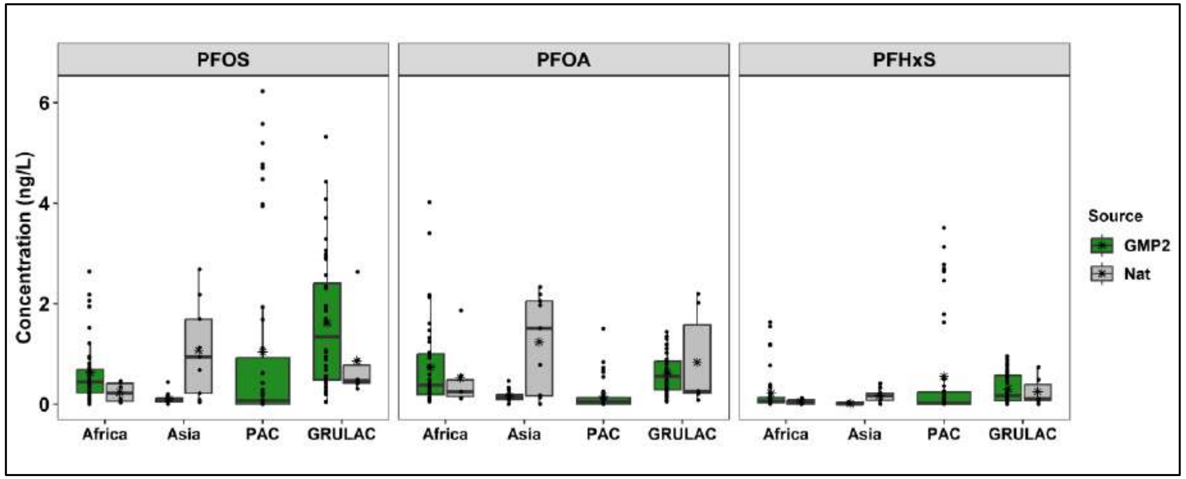
Water

for PFAS and active sampling only

- Results from water network were sent to national coordinators (and UNEP) on 29 August 2020
  Other water results were sent as part of the national samples
- Results for water and air samples were presented at the on-line regional workshop in October 2020
- The water results are contained in the UNEP regional report for Africa
  (HF sent to UNEP in March 2023, not yet published)
- A global report, summarizing PFAS results from all water samples are contained in a global report for water
  (HF sent to UNEP in January 2023, not yet published)

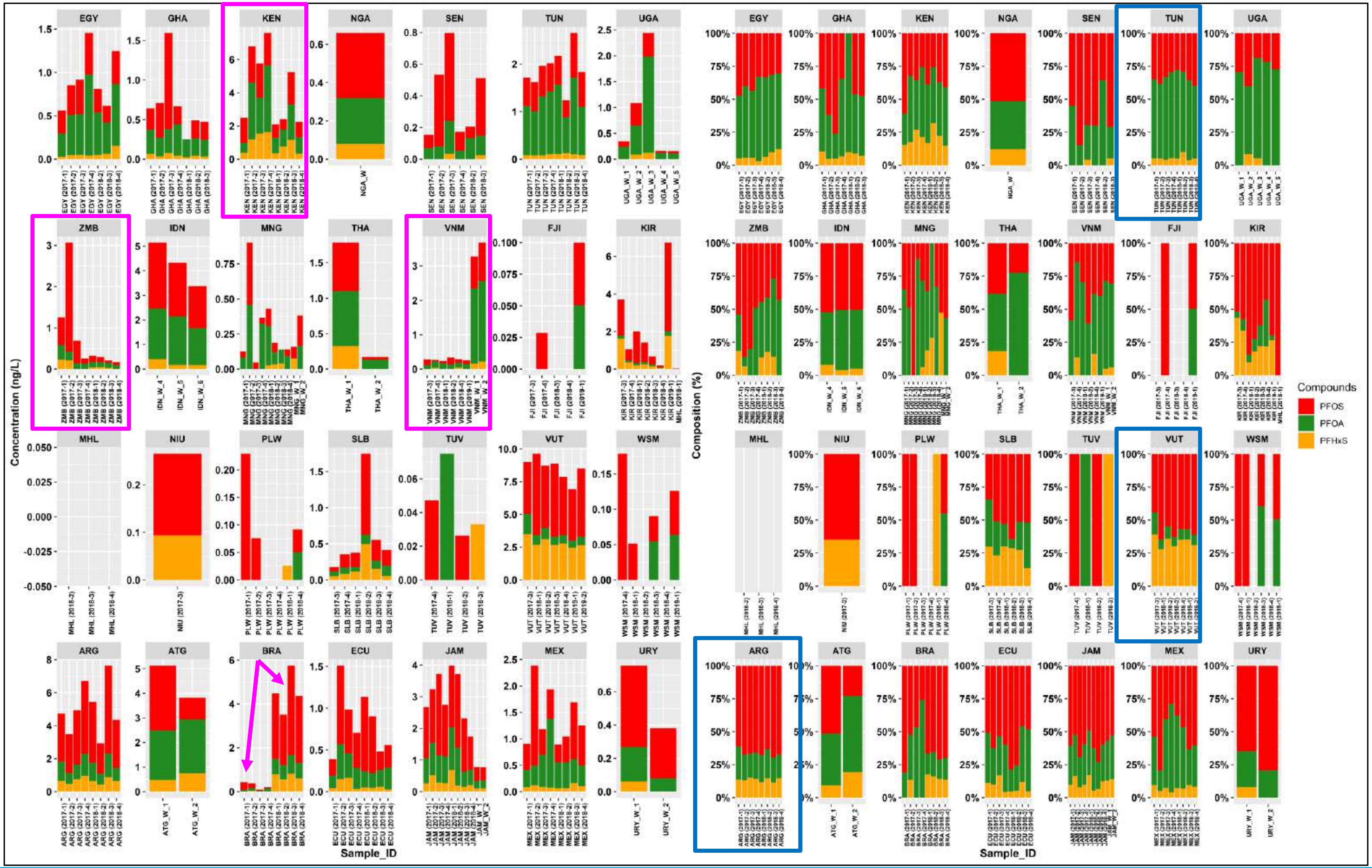
PFAS in water overview

- 168 water samples were analyzed for PFAS, of these:
  - 144 were from GMP2 water network
  - 24 samples were submitted as national samples
- In comparison, the amounts were low
- Maximum values from GMP2 were in Africa (PFOA) and PAC (PFOS and PFHxS)



	Africa		Asia		PAC	GRULAC		Overall	
	GMP2 (N=44)	Nat (N=6)	GMP2 (N=14)	Nat (N=9)	GMP2 (N=46)	GMP2 (N=40)	Nat (N=6)	GMP2 (N=144)	Nat (N=21)
PFOS (ng/L)									
Mean (SD)	0.64 (0.64)	0.23 (0.20)	0.11 (0.11)	1.07 (0.95)	1.04 (1.85)	1.61 (1.35)	0.86 (0.89)	0.99 (1.39)	0.77 (0.83)
Median [Min, Max]	0.45[0, 2.64]	0.22 [0.03, 0.45]	0.07 [0, 0.44]	0.94 [0.04, **2.68**]	0.07 [0, **6.23**]	1.35 [0.04, 5.32]	0.47 [0.30, 2.63]	0.37 [0, 6.23]	0.44 [0.03, 2.68]
PFOA (ng/L)									
Mean (SD)	0.73 (0.85)	0.52 (0.68)	0.176 (0.12)	1.24 (0.97)	0.16 (0.30)	0.62 (0.40)	0.83 (0.99)	0.46 (0.60)	0.92 (0.91)
Median [Min, Max]	0.38 [0.05, **4.02**]	0.24 [0.11, 1.86]	0.13 [0, 0.46]	1.51 [0, **2.33**]	0.05 [0, 1.51]	0.55[0.05 1.44]	0.25 [0.08, 2.20]	0.23 [0, 4.02]	0.26 [0, 2.33]
PFHxS (ng/L)									
Mean (SD)	0.22 (0.40)	0.05 (0.06)	0.01 (0.02)	0.17 (0.14)	0.55 (1.05)	0.31 (0.30)	0.26 (0.30)	0.33 (0.67)	0.16 (0.19)
Median [Min, Max]	0.06 [0, 1.63]	0.04 [0, 0.13]	0 [0, 0.05]	0.16 [0, 0.41]	0.01 [0, **3.51**]	0.17 [0, 0.95]	0.11 [0, **0.74**]	0.06 [0, 3.51]	0.10 [0, 0.74]

Scale and pattern by sample



Pattern: stable

Scale: large variation

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Priority perfluoroalkyl substances in surface waters - A snapshot survey from 22 developing countries

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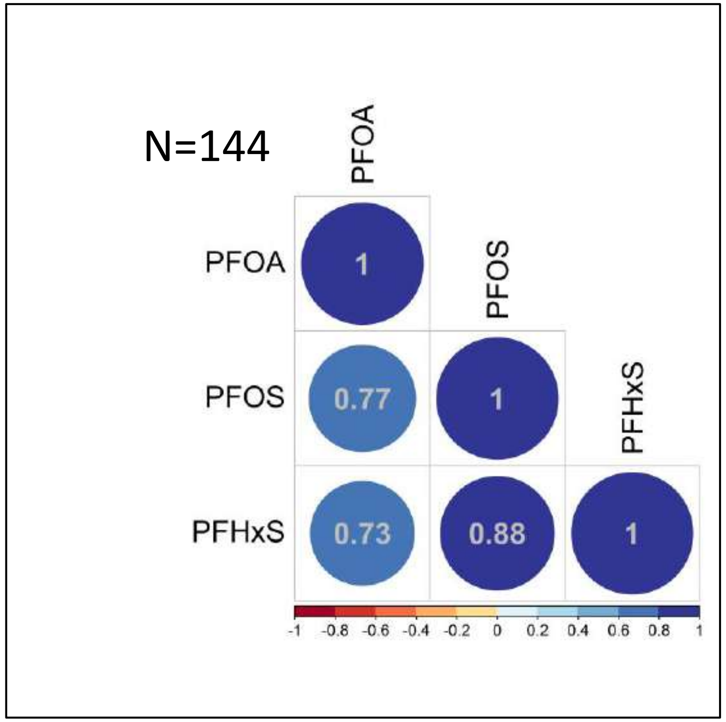
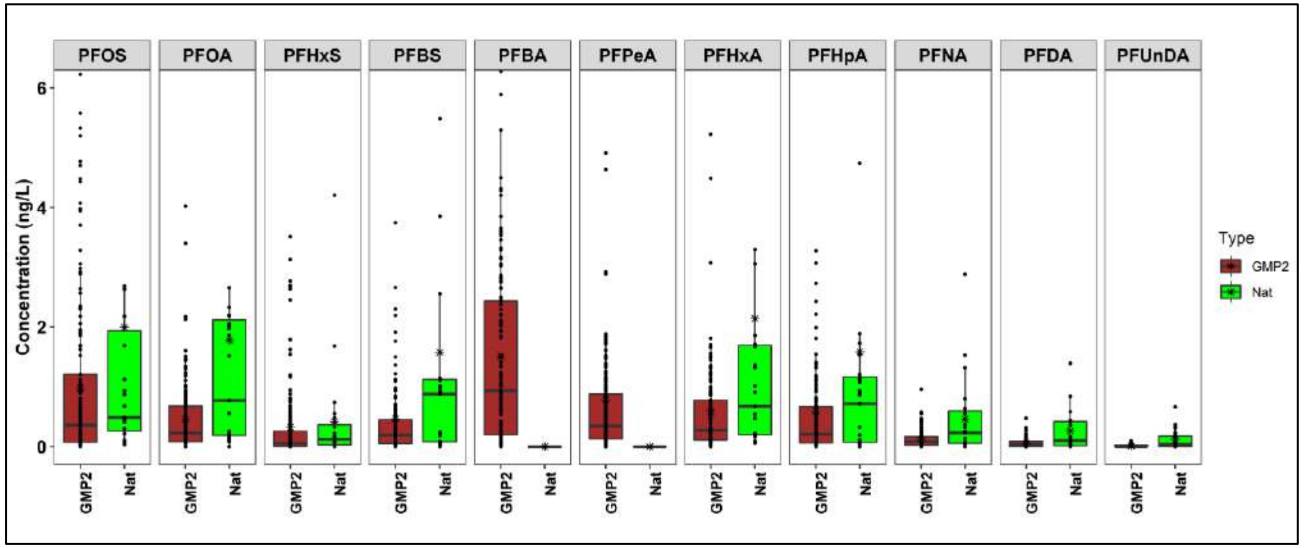
https://doi.org/10.1016/j.chemosphere.2021.129612



- Water sampling approach with 4 samples per year successfully tested and recommended for future monitoring projects
- VUT, ARG: stable scale and pattern at measurable concentrations, incl. PFHxS.
- KEN, KIR: larger differences between measurements; quite stable pattern
- BRA: change of sampling location -> difference in scale



Human milk (PFAS)

- Results of GMP2 samples were sent to national coordinators (and UNEP) on 8 August 2020
- Results for national samples and human milk were presented at on-line regional workshop in November 2021
- All human milk results for listed substances are contained in the UNEP regional report for Africa
  (HF sent to UNEP in March 2023, not yet published)
- Stored human milk samples, prior to 2016, were re-analyzed by MTM Örebro University and published in a peer-reviewed journal (2022). Includes sub-samples from Brazil (2012)
- These samples are referenced as WHO milk in the dwh and not according to performing laboratory or donor

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Regional occurrence of perfluoroalkane substances in human milk for the global monitoring plan under the Stockholm Convention on Persistent Organic Pollutants during 2016–2019

Heidelore Fiedler*, Mohammad Sadia

Front. Environ. Sci. Eng. 2022, 16(10): 132
https://doi.org/10.1007/s11783-022-1541-8

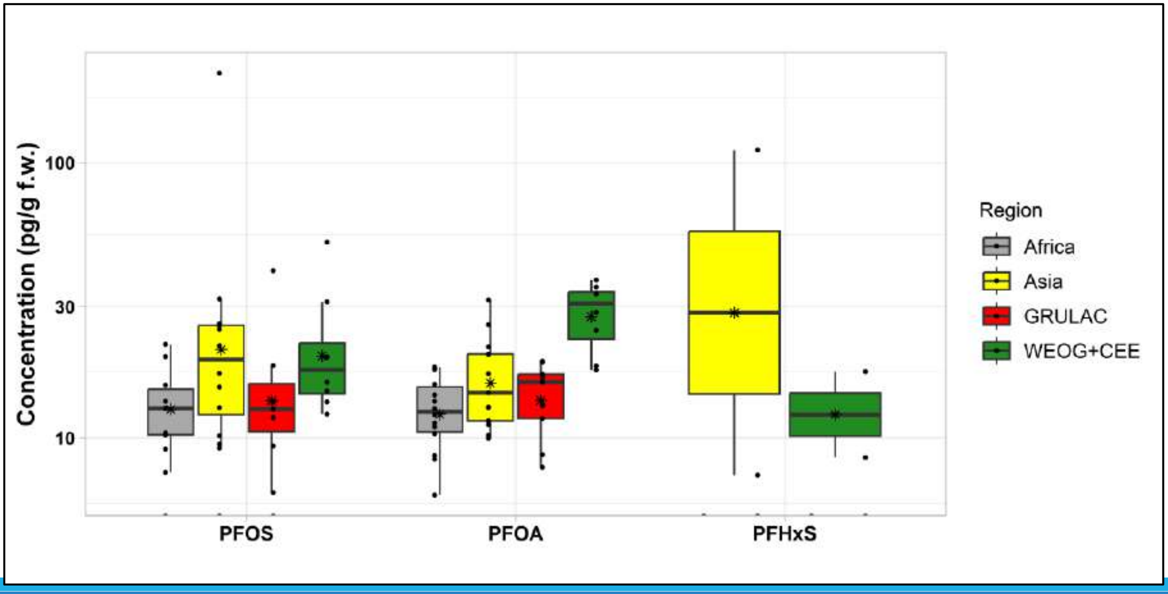
RESEARCH ARTICLE

Perfluoroalkane acids in human milk under the global monitoring plan of the Stockholm Convention on Persistent Organic Pollutants (2008–2019)

Heidelore Fiedler (✉)[1], Mohammad Sadia[1,#], Thomas Krauss[2], Abeer Baabish[1], Leo W.Y. Yeung[1]

SC PFAS in human milk (GMP2)

	Africa (N=14)	Asia (N=13)	GRULAC (N=9)	WEOG+CEE (N=8)	Overall (N=44)
PFOS					
Mean (SD)	9.55 (7.34)	32.0 (54.8)	12.5 (12.1)	22.3 (13.2)	19.1 (31.6)
Median [Min, Max]	10.3 [0, 21.9]	17.2 [0, 212]	11.8 [0, 40.5]	17.8 [12.2, 51.4]	13.2 [0, 212]
PFOA					
Mean (SD)	12.7 (3.75)	16.9 (6.67)	14.3 (4.19)	28.6 (7.66)	17.2 (7.87)
Median [Min, Max]	12.5 [6.20, 18.1]	14.6 [9.98, 31.8]	15.9 [7.81, 19.0]	31.0 [17.7, 37.4]	15.8 [6.20, 37.4]
PFHxS					
Mean (SD)	0	9.11 (30.7)	0	3.24 (6.46)	3.28 (16.9)
Median [Min, Max]	0	0 [0, 111]	0	0 [0, 17.4]	0 [0, 111]

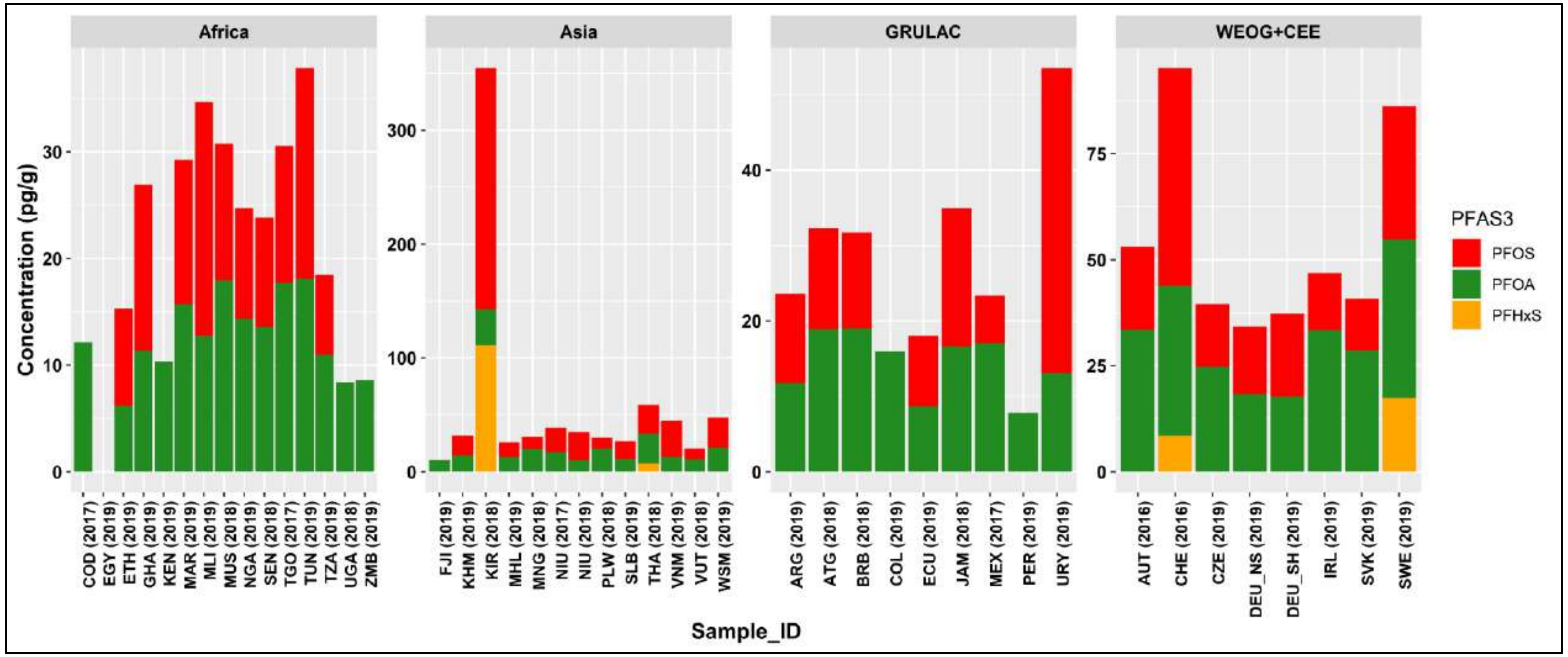


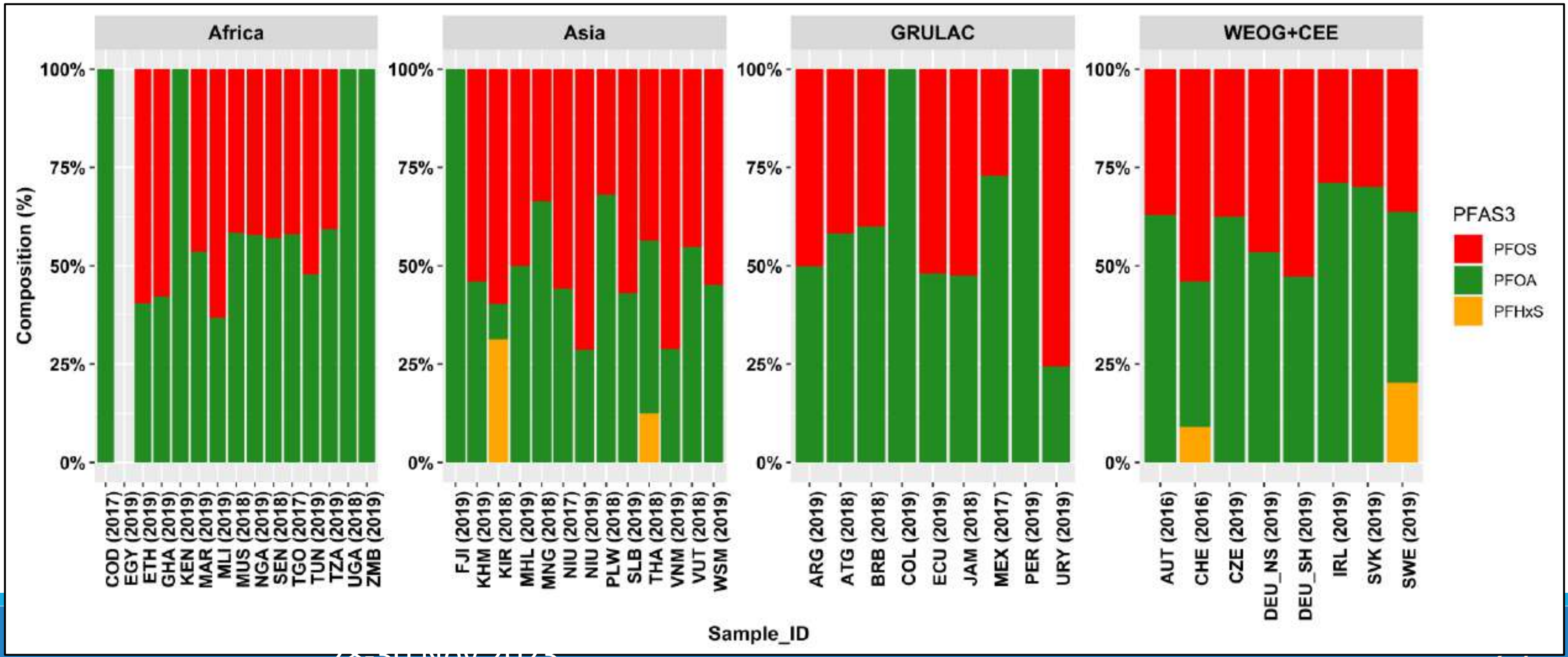
- High PFOS and PFHxS values for Kiribati drive mean values for Asia
- PFHxS not quantified in Africa and GRULAC

Note: y-axis in log scale

Human milk PFAS3 – GMP2 n=44

- KIR extrem values for PFOS + PFHxS
- PFHxS only quantified in KIR, THA, CHE, SWE
- No sample from Egypt received






Chemosphere 277 (2021) 130287

Contents lists available at ScienceDirect

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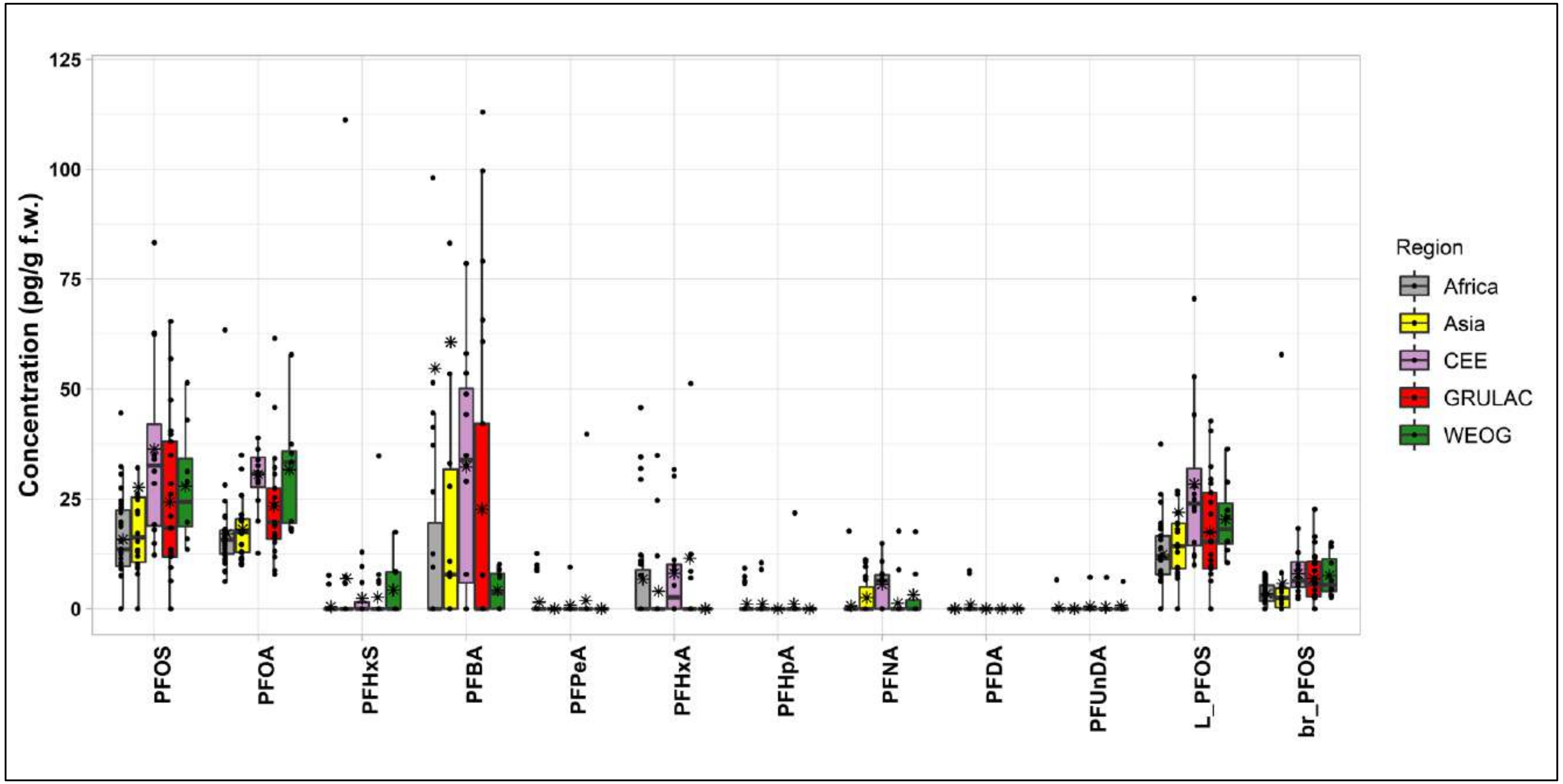
journal homepage: www.elsevier.com/locate/chemosphere

Regional occurrence of perfluoroalkane substances in human milk for the global monitoring plan under the Stockholm Convention on Persistent Organic Pollutants during 2016–2019

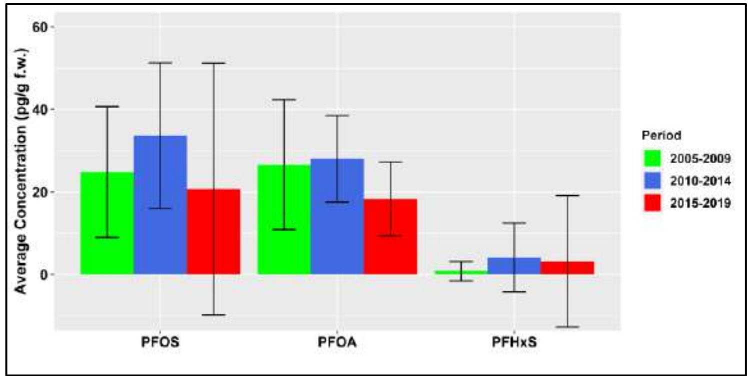
Heidelore Fiedler*, Mohammad Sadia

Human milk: PFAS re-analysis of all samples

Re-analysis of PFAS in historic pools PFAS necessary: (1) more substances, and (2) improved analytical method

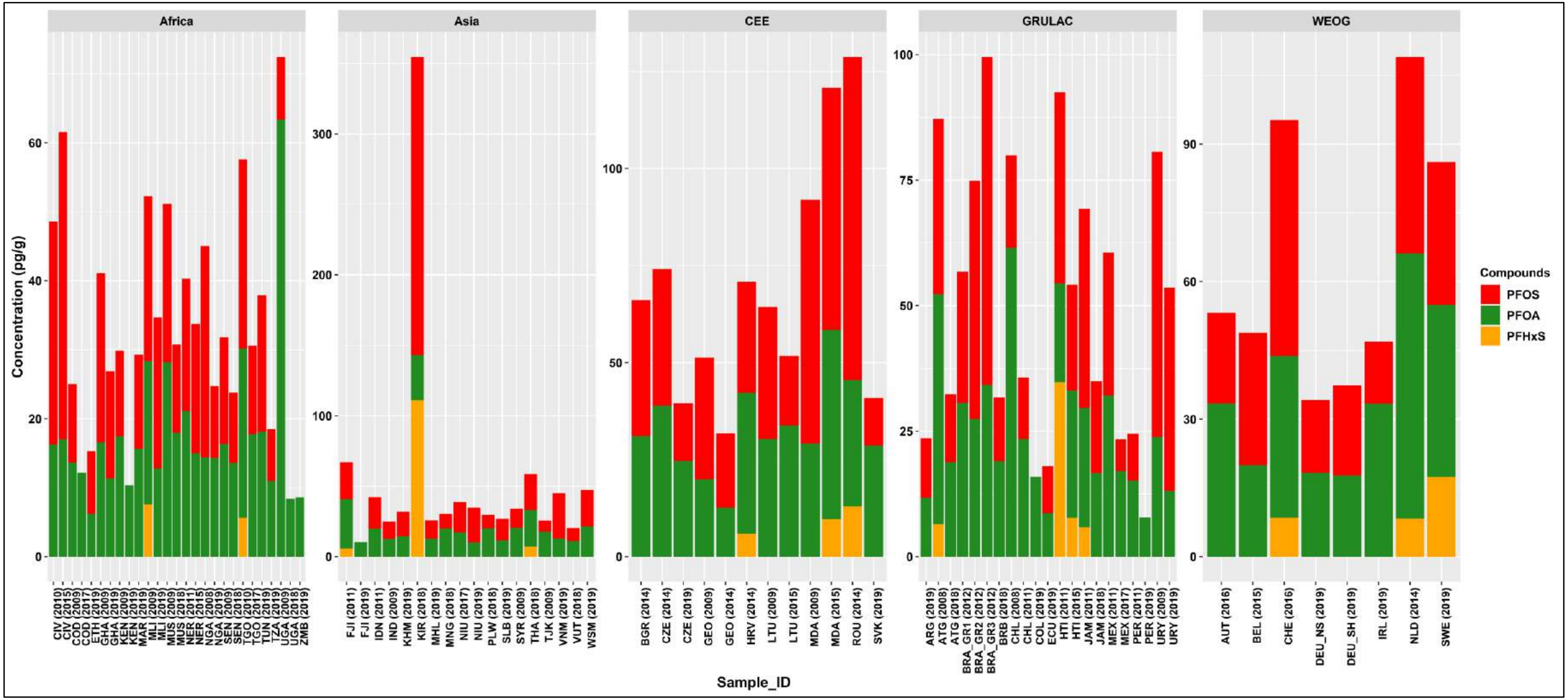


10 PFAS could be quantified in 84 national pools (Brazil = 3 pools, GR1, GR2, GR3)



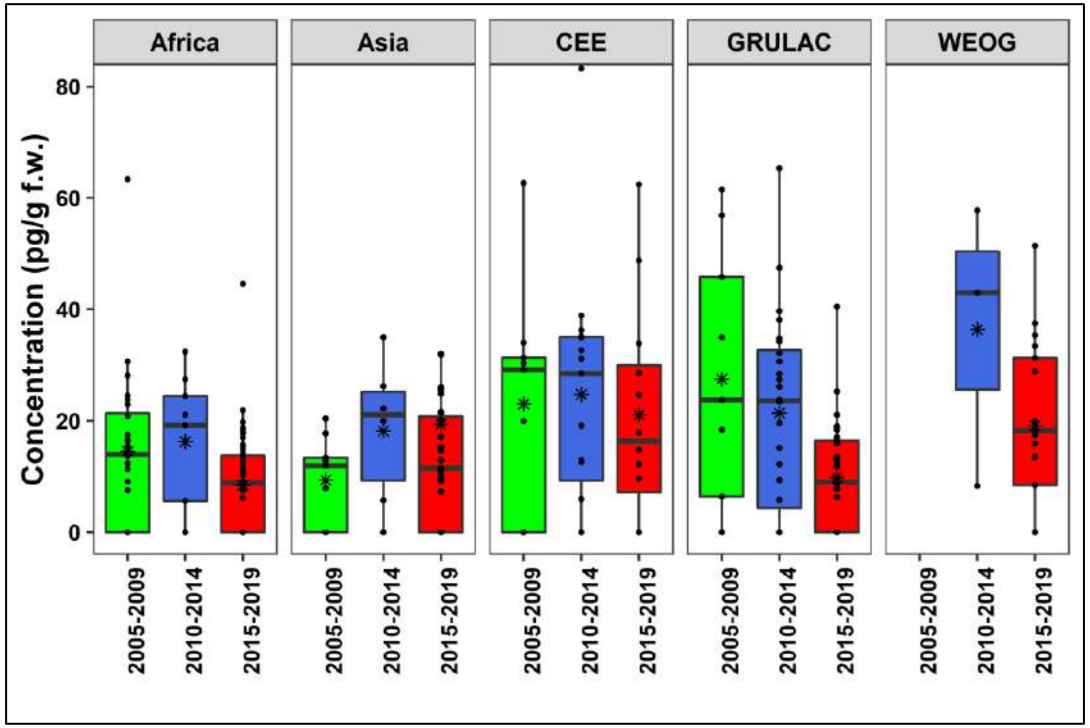
Fiedler H, Sadia M, Krauss T, Baabish A, Yeung L W Y (2022). Perfluoroalkane acids in human milk under the global monitoring plan of the Stockholm Convention on Persistent Organic Pollutants (2008-2019). Frontiers of Environmental Science & Engineering, 16(10): 132

Human milk: 3 PFAS (N=86)



PFHxS: African samples - quantified in Mali (2009) and Togo (2010), but not in subsequent years

Trends for PFAS3

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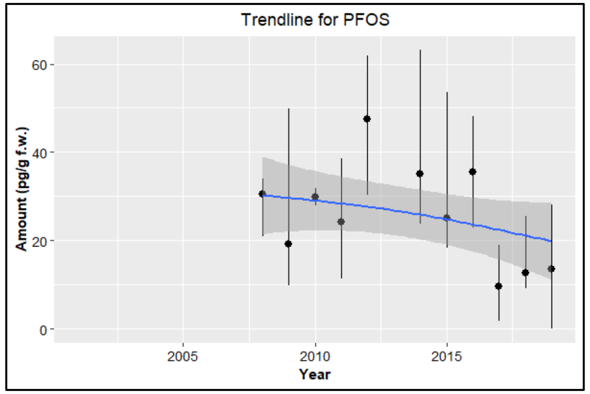
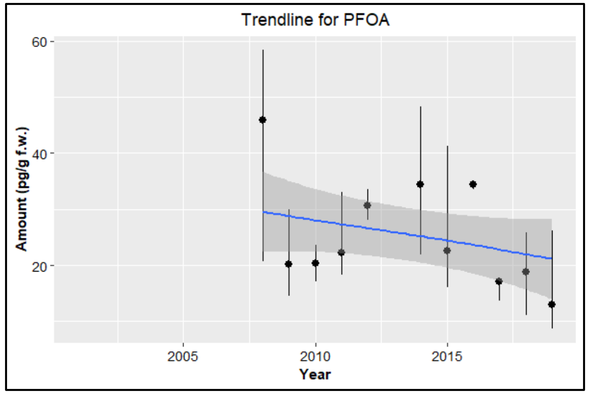
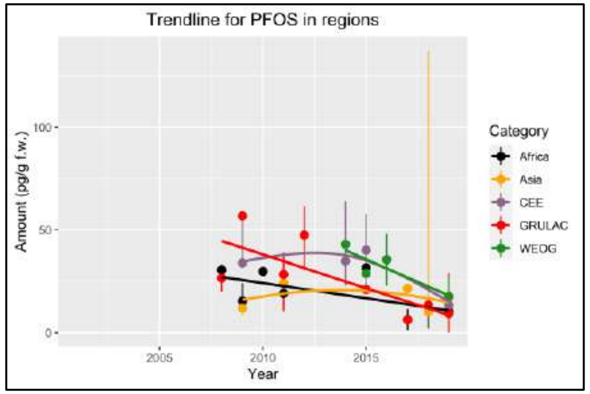
journal homepage: www.elsevier.com/locate/chemosphere

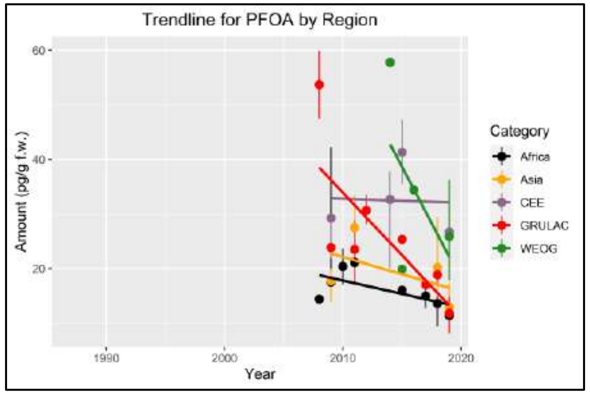
Persistent organic pollutants in human milk from *primiparae* – correlations, global, regional, and national time-trends

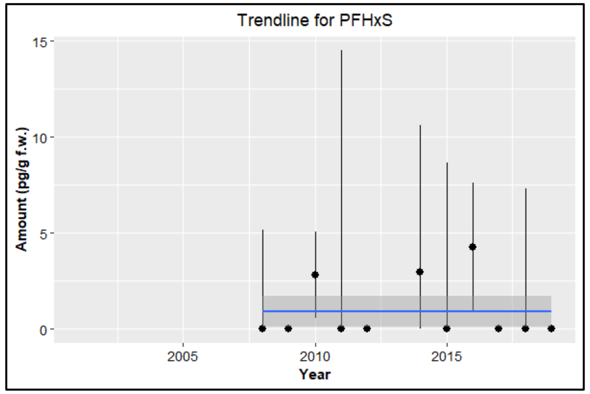
Heidelore Fiedler[a,*], Xue Li[b], Jin Zhang[c]

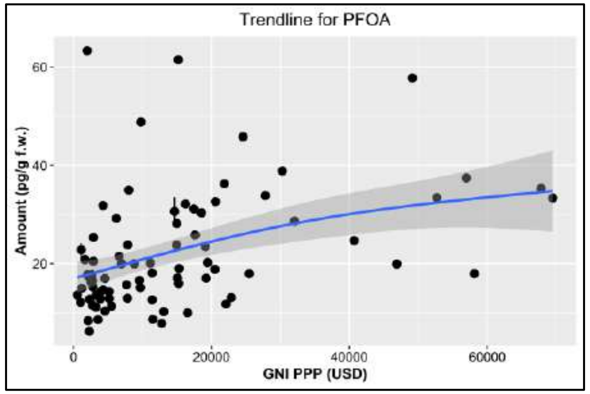












Summary and conclusions

- Sampling and analysis programme generated a wealth of quantitative data as to the scale of POPs present in 42 countries and other metadata. Analytical methods have been modified and adapted to reach high performance.
- Assessment as to significance for regional interpretation or usefulness of the data not known.
- It is of outmost importance to implement the sampling and analytical protocols to achieve coherent datasets for further assessment. Long time for execution of the project considered to be the biggest draw-back.
  - The water sampling implementation must be valuated as success and according to the GMP guidance document.
  - Gaps in PAS/PUF sampling when wrong PUFs were exposed so that not all POPs could be determined. Sampling frequency (as to years) needs to be agreed.
- Component of national samples with mirror analysis disappointing: only 28 of 42 countries sent national samples, 33% did not have have samples of their national interest analyzed in an expert laboratory. Further, the majority of POPs labs did not take the opportunity to test their own chemical analytical capacities in these mirror samples.
  Africa=11 of 15 participating countries sent samples, Asia=4 of 7, Pacific Islands=4 of 9, GRULAC=9 of 11.
- Component with active air sampler only punctual implementation.
- Missed opportunity: POPs under consideration for listing in the Stockholm Convention have been analyzed and data from developing countries became available.
- Monitoring results for PFAS and dl-POPs of UNEP/GEF GMP2 projects were not included in the global report (and regional reports) prepared for the COP.

Final meeting of the UNEP/GEF project
“Continuing Regional Support for the POPs Global Monitoring Plan under the Stockholm Convention in the Africa Region”

28-30 November 2023
Casablanca, Morocco

Key findings on POPs monitoring in the Africa Region: Human milk survey

Rainer Malisch
CVUA Freiburg, Germany

WHO/UNEP-coordinated human milk studies on POPs

- Starting point: participation of 15 countries from Africa in the 2016-2019 study
- Discussion of these results in a wider context

Coordinator	Round	Period	N (countries)	Coverage of POPs
WHO	1	1987-1988	19	PCB, PCDD/PCDF
WHO	2	1992-1993	19	PCB, PCDD/PCDF
WHO	3	2000-2003	26	21 POPs
Joint WHO/UNEP	4	2005-2007	13	21 POPs
Joint WHO/UNEP	5	2008-2012	45	22 POPs
UNEP	6	2014-2015	17	22 POPs
UNEP	7	2016-2019	43	30 listed + 2 proposed POPs

2000-2019:

- 82 countries (19 from Africa)
- Increasing number of analytes of interest

Comprehensive results available for samples of the 2016-2019 period

		COP No	Year	Parameter	Parent POPs	Transformation products	No of analytes
			2001	**1. Initial 12 POPs**			
1	1			Aldrin	Aldrin		1
2	2			Chlordane	cis- and trans-chlordane	cis- and trans-nonachlor, oxychlordane	5
3	3			DDT	p,p'-DDT, o,p'-DDT	p,p'-DDE, o,p'-DDE, p,p'-DDD, o,p'-DDD	6
4	4			Dieldrin	Dieldrin		1
5	5			Endrin	Endrin	Endrin ketone	2
6	6			Heptachlor	Heptachlor	Heptachlorepoxide	2
7	7			Hexachlorbenzene (HCB)	Hexachlorbenzene		1
8	8			Mirex	Mirex		1
9	9			Polychlorinated biphenyls (PCB)	ΣPCB6 (6 "indicator congeners"): 28, 52, 101, 138, 153, and 180		6
					PCB with TEFs* (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189		12
10	10			Toxaphene	Congeners P26, P50, P62		3
11	11			Polychlorinated dibenzo-p-dioxins (PCDD)	2,3,7,8-substituted PCDD (7 congeners)		7
12	12			Polychlorinated dibenzofurans (PCDF)	2,3,7,8-substituted PCDF (10 congeners)		10
				* PCB with TEFs (Toxic Equivalency Factors) assigned by WHO in 1998			
		COP No	Year	Parameter	Parent POPs	Transformation products	
		COP-4	2009	**2. New POPs**			
13	1			Alpha hexachlorocyclohexane (alpha-HCH)	alpha-HCH		1
14	2			Beta hexachlorocyclohexane (beta-HCH)	beta-HCH		1
15	3			Gamma hexachlorocyclohexane (gamma-HCH), common name: Lindane	gamma-HCH		1
16	4			Chlordecone	Chlordecone		1
17	5			Pentachlorobenzene	Pentachlorbenzene		1
18	6			Hexabromobiphenyl (HBB)	PBB 153		1
19	7			Tetra- and pentabromodiphenyl ether	PBDE 47, 99; optional: PBDE 100		2
20	8			Hexa- and heptabromodiphenyl ether	PBDE 153, 154, 175/183 (co-eluting)		3
21	9			Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF)	PFOS (linear and branched isomers)		
		COP-5	2011	**3. new POPs**			
22	1			Technical endosulfan and related isomers	alpha-, beta-endosulfan, endosulfan sulfate		4
		COP-6	2013	**4. new POPs**			
23	1			Hexabromocyclododecane (HBCD)	alpha-, beta-, gamma-HBCD		3
		COP-7	2015	**4. new POPs**			
24	1			Hexachlorobutadiene	HCBD		1
25	2			Pentachlorophenol + salts		[Pentachloranisole (PCA)]	2
26	3			Polychlorinated naphthalenes	[PCN *(congeners to be decided)*]		21
		COP-8	2017	**5. new POPs**			
27	1			Decabromodiphenylether (DecaBDE)	PBDE-209		1
28	2			Short-chained chlorinated paraffins (SCCPs)	[SCCP] *)		thousands
(24)	3			Hexachlorbutadiene	HCBD		(1)
		COP-9	2019	**6. new POPs**			
29	1			Dicofol	[Dicofol]		1
30	2			PFOA and salts	PFOA		
				Proposed for listing			
31				Medium-chained chlorinated paraffins (MCCPs)			thousands
32				Perfluorhexane sulfonic acid	PFHxS		
		[POP]: to be decided. Presently, the analytical methods still need further development before analytes can be recommended.					101

Reference laboratories:

CVUA Freiburg, Germany
University Örebro, Sweden

- ✓ **30 listed POPs**
- ✓ **2 proposed POPs**
  - ➢ 101 chlorinated/ brominated analytes without CPs; thousands for CPs
  - ➢ PFOS (linear and branched), PFOA, PFHxS

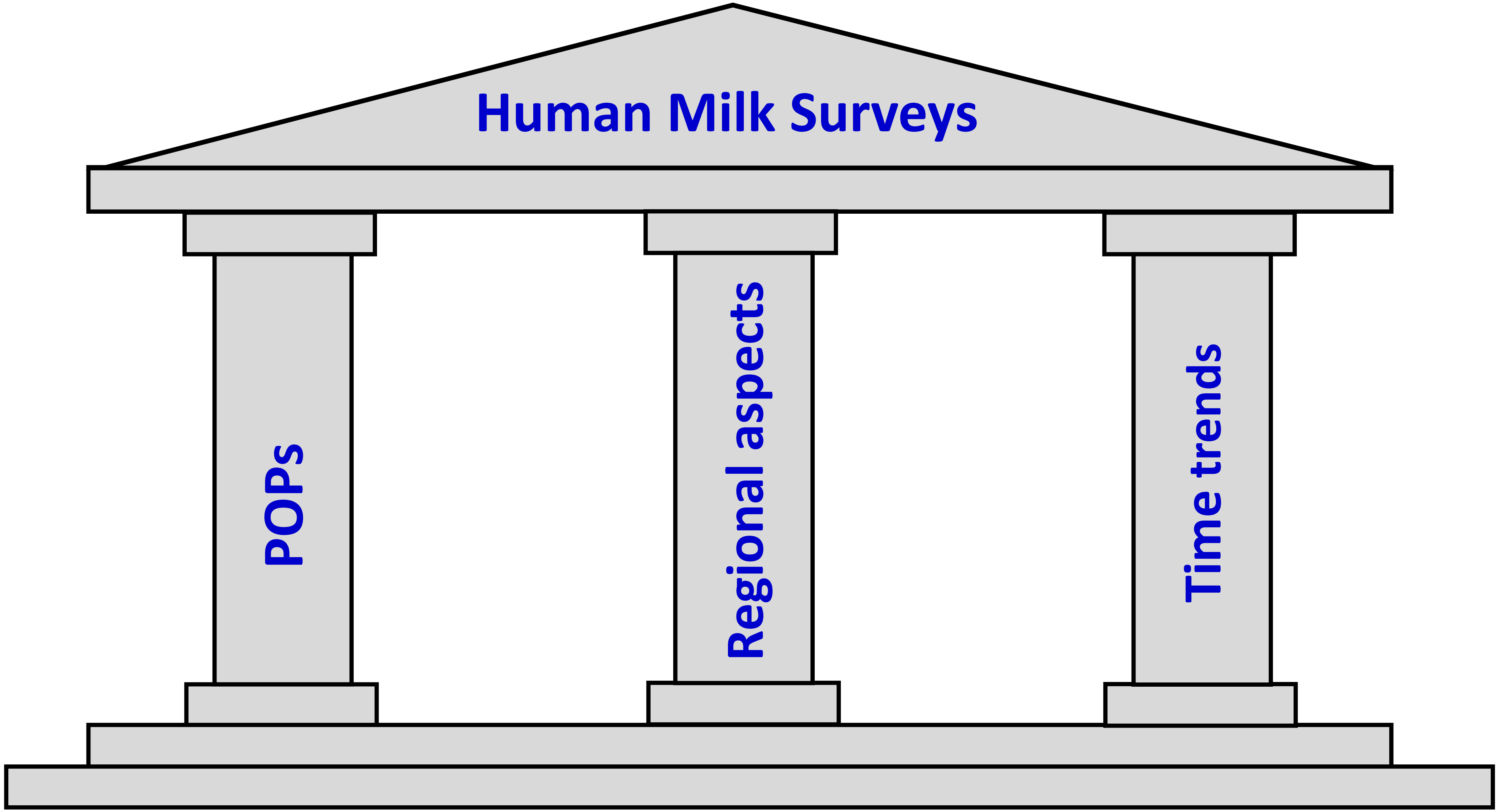
No multi-method for simultaneous determination –
about half a dozen of different analytical methods necessary

Unique characteristic among the core matrices of the GMP: results for the full set of 32 POPs of interest available for samples of the 2016-2019 period

including

- **decabromodiphenyl ether [PBDE-209]** and **short-chain chlorinated paraffins [SCCP]** as listed in 2017
- **dicofol** and **perfluorooctanoic acid [PFOA]** as listed in 2019,
- **medium-chain chlorinated paraffins [MCCP]** and **perfluorohexane sulfonic acid [PFHxS]** as proposed for listing

Three pillars



- 30 listed POPs
- 2 proposed POPs

- Countries
- UN-Regions
- Global

Art. 16:
Effectiveness evaluation

Presentation of results for the three pillars

- Presentation of concept, analysis, results and discussion of these global studies for these POPs: complex task which cannot be fulfilled in one presentation/publication
- Therefore, a series of publications as chapters to five parts of compendium “Persistent organic pollutants in human milk”

➢ Open access

➢ Supported by UNEP and CVUA Freiburg

Content

I Introduction

II Analytical methods and quality control

III WHO/UNEP-coordinated exposure studies 2000-2019: results of chlorinated and brominated POPs and discussion

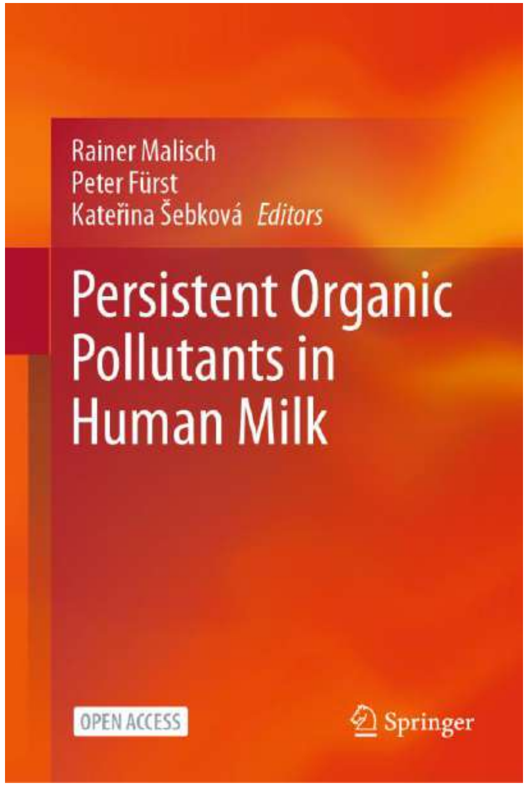
- (i) PCB, PCDD and PCDF;
- (ii) chlorinated pesticides and industrial chemicals;
- (iii) polybrominated substances;
- (iv) chlorinated paraffins;
- (v) polychlorinated naphthalenes.

IV Assessments

- ✓ time trends:
  - PCB, PCDD/PCDF,
  - Selected chlorinated pesticides
  - PFAS
- ✓ risk-benefit analysis for dioxin-like compounds

V Summary and conclusions

1	Alvarez	Jacqueline
2	Dambacher	Benjamin
3	Falandysz	Jerzy
4	Fernandes	Alwyn
5	Fürst	Peter
6	Hardebusch	Björn
7	Kalina	Jiří
8	Klánová	Jana
9	Krätschmer	Kerstin
10	Kypke	Karin
11	Lippold	Ralf
12	Malisch	Karin
13	Malisch	Rainer
14	Moy	Gerald
15	Peterson	Richard E.
16	Polley	Julia
17	Sapunova	Daria
18	Schächtele	Alexander
19	Šebková	Kateřina
20	Tritscher	Angelika
21	Tschiggfrei	Karin
22	van den Berg	Martin
23	van Duursen	Majorie
24	van Leeuwen	Rolaf
25	Vetter	Walter
26	Witt	Ana
27	Zwickel	Theresa

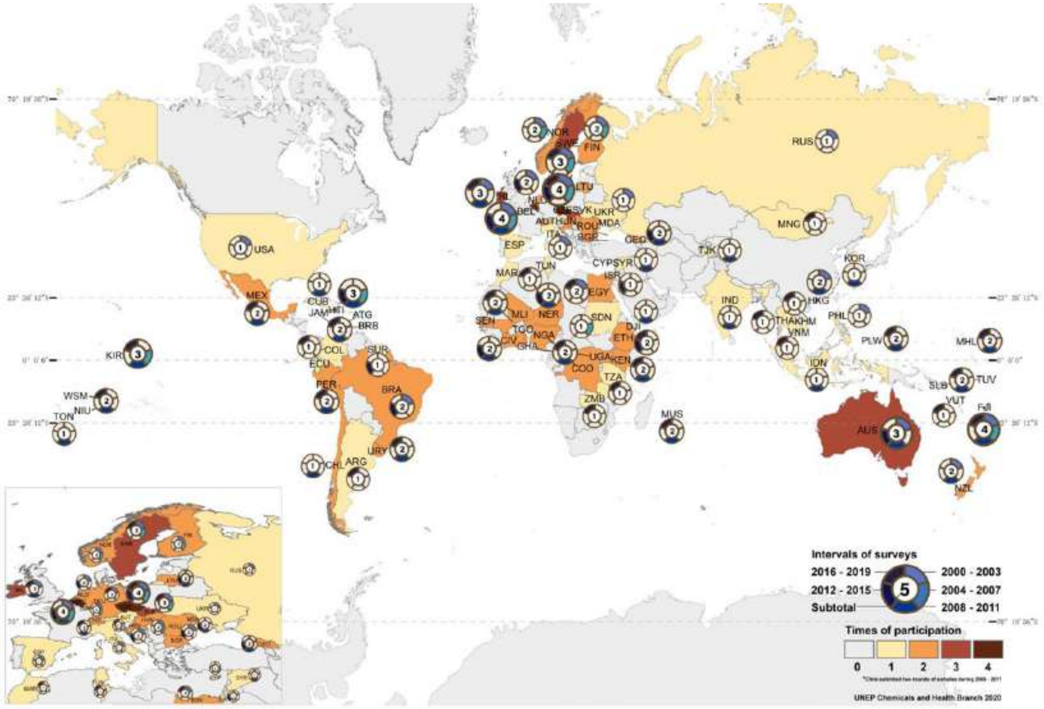


https://link.springer.com/book/10.1007/978-3-031-34087-1

Key message A – Efficient and effective tool with global coverage as key contributor to the Global Monitoring Plan (GMP)

Concept of the WHO- and/or UNEP-coordinated exposure studies:

- ✓ collection of (usually 50) individual samples from mothers fulfilling protocol criteria;
- ✓ preparation of **pooled** (physically averaged) **samples considered to be representative for a country/subgroup**;
- ✓ analysis of the pooled samples in reference laboratories contributes to reliability and reduces uncertainty
- ➢ **Cost-effective concept: Analysis of one or few pooled representative human milk samples is far less expensive than the analysis of a high number of individual samples, particularly for PCDD/PCDF or CPs**



Global coverage 2000 – 2019: 82 countries

Key message B – Relative importance (“ranking”) of chemicals

		COP No	Year	Parameter	Parent POPs	Transformation products	No of analytes
			2001	**1. Initial 12 POPs**			
1	1			Aldrin	Aldrin		1
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3	3			DDT	p,p'-DDT, o,p-DDT	p,p'-DDE, o,p'-DDE, p,p-DDD, o,p'-DDD	6
4	4			Dieldrin	Dieldrin		1
5	5			Endrin	Endrin	Endrin ketone	2
6	6			Heptachlor	Heptachlor	Heptachlorepoxide	2
7	7			Hexachlorbenzene (HCB)	Hexachlorbenzene		1
8	8			Mirex	Mirex		1
9	9			Polychlorinated biphenyls (PCB)	ΣPCB6 (6 "indicator congeners"): 28, 52, 101, 138, 153, and 180		6
					PCB with TEFs* (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189		12
10	10			Toxaphene	Congeners P26, P50, P62		3
11	11			Polychlorinated dibenzo-p-dioxins (PCDD)	2,3,7,8-substituted PCDD (7 congeners)		7
12	12			Polychlorinated dibenzofurans (PCDF)	2,3,7,8-substituted PCDF (10 congeners)		10
				* PCB with TEFs (Toxic Equivalency Factors) assigned by WHO in 1998			
		COP No	Year	Parameter	Parent POPs	Transformation products	
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13	1			Alpha hexachlorocyclohexane (alpha-HCH)	alpha-HCH		1
14	2			Beta hexachlorocyclohexane (beta-HCH)	beta-HCH		1
15	3			Gamma hexachlorocyclohexane (gamma-HCH), common name: Lindane	gamma-HCH		1
16	4			Chlordecone	Chlordecone		1
17	5			Pentachlorobenzene	Pentachlorbenzene		1
18	6			Hexabromobiphenyl (HBB)	PBB 153		1
19	7			Tetra- and pentabromodiphenyl ether	PBDE 47, 99; optional: PBDE 100		2
20	8			Hexa- and heptabromodiphenyl ether	PBDE 153, 154, 175/183 (co-eluting)		3
21	9			Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF)	PFOS (linear and branched isomers)		
		COP-5	2011	**3. new POPs**			
22	1			Technical endosulfan and related isomers	alpha-, beta-endosulfan, endosulfan sulfate		4
		COP-6	2013	**4. new POPs**			
23	1			Hexabromocyclododecane (HBCD)	alpha-, beta-, gamma-HBCD		3
		COP-7	2015	**4. new POPs**			
24	1			Hexachlorobutadiene	HCBD		1
25	2			Pentachlorophenol + salts		[Pentachloroanisole (PCA)]	2
26	3			Polychlorinated naphthalenes	[PCN (congeners to be decided)]		21
		COP-8	2017	**5. new POPs**			
27	1			Decabromodiphenylether (DecaBDE)	PBDE-209		1
28	2			Short-chained chlorinated paraffins (SCCPs)	[SCCP] *)		thousands
(24)	3			Hexachlorobutadiene	HCBD		(1)
		COP-9	2019	**6. new POPs**			
29	1			Dicofol	[Dicofol]		1
30	2			PFOA and salts	PFOA		
				Proposed for listing			
31				Medium-chained chlorinated paraffins (MCCPs)			thousands
32				Perfluorhexane sulfonic acid	PFHxS		
		[POP]: to be decided. Presently, the analytical methods still need further development before analysis can be recommended.					101

Reference laboratories:

CVUA Freiburg, Germany
University Örebro, Sweden

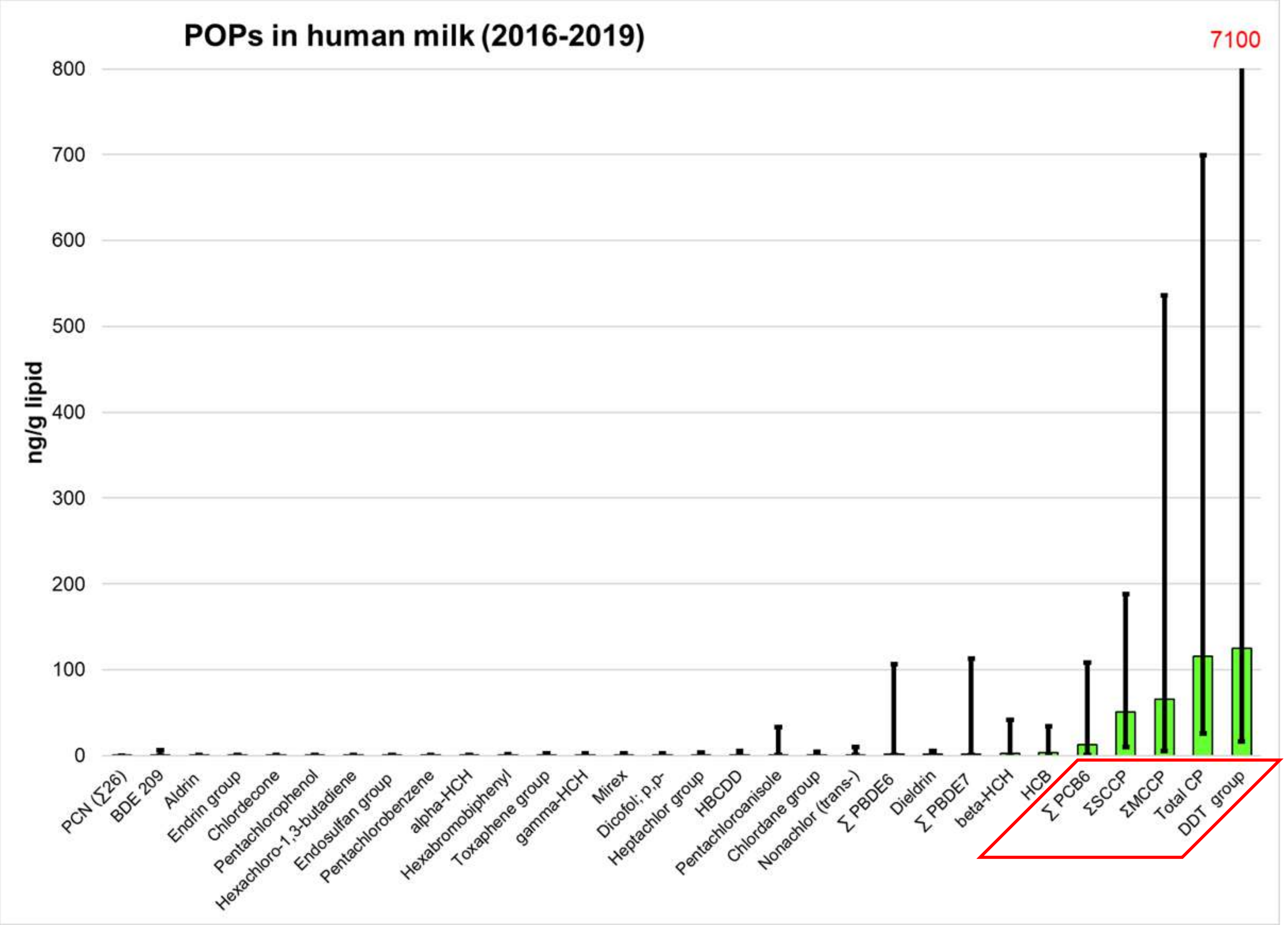
✓ 30 listed POPs

✓ 2 proposed POPs

“Ranking” based on increasing or decreasing concentrations possible for *chlorinated/brominated POPs (ng/g lipid)*

- ***Separate:***
  - ***Dioxin-like compounds: pg/g lipid;***
  - ***PFAS: pg/g fresh weight or ng/L***
- ***Risk assessments need to consider potential adverse effects***

Key message B – Relative importance (“ranking”) of chemicals

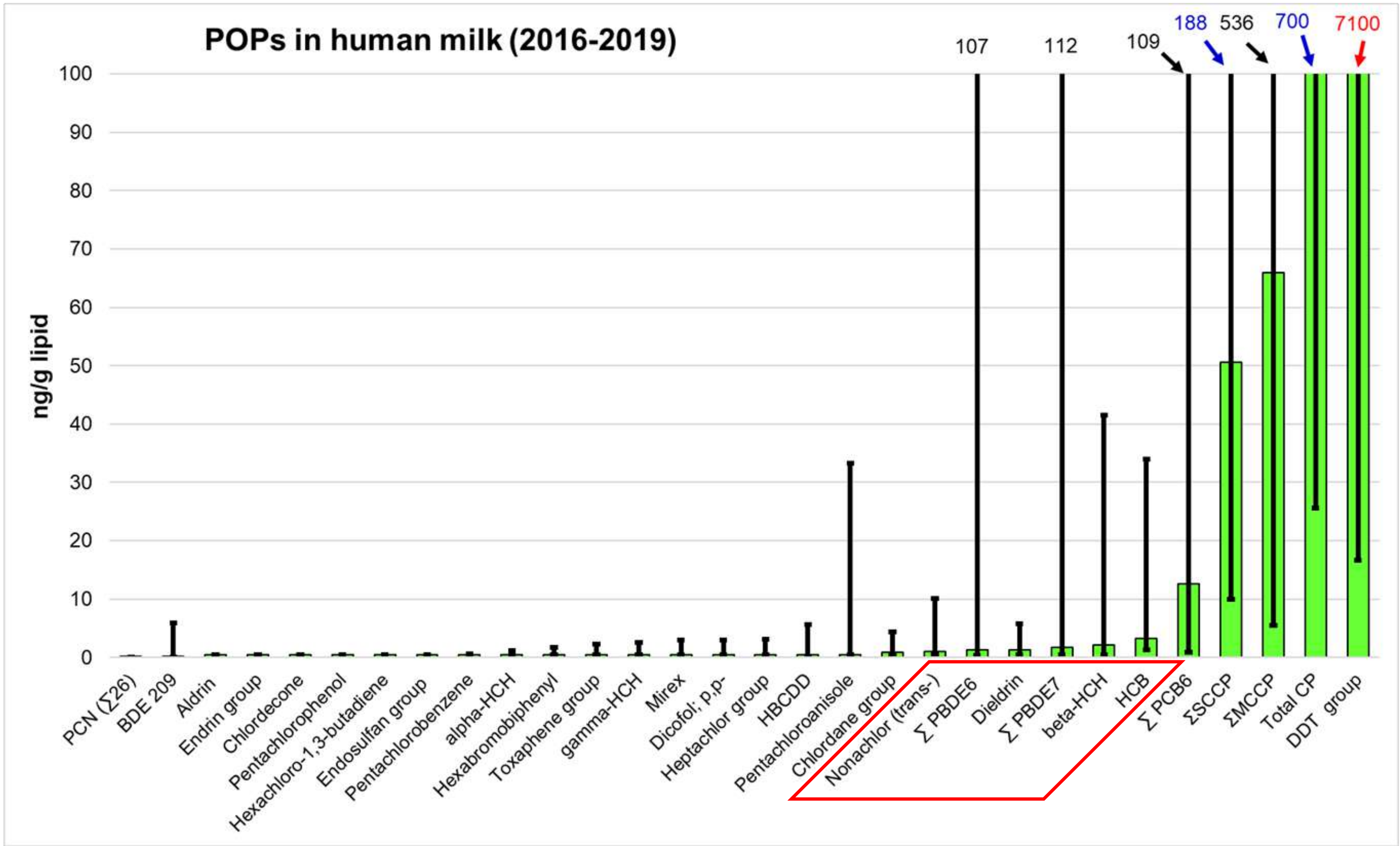


Range of concentrations of lipophilic chlorinated and brominated POPs in human milk (ng/g lipid) from 43 countries in the period 2016-2019
(median with error bars indicating the minimum and maximum)
(*without dioxin-like chemicals [pg TEQ/g lipid]*)

Chlorinated and brominated POPs (1):

- By far highest concentrations found for **DDT** and **chlorinated paraffins**
  - Maximum found for **DDT** *(7100 ng/g lipid)* a factor of 10 higher than for **CPs** *(700 ng/g lipid for the **sum of SCCP and MCCP**)*
  - However, median of **CP** concentrations *(116 ng ∑ SMCCP/g lipid)* comparable to median of **DDT** concentrations *(125 ng/g lipid)*
  - High CP concentrations caused predominantly by **MCCPs** *(median 66 ng/g lipid; maximum 536 ∑ SMCCP ng/g lipid)*, with **SCCP** concentrations of 61 ng/g lipid as median and 188 ng/g lipid as maximum.
- **PCB** as next following group in the ranking of decreasing levels on average an order of magnitude lower concentrations than the **CP** concentrations *(median 12.7 ng **NDL-PCB** /g lipid, maximum 109 ng/g lipid)*

Key message B – Relative importance (“ranking”) of chemicals

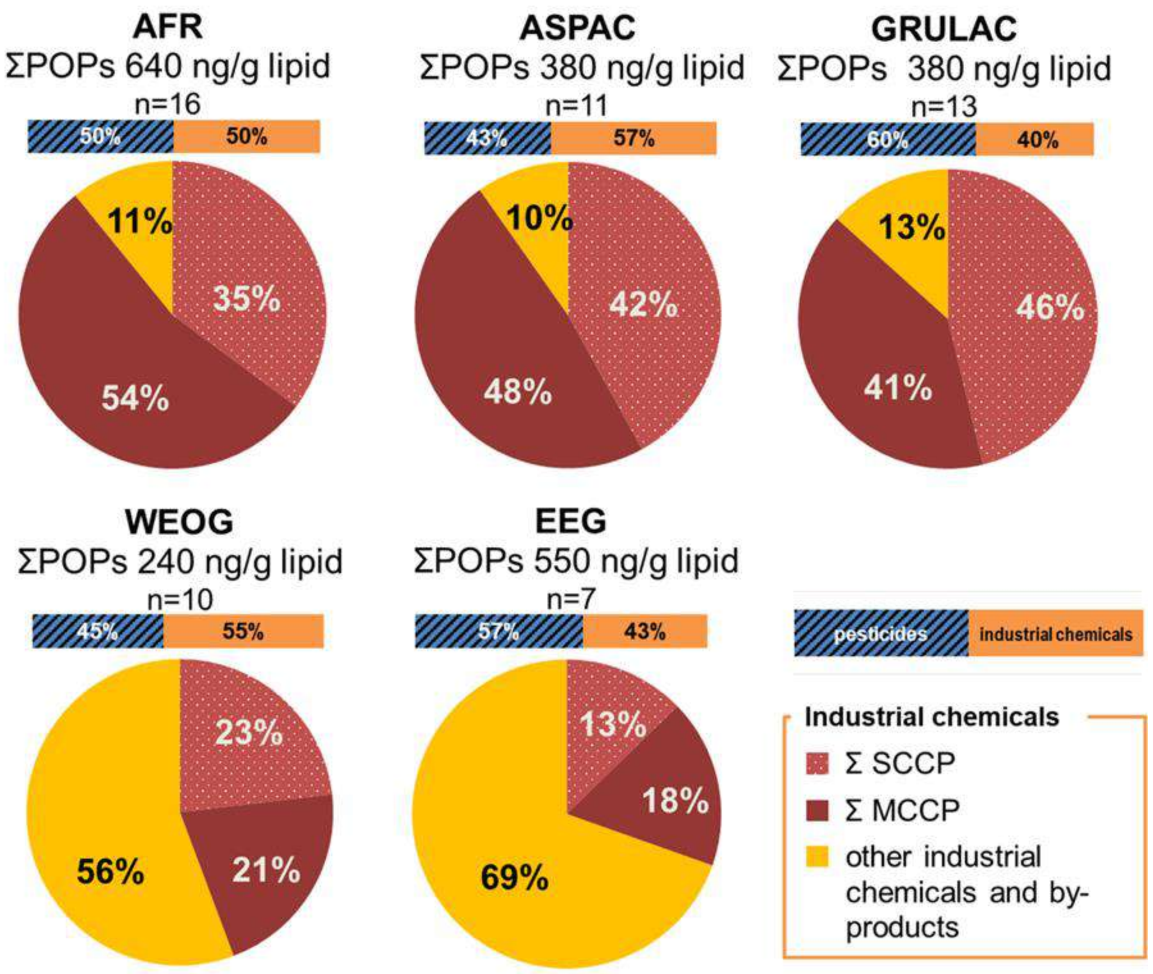


Chlorinated and brominated POPs (2):

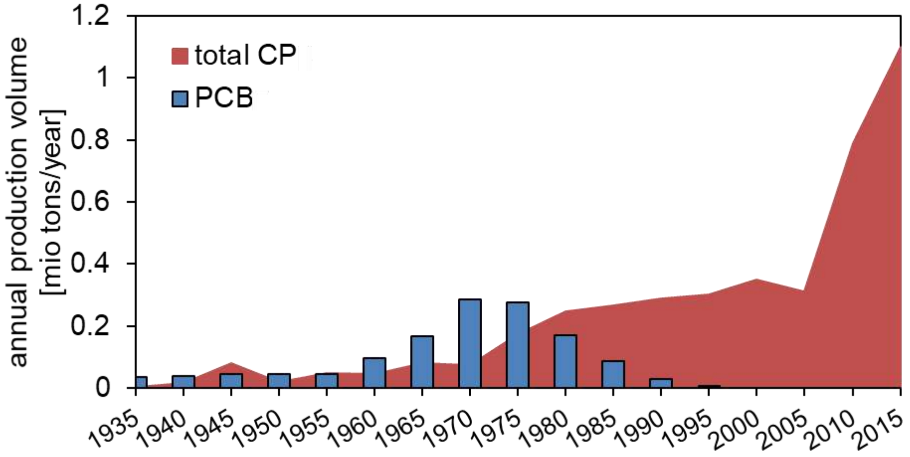
- **Nonachlor, ∑ $PBDE_6$** (and ∑ $PBDE_7$ including BDE-209, **dieldrin, beta-HCH, HCB:** median between 1 ng/g and 10 ng/g lipid, maximum up to 110
- Range below 5 ng/g lipid: seen as **background concentrations**
- Concentrations of **many POPs** frequently below LOQ (0.5 ng/g lipid)

Range of concentrations of lipophilic chlorinated and brominated POPs in human milk (ng/g lipid) from 43 countries in the period 2016-2019
(median with error bars indicating the minimum and maximum)
(without dioxin-like chemicals [pg TEQ/g lipid])

Key message B – Relative importance (“ranking”) of chemicals



- **SCCPs** and **MCCPs dominated** the share of POPs grouped as industrial chemicals and by-products in most areas
- **Cause for follow-up studies and for further (or, in the case of MCCPs, any) regulatory efforts**

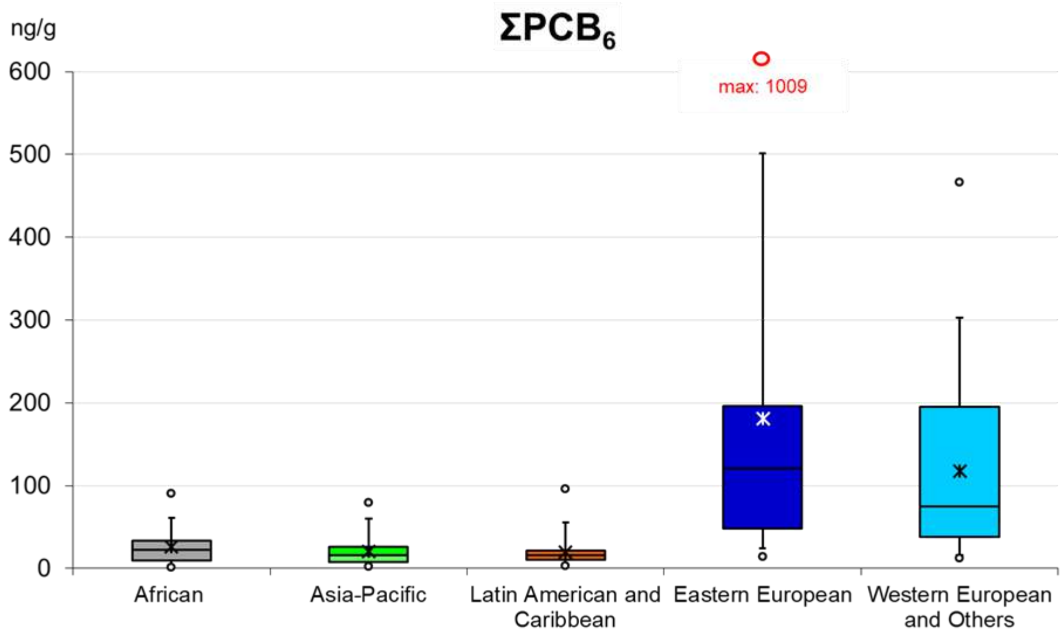


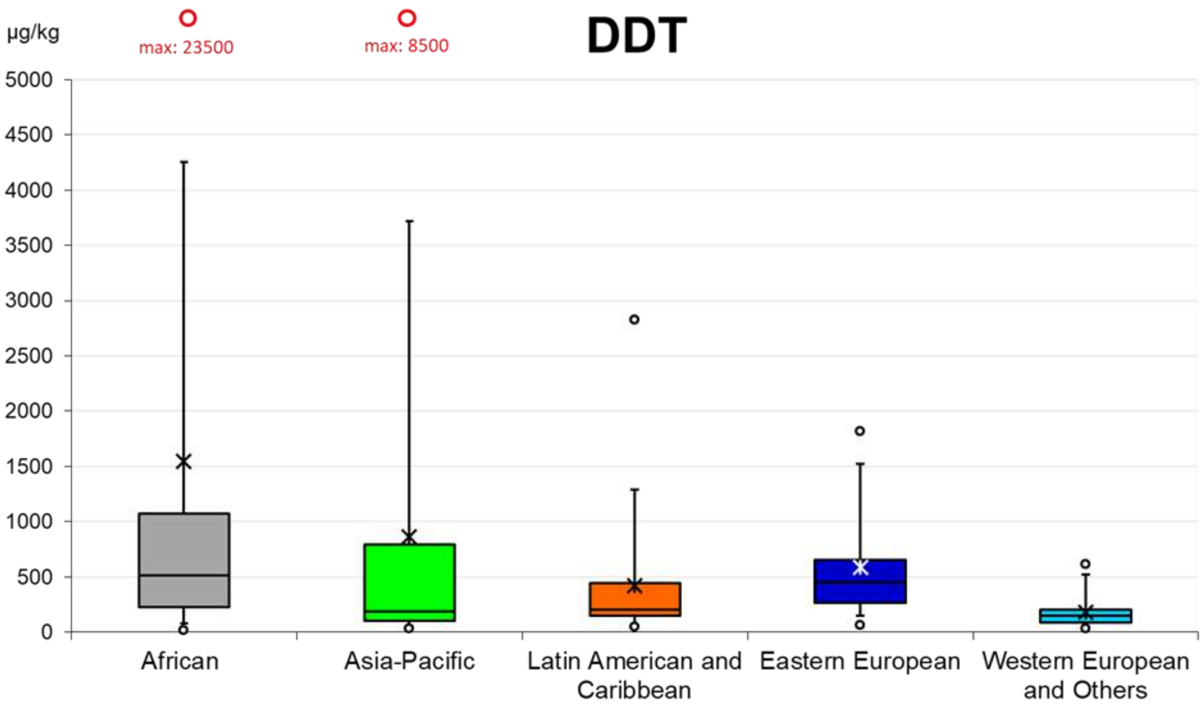
Median sum of all POPs in pooled human milk samples 2015-2019

- *Pesticides: aldrin, chlordane, chlordecone, DDT, dicofol; dieldrin, endosulfan, endrin, heptachlor, α-HCH, β-HCH; γ-HCH; mirex, pentachlorobenzene, pentachlorophenol (including pentachloroanisole) and toxaphene;*
- *(Other) Industrial chemicals and by-products: hexabromobiphenyl (HBB), HBCDD, HCB, hexachlorobutadiene; PBDE; PCB, PCDD, PCDF and PCN.*

Key message C – Regional differentiation

- Countries assigned to one of the five UN regions
- Concentrations can vary **between UN regions**
- For some POPs a wide range found **between countries in UN regions**

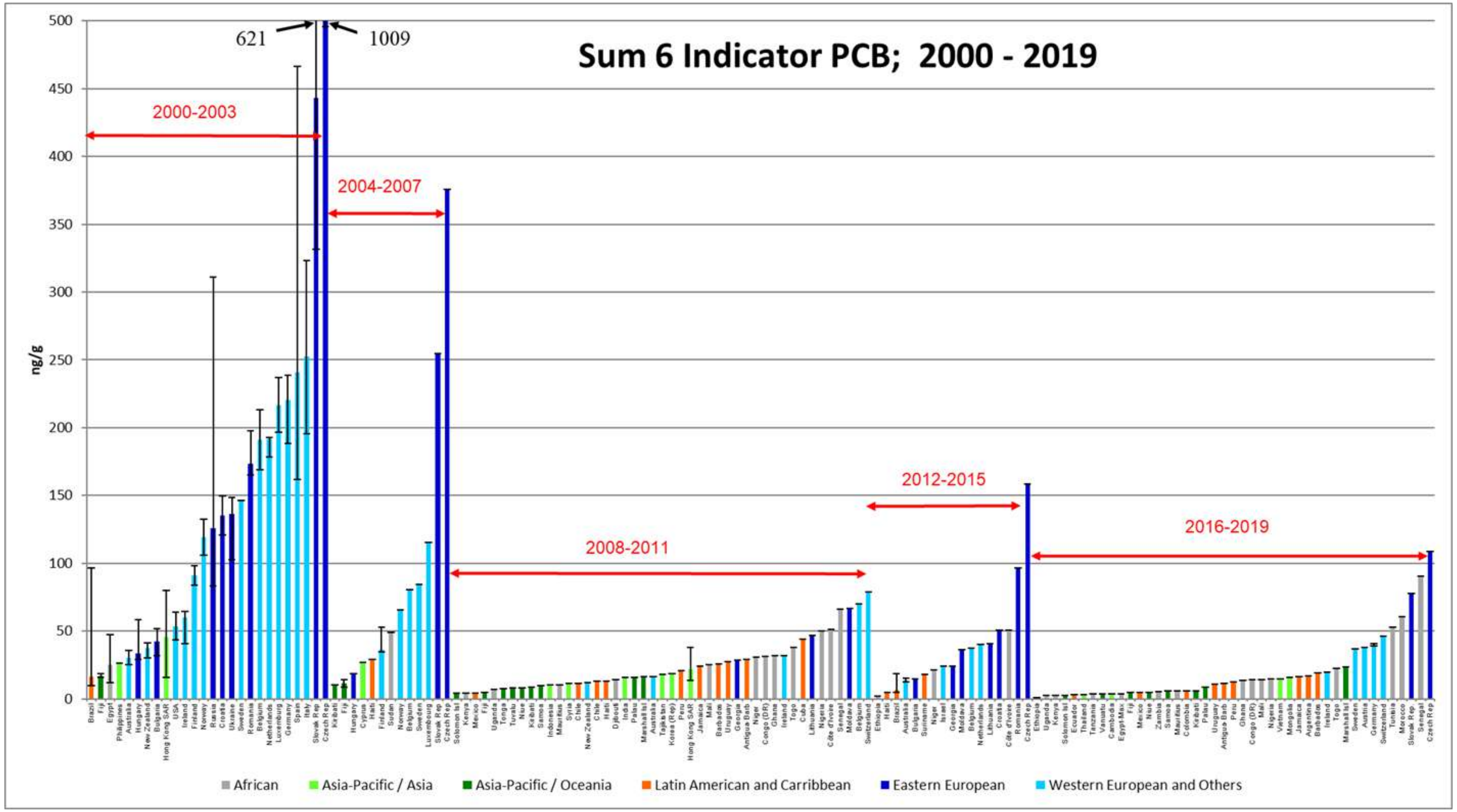




N = 232 pooled samples from 82 countries

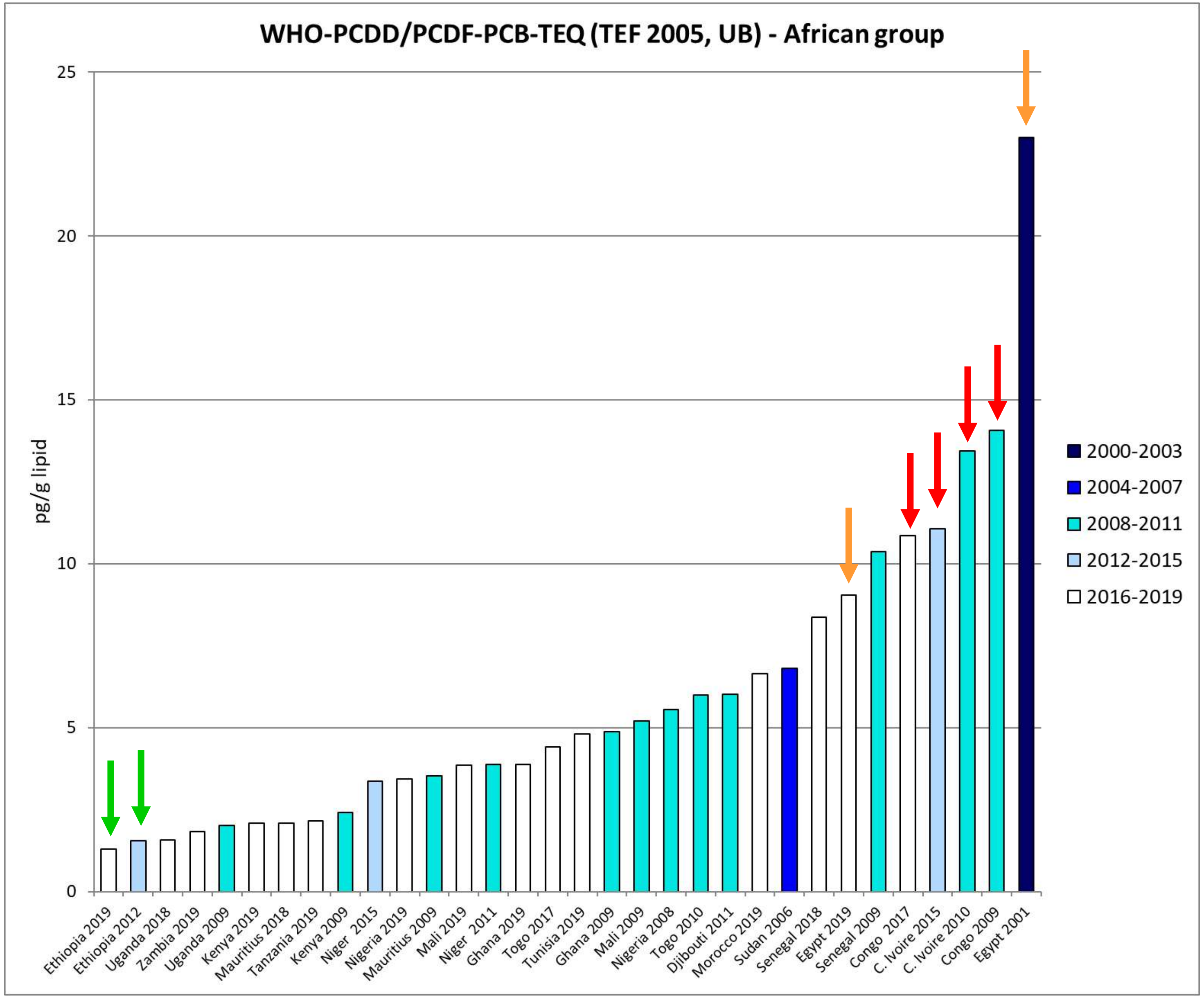
Key message C – Regional differentiation

- Concentrations have to be seen in context with sampling period (*time trends*)



- Upper third of frequency distribution might give more reason for follow-up studies than lower third
- Comprehensive data sets available for assessments of individual POPs in a certain country/region at a certain time

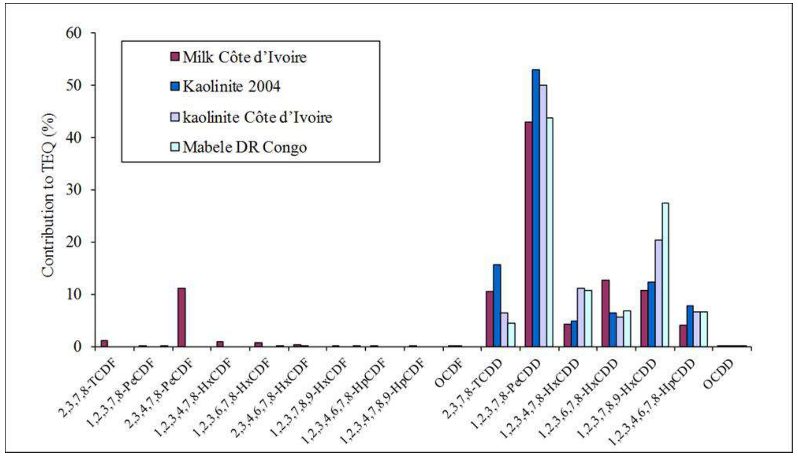
Key message C – Regional differentiation

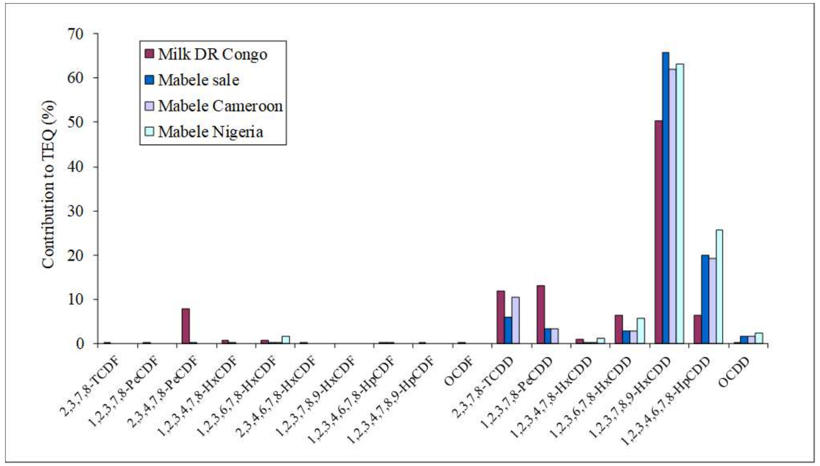


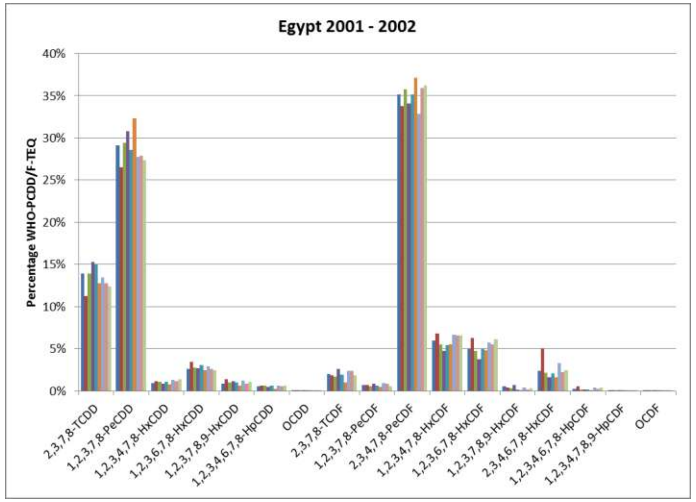
African group: widest variation in contamination of human milk with **total TEQ**

- **Ethiopia (↓)** with the lowest levels of total TEQ of all countries in the 2000-2019 studies
  (1.29 pg total TEQ/g lipid in 2019, 1.54 pg total TEQ/g lipid in 2019)
- **Egypt (↓)**
  - **2001/2002:** high levels comparable to levels in Europe at that time
    (median of 23.0 pg total TEQ/g lipid for 9 pooled samples; max 49 pg total TEQ/g lipid)
  - **2019**: decreasing to 9 pg total TEQ/g lipid
- **Côte d'Ivoire** and **DR Congo (↓)** in the upper third of frequency distribution

Key message C – Regional differentiation







PCDD/PCDF patterns - indication of possible sources

- PCDD-dominated patterns in **Côte d'Ivoire** and **DR Congo** mirror patterns found in certain clays with high PCDD/PCDF concentrations and hint at ***consumption of such clays ("geophagy")*** by pregnant women
- PCDD/PCDF pattern in **Egypt (2000-2002)** could indicate ***combustion and drying processes***

Malisch, R., Schächtele, A., van Leeuwen, F.X.R., Moy, G., and Tritscher, A. 2023. WHO- and UNEP-coordinated exposure studies 2000-2019: Findings of polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. In: Persistent organic pollutants in human milk (eds. Malisch, R., Fürst, P. and Šebková, K.), Springer Nature, Part III

Key message D – Time Trends

Aim of WHO/UNEP-coordinated exposure studies: providing data for effectiveness evaluation of Stockholm Convention

➢ **Minimization of sources of variation**

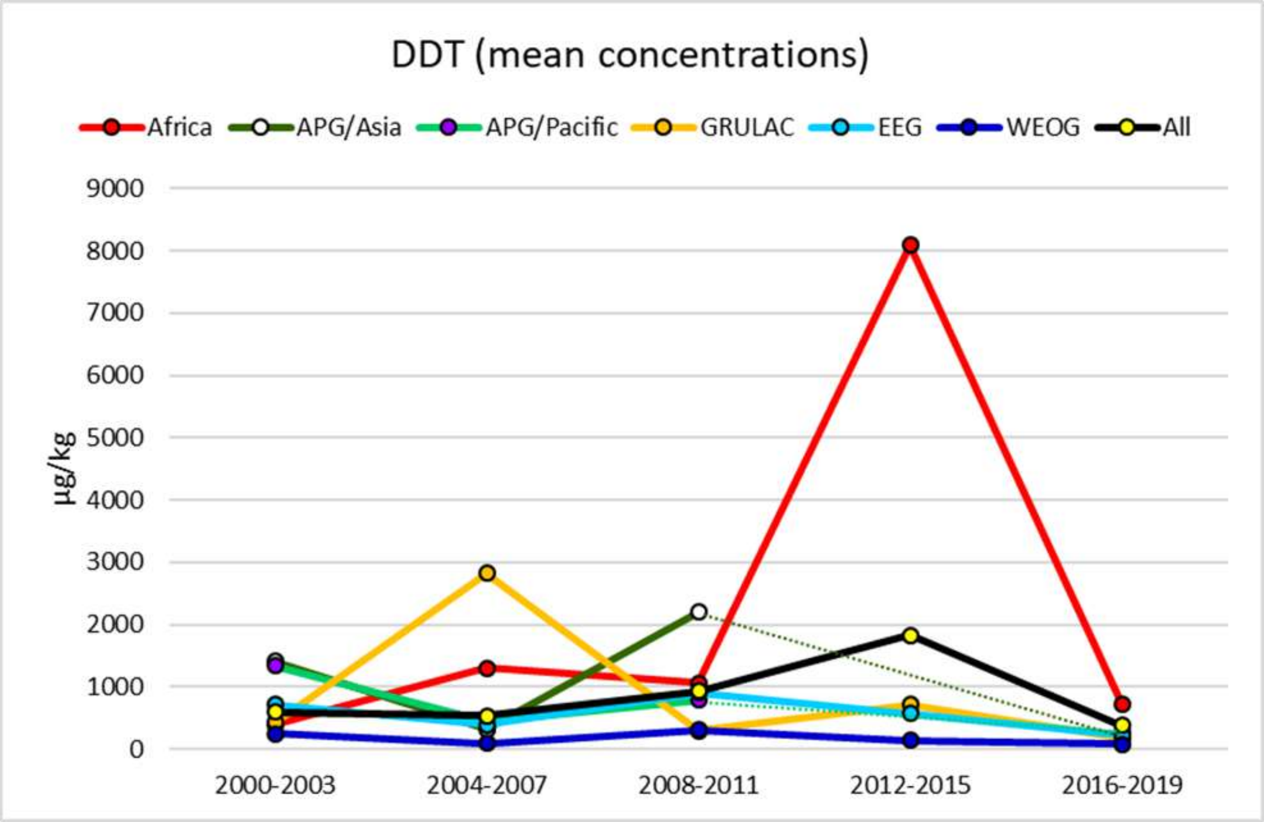
- **Sampling design (harmonized protocol for representative pooled samples)**
- **Analysis of pooled samples by Reference Laboratories**

Global Monitoring Plan (GMP) guidance document:

- **<u>Temporal trend studies</u> should be able to detect a 50% decrease in the levels of POPs within a 10-year period**
- **However, no stipulation of a quantitative goal for reduction / decrease in POPs levels in countries / regions**
- **Convention's objectives:**
  - ➢ **either to eliminate or to reduce production, use and releases, depending on annex where chemical listed, but rate of decline is nowhere specified or required**

Key message D – Time Trends

With regard to participation of different countries in different rounds, conclusions on time trends cannot easily be drawn from the general data base using means or medians for certain periods

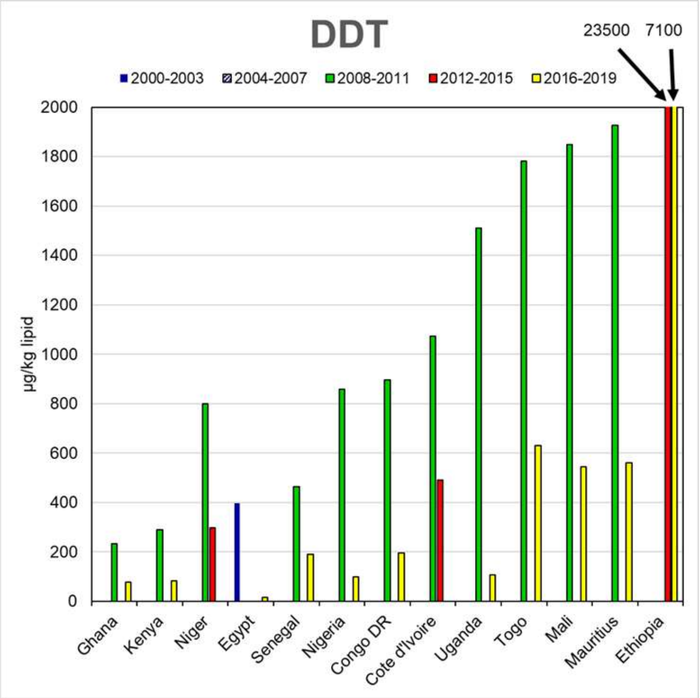


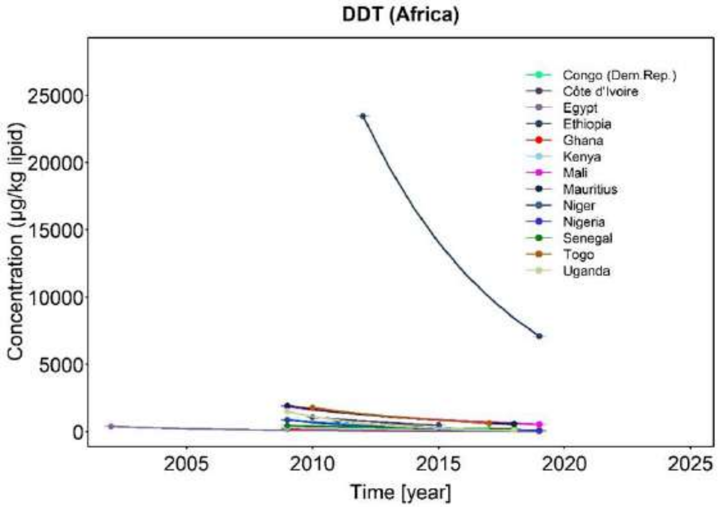
Time trends for mean concentrations of DDT in human milk (expressed as µg DDT complex /kg lipid)

General estimation of time trends based on all results of the 2000-2019 period – example DDT

- Decrease observed from 2000-2003 period to 2016-2019 period in all regions
- Considerable differences among regions and a great variation among the rounds
  - *In Africa: variation caused by results of Ethiopia in comparison to other countries in two periods:*
    - *2012-2015: 23.500 µg/kg lipid,*
    - *2016-2019: 7.100 µg/kg,*

Key message D – Time Trends





More precise approach:
estimation of time trends based on results of countries with repeated participation over time

DDT in Africa: In all countries, decrease observed in comparison to previous surveys

Reduction rates should be seen also in context with the concentration range **(differentiation of levels above or in the range of the background contamination):**

- If **high levels** are found, **sources** might be detected which could be eliminated.
- However, **at low background** levels, other factors, e.g. contamination of feed and food by air via long-range transport and subsequent bioaccumulation, cannot be influenced locally.

Key message D – Time Trends

GMP guidance document recommends to apply simple linear regression or Theil-Sen estimator for power analysis of statistical trends

Important:

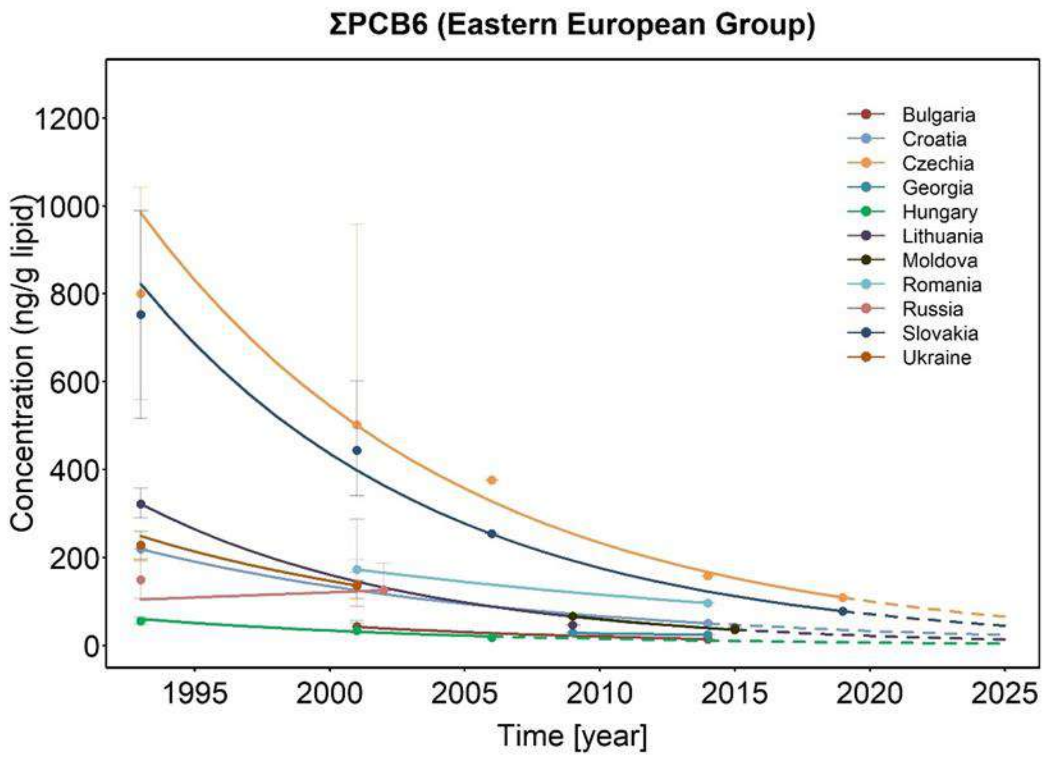
- Trends can be derived if trend test (significance of Theil-Sen estimator) is positive on 95% confidence level of significance (i.e. p-values < 0.05).
- As Theil-Sen p is never below 0.05 for less than 5 data points and for most countries only less than 5 data points were available, statistically significant trends could be derived only for regions (combining data from countries) and few countries.
- For many countries, only two or three data points are available. In these cases, the observed changes of the concentrations are statistically not significant and indicate tendencies.

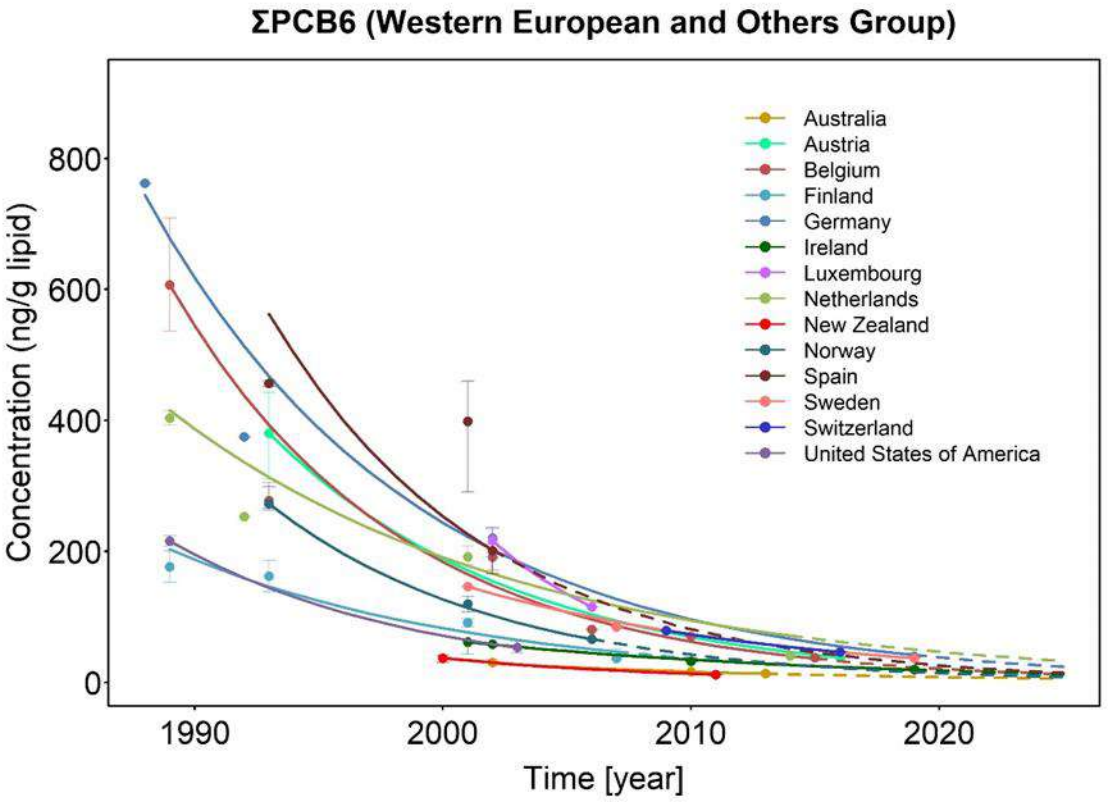
Key message D – Time Trends

UN Regional Groups	N of countries	Overall decrease rate (%) per 10 years (Theil-Sen method)		
		DDT	beta-HCH	HCB
Africa	13	74	83	11
Asia-Pacific	8	80	98	67
Latin America and Caribbean	9	50	52	31
Eastern Europe	6	39	63	47
Western Europe and Others	8	39	63	45
Global / median of 5 UN Regional Groups	44	58	84	57

countries with repeated participation

Key message D – Time Trends





Time trends of ΣPCB$_6$ concentrations between 1987 and 2019 in 25 EEG and WEOG countries with repeated participation

- **Significant reductions were already achieved in the 1990s**
- **Decrease between 85% and 95% between end of 1980s and 2019 in countries with highest levels**

Key message D – Time Trends

For time trend analysis of ΣPCB_6 between 1987 and 2019: results of 247 pooled samples

On a global level, decrease rate of PCB over 10 years was 71% calculated by the Theil-Sen method

UN Regional Groups	N of countries	Overall decrease rate (%) per 10 years (Theil-Sen method)
Africa	13	50
Asia-Pacific	10	65
Latin America and Caribbean	9	34
Eastern Europe	11	53
Western Europe and Others	14	63
Global / median of 5 UN Regional Groups	57	71

countries with repeated participation

Key message D – Time Trends

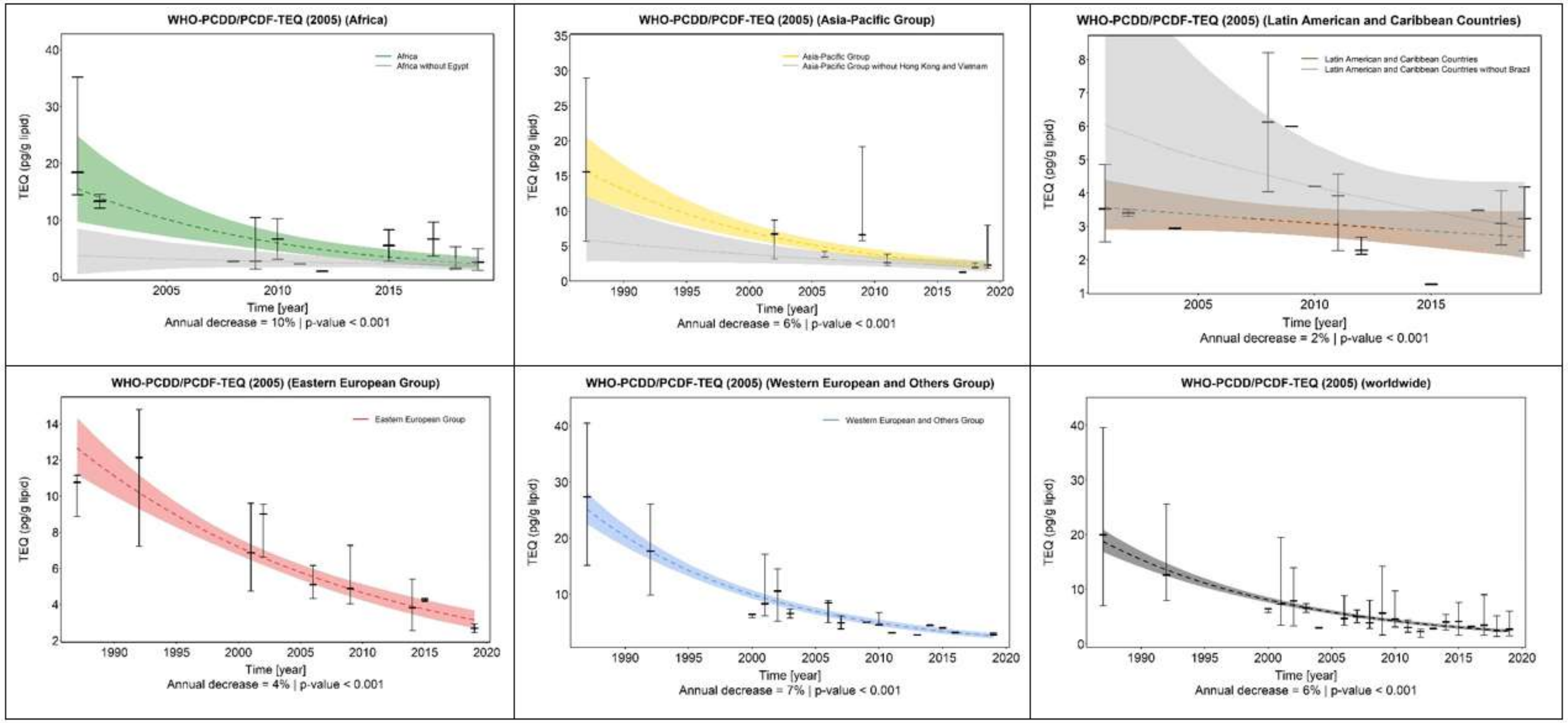


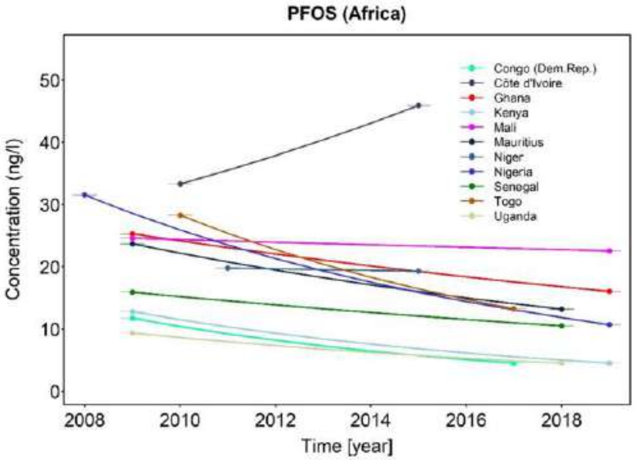
Figure 17: Theil-Sen exponential trends of WHO-PCDD/PCDF-TEQ concentrations (pg WHO-PCDD/PCDF-TEQ_{2005} / g lipid) in the 5 UN regions and worldwide

Countries with repeated participation

Time trends of dioxin-like compounds between 1987 and 2019:

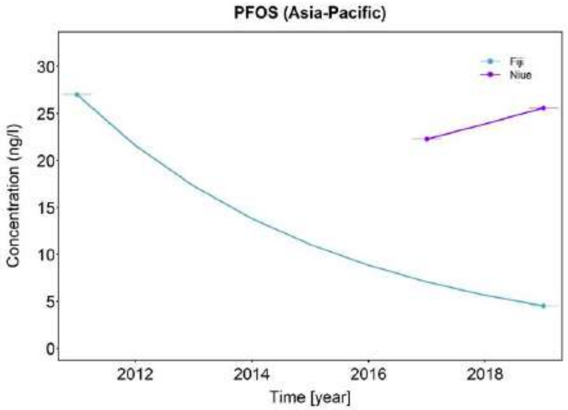
- ✓ **Significant reductions were already achieved in the 1990s**
- ✓ **Global decrease rate per 10 years:**
  - ➢ **WHO-PCDD/PCDF-TEQ: 48%**
  - ➢ **Total TEQ (WHO_{2005}-TEQ): 50%**

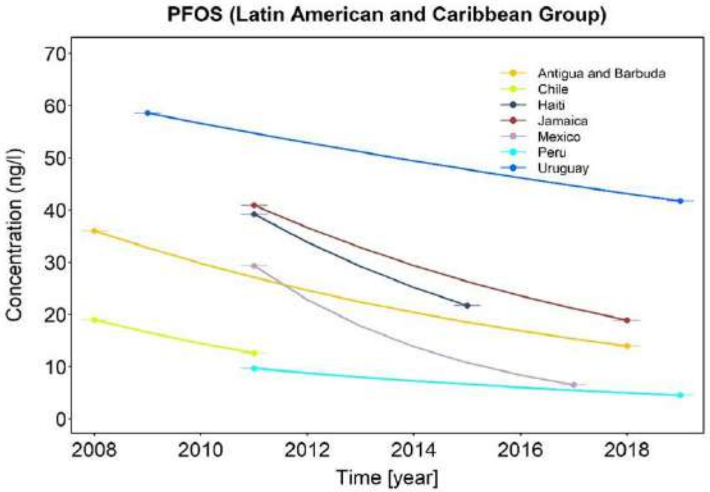
Key message D – Time Trends

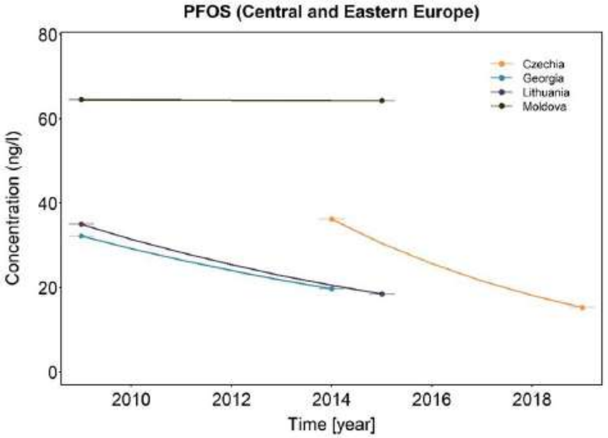


Time trends of PFOS between 2008 and 2019

- **in nearly all countries with repeated participation, decreasing tendencies from 2008-2011 to 2016-2019**







no WEOG countries with repeated particpation

Worldwide	N of countries	Overall decrease (%) per 10 years	p-value overall
All countries	59	48.3	<0.001
Countries with repeated participation	24	52.2	<0.001

Key message D – Time Trends

Median **decrease** per 10 years:

- 58% for DDT,
- 84% for beta-HCH,
- 57% for HCB,
- 32% for PBDE
- 48% for PFOS
- 70% for PCB
- 48% for PCDD and PCDF (expressed as TEQ)

Decrease / Increase (%) of total CP

Table 7: Overall decrease (%) of total CP concentrations in the 5 UN Regional Groups and worldwide (computed using all individual samples). Negative decreases are to be read as increase. (n = number of samples)

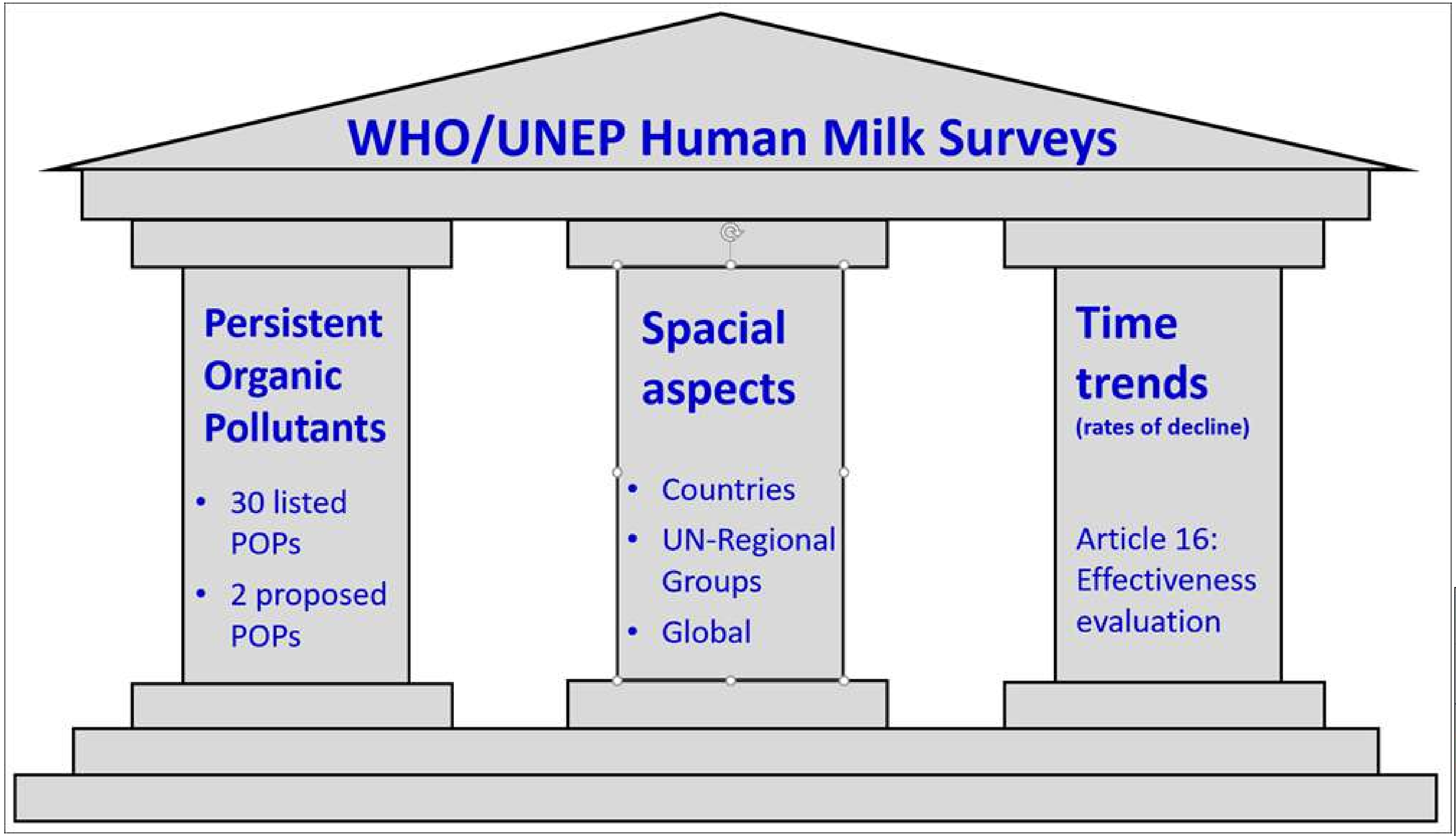
UN Regional Groups	n	Overall decrease per 10 years [%]	p-value
African	27	-6.3	0.663
Asia-Pacific	15	-179	0.009
Latin American and Caribbean	21	9.5	0.737
Eastern European	11	-197	0.007
Western European and Others	10	63	0.001
global	84	-29	< 0.001

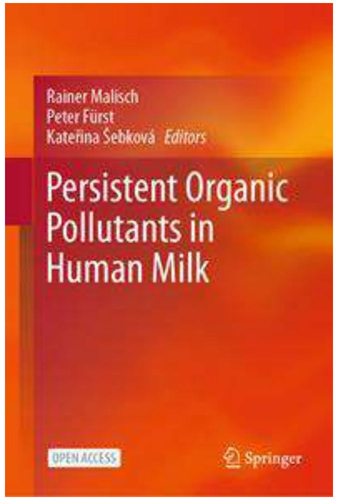
In contrast to decrease for various POPs, **CP** as "emerging POP" **increasing tendencies** in some UN Regional Groups.

On a global level, statistically significant **increase** of total CP concentrations in human milk of 30% over 10 years

Key messages - Conclusions

Key contributor to GMP – assessments of three pillars





Number of Pages
XXVII, 689

Number of Illustrations
9 b/w illustrations, 309 illustrations in colour

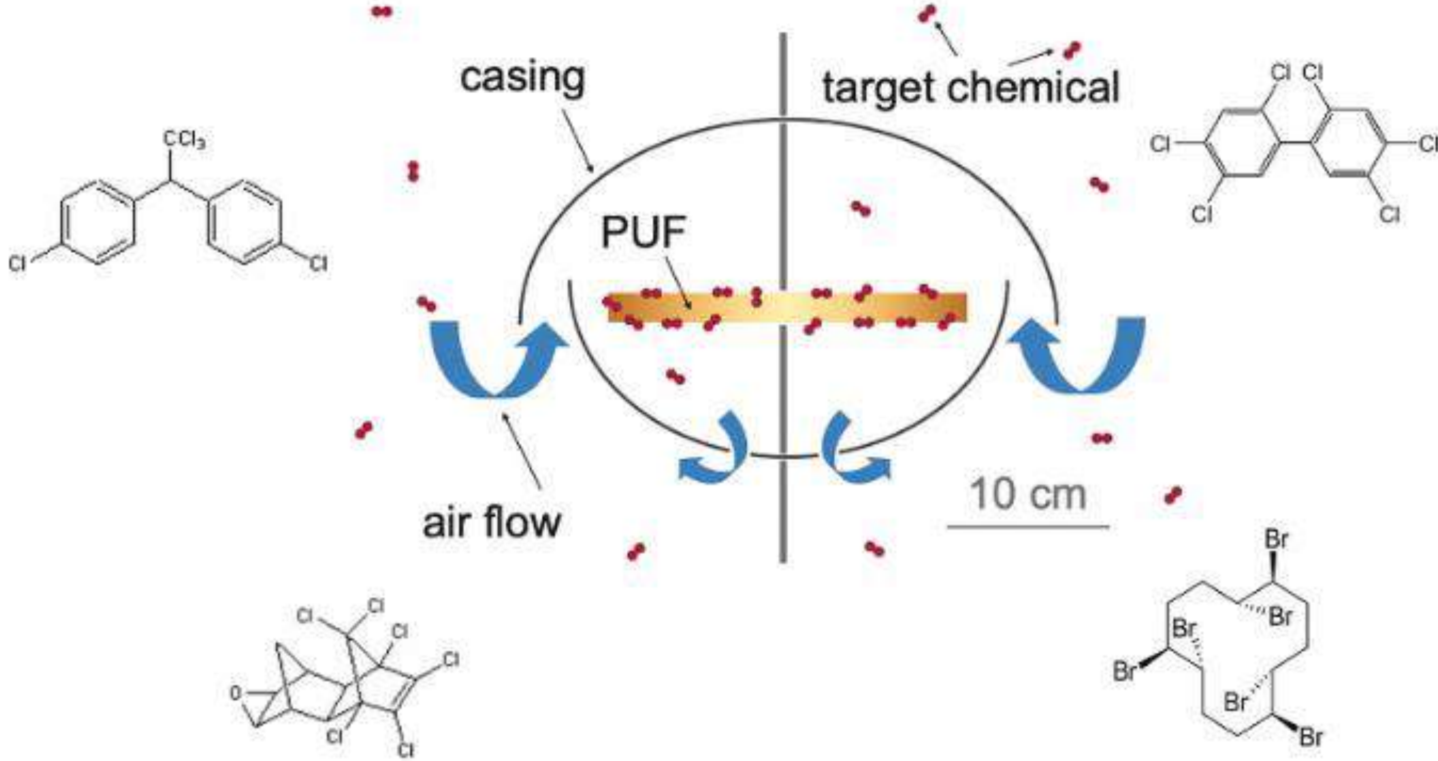
URL: https://link.springer.com/book/10.1007/978-3-031-34087-1

Key messages – Acknowledgement

Editors, authors and co-authors

The comprehensive work over three decades was only possible due to the cooperation and support of many institutions and their staff:

- WHO
- UNEP
- Countries
- National coordinators
- Funding bodies (GEF, others)
- Laboratories



Results of the GMP2 study on POPs in African Air

Jacob de Boer, Rianne van Dijk

Specilal Issue Chemosphere

Chemosphere 324 (2023) 138271

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Check for updates

Persistent organic pollutants in air from Asia, Africa, Latin America, and the Pacific

Jacob de Boer [a,*], Rianne van Dijk [a], Manoli Abalos [b], Esteban Abad [b]

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[b] *Consejo Superior de Investigaciones Científicas, Dioxins Laboratory (IDAEA-CSIC), Carrer de Jordi Girona 18-26, 08034, Barcelona, Spain*

Overview

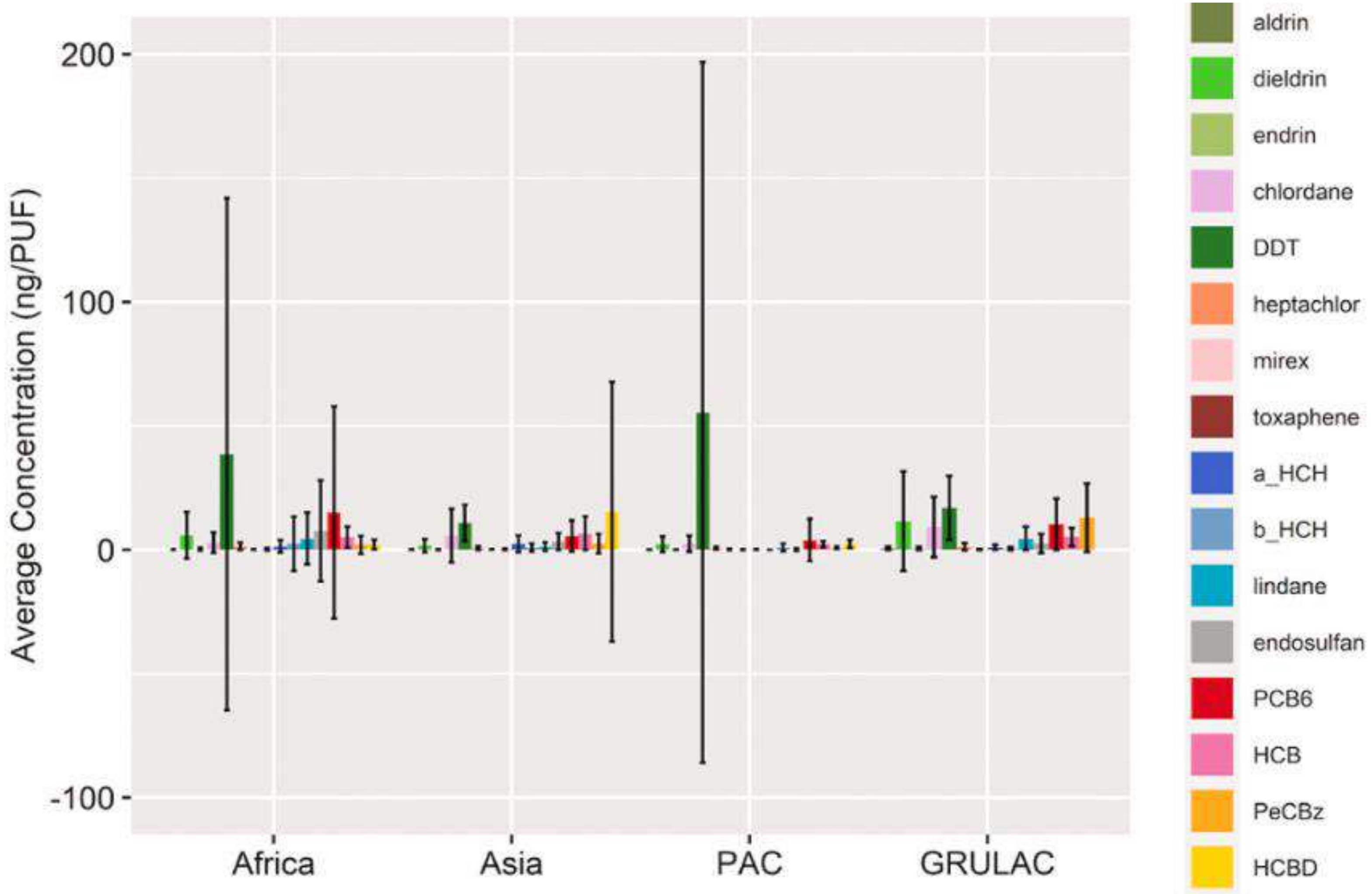
Countries:

- DRC
- Egypt
- Ethiopia
- Ghana
- Kenya
- Mali
- Mauritius
- Morocco
- Nigeria
- Senegal
- Tanzania
- Togo
- Tunesia
- Zambia

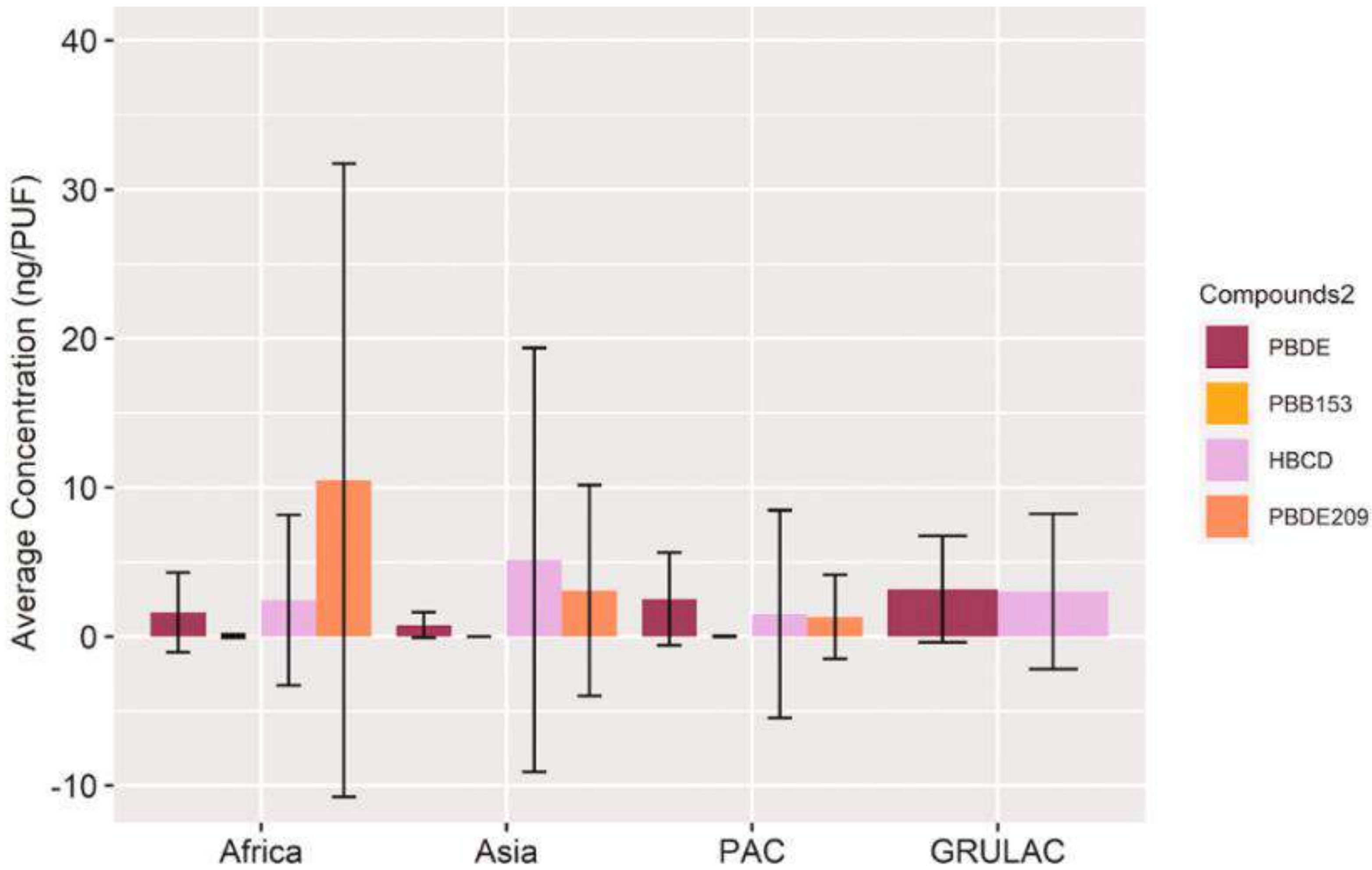
- 2017
- 2018
- 2019

- 1 PUF per 3 months
- PCB, OCPs, BFRs
- Toxaphene

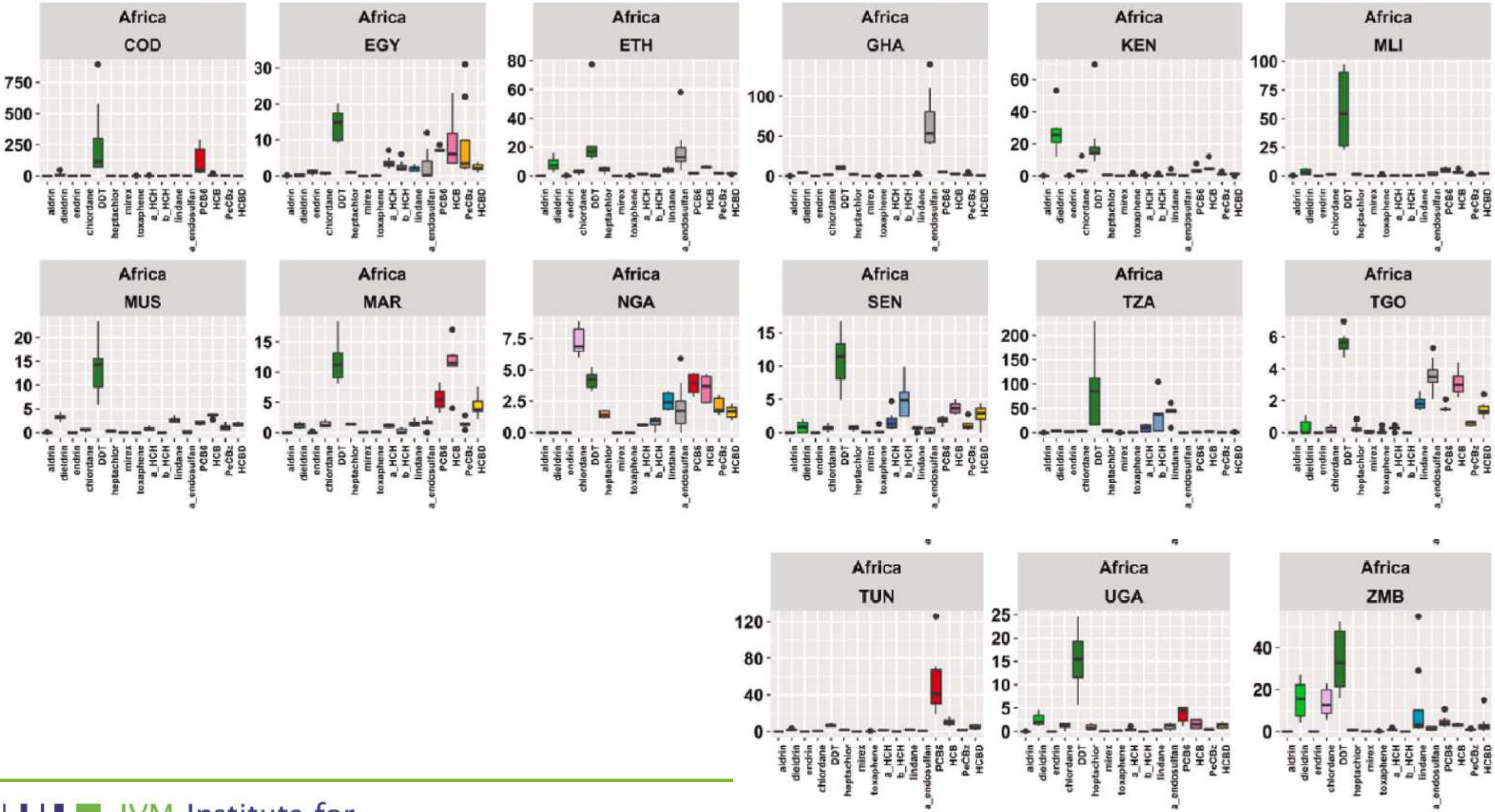
PCBs and Pesticides - Comparison Continents



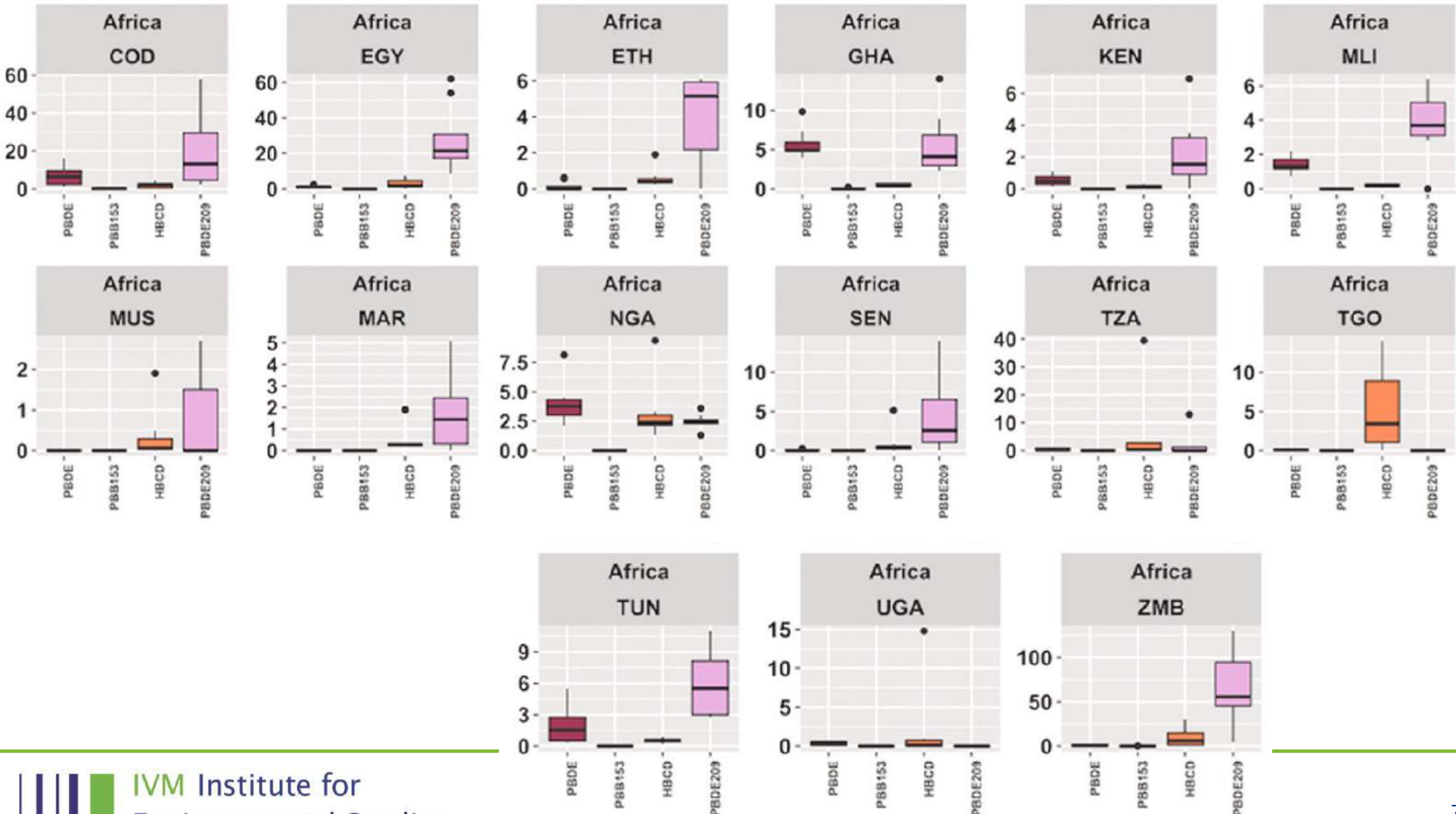
BFRs in Air – Comparison Continents



PCBs and Pesticdes in Africa

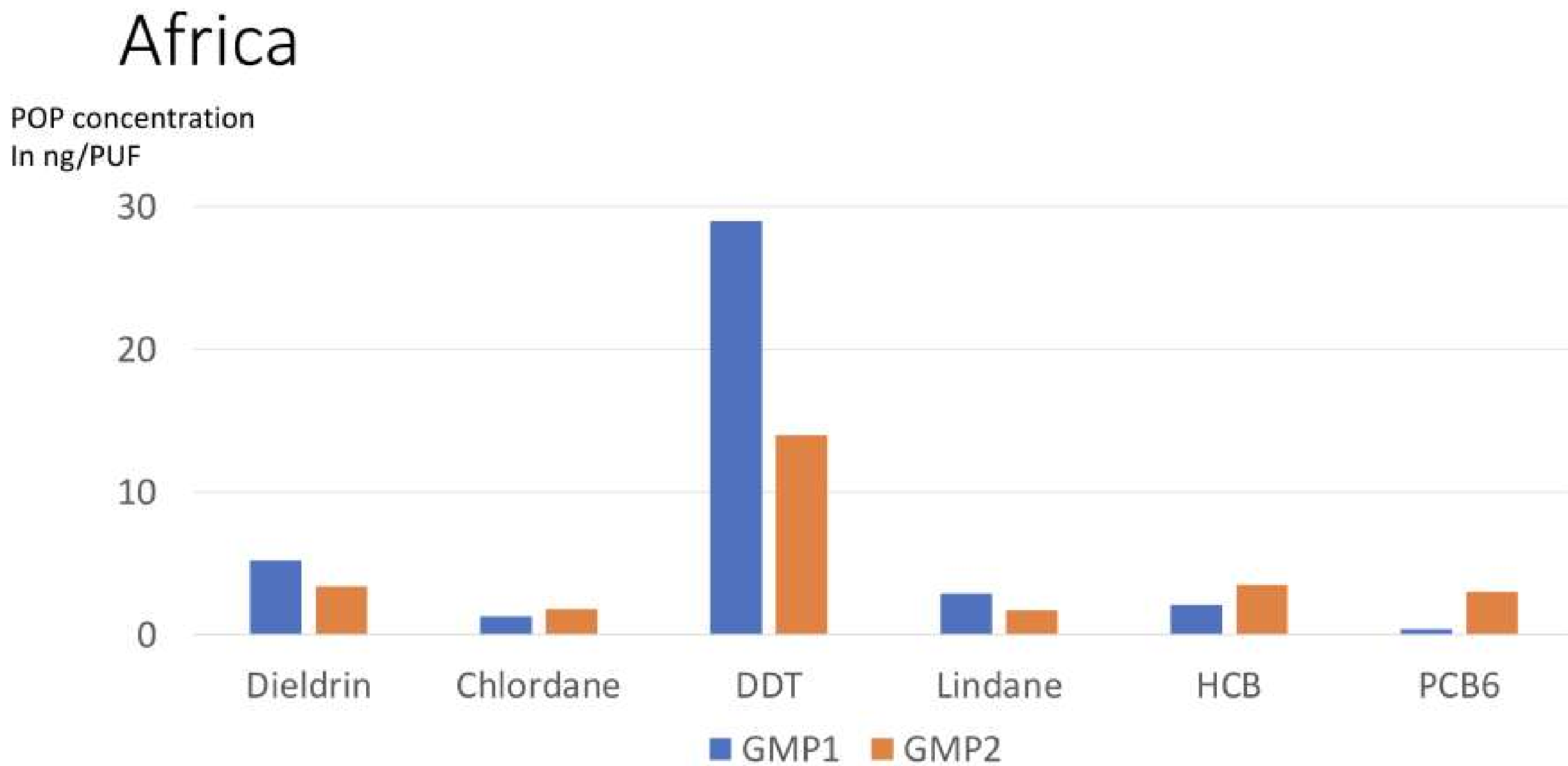


PBDEs in Air

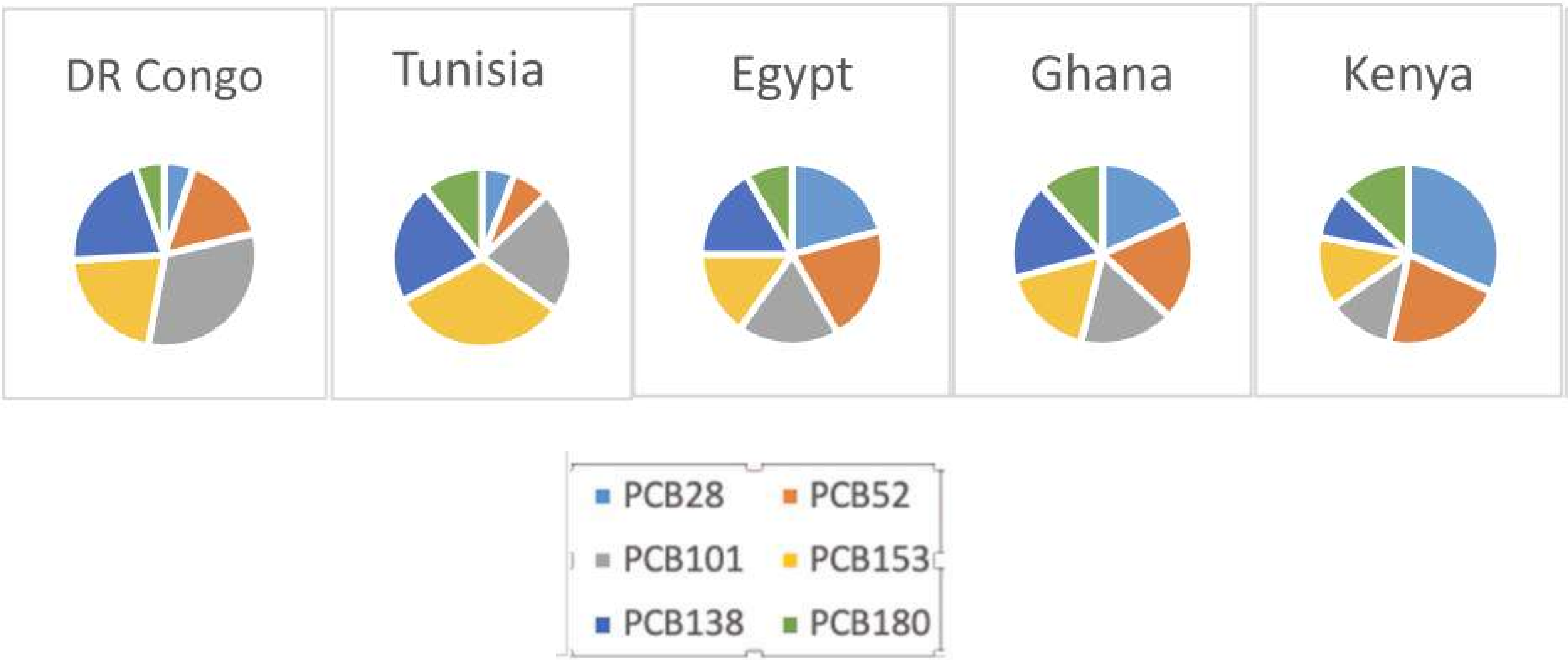


Africa COD
Africa EGY
Africa ETH
Africa GHA
Africa KEN
Africa MLI
Africa MUS
Africa MAR
Africa NGA
Africa SEN
Africa TZA
Africa TGO
Africa TUN
Africa UGA
Africa ZMB
PBDE
PBB153
HBCD
PBDE209

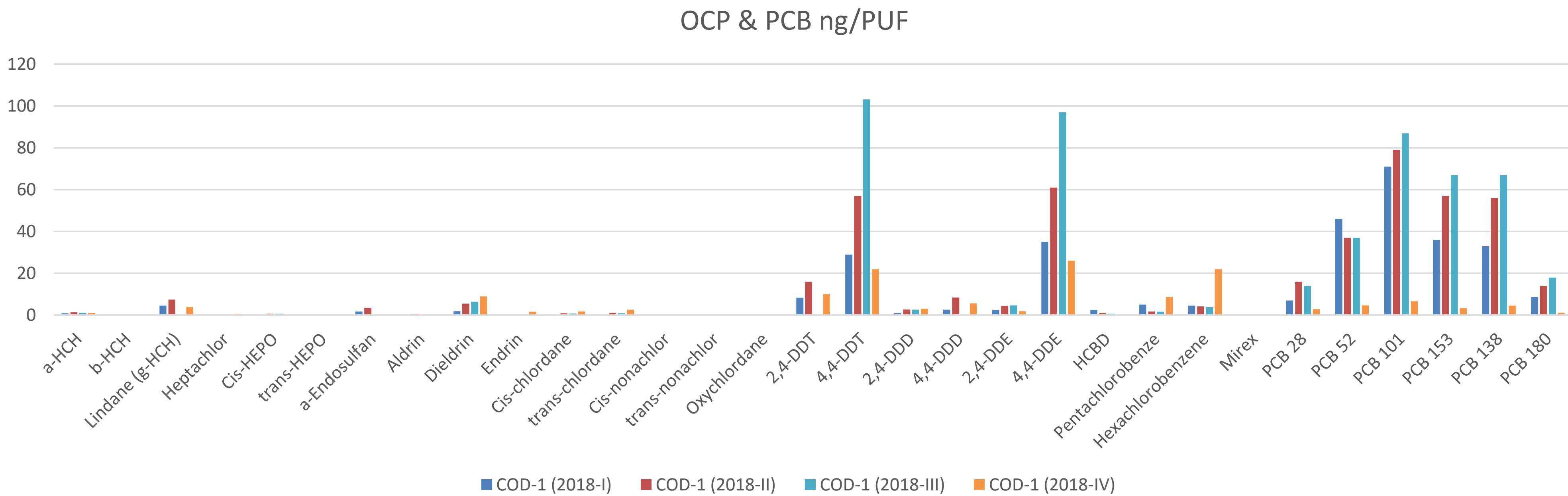
Comparison GMP 1 and 2

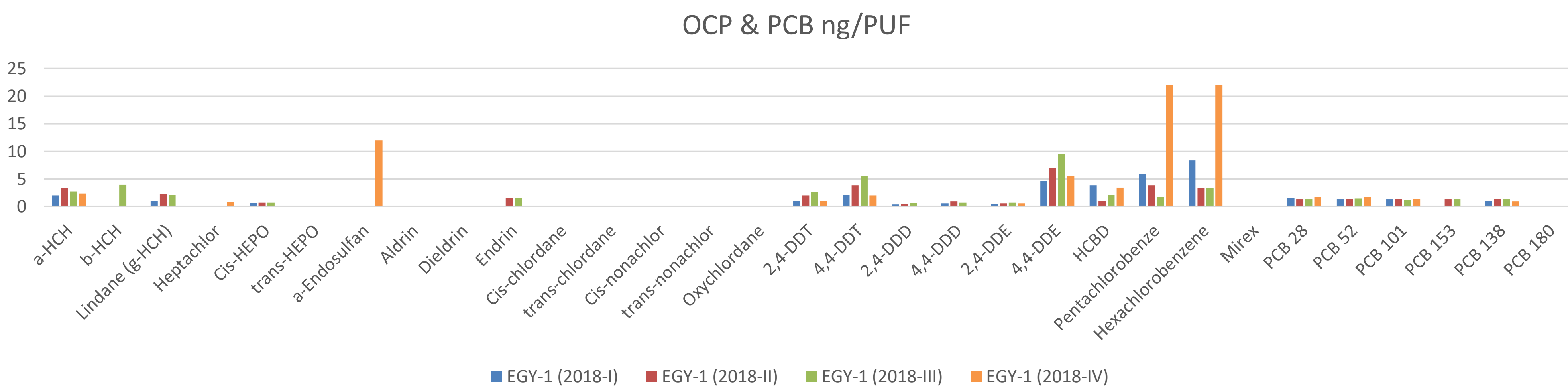


PCB Patterns in Air

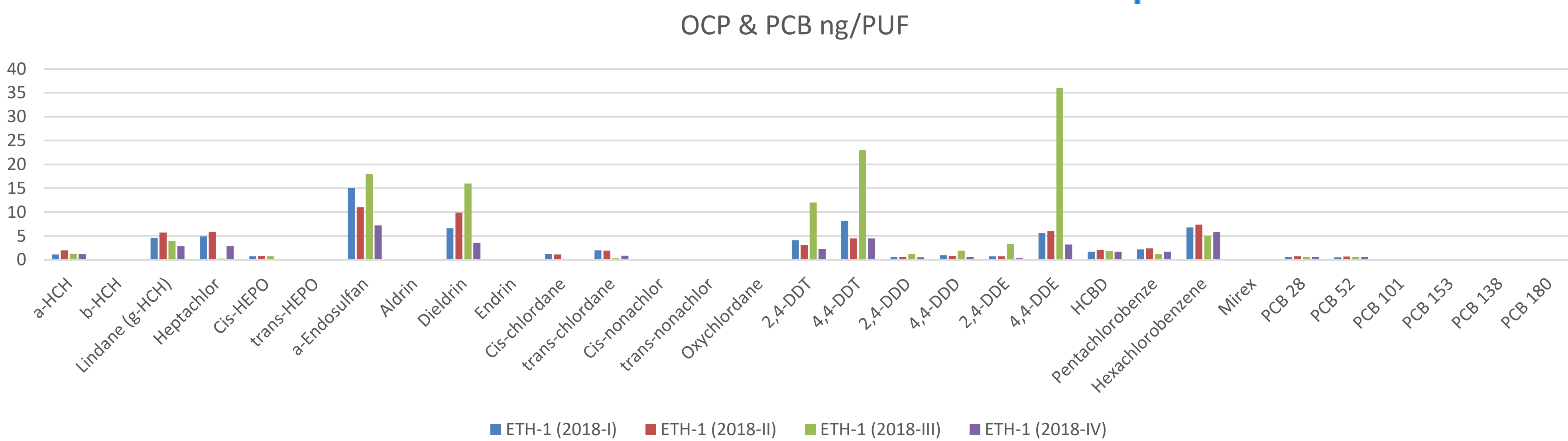


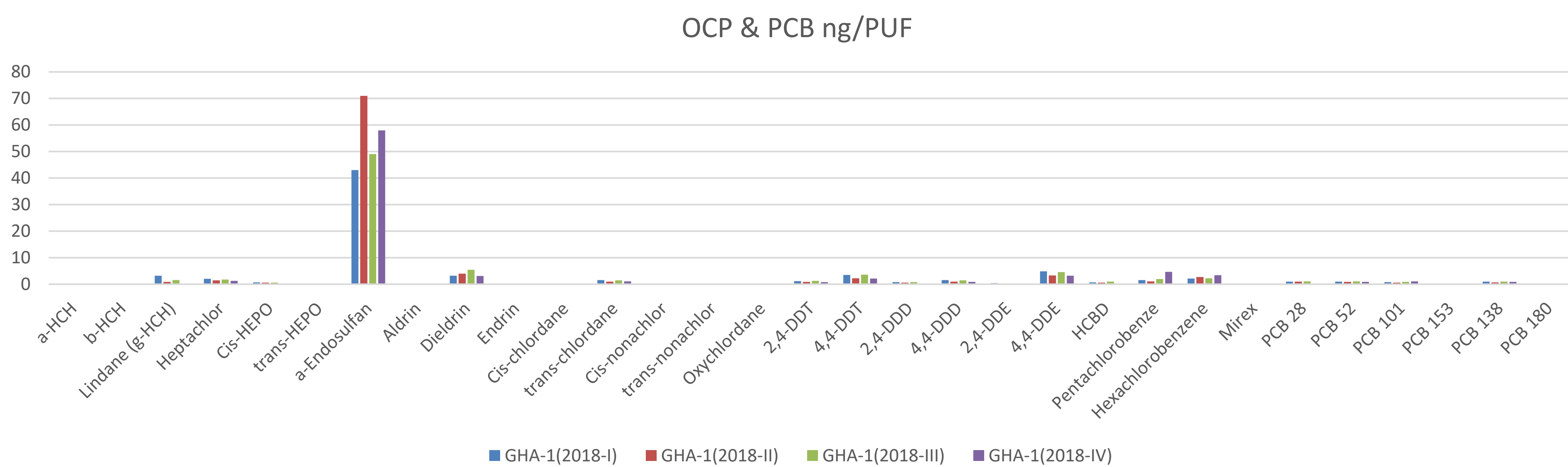
DRC and Egypt – PCB/OCP



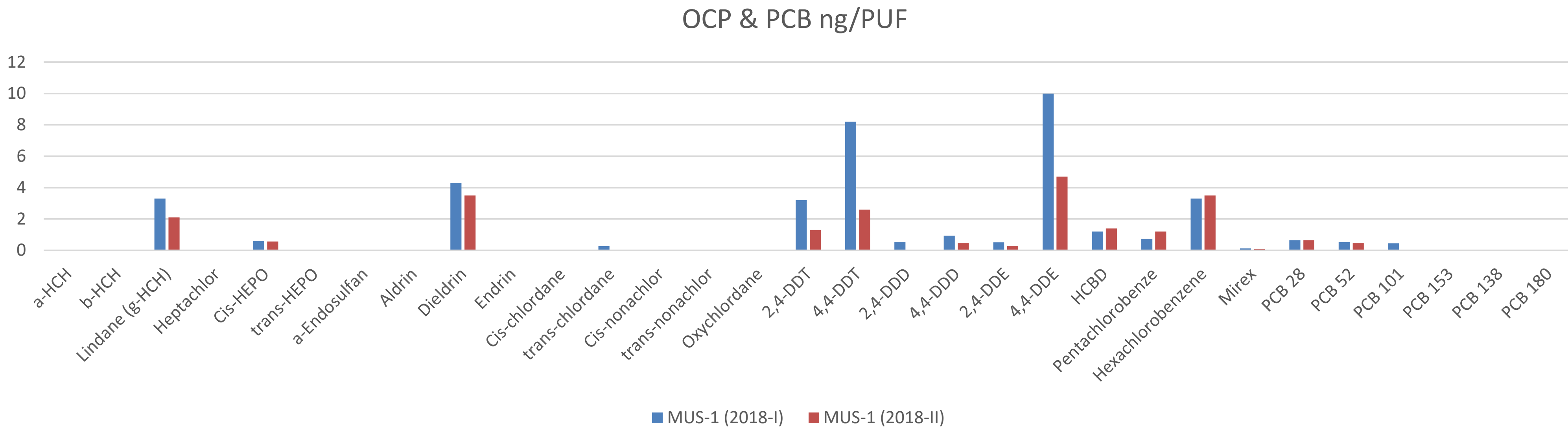


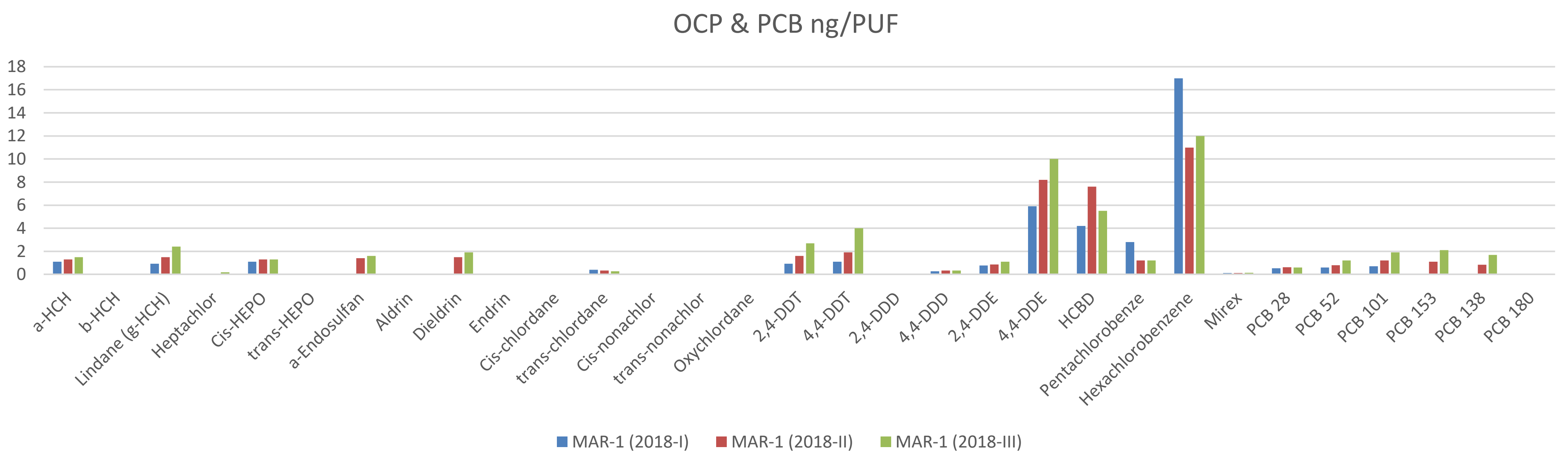
Ethiopia and Ghana - PCB/OCP



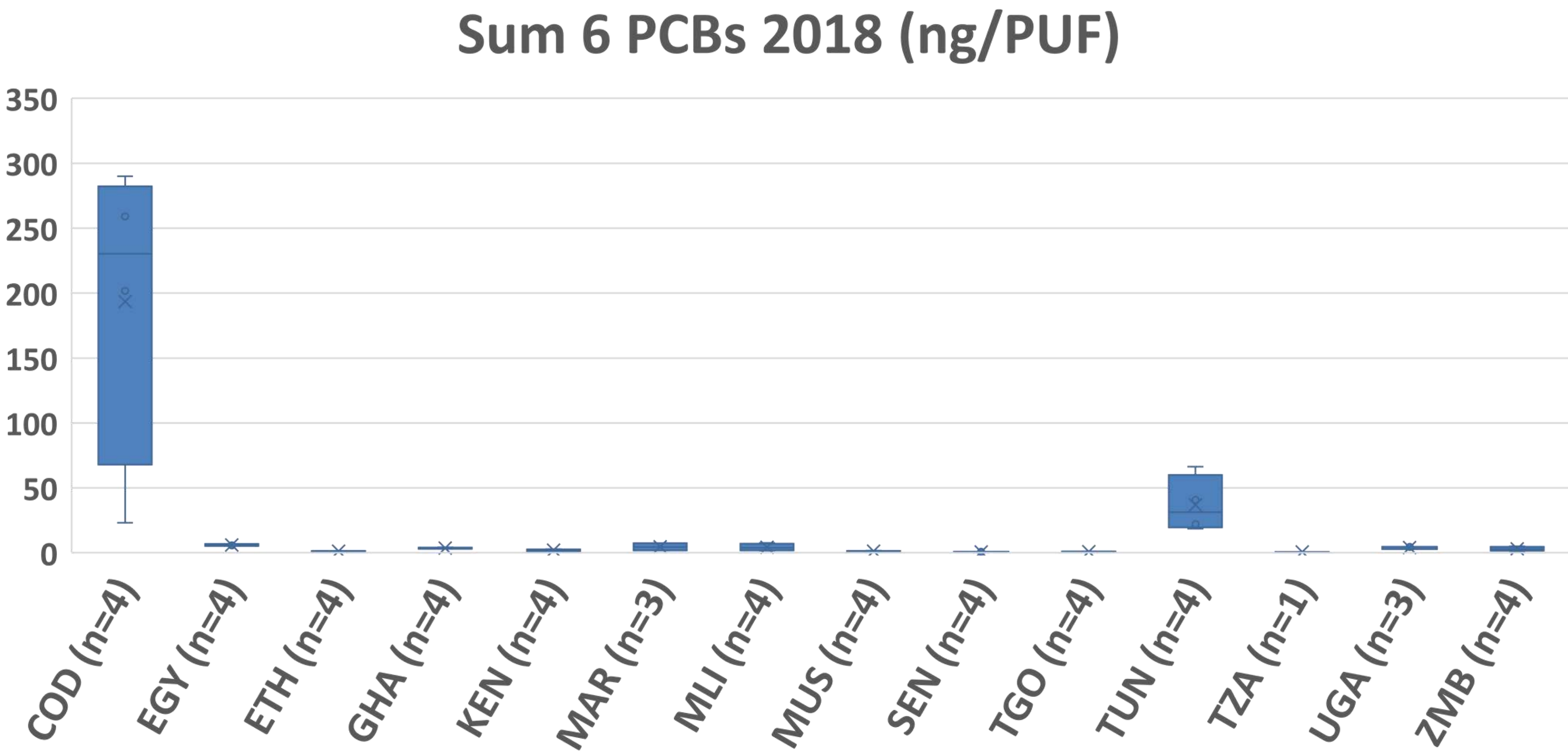


Mauritius and Morocco - PCB/OCP

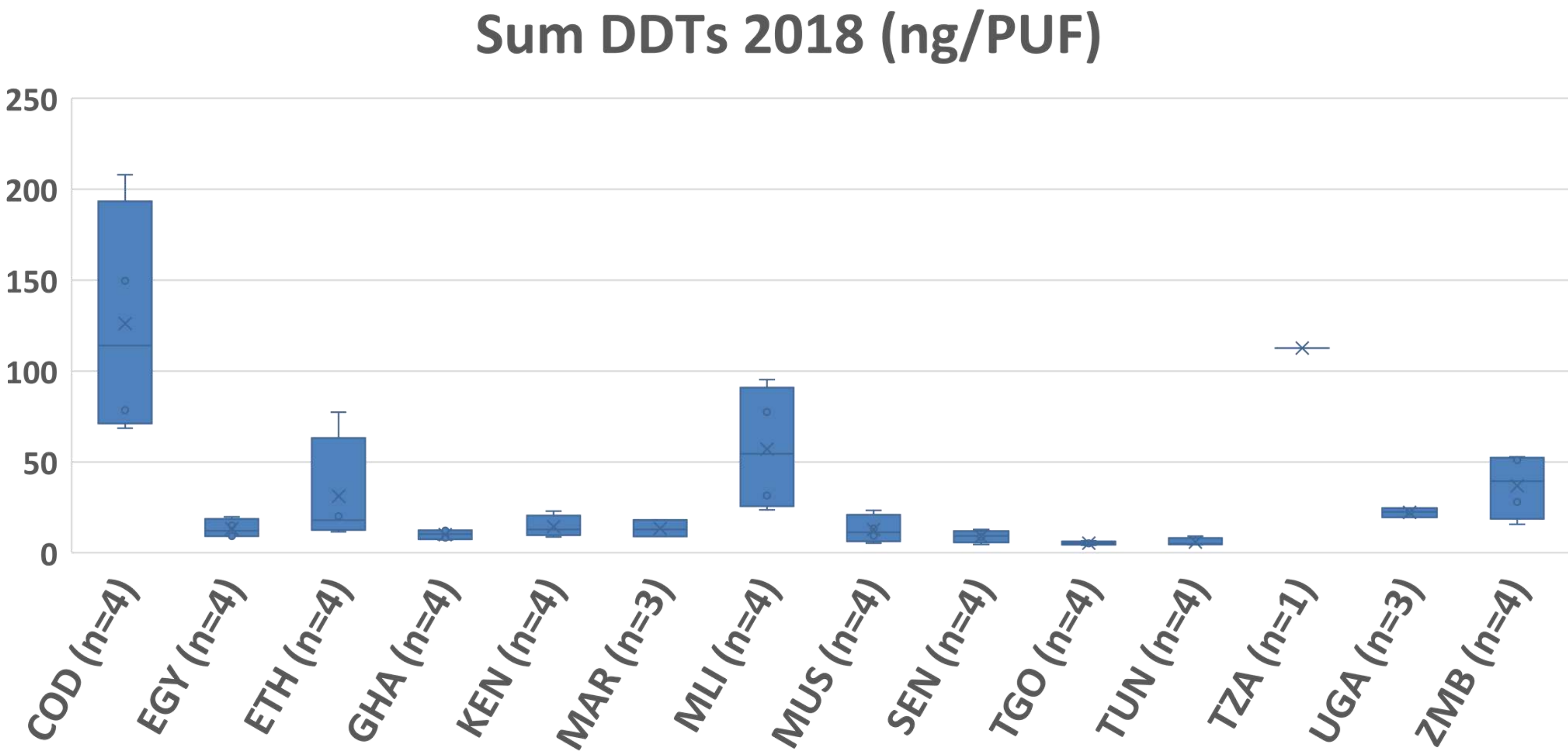




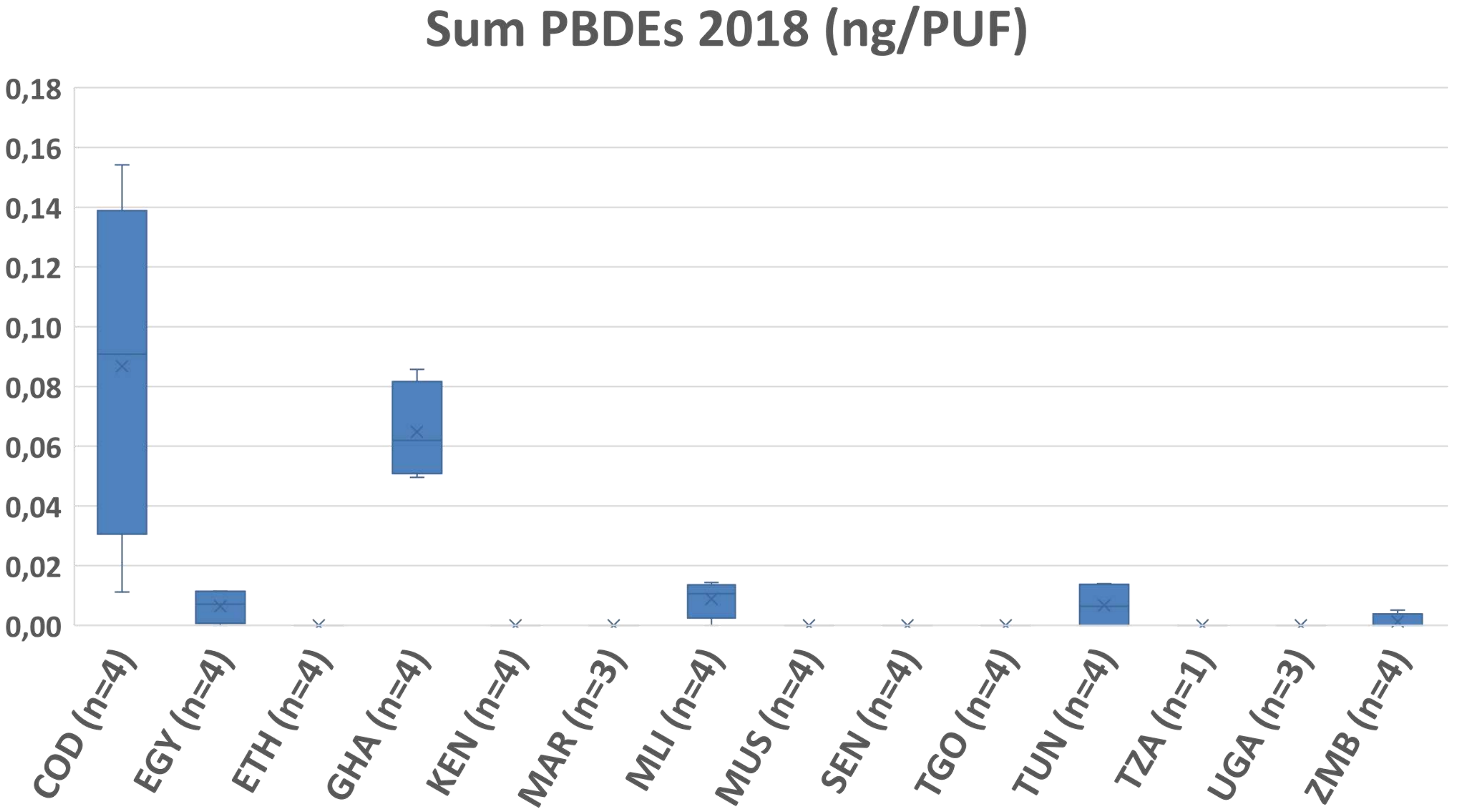
Africa, 2018 – Sum 6 PCBs



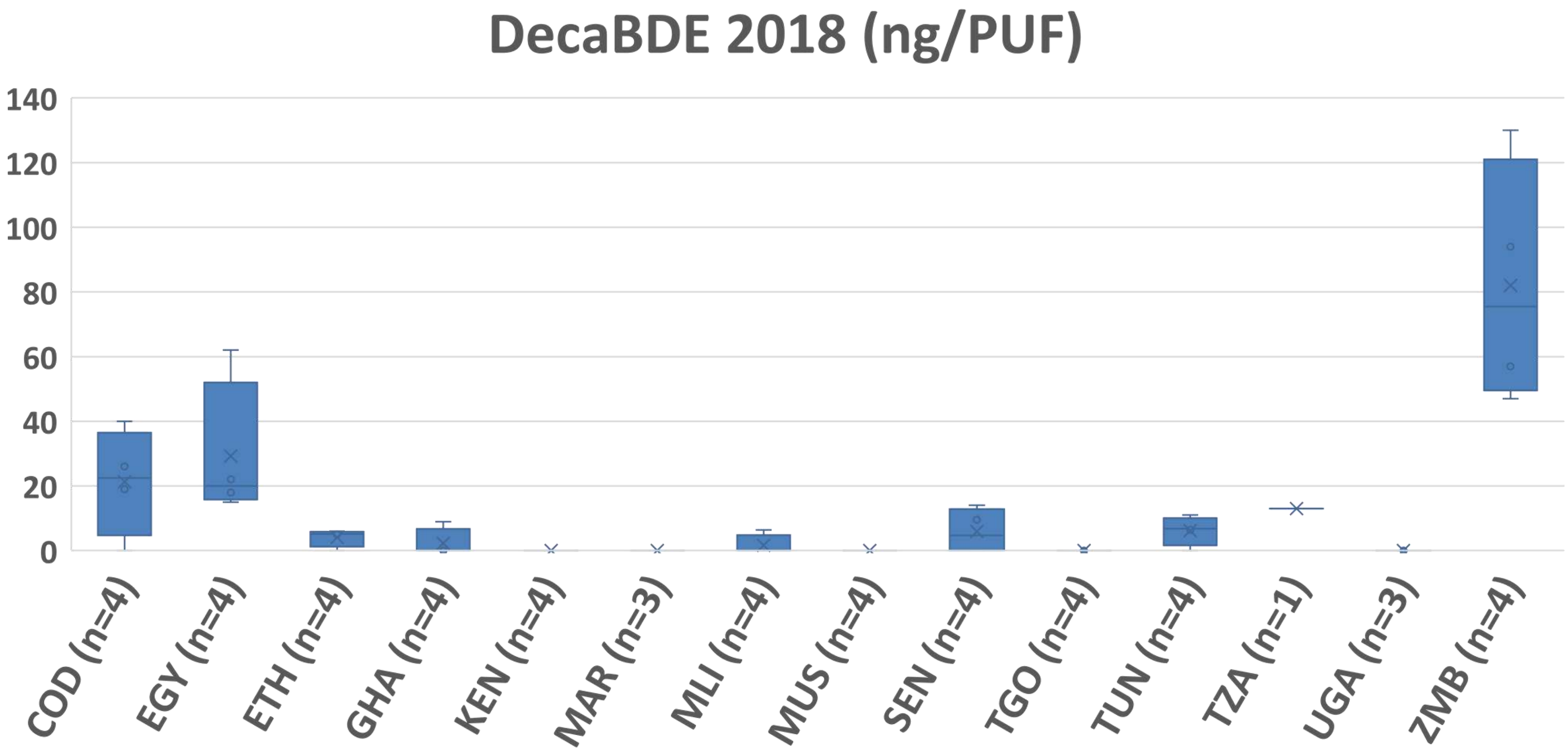
Africa, 2018, sum DDT



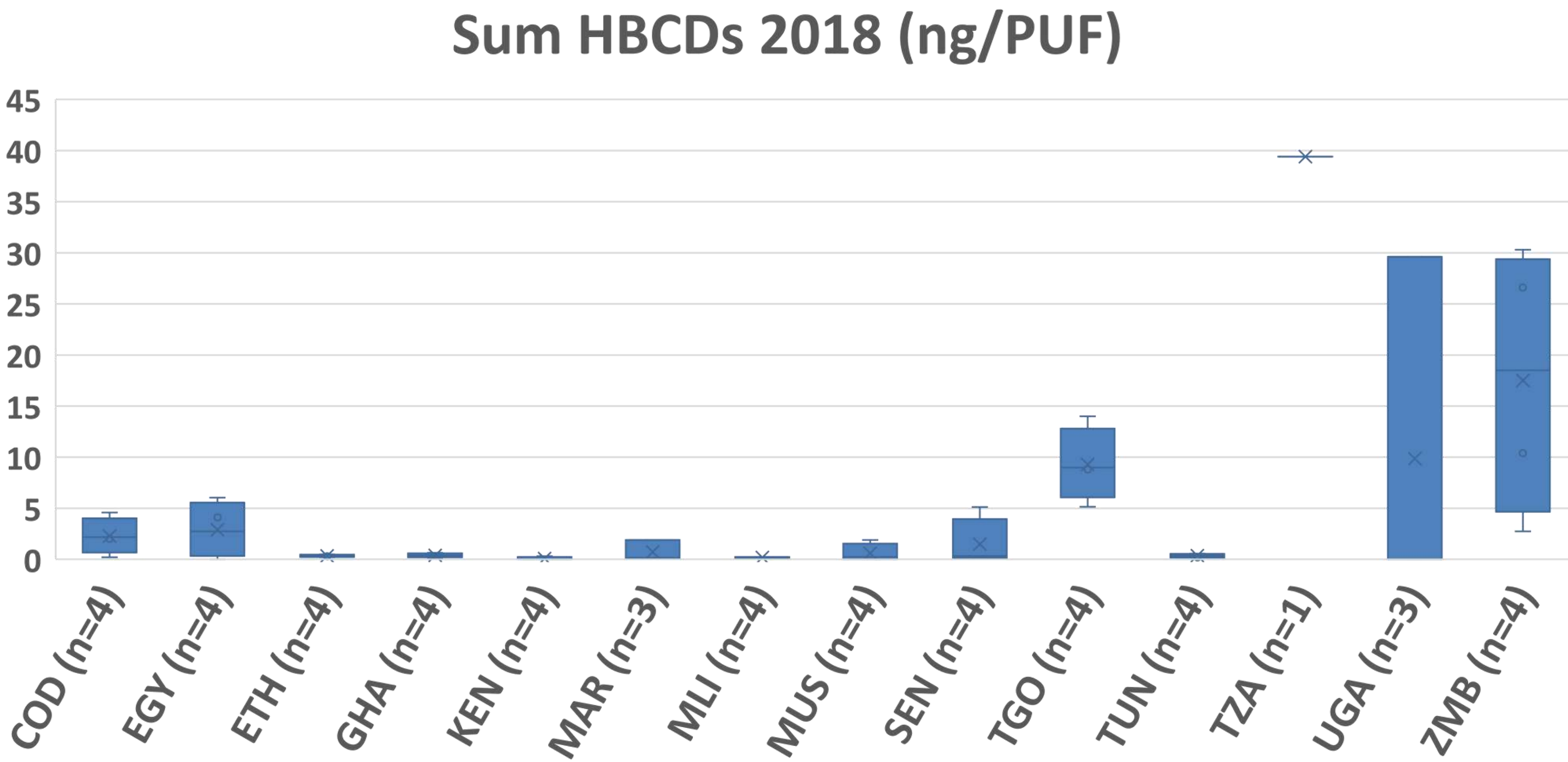
Africa, 2018 – Sum PBDEs



Africa, 2018 – DecaBDE

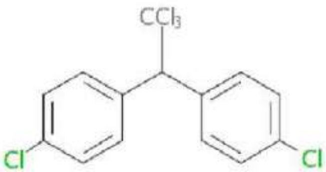


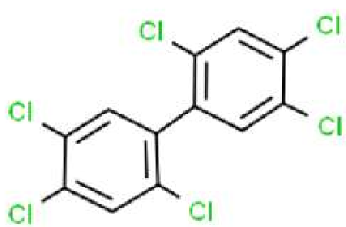
Africa 2018, HBCD



Conclusions

- POP data in air from 43 countries worldwide were collected
- 14 African countries included
- Worldwide, DDT/DDE and PCBs are dominant, decreasing slightly
- In Africa DecaBDE and HBCD are higher than on other continents and tend to increase
- A substantial number of OCP concentrations have decreased to non-detectable values
- DRC: relatively high pollution with DDT/E, PCBs and BFRs
- Zambia : relatively high decaBDE and HBCD contamination
- Ugnada: relatively high HBCD contamination





Results of the UNEP Worldwide Monitoring of Persistent Organic Pollutants in Sediments, Biota and Food Products

Jacob de Boer, Manuela Abalos, Manuel Heinzelmann, Rianne van Dijk, Heidelore Fiedler, Esteban Abad

Objectives

- Generate POPs data from samples relevant for and chosen by the participating countries

- Compare the analytical capability of the participating laboratories with that of the reference laboratories

Overview study

Asia/Pacific	Africa	GRULAC
Mongolia	Egypt	Antigua&Barbuda
Thailand	Ethiopia	Argentina
Vietnam	Ghana	Barbados
Fiji	Kenya	Brazil
Samoa	Mauritius	Chile
	Morocco	Colombia
	Nigeria	Jamaica
	Senegal	Uruguay
	Tanzania	
	Tunisia	
	Uganda	
	Zambia	

Matrices	Matrices	Target Compounds
Fish	Shellfish	PCBs
Sediment	Soil	OCPs
Eggs	Chicken	Toxaphene
Butter	Sugar	PBB
Cow milk	Beef	PBDEs
Maize	Flax seeds	HBCD
Beef	Pork	
Olive oil	Pulse	
Honey	Bananas	
Indoor air	Horse meat	
Sea buckthorn	Mutton	
Tomatoes	Kale	
Guinea fowl		

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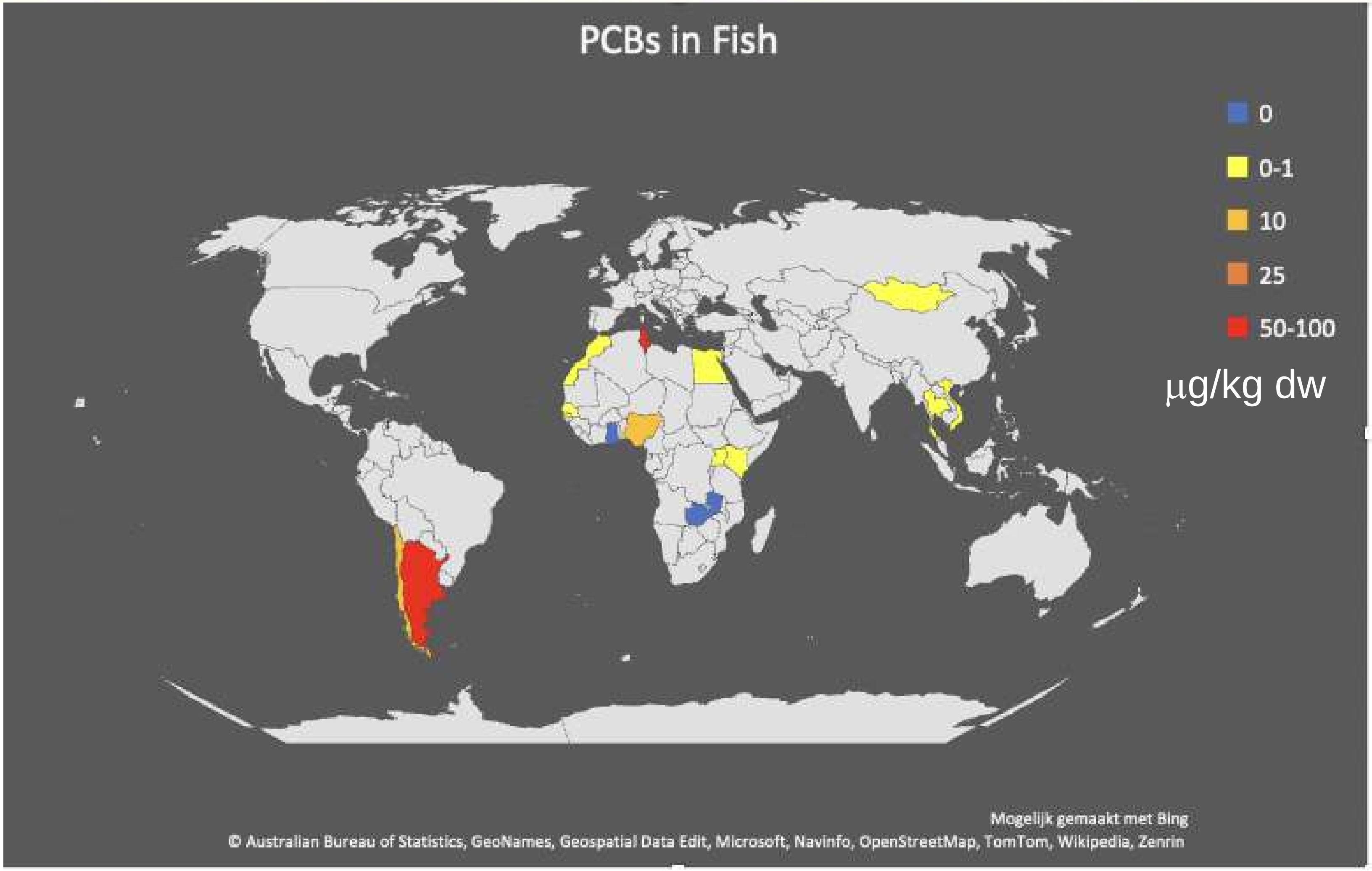
Protocol

- A detailed 15 page protocol was provided. Details included:

  Scope, suggestions for samples, sampling details, instructions for splitting the sample in two parts for the mirror study, use of tools, details on dispatch, permits for transport, use of dry ice, labelling, and courier and customs information

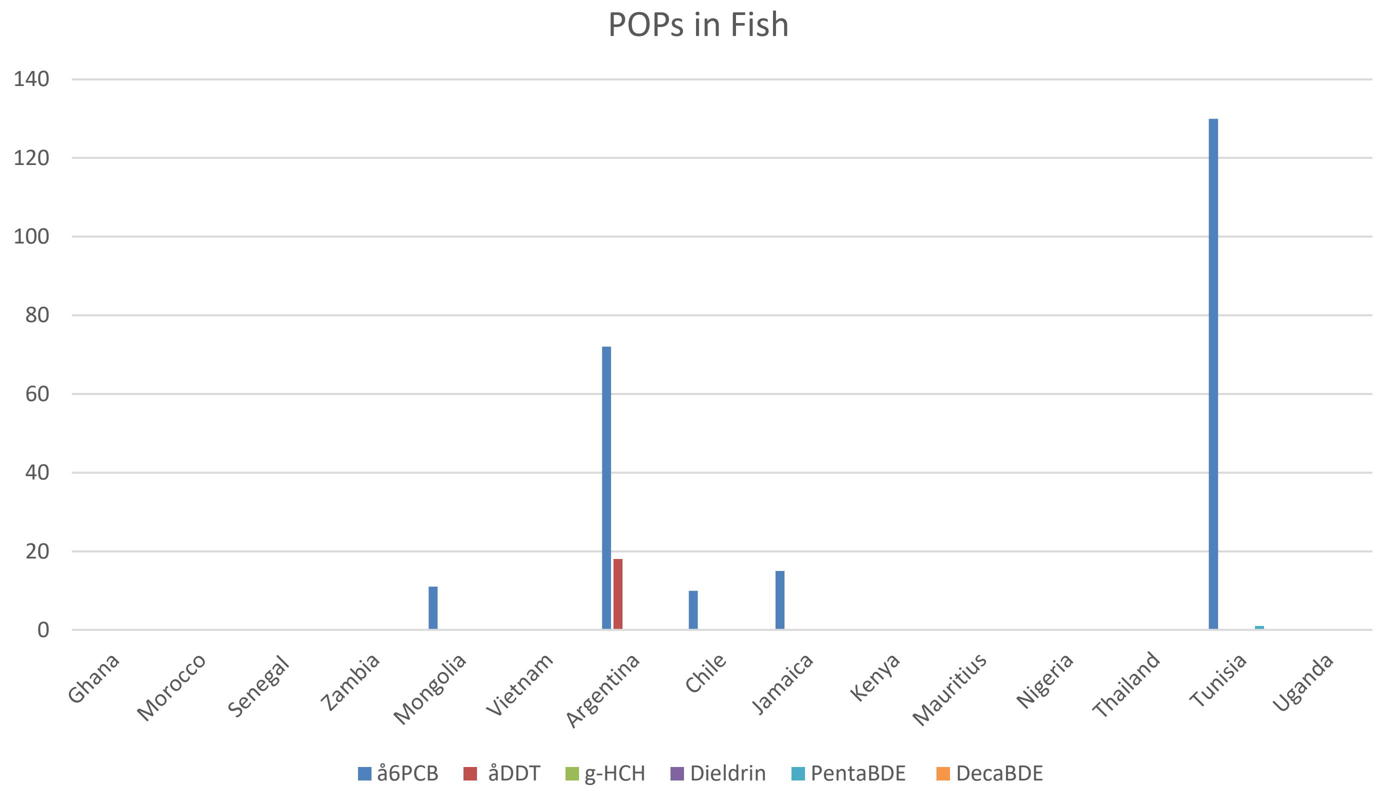
Transport problems…

Σ 6 PCBs in fish



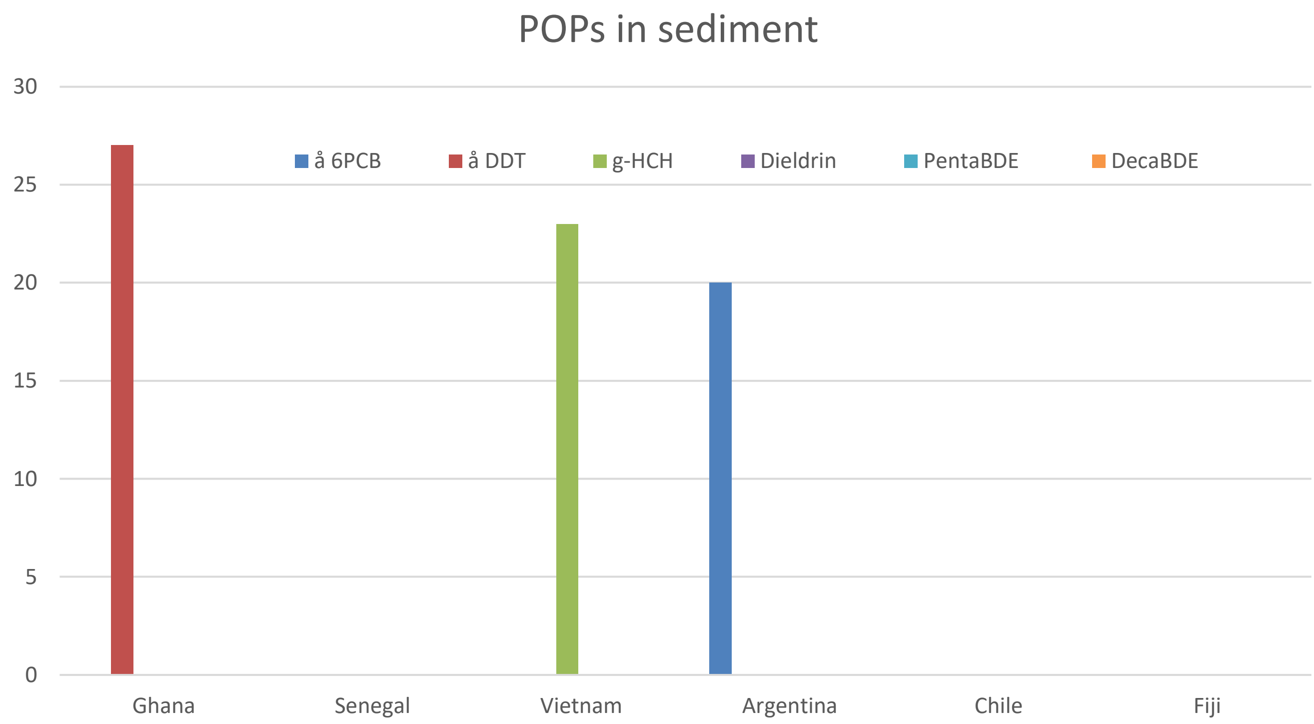
Σ 6 PCBs and other POPs in fish

µg/kg dw



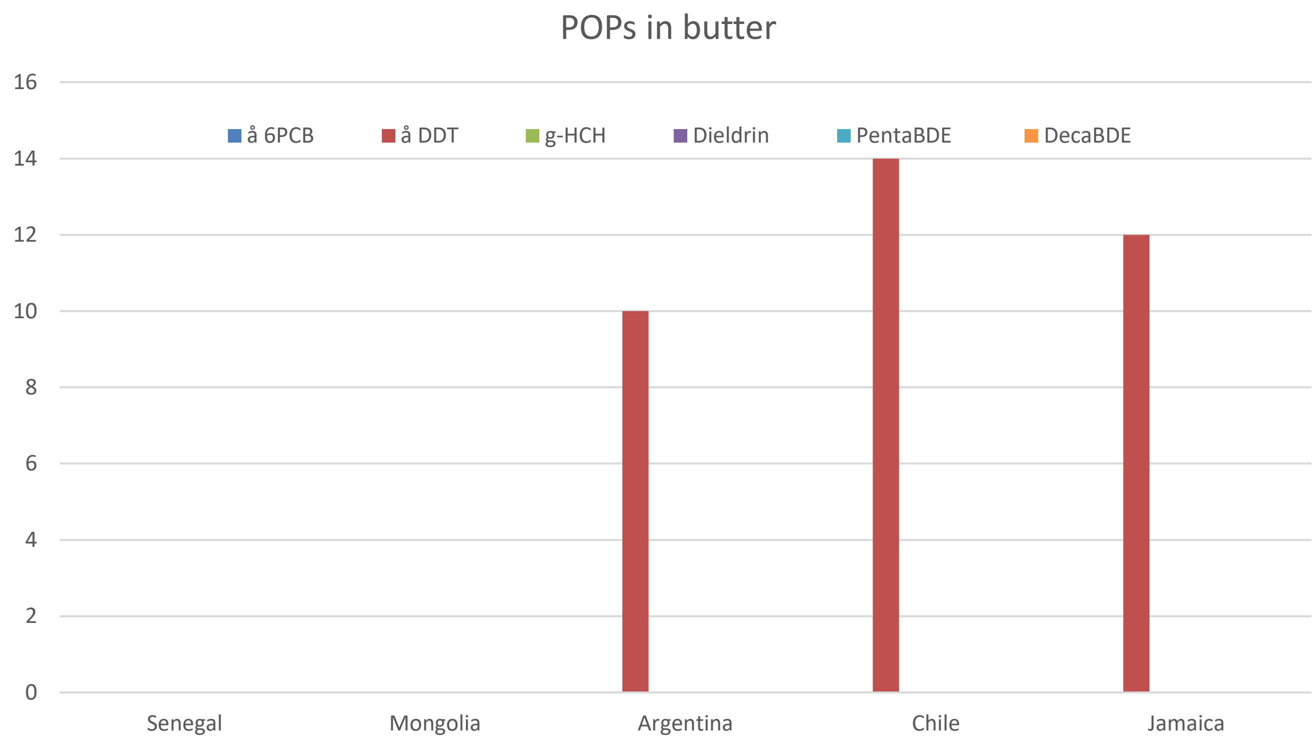
POPs in sediment

µg/kg dw



POPs in butter

μg/kg ww



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Mirror Study Results

Country	POP	Matrix	Total (n)	Acceptable (n)	Comments
Vietnam	PBDE	Sediment	64	34	DecaBDE often too high; acceptable values often <LOD
Tunisia	PCB	Fish, eggs, butter, olive oil	24	8	Acceptable values all <LOD
	OCP	Fish, eggs, butter, olive oil	66	14	Acceptable values all <LOD

A few countries delivered results after the deadline

Example of comparison

PCB	Results Expert Lab µg/kg dw	Results Country µg/kg dw
Matrix	Fish	Fish
28	2.4	<9.375
52	3	<1.59
101	6.2	<1.71
153	55	<3.33
138	36	<2.00
180	27	<10.52

	Results Expert Lab µg/kg dw	Results Country µg/kg dw
2,4'-DDT	<0.08	NA
4,4'-DDT	*0.19	53.48
2,4'-DDD	<0.05	NA
4,4'-DDD	0.69	9.490
2,4'-DDE	*0.05	NA
4,4'-DDE	2.3	<0.508

* Between LOD and LOQ; NA: not analysed

Concluding remarks

- No samples at all received from four countries
- Disappointing participation in mirror study
- Challenges in sending samples
- Many countries experience huge difficulties due to the **lack of a well-working GC/MS and unavailability of ^{13}C labeled standards**
- **DDT and PCBs** are the major POPs in most countries
- Occasional high values for HBCD, penta- and hexachlorobenzene, HCHs
- Levels of most other POPs (e.g., mirex, PBB, toxaphene, chlordanes, heptachlor epoxide, endosulfan, drins) are low - <LOD

- Further reading: *Chemosphere*, Special Issue on:

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