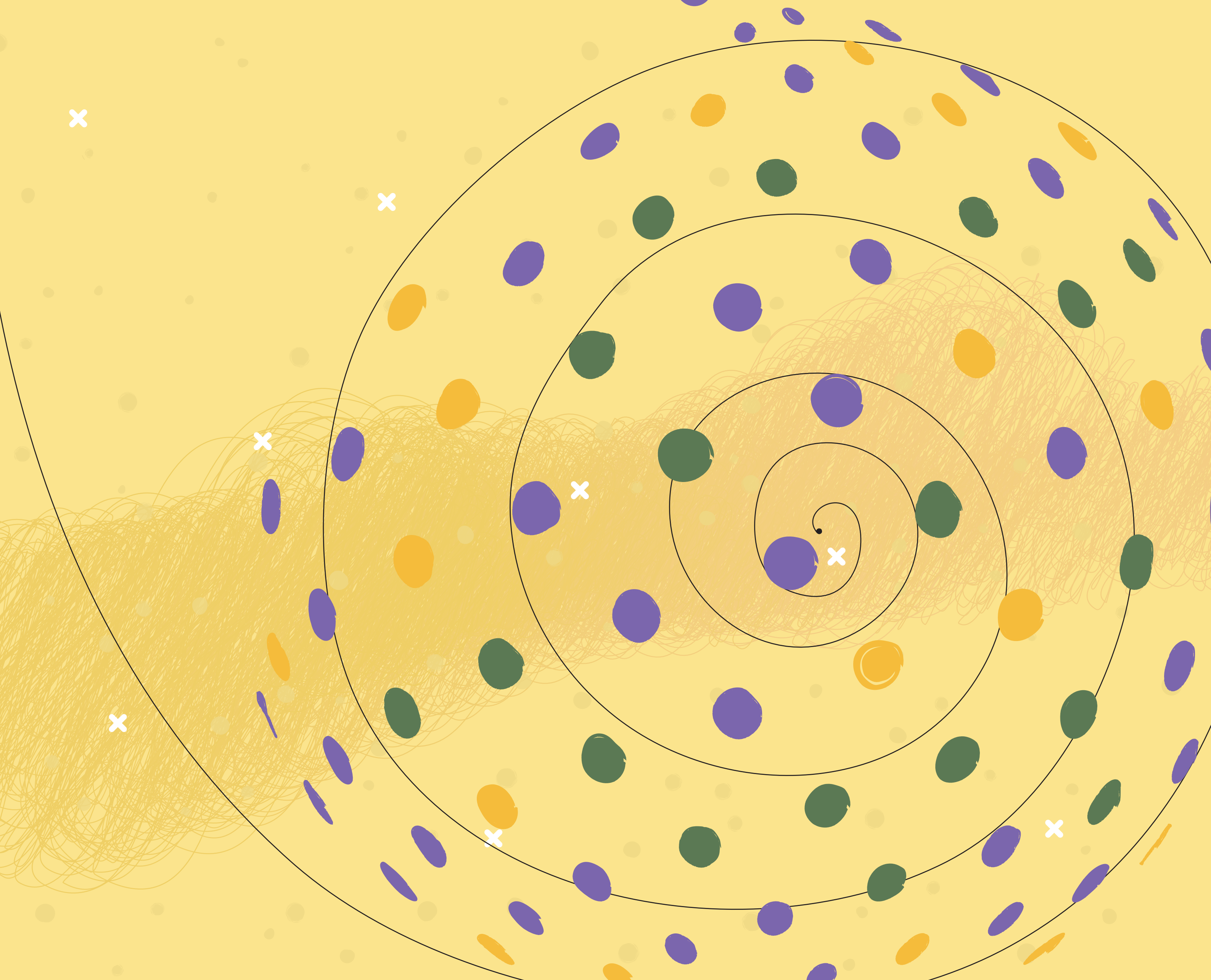
UN environment programme

Regional Report

Continuing Regional Support for the POPs Global Monitoring Plan under the Stockholm Convention in the Latin American and Caribbean Region



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ABBREVIATIONS

AAS	Active air sampling/sampler
CEE	Central and Eastern Europe
DDT	Dichlorodiphenyltrichloroethane
GEF	Global Environment Facility
GMP	Global monitoring plan
GRULAC	Group of Latin America and the Caribbean
HCH	Hexachlorocyclohexane
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
PAS	Passive air sampler(s)
PBDE	Polybrominated diphenylether(s)
PCB	Polychlorinated biphenyl(s)
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PFAS	Perfluororoalkane substances
PFHxS	Perfluorohexanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PUF	Polyurethane foam
TEF	Toxicity equivalency factor
TEQ	Toxic equivalent
UN	United Nations
UNEP	United Nations Environment Programme
WBC	World Bank classification (of income groups)
WEOG	Western European and Other Groups

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SECTION 1

Introduction

Photo: ©UNEP/ Victor Estellano

1. INTRODUCTION

Persistent organic pollutants (POPs) are characterized by certain toxic properties which include resistance to degradation in the environment, bioaccumulation across food chains and long-range transportation though air, water currents or migratory species (United Nations Environment Programme [UNEP] and Secretariat of the Stockholm Convention 2017). There are gender and age-differentiated windows of susceptibility and exposure to these harmful chemicals. Men and women, and children differ in their physiological susceptibility to the effects of exposure to hazardous chemicals, and different social roles related to gender, age and socioeconomic status can affect exposure to POPs (UNEP 2019a). For example, pregnancy, and lactation are periods of susceptibility for women and children where the transfer of POPs can occur (Secretariat of the Strategic Approach to International Chemicals Management 2018).

This report addresses activities and results in support of the global monitoring plan (GMP) as stipulated by the Stockholm Convention on POPs and coordinated by the United Nations Environment Programme (UNEP). The report covers the period of the UNEP/GEF GMP2 project implemented for 11 countries in the Group of Latin America and the Caribbean (GRULAC). The report covers the time between 2016 and 2021.

Activities related to the two rounds of interlaboratory assessments, are referred to in a separate report (UNEP 2023a).

1.1. Compounds to be monitored

The UNEP/GEF GMP2 projects from the onset had the POPs listed until 2013 included (see Table 1, upper part). At the mid-term workshops in 2017, it was agreed with the participating countries and the expert laboratories to expand the spectrum to all POPs listed. In addition, agreement was reached to also include perfluorohexanesulfonic acid (PFHxS), which is recommended for listing by the POPs review committee (Secretariat of the Stockholm Convention 2019a) (see lower part of Table 1).

Table 1: Recommended analytes (UNEP 2019b)

COP	POPs or POPs group	Recommended analytes
Initial POPs	Aldrin	Aldrin
	Chlordane	cis- and trans-chlordane; and cis- and trans-nonachlor, oxychlordane
	Dichlorodiphenyltrichloroethane (DDT)	4,4'-DDT, 2,4'-DDT and 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, 2,4'-DDD
	Dieldrin	Dieldrin
	Endrin	Endrin
	Hexachlorobenzene	HCB
	Heptachlor	Heptachlor and heptachlorepoxide
	Mirex	Mirex
	PCB	ΣPCB_6 (6 congeners): 28, 52, 101, 138, 153, and 180
		PCB with TEFs (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189
	PCDD/PCDF	2,3,7,8-substituted PCD/PCDF (17 congeners)
	Toxaphene	Congeners P26, P50, P62
COP-4	Chlordecone	Chlordecone
	alpha-hexachlorocyclohexane	α-HCH
	beta-hexachlorocyclohexane	β-HCH
	Lindane	γ-HCH
	Hexabromobiphenyl	PBB 153
	Pentachlorobenzene	PeCBz
	Tetra and pentabromodiphenyl ether *	PBDE 47, 99, 153, 154, 175/183 (co-eluting), Optional: PBDE 17, 28, 100
	Hexa and heptabromodiphenyl ether **	
	Perfluorooctane sulfonic acid	PFOS (linear and branched PFOS, ∑PFOS) for air, precursor compounds: FOSA, NMeFOSA, NEtFOSA, NMeFOSE, NEtFOSE)
COP-5	Endosulfan	α-, β-endosulfan; and endosulfan sulfate
COP-6	Hexabromocyclododecane	α-HBCD, β-HBCD, γ-HBCD
COP-7	Hexachlorobutadiene	HCBD
	Pentachlorophenol	[PCP, PCA]
	Polychlorinated naphthalenes (PCN)	[PCN]
COP-8	Short-chain chlorinated paraffins (SCCP) (C_{10}-C_{13}) alkanes	[SCCP]
	Decabromodiphenyl ether	PBDE 209
COP-9	Dicofol	Dicofol
	Perfluorooctanoic acid	PFOA
COP-10	Perfluorohexanesulfonic acid	PFHxS

* commercial pentabromodiphenyl ether, c-penta BDE

** commercial octabromodiphenyl ether, c-octa BDE

Note: For substance groups in [square brackets], no decision has been made as to the recommended analytes to be analyzed.

1.2. Matrices to be sampled

Passive air samplers (PAS) have been developed as simple and cost-effective and PAS equipped with polyurethane foam (PUF) disks (Shoeib and Harner 2002; Herkert, Martinez and Hornbuckle 2016) or XAD resins (Wania *et al*. 2003) have been widely applied to measure and assess atmospheric concentrations of POPs, due to their capacity to retain POPs at low cost and ease of handling. The sorbing matrix (PUF) is usually installed in protective chamber, which can be either formed like a dome or a cylinder (Shoeib and Harner 2002). This protective chamber used to protect the sorbent from the deposition of the large particle, sunlight, precipitation, and help to reduce the impact of wind speed on the sampling rate.

Among the core matrices to evaluate changes in POPs concentrations over time, human milk and human blood were recommended to assess human exposure. In the UNEP-coordinated projects, human milk was chosen to be analyzed for all POPs listed in the annexes of the Convention. The biomonitoring component of the GMP has been put in place by UNEP in coordination with the World Health Organization (WHO) (Secretariat of Stockholm Convention on Persistent Organic Pollutants 2012). Due to inherent persistence and bioaccumulation of POPs, the biomonitoring samples should be collected from primiparae, *i.e.*, mothers having their first child.

In order to promote reliability and comparability of results, samples were collected by the participating countries following a comprehensive protocol originally developed by WHO and modified by UNEP to allow analysis for all POPs (UNEP 2017a). Participating countries were encouraged to adhere as closely as possible to the protocol, which provides guidance on the number and type of samples, selection of donors, collection, storage and pooling of samples, and shipping of samples to the CVUA, contracted by UNEP. For each sample, national approval was obtained before sampling, following the general ethical guidelines for studies involving human subjects by the WHO (World Health Organization [WHO] 2011). The identity of the mothers was not disclosed. In brief, one national pool as a representative sample should be prepared by collecting 50 mL of breast milk from 50 mothers for up to 50 million citizens. The most important criterion is that the donating mother should be *primiparae*; all other criteria were less important and included that the donor should be (i) healthy, (ii) exclusively breastfeeding one child (no twins), and (iii) residing in the area since about five years. The recommended time for taking the sample should be 3-8 weeks after delivery (UNEP 2017a).

To avoid contamination of the sample, CVUA sent 100 mL pre-cleaned glass bottles to each participating country to collect the breast milk from individual mothers. In addition, a 2 L pre-cleaned glass bottle was provided to prepare the national pool. For the national pool, 25 mL human milk (if available) from each mother was placed into glass bottle, kept in a fridge or freezer until shipment to the central laboratory in Freiburg. After arrival, CVUA took one aliquot of 10 mL and shipped to MTM Research Centre at Örebro University for PFAS analysis. The results are reported *per* national pool or national sub-pool in the case of Niue and Germany.

The GMP defined water as a core matrix to evaluate changes over time caused by Party action to eliminate POPs according to the goals of the Stockholm Convention (Fiedler *et al.* 2019; UNEP 2019b; Fiedler *et al.* 2020a) for PFOS and PFOA; not for the other POPs. The previous versions and the latest version of the GMP guidance document already included PFHxS (UNEP 2021). The aim of the UNEP-coordinated GMP2 projects was to test the suitability of the guidance document established for water sampling (Weiss *et al.* 2015) and investigate the levels of PFOS, PFOA and PFHxS in surface water samples collected from developing countries in Africa, Asia-Pacific, and GRULAC countries.

To summarize, the matrices for POPs analysis include the following core matrices:

1	Ambient air:	for all POPs (including PFOS precursors and PBDE 17 and PBDE 28)
2	Human milk:	All POPs
3	Water:	PFOS, PFOA and PFHxS

This report covers the core matrices only and does not present other matrices albeit analyzed by the expert laboratories and following general guidance produced under the UNEP/GEF GMP2 projects (UNEP 2017b). The sampling strategies followed national priorities to collect 'samples of national interest' but also had a strong capacity building component since the sampling strategy was built on having mirror samples; *i.e.*, the same sample analyzed in an expert laboratory and in a national laboratory. For information, the national reports produced by the participating countries should be consulted.

SECTION 2

Characteristics of the participating countries

Photo: ©UNEP / Elsemieke de Boer

2. CHARACTERISTICS OF THE PARTICIPATING COUNTRIES

2.1. Global development indicators of participating countries

For the characterization of the economic situation in a country, the World Bank Classification (WBC) is used by defining the four income groups (L, LM, UM, H) as the gross national income (GNI) per capita in US$ according to the Atlas methodology (World Bank n.d. a). The classification of the participating countries in the respective years are shown in Table 2. Economically, the eleven countries are either high (WBC classification 'H': Antigua and Barbuda, Barbados, Chile, Uruguay) or upper-middle income countries (WBC classification 'UM': Brazil, Colombia, Ecuador, Jamaica, Mexico, Peru). Argentina was the only country having different classifications: 'H' in 2017 and 'UM' in 2018 and 2019.

The second parameter is the population density (PopDen), which is defined as population density per square kilometer of land area (population/km²) (World Bank n.d. b). There is no internationally accepted scheme and therefore we defined population density codes (PD_Codes) as shown in Table 3. The countries in GRULAC differed largely but did not change the code between years. Among the poorly densely populated countries were Argentina, Peru, and Uruguay having less than 25 inhabitants per km² whereas Barbados was the most densely populated country with more than 330 population/km² (World Bank n.d. c).

2.2. Assessment and visualization of results

All data were maintained in Microsoft Office 365 Excel®; statistical evaluations were made using R packages with R-Studio. The Kruskal-Wallis H test was used to determine if there are statistically significant differences between the independent variables and dependent variables. Post-hoc analysis was performed using the pairwise Wilcoxon test. Adjustment of the p-value was made using the Benjamini-Hochberg method. Significance level was set to p=0.05.

For the presentation of the results, we show established the sequence to list alphabetically according to the ISO3 alpha code the countries in South America and afterwards the Caribbeans and North American countries.

Table 2: WBC classifications of the GRULAC countries. GNI in USD

Country name	ISO-3	2017		2018		2019	
		GNI	WBC	GNI	WBC	GNI	WBC
Argentina	ARG	23 000	H	22 460	UM	22 090	UM
Antigua and Barbuda	ATG	18 780	H	20 480	H	21 340	H
Brazil	BRA	14 250	UM	14 600	UM	14 980	UM
Barbados	BRB	15 080	H	15 320	H	15 740	H
Chile	CHL	23 460	H	23 620	H	25 040	H
Colombia	COL	13 910	UM	14 480	UM	15 260	UM
Ecuador	ECU	11 350	UM	11 510	UM	11 500	UM
Jamaica	JAM	9 330	UM	9 590	UM	9 910	UM
Mexico	MEX	19 210	UM	19 710	UM	19 860	UM
Peru	PER	11 930	UM	12 430	UM	12 820	UM
Uruguay	URY	21 730	H	22 250	H	22 850	H

Table 3: Population density and PD_Codes of the GRULAC countries

Country name	ISO3	2017		2018		2019	
		Population/km²	PD_Code	Population/km²	PD_Code	Population/km²	PD_Code
Antigua and Barbuda	ATG	217	PD_200-330	219	PD_200-330	221	PD_200-330
Argentina	ARG	16	PD<25	16	PD<25	16	PD<25
Barbados	BRB	666	PD_330-2000	667	PD_330-2000	667	PD_330-2000
Brazil	BRA	25	PD<25	25	PD_25-90	25	PD_25-90
Chile	CHL	25	PD<25	25	PD_25-90	25	PD_25-90
Colombia	COL	44	PD_25-90	45	PD_25-90	45	PD_25-90
Ecuador	ECU	68	PD_25-90	69	PD_25-90	70	PD_25-90
Jamaica	JAM	270	PD_200-330	271	PD_200-330	272	PD_200-330
Mexico	MEX	64	PD_25-90	65	PD_25-90	66	PD_25-90
Peru	PER	25	PD<25	25	PD<25	25	PD_25-90
Uruguay	URY	20	PD<25	20	PD<25	20	PD<25

SECTION 3

National activities with respect to sampling and POPs analysis

Photo: ©???

3. NATIONAL ACTIVITIES WITH RESPECT TO SAMPLING AND POPS ANALYSIS

3.1. Sampling

For the sampling at national level, standard operational procedure (SOP) documents were developed and made available in English, Spanish and French for the core matrices air using passive samplers (UNEP 2017c), water (UNEP 2017d), and human milk (UNEP 2017a). A fourth SOP was developed for the national samples (UNEP 2017b), which are not included in this report but can be found in the national reports for this project.

3.1.1. Core matrix air with PAS/PUF

For the GMP2 projects, a similar approach was taken having pairs of PAS exposed at one site, each of them equipped with one pre-cleaned PUF to capture a specified group of POPs. *Per* site, a maximum of 12 PAS were set up whereby each PUF from PAS with odd numbers were shipped to the expert laboratories and PUFs from even-numbered PAS should be analyzed in a national laboratory. As a general rule, each PUF should be exposed for one season, *i.e.*, three months, and be analyzed for the respective POPs group. For dl-POPs and toxaphene, since analysis is complex and expensive and concentrations were expected to be low, four PUFs should be combined for one annual sample.

All countries will have at least the samplers (and analyses) highlighted. PAS 7 and PAS 8 are special cases and will be exposed only when there is a national dioxin laboratory. In such cases, the expert laboratory and the national laboratory both will analyse the PUFs on the quarterly basis. The set-up of the PAS/PUFs at a sampling site is detailed in Table 4.

Table 4: Assignment of samplers, PUFs, and analytes according to laboratory per country

PAS	PUF*	Destination Laboratory	Group of chemicals for analysis	# of analyses per year
PAS 1	I, II, III, IV	Basic POPs pesticides in expert back-up laboratory	aldrin, dieldrin, endrin, chlordane, DDT, alpha, beta, and gamma-HCHs, heptachlor, mirex, HCB, pentachlorobenzene, endosulfan, toxaphene	4
PAS 2	I, II, III, IV	Basic POPs in national POPs laboratory	aldrin, dieldrin, endrin, chlordane, DDT, alpha, beta, and gamma-HCHs, heptachlor, mirex, HCB, pentachlorobenzene, endosulfan, toxaphene	4
PAS 3	I, II, III, IV	Indicator PCB in expert back-up laboratory	6 indicator PCB	4
PAS 4	I, II, III, IV	Indicator PCB in national POPs laboratory	6 indicator PCB	4
PAS 5	I, II, III, IV	Dioxin-like POPs in expert back-up laboratory (combined into one extract as annual average)	17 PCDD/PCDF, 12 dl-PCB	1
PAS 6	I, II, III, IV	Dioxin-like POPs in national dioxin laboratory (combined into one extract as annual average)	17 PCDD/PCDF, 12 dl-PCB	1
PAS 7	I, II, III, IV	Dioxin-like POPs in expert back-up laboratory (each exposure to generate one seasonal data point; total of 4 per year and country)	17 PCDD/PCDF, 12 dl-PCB	4
PAS 8	I, II, III, IV	Dioxin-like POPs in national laboratory (each exposure to generate one seasonal data point; total of 4 per year and country)	17 PCDD/PCDF, 12 dl-PCB	4
PAS 9	I, II, III, IV	PBDE in expert laboratory	8 PBDE, HBCD, HBB	4
PAS 10	I, II, III, IV	PBDE in national laboratory	8 PBDE, HBCD, HBB	4
PAS 11	I, II, III, IV	PFOS in expert laboratory	3 PFAS	4
PAS 12	I, II, III, IV	PFOS in national laboratory	3 PFAS	4

*Roman numbers (I, II, III, and IV) represent the sampling seasons

Note: Exposure periods are as follows

- Seasonal: 3 months with I=Jan-Mar, II=Apr-Jun, III=Jul-Sep, IV=Oct-Dec
- Annual: 4 PUFs from each 3-months exposure combined into one extract for analysis, maximum of 4 PUFs (with one PUF for each season).

All countries from the GRULAC region participated in the air monitoring with PAS/PUFs. The identification of the sampling sites is provided in Appendix in Table S 2 and a graphical sketch indicating the geographic location in Figure 1.

Photographic impressions of the air sampling sies with the PAS exposed are shown below.

Figure 1: Geographical sketch of countries participating in the UNEP/GMP2 GRULAC project (graphics, courtesy of Chemicals and Health Branch, Industry and Economy Division of UNEP)

Sampling site for air with PAS/PUF: Antigua and Barbuda, © Ministry of Agriculture, Fisheries and Barbuda Affairs

Sampling site for air with PAS/PUF: Argentina, © National Industrial Technology Institute

Sampling site for air with PAS/PUF: Barbados, © Ministry of Environment and Natural Beautification

Sampling site for air with PAS/PUF: Brazil, © Environmental Company of the San Pablo State

Sampling site for air with PAS/PUF: Chile, © Environmental Ministry

Sampling site for air with PAS/PUF: Colombia, © Antioquia University

Sampling site for air with PAS/PUF: Ecuador, © Ministry of Environment, Water, Technology

Sampling site for air with PAS/PUF: Jamaica, © University of the West Indies

Sampling site for air with PAS/PUF: Mexico, © National Institute of Ecology and Climate Change (INECC)

Sampling site for air with PAS/PUF: Uruguay © Ministry of Environment

3.1.2. Core matrix air with active sampler

Following the recommendation in the GMP guideline (UNEP 2019b), one site in Brazil was selected to host an active air sampler (AAS).

Sampling site for air with AAS: Brazil, © Environmental Company of the San Pablo State

3.1.3. Core matrix water

PFAS were not among the initial twelve POPs at the onset of the Stockholm Convention in 2001 (entry into force in 2004) but were listed through the POPs review process. PFOS, its salts and perfluorooctanesulfonyl fluoride (PFOSF) have been listed into annex B of the Stockholm Convention in 2009 (Secretariat of the Stockholm Convention 2009) with an amendment in 2019 (Secretariat of the Stockholm Convention 2019b); PFOA, its salts and PFOA-related compounds have been listed in Annex A in 2019 (Secretariat of the Stockholm Convention 2019c). PFHxS is recommended for listing at the next meeting of the Conference of the Parties to the Stockholm Convention in 2021/2022 (Secretariat of the Stockholm Convention 2019a). With the listing of PFOS in 2009, water has been chosen as a core matrix (Weiss *et al*. 2015). So far, water is a core matrix in the GMP for the perfluorinated compounds only; not for any of the brominated or chlorinated POPs (UNEP 2019b).

Surface water samples were collected by staff from local laboratories or institutions from developing countries participating in the water sampling activity of the UNEP/GMP2 projects. Across the projects, a total of 22 countries participated; of these five were from the GRULAC region. The identification of the sampling sites is provided in Appendix in Table S 3. The graphical sketch of the water sampling sies is shown in Figure 2.

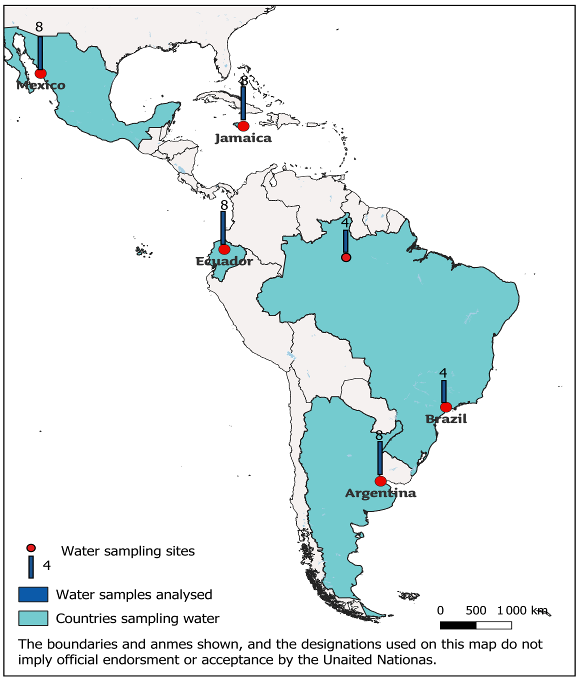

Figure 2: Geographical sketch of water sampling locations under UNEP/GMP2 GRULAC project

All water samples were collected according to the protocol for the sampling of water as a core matrix in the UNEP/GEF GMP2 projects (UNEP 2017d). To ensure integrity of the samples and to minimize contamination, each country had received nine 1-L high-density polyethylene (HDPE) bottles from Örebro University; it was attempted to have eight samples from each country plus one blank. The protocol prescribes to have an area- and time-integrative sampling location since sampling occurred only 4-times *per* year. Water samples were taken as surface water samples at a recommended depth of about 1 m from either the mouth of a large river, an estuary or bay in each country (for details of sampling locations, see Table S 3. One location for each country was chosen except for Brazil where the location was changed after the first year. Water samples were collected throughout the years 2017 and 2018. Samples were taken at the end of each quarter of the year, classified into four intervals using the Roman numbers I, II, III, and IV, respectively. In total 144 water samples were analyzed; GRULAC contributed with 40 samples, which corresponds to 100 % realization of the planned activities (5 countries with four samples per year during two years; thus, a total of eight samples).

In addition, Antigua and Barbuda, Jamaica, and Uruguay collected water samples as part of the national samples. These were collected according to the protocol, shipped to Örebro University, and analyzed for PFAS.

Sampling site for water: Brazil; amazon River (2 sites), © Environmental Company of the San Pablo State

Sampling site for water: Mexico, © National Institute of Ecology and Climate Change (INECC)

3.1.4. Core matrix human milk

Human milk samples have been collected as national pools and sent for analysis. The human milk sampling survey was conducted following a protocol originally developed by WHO (2007), adapted for the regional projects in the SOP by UNEP (UNEP 2017a). The procedure and criteria are also contained in the GMP guidance document (UNEP 2021) with the objective to be representative of the country. Most important, donor mothers should be primipara and collected between three and twelve weeks after delivery.

Other recommended parameters included

- Mother should be under 30 years of age (the national coordinator might consult national health statistics for possible advice on setting the maximum age)
- Both mother and child should be apparently healthy, including normal pregnancy.
- Mother should be breastfeeding one child only (*i.e.*, no twins).
- Mother should have resided in the represented area (country) for at least the previous ten years.
- Mother should not reside in local areas where emissions of POPs are known or suspected to result in elevated concentrations of POPs in the local population.
- Mother should be available for sample collection within 3 to 8 weeks of delivery.

To avoid contamination of the sample, the State Institute for Chemical and Veterinary Analysis of Food (CVUA) in Freiburg, Germany (CVUA) as the reference laboratory in this project sent 100 mL pre-cleaned glass bottles to each participating country to collect the breast milk from individual mothers. In addition, a 2 L pre-cleaned glass bottle was provided to prepare the national pool. For the national pool, 25 mL human milk (if available) from each mother was placed into glass bottle, kept in a fridge or freezer until shipment to the central laboratory in Freiburg. After arrival, CVUA took one aliquot of 10 mL and shipped to MTM Research Centre at Örebro University for PFAS analysis. The results are reported per national pool or national sub-pool in the case of Niue and Germany.

Further, all countries sent their samples, either as a national pool or individual samples to the expert laboratory at the State Institute for Chemical and Veterinary Analysis of Food (CVUA) in Freiburg, Germany, for analysis of brominated and chlorinated POPs. CVUA subsequently sent an aliquot of 10 mL to MTM Research Center, Örebro University, Sweden, for analysis of perfluorinated compounds.

The recommendations included in the guidance document as regards the criteria for selecting donor mothers as well as the procedure for the chemical analysis are not repeated in the country sections. Details may be found in the national reports by participating country.

Argentina

Las muestras de leche humana fueron obtenidas de acuerdo a los lineamientos y protocolos sugeridos por PNUMA (UNEP 2017a).

La toma de muestra representativa de zona urbana fue realizada en la ciudad de Buenos Aires, en el hospital Materno Infantil Ramón Sardá. Las donantes fueron entrevistadas por el personal de salud a fin de corroborar su voluntad y aptitud para participar del monitoreo, y respondieron al cuestionario/encuesta sobre hábitos de consumo relacionados a la potencial presencia de COP en leche humana.

Las muestras fueron tomadas entre octubre de 2017 y julio de 2018. Del total de muestras recibidas en el laboratorio, se determinaron aptas para el análisis a 49 de ellas. Estas 49 muestras componen el pool enviado al laboratorio experto, el cual realizó el análisis de COP completo, Laboratorio de CVUA, Friburgo, Alemania.

Barbados

The collection of the samples of human milk comprised four stages. These were as follows:

- Seeking permission from local ethics board;
- Seeking assistance from the Ministry of Health regarding the collection of samples;
- Collecting of the samples of human milk; and
- Analysing the samples.

The Environmental Protection Department (EPD) applied to the local ethics board to obtain permission to undertake the collection of the samples of human milk. The local ethic committee comprises representatives from the Ministry of Health and the University of the West Indies. The application outlined, inter alia, the protocols for ensuring confidentiality, a brief assessment of the risk and benefits of the project, a description of the participants and the selection criteria, and the purpose of the research.

After the EPD obtained approval from the ethics committee, the EPD sought to gain access, through the Ministry of Health, to the records from the antenatal clinics in the polyclinics. Access to these records: facilitated the identification of potential mothers for the study and allowed those mothers to be contacted. Due to the limited time to collect the required minimum number of 50 samples, the Department decided to screen postnatal mothers. Screening of the mothers was conducted according to the procedure outlined in the "*Global Monitoring Plan on Persistent Organic Pollutants: Guidelines for Organization, Sampling and Analysis of Human Milk on Persistent Organic Pollutants*" (UNEP 2017a).

With the assistance of the Ministry of Health, the Department identified and contracted two retired nurses to contact potential candidates for the study and collect the 50 ml samples from eligible and consenting participants. Samples were collected over the period from July to September 2017. Collected samples were stored at 4 °C and transported to the FST (on the same day that they were collected or as soon as practicable) where they were stored at -18 °C.

Samples were collected from 51 primparae mothers under the age of 21.3 years. The mothers were breastfeeding only one child (*i.e.*, no twins), resided in the area for at least the previous ten years, and were available for sample collection within three to eight weeks of delivery. Additionally, the mother reportedly had a normal pregnancy and both the mother and child appeared to be healthy.

Colombia

The monitoring of human milk in Colombia was implemented by the National Institute of Health. The 50 samples of breast milk were collected between October 2017 and January 2019 from milk banks. The milk banks were located at the following hospitals: Hospital Camino Adelita de Char, Hospital Universitario de Nariño, Hospital General de Medellín, and Hospital Universitario Erasmo Meoz from Barranquilla, Pasto, Medellin and Cúcuta cities, respectively. The samples were stored at –20°C until pooling. For the national pool, 25 mL of each sample were added to a 2000 mL glass bottle, frozen at -20°C and shipped to the CVUA laboratory on 28 January 2019.

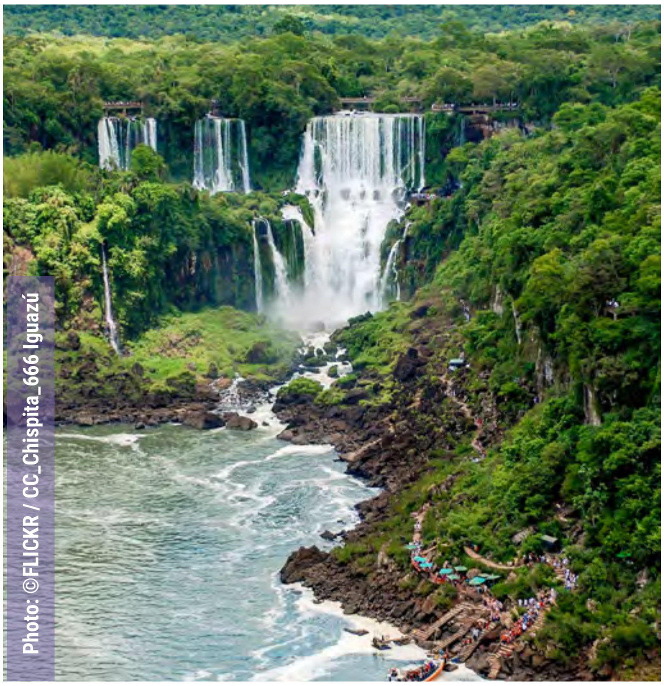
Photo: ©FLICKR / CC_Chispita_666 Iguazú

Preparation of national pool human milk in Colombia, © Antioquia University / Boris Avila

Ecuador

Para realizar el muestreo de leche materna se contó con el apoyo de la Gerencia del Proyecto de Nutrición del Ministerio de Salud Pública (MSP), a través de los Bancos de leche del con los que cuenta el Ministerio de Salud Pública.

La metodología para la selección de las madres donantes y la recolección de muestras fue aplicada de acuerdo con lo indicado en la "Guía para la organización, el muestreo y el análisis de COP en leche materna" elaborada por PNUMA.

Mexico

En el marco de la OMS, se ha elaborado un protocolo para la metodología de muestreo y preparación de muestras para estudios de exposición a contaminantes orgánicos persistentes. Este protocolo constituye la base del componente de la leche humana del plan mundial de vigilancia (GMP) (UNEP 2017a).

Los principales objetivos de estos estudios son:

1. Producir datos fiables y comparables sobre las concentraciones de contaminantes orgánicos persistentes en la leche humana para seguir mejorando la evaluación del riesgo para la salud de los lactantes
2. Proporcionar una visión general de los niveles de exposición en varios países y zonas geográficas y permitir sacar conclusiones sobre las prioridades de seguimiento en un país/región,
3. Determinar las tendencias de los niveles de exposición.

Con el fin de promover la fiabilidad y la comparabilidad de los resultados, las muestras son recogidas por los países participantes siguiendo un protocolo integral armonizado desarrollado por la OMS (WHO 2007) y modificado por el PNUMA (UNEP 2017a). Para todos los estudios, se aplicaron estrictamente los siguientes criterios de selección de las madres donantes:

- Madres primerizas
- Deben estar sanas
- Deben estar amamantando exclusivamente a un hijo

Para obtener datos estadísticamente fiables, se recluta un número adecuado de donantes individuales para proporcionar muestras. Los protocolos recomiendan un mínimo de 50 muestras individuales para cada país. Se mezclan alícuotas iguales de estas muestras individuales para formar una muestra compuesta representativa ("muestra conjunta").

Para la ubicación de las madres donantes de leche se eligió la zona de Los Mochis.

Una vez detectada la madre donante, se procedió a explicarle el proyecto, se le leyó el consentimiento informado y, en caso de estar de acuerdo, se procedió a solicitar su autorización firmando en la parte correspondiente. Posteriormente, se le asignó un código de identificación único y se le aplicó una encuesta sobre información personal, hábitos alimenticios y demás cuidados prenatales, la cual se anexa al final de este documento. El trabajo de recolección de la información y la toma muestras se realizó en el periodo del 28 al 31 de octubre de 2017. El número total de madres participantes en este estudio fue de 48, todas cumplieron los criterios de inclusión solicitados: ser madre primeriza, estar dentro del rango de edad (máx. 30 años), madre e hijo aparentemente saludables, la madre debe estar amamantando solamente a un hijo (no gemelos), haber vivido en la misma zona de 10 años a la fecha de muestreo, madres que estén exclusivamente o principalmente amamantando, no vivir cerca de incineradores, fábricas de papel, metal y/o productos químicos y estar entre la tercera y la octava semana después del parto (UNEP 2010).

Finalmente, se les entregó un frasco previamente tratado para garantizar la esterilización de este y se les explicó cómo hacer la extracción de leche materna ellas mismas, enfatizando en la cantidad mínima requerida de 50 ml y los cuidados de higiene previos a la toma de muestra. Se les dejó el frasco un máximo de 24 horas para realizar la extracción, con la indicación de colocar la muestra obtenida en la heladera, buscando la conservación a los 4°C. Las muestras fueron recogidas según el llamado de las participantes, y cada frasco con leche materna fue trasportado en una hielera con refrigerantes, procurando que la temperatura estuviera entre los 4 ° y 8 °C. Al llegar al laboratorio, las muestras recolectadas fueron almacenadas en el refrigerador en un lapso no mayor a 72 horas, y se procedió a formar la muestra combinada o "pool sample".

Las muestras individuales fueron homogenizadas agregando calor hasta alcanzar los 38°C, estabilizadas con pastillas de dicromato de potasio y agitándolas durante 10 minutos. Posteriormente, se tomaron 10 ml de cada una de las muestras individuales y se depositaron en un recipiente de vidrio de 1 L previamente tratado para asegurar la integridad de las muestras. Finalmente, se obtuvieron 480 ml de los cuales se apartaron 50 ml para analizar COP simples en el laboratorio nacional y el resto fue enviado al laboratorio de referencia de la OMS, en el cual se analizaron COP analíticamente simples y complejos.

Se tomaron otros 15 ml de leche materna de cada frasco individual para preparar una segunda muestra combinada, la cual fue enviada al banco mundial de leche materna de la OMS.

Los 25 ml restantes de las muestras individuales se conservaron en el mismo frasco y se enviaron al laboratorio nacional para analizar COP simples de manera individual. Todas las muestras fueron conservadas en un ultra-congelador a -20 °C antes de ser enviadas a los laboratorios destino y se enviaron en hieleras con refrigerantes a una temperatura entre 4°C y 8°C.

3.2. Results generated by national laboratories

Sampling strategies and results for the national samples are described in the national reports developed for this project.

The results are presented according to alphabetical order of the country name and address the analysis of the core matrices only. Within each section, the matrices follow the same sequence as shown for the results of the expert laboratories with the POPs in the same sequence as well.

3.2.1. Argentina

Human milk

Los análisis de COP iniciales fueron realizados en el Laboratorio de Cromatografía y Ensayos Especiales (LCyEE), perteneciente al Departamento de Red de Laboratorios Lácteos de INTI, utilizando cromatografía gas-líquido acoplada a detección de captura de electrones (GC-µECD).

El método de procesamiento de muestras aplicado para el análisis de COP fue QuEChERs, adaptado por el laboratorio a la matriz leche humana. Las muestras utilizadas para la validación del mismo corresponden a donantes no incluidas en el estudio y a muestras dentro del estudio, que no cumplían con los requisitos para incluirse en el pool de muestras. Los parámetros de validación verificados para el método fueron: repetibilidad, veracidad, efecto matriz, límite de detección (LOD), límite de cuantificación (LOQ), linealidad. La cuantificación de los analitos fue realizada por curva de calibración en matriz leche humana.

El análisis del porcentaje de materia grasa en las muestras de leche humana fue realizado mediante espectrofotometría de infrarrojo, según norma ISO 9622 IDF 141:2013.

3.2.2. Colombia

Water was not a core matrix in Colombia; therefore, no samples were collected or analyzed.

Ambient Air

The national analysis of the PUFs was undertaken by the Grupo Diagnóstico y Control de la Contaminación – GDCON from Universidad de Antioquia – Colombia.

Brominated and chlorinated POPs: the results per group of brominated or chlorinated POPs (as sums of isomers or congeners) are shown in Table 5. All data refer to 1 PUF and 3 month of exposure time and are given in ng/PUF. The LOQ of the national laboratory was 1.00 ng/PUF. Mirex, endosulfan, HCB, PeCBz, $PBDE_8$, and HBCD as well as dioxin-like POPs and PFAS were not analyzed by the national laboratory due to lack of capacity. For dioxin like POPs and PFAS, there is no instrumentation available.

Table 5: Brominated and chlorinated POPs in PAS/PUF - Colombia: 2017 and 2018 corresponds to the monitoring year and the numbers I-IV to the quarters of each year. The values are in ng/PUF.

2017-I	2017-II	2017-III	2017-IV	2018-I	2018-II	2018-III	2018-IV
Chlordane							
7.45	4.58	8.79	4.14	4.09	4.60	5.89	5.34
Mean (SD): 5.61 (1.70);Median: 4.97; Min – Max: 4.09 – 8.79							
Drins							
<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Mean (SD): <1.00 (0); Median: <1.00; Min – Max: <1.00							
DDT							
13.1	8.38	15.3	7.93	10.3	9.41	11.7	9.91
Mean (SD): 10.8 (2.48); Median: 10.1; Min – Max: 7.93 – 15.3							
Heptachlor							
<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Mean (SD): <1.00 (0); Median: <1.00; Min – Max: <1.00							
HCHs							
<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Mean (SD): <1.00 (0); Median: <1.00; Min – Max: <1.00							
PCB6							
9.39	6.12	26.7	6.95	6.23	5.51	2.49	2.84
Mean (SD): 8.28 (7.77); Median: 6.17; Min – Max: 2.49 – 26.7							

Human Milk

Human milk samples were analyzed in the laboratory of the Grupo Diagnóstico y Control de la Contaminación – GDCON – at Universidad de Antioquia. Results of Individual samples (50 x 25 mL) are described in the national report developed for this project. In Table 6, the concentrations of chlorinated and brominated POPs in the national human milk pool (ng/g lipid) are shown. The following POPs were not analyzed by the national laboratory due to lack of capacity and instruments: Dioxin like POPs, HBCD, PFAS, SCCPs, Toxaphene, PBDE6, and PBDE 209.

Table 6: Concentrations of chlorinated and brominated POPs in national human milk (ng/g lipid) for Colombia.

POPs	ng/g lipid	POPs	ng/g lipid
ΣChlordane	<1.70	HCB	NR
Dieldrin	NR	ΣPCB6	<1.70
ΣDDT	16.1	Toxaphene	NR
ΣHCHs	NR	ΣPBDE6	NR
cis_Hepo	<1.70	PBDE209	NR
Mirex	NR		

Ecuador

En el laboratorio de Agrocalidad para el análisis de leche materna se tomó como referencia el método de la AOAC "Official Method 2007.01", "Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate". Y el método "Foods of Plant origin: Determination of Pesticide residues using GC-MS and /or LC-MS/(MS) following acetonitrile extraction/partitioning and cleanup by dispersive SPE-QuEChERS method. EN 15662:2008".

Y el análisis instrumental se realizó por cromatografía de gases con detector de captura de electrones (GC-ECD), con un equipo Varian 3800.

Muestra de PUF (6,0 g), 10 ng de tetraclorometaxileno (TCMX) añadido por muestra de extracción con tolueno-metanol. Clean-up con Florisil. Análisis por GC/μECD PUF. Los resultados se encuentran en las tablas siguientes. Se ve, que la mayoría de los resultados son abajo del límite de cuantificación.

Table 7: The results of the Agrocalidad laboratory analysis of breast in 2017

ANALITOS	LIMITE DE DETECCION	LIMITE DE CUANTIFICACIÓN	Enero -Marzo 2017			Abril -Junio 2017			Julio -septiembre 2017			Octubre Diciembre 2017		
			ECU -2-2017-1	ECU -4-2017-1	ECU -10-2017-1	ECU -2-2017-11	ECU -4-2017-11	ECU -10-2017-II	ECU -2-2017-III	ECU -4-2017-III	ECU -10-2017-III	ECU -2-2017-IV	ECU -4-2017-IV	ECU -10-2017-IV
	LOD (ng /PUF)	LOQ (ng /PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc (ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)	Conc .(ng / PUF)
SUBRROGADO**	0,2	0,6	8,6	9,5	8,94	9	9,05	8,4	7,95	9,05	8,35	9	8,7	8,4
ALFA HCH	0,1	0,3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOD	<LOD
HEXACLOROBENCENO	0,1	0,3	<LOQ	<LOQ	<LOD	1,1	1,2	1,3	1,9	2,1	2	<LOQ	<LOD	<LOD
BETA HCH	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOQ	<LOD	<LOD	<LOQ	<LOD
LINDANO	0,1	0,3	0,4	<LOQ	0,5	1,4	1,3	1,5	1,05	1,2	0,9	<LOQ	<LOQ	<LOQ
HEPTACLORO	0,1	0,3	<LOQ	0,5	<LOQ	1,1	1,2	0,9	0,7	0,5	0,8	<LOQ	<LOQ	<LOQ
ALDRIN	0,1	0,3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOD
HEPTACLORO EPOXIDO B	0,1	0,3	<LOQ	<LOQ	0,4	0,7	0,5	0,8	1,8	1,3	1,5	0,8	0,9	1,1
OXICLORDANO	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOD	<LOD	<LOD	<LOD
HEPTACLORO EPOXIDO A	0,1	0,3	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOD
o,p DDE	0,3	0,9	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOD	<LOD
ALFA ENDOSULFAN	0,2	0,6	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOD	0,6	<LOQ	<LOQ	0,7	<LOQ	<LOQ
CISCLORDANO	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOD	<LOQ	<LOD	<LOD
p,p DDE	0,2	0,6	0,6	0,9	0,8	0,7	<LOQ	<LOQ	1,7	1,5	1,4	1,1	0,9	1
DIELDRIN	0,2	0,6	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
ENDRIN	0,2	0,6	<LOD	<LOQ	<LOQ	<LOQ	<LDQ	<LOQ	<LOD	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BETA ENDOSULFAN	0,2	0,6	<LOD	<LOD	<LOQ	<LOD	0,6	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOD	<LOQ
p,p DDD	0,2	0,6	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOD	0,7	<LOQ	0,8	<LOD	<LOQ	<LOD
o,p DDT	0,2	0,6	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOQ	<LOD	<LOQ	<LOQ	<LOD	<LOD	<LOD
ENDRIN ALDHEIDO	0,3	0,9	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD
ENDOSULFAN SULFATO	0,2	0,6	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	0,7	<LOQ	<LOQ	<LOQ	<LOD	<LOD
p,p DDT	0,2	0,6	<LOQ	<LOQ	<LOD	<LOD	<LOQ	<LOQ	0,9	<LOQ	0,8	0,6	<LOQ	<LOQ
ENDRIN CETONA	0,2	0,6	<LOD	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD
MIREX	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD
PCB -28	0,4	1,2	<LOQ	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOQ	<LOD	<LOQ	<LOD
PCB -52	0,5	1,5	<LOD	1,5	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOQ	<LOD	<LOQ
PCB -101	0,6	1,8	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PCB -118	0,5	1,5	2	1,7	<LOD	<LOQ	2,7	<LOQ	1,7	<LOQ	2,3	<LOQ	1,9	<LOQ
PCB -138	0,4	1,2	<LOD	1,2	1,6	<LOQ	1,9	<LOQ	1,5	<LOQ	1,4	<LOQ	<LOD	3,85
PCB -153	0,6	1,8	<LOQ	<LOD	<LOD	<LOQ	<LOD	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOD	<LOD
PCB -180	0,5	1,5	<LOD	<LOQ	<LOD	<LOQ	1,5	<LOQ	<LOD	<LOQ	<LOQ	<LOD	<LOD	<LOD

Table 8: The results of the Agrocalidad laboratory analysis of breast in 2018

ANALITOS	LIMITE DE DETECCION	LIMITE DE CUANTIFICACIÓN	Enero-Marzo 2018			Abril-Junio 2018			Julio-Septiembre 2018			Octubre-Diciembre 2018		
			ECU -2-2018-1	ECU -4-2018-1	ECU -10-2018-1	ECU -4-2018-11	ECU -10-2018-II	ECU -2-2018-11	ECU -2-2018-III	ECU -4-2017-III	ECU -10-2017-III	ECU -2-2018-IV	ECU -4-2018-IV	ECU -10-2018-IV
	LOD (ng /PUF)	LOQ (ng /PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)	Conc (ng / PUF)
SUBRROGADO**	0,2	0,6	15,36	9,07	7,87	8,37	8,21	7,89	8,35	9	8,7	8,4	9,3	9
ALFA HCH	0,1	0,3	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOQ	<LOD
HCB	0,1	0,3	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOQ	<LOD	<LOD
BETA HCH	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOD	<LOQ	<LOD	<LOD	<LOD
LINDANO	0,1	0,3	1,8	<LOQ	2,5	<LOQ	<LOQ	<LOQ	1,3	<LOQ	1,9	<LOQ	0,8	<LOD
HEPTACLORO	0,1	0,3	<LOD	<LOQ	1,9	1,1	<LOQ	1,5	1,8	<LOQ	1,3	0,7	<LOD	<LOQ
ALDRIN	0,1	0,3	<LOD	<LOD	<LOQ	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOD	<LOQ	<LOD
HEPTACLORO EPOXIDO B	0,1	0,3	<LOQ	<LOQ	0,7	1,9	<LOQ	<LOD	<LOQ	1,4	1,7	<LOQ	<LOD	<LOQ
OXICLORDANO	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOQ
HEPTACLORO EPOXIDO A	0,1	0,3	<LOQ	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOQ
OPDDE	0,3	0,9	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD
ALFA ENDOSULFAN	0,2	0,6	1,5	<LOQ	1,8	<LOQ	<LOQ		<LOQ	1,2	<LOQ	<LOQ	<LOD	<LOD
CISCLORDANO	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOD	<LOD
PPDDE	0,2	0,6	<LOQ	<LOD	<LOD	<LOQ	1,94	2,05	1,2	1,5	1,7	<LOQ	<LOD	<LOQ
DIELDRIN	0,2	0,6	<LOQ	<LOD	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOD	<LOD
ENDRIN	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOQ	<LOD
BETA ENDOSULFAN	0,2	0,6	1,9	<LOD	<LOQ	2,6	<LOQ	<LOD	<LOQ	0,9	<LOQ	<LOQ	<LOQ	<LOD
PPDDD	0,2	0,6	<LOQ	<LOD	<LOD	<LOD	<LOQ	<LOD	1,1	<LOQ	<LOQ	<LOD	<LOQ	<LOD
OPDDT	0,2	0,6	<LOD	<LOQ	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOQ	<LOD
ENDRIN ALDHEIDO	0,3	0,9	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
ENDOSULFAN SULFATO	0,2	0,6	<LOQ	1,2	<LOD	<LOQ	<LOQ	<LOD	<LOQ	1,7	<LOQ	<LOD	<LOQ	<LOD
PPDDT	0,2	0,6	1,1	<LOQ	<LOQ	1,8	<LOQ	<LOD	<LOD	1,1	<LOQ	1,4	<LOQ	<LOQ
ENDRIN CETONA	0,2	0,6	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOQ	<LOQ	<LOD	<LOD	<LOD	<LOD
MIREX	0,2	0,6	<LOD	<LOQ	<LOD	8,5	8	7,95	<LOQ	<LOQ	<LOD	<LOD	<LOD	<LOD
PCB -28	0,3	0,9	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD
PCB -52	0,4	1,2	<LOD	2,7	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOQ	<LOD	<LOD	<LOD	<LOQ
PCB -101	0,5	1,5	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PCB -118	0,4	1,2	2,8	<LOQ	3,5	<LOQ	<LOQ	<LOQ	1,7	<LOQ	1,9	<LOQ	2,8	<LOQ
PCB -138	0,3	0,9	<LOD	<LOQ	2,9	3,1	<LOQ	2,5	1,5	<LOQ	<LOD	4,5	<LOD	<LOQ
PCB -153	0,5	1,5	<LOQ	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
PCB -180	0,4	1,2	<LOD	<LOQ	<LOD	<LOD	<LOQ	<LOD	<LOQ	<LOQ	<LOQ	<LOD	<LOD	<LOQ

SECTION 4

Results from expert laboratories

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4. RESULTS FROM EXPERT LABORATORIES

Chemical analysis was performed by the national POPs laboratories assigned by the national coordinator in each country (for results, see section 4.2) and so-called 'expert laboratories' with the following assignments according to POPs group and matrix:

- CSIC in Barcelona, Spain: Air and national samples: Organochlorine pesticides (OCP), indicator PCB (PCB_6), dl-POPs (PCDD/PCDF, dl-PCB), [toxaphene, PBDE, HBB, HBCD sum]
- MTM Research Centre, Örebro University in Örebro, Sweden: Air, water, human milk [PFOS, PFOA, PFHxS]
- E&H VU Vrije Universiteit in Amsterdam, the Netherlands (formerly IVM): Air and national samples: OCP, PCB_6, PBDE, [HBB, HBCD]
- CVUA Freiburg, Germany: Human milk: OCP, PCB_6, toxaphene, [PBDE, HBCD, HBB, PCN and SCCP]

Groups of POPs printed in [square brackets] were not analyzed in the GMP1 projects. Note: the group of the OCP contains some pesticides that were listed as 'new' POPs such as endosulfan, HCH isomers (although voluntarily already included in the GMP1), chlordecone, pentachlorobenzene, hexachlorobutadiene (HCBD). For these and the POPs printed in [square brackets] no comparative data were available when examining the results of the GMP2 projects.

The list of POPs above includes more POPs than had been proposed in the approved project document (UNEP 2015a).

4.1. Chemical analysis and reporting of results

Generic protocols for the analysis of POPs had been developed in a previous GEF project for organochlorine pesticides and indicator PCB (PCB_6) (UNEP 2014a), polybrominated diphenyl ether (UNEP 2014b), and perfluoroalkane substances (UNEP 2015b). They were used in this GMP2 project. In brief, brominated and chlorinated POPs were analyzed using GC/MS instrumentation whereby dl-POPs were detected with HRMS as sector-field instruments. PFAS were analyzed using LC/MSMS.

POPs were determined as the mass concentration (ng or pg) extracted from the PUFs. For certain groups of POPs, such as dl-POPs or toxaphene, it was recommended to combine four PUFs to an annual sample. For comparison of results, all data were normalized to one PUF and a 3-month exposure time.

For the sums of OCPs, the mass concentrations were added and no 'equivalents' used. Concentrations for OCPs, PCB_6, and BFRs in air were reported in ng/PUF and in nanogram per gram lipid (ng/g lipid) for human milk.

The TEQs are reported for the combined PCDD/PCDF, namely for seven 2,3,7,8-substituted PCDD and ten 2,3,7,8-substituted PCDF (expressed as TEQ_DF) and TEQ for 12 non-ortho and mono-ortho PCB (expressed as TEQ_PCB). Concentrations for dl-POPs were reported in picogram per PUF (pg TEQ/PUF) for PAS/PUF air samples, femtogram *per* cubic metre (fg TEQ/m^3) for AAS samples, and picogram *per* gram lipid (pg/g lipid) for human milk.

Concentrations for PFAS were reported in picogram per PUF (pg/PUF) in air, pg/g fresh weight (f.w.) in human milk, and nanogram per liter (ng/L) for water.

In order to compare, results should be reported according to number of PUFs (and exposed); thus, when four PUFs were combined, the amount should be divided by a factor of 4 to receive the amount *per* PUF. For HBCD, first a screening using GC/MS should be performed and only samples, where HBCD was quantifiable in the GC/MS screening will undergo isomer-specific analysis using LC/MS.

Since no conversion to volume was made, temperature, windspeed, precipitation or characteristics of the PUFs (density) were not considered.

4.2. Ambient air

4.2.1. Chlorinated POPs

Data are available from 104 dataset as shown in Table 9. The number of results are shown by year and it can be seen that Peru did not provide any sample in 2017 but two in 2019. The sequence of the countries is alphabetically with the South American countries first, and then followed by the Noth American and Caribbean countries. There were 83 quarterly samples and 21 annual samples, whereby up to four PUFs were combined for toxaphene analysis.

Table 9: Number of PUFs per country and year, analyzed for chlorinated POPs

Year →	2017 (N=49)	2018 (N=53)	2019 (N=2)	Overall (N=104)
ARG	5	5		10
BRA	5	5		10
CHL	5	5		10
COL	5	5		10
ECU	5	5		10
PER		3	2	5
URY	5	5		10
ATG	4	5		9
BRB	5	5		10
JAM	5	5		10
MEX	5	5		10

The summary of results for the chlorinated POPs (Cl-POPs) is shown in Table 10. The detailed results are contained as Table S 4 and Table S 5. The graphical overview on the scale of the Cl-POPs is shown in Figure 3. All data refer to 1 PUF and 3 months of exposure time and are given in ng/PUF.

The highest mean and median values were found for DDT (17.0 ng/PUF and 15.4 ng/PUF), followed by PeCBz (13.0 ng/PUF and 7.38 ng/PUF), and drins (12.6 ng/PUF and 5.64 ng/PUF). However, the countries differ largely by chemical: the drins peaked in Barbados, DDT in Peru, PCB_6 in Argentina (range from 25.5 ng/PUF to 48.5 ng/PUF), and PeCBz in Uruguay and Antigua and Barbuda, chlordane in Jamaica and Barbados. Toxaphene was quantified only in Antigua and Barbuda and Mexico, whereby the Mexican values were the highest in all GMP2 projects. Among the HCHs, lindane contributed most to the sum of the three HCHs.

The results of the PUF extracts for PCB_6 and the six congeners are detailed in Table S 5. It can be seen that no PCB could be quantified in the seven samples from ATG; all values for individual congeners and were below the LOQ of 0.25 ng/PUF and subsequently, the sum PCB_6 was zero as well.

Table 10: Chlorinated POPs POPs in PAS/PUF: Mean (with standard deviation, SD), median, minimum and maximum values (ng/PUF). Note: 0 = LOQ

POPs	Central tendencies	ARG (N=10)	BRA (N=10)	CHL (N=10)	COL (N=10)	ECU (N=10)	PER (N=5)	URY (N=10)	ATG (N=9)	BRB (N=10)	JAM (N=10)	MEX (N=10)	Overall (N=104)
chlordane	Mean (SD)	5.68 (1.82)	4.14 (1.06)	0	9.05 (0.90)	0.21 (0.30)	0.94 (0.32)	4.93 (1.20)	5.40 (2.57)	31.0 (6.08)	33.9 (8.50)	1.65 (1.35)	9.22 (12.2)
	Median [Min, Max]	6.08 [2.18, 7.78]	4.24 [2.58, 5.59]	0	8.89 [7.70, 10.8]	0 [0, 0.669]	1.00 [0.50, 1.26]	5.05 [2.61, 6.24]	5.52 [2.33, 9.01]	31.3 [22.1, 40.8]	37.0 [19.5, 41.8]	1.35 [0.47, 4.74]	4.74 [0, 41.8]
drins	Mean (SD)	2.22 (0.84)	5.56 (1.33)	0	6.36 (0.86)	1.55 (0.34)	2.54 (0.77)	12.3 (3.05)	3.84 (1.93)	72.4 (15.0)	18.0 (5.18)	7.23 (7.07)	12.6 (21.0)
	Median [Min, Max]	2.10 [0.94, 3.76]	5.43 [4.08, 7.27]	0	6.27 [4.85, 7.88]	1.54 [1.11, 1.95]	2.88 [1.40, 3.02]	13.2 [6.85, 15.4]	3.56 [1.84, 6.81]	75.6 [46.3, 90.7]	18.6 [9.24, 24.1]	5.93 [1.37, 23.7]	5.64 [0, 90.7]
DDT	Mean (SD)	6.75 (1.97)	18.8 (4.36)	0.59 (0.62)	31.3 (2.47)	20.1 (7.11)	45.5 (19.7)	26.4 (7.62)	15.4 (8.09)	2.45 (0.57)	17.8 (5.78)	15.7 (7.94)	17.0 (12.9)
	Median [Min, Max]	6.78 [4.06, 10.3]	19.1 [13.3, 24.6]	0.36 [0.30, 2.10]	31.5 [27.2, 35.0]	17.6 [13.4, 32.4]	51.0 [19.0, 61.1]	25.0 [15.4, 38.8]	15.3 [6.24, 31.8]	2.41 [1.72, 3.32]	20.0 [7.73, 24.2]	11.4 [7.60, 26.9]	15.4 [0.30, 61.1]
heptachlor	Mean (SD)	3.42 (1.03)	3.85 (0.92)	0	1.47 (0.23)	0	0.58 (0.13)	0.89 (0.40)	0.06 (0.15)	1.35 (0.360	1.01 (0.34)	0.18 (0.37)	1.21 (1.38)
	Median [Min, Max]	3.72 [1.51, 4.56]	3.81 [2.79, 5.58]	0	1.39 [1.14, 1.86]	0	0.62 [0.38, 0.67]	0.926 [0, 1.38]	0 [0, 0.408]	1.29 [0.90, 1.87]	1.16 [0.40, 1.23]	0 [0, 1.01]	0.957 [0, 5.58]
mirex	Mean (SD)	0.27 (0.09)	0.30 (0.13)	0	0.01 (0.03)	0	0.03 (0.05)	0.77 (0.16)	0.16 (0.04)	0.01 (0.03)	0	0	0.15 (0.24)
	Median [Min, Max]	0.266 [0.13, 0.44]	0.301 [0.16, 0.43]	0	0 [0, 0.08]	0	0 [0, 0.11]	0.81 [0.42, 0.92]	0.153 [0.12, 0.24]	0 [0, 0.086]	0	0	0 [0, 0.917]
toxaphene	Mean (SD)	0	0	0	0	0	0	0	0.82 (0.14)	0	0	4.11 (0.94)	0.47 (1.25)
	Median [Min, Max]	0	0	0	0	0	0	0	0.82 [0.72, 0.92]	0	0	4.11 [3.44, 4.77]	0 [0, 4.77]
HCHs	Mean (SD)	4.56 (1.01)	12.6 (2.77)	0.53 (0.24)	10.8 (2.65)	14.4 (3.85)	8.64 (2.48)	5.27 (1.73)	1.19 (1.16)	4.92 (1.19)	2.56 (0.78)	0.67 (0.27)	5.94 (5.12)
	Median [Min, Max]	4.98 [2.75, 5.63]	12.4 [8.79, 16.3]	0.406 [0.29, 0.90]	10.2 [7.55, 15.0]	14.1 [8.74, 20.0]	9.28 [5.12, 10.9]	5.16 [2.66, 8.41]	1.04 [0, 3.03]	5.47 [3.01, 5.86]	2.24 [1.66, 4.05]	0.755 [0, 0.828]	4.95 [0, 20.0]
endosulfan	Mean (SD)	4.17 (1.56)	3.39 (2.95)	0	0.68 (0.75)	0.50 (0.71)	1.43 (1.35)	4.29 (2.08)	0.56 (0.69)	0	0.13 (0.37)	11.9 (3.84)	2.53 (3.86)
	Median [Min, Max]	4.11 [2.08, 6.72]	2.18 [1.02, 9.45]	0	0.515 [0, 1.70]	0 [0, 1.56]	1.26 [0, 3.22]	4.07 [1.91, 8.24]	0 [0, 1.34]	0	0 [0, 1.04]	10.9 [7.14, 18.4]	1.04 [0, 18.4]
PCB6	Mean (SD)	33.9 (8.28)	12.5 (1.44)	0.70 (0.83)	12.4 (3.37)	2.46 (0.39)	22.8 (2.72)	14.6 (3.38)	0	2.86 (0.49)	12.6 (2.12)	3.47 (0.98)	10.3 (10.4)
	Median [Min, Max]	30.4 [25.5, 48.5]	12.7 [10.3, 14.7]	0.514 [0, 2.30]	11.7 [7.90, 19.6]	2.40 [2.05, 3.05]	23.2 [19.2, 25.4]	13.8 [10.4, 20.8]	0	2.76 [2.28, 3.47]	12.7 [8.31, 15.8]	3.32 [2.03, 5.31]	10.3 [0, 48.5]
HCB	Mean (SD)	11.2 (8.15)	5.43 (2.14)	4.13 (1.21)	4.36 (1.17)	4.92 (1.04)	9.02 (2.67)	4.31 (0.73)	2.73 (0.98)	2.51 (0.26)	5.34 (1.55)	4.20 (1.38)	5.14 (3.60)
	Median [Min, Max]	12.1 [1.24, 20.6]	4.80 [3.57, 9.16]	4.31 [2.33, 5.58]	3.90 [3.15, 6.00]	4.94 [2.99, 6.30]	9.10 [6.25, 11.7]	4.26 [3.25, 5.29]	2.84 [1.06, 3.68]	2.48 [2.24, 2.98]	5.77 [2.33, 7.54]	3.85 [2.62, 6.85]	4.24 [1.06, 20.6]
PeCBz	Mean (SD)	14.7 (13.2)	10.8 (12.8)	3.94 (3.53)	9.47 (9.71)	17.5 (12.1)	4.70 (1.11)	26.5 (13.6)	26.1 (21.5)	3.31 (2.34)	13.5 (17.0)	9.67 (9.66)	13.0 (13.8)
	Median [Min, Max]	12.6 [2.14, 42.0]	8.84 [0, 40.1]	3.14 [0, 9.36]	4.66 [1.26, 27.9]	15.6 [1.66, 32.0]	4.65 [3.47, 6.03]	23.3 [14.6, 55.3]	34.7 [3.53, 54.1]	2.98 [0, 7.38]	7.34 [2.87, 54.5]	7.25 [2.71, 32.6]	7.38 [0, 55.3]

The concentrations of Cl-POPs in each sample per country are shown in Figure 4 as stacked bars. The mean values of the Cl-POPs by country are included as Figure 5 and as unscaled box plots in Figure 6. Finally, Figure 7 and Figure 8 visualize the findings as box whisker plots, either for the Cl-POPs in each country or for each Cl-POPs across the countries.

Applying a significance of p=0.05, the data for the Cl-POPs showed that there are significant differences between the countries as to the scale of the POPs in the PAS/PUFs ($p=<2.2 \times 10^{-16}$) and a chi value of 130. Assessment of pairwise values gave significant differences for Chile with all other countries ($p<4.5\times10^{-5}$); also, Antigua and Barbuda was significantly different from other countries. There was no significant difference as to the years (p=0.62).

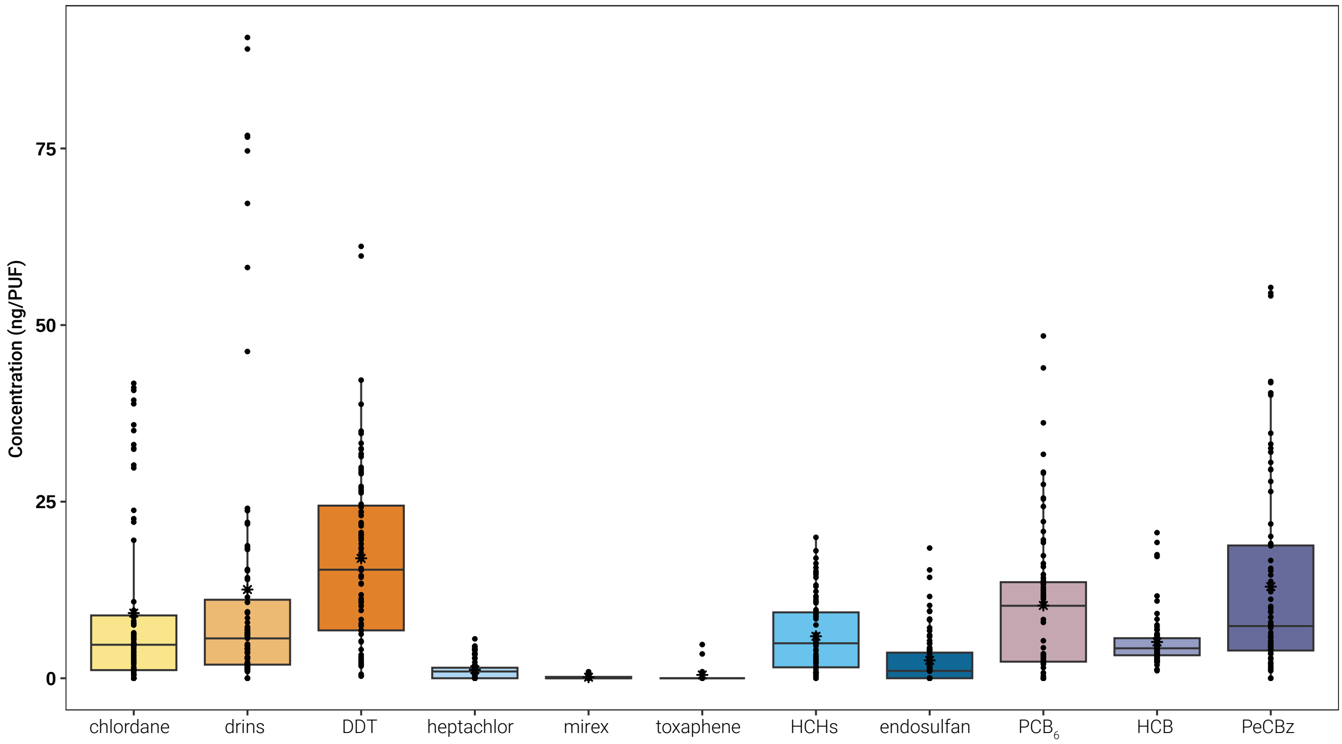


Figure 3: PAS/PUF: Box plots for chlorinated POPs, summary across all samples (n=104)

Box 1 for all the box and whiskers plots in this report:

The whiskers represent the minimum and maximum concentrations without the outliers. The lower border of the box represents the first quartile (25%), the line inside the box the median and the upper border is the third quartile (75%). The asterisk represents the mean value. The dots outside the whiskers are outliers, which were defined as all concentrations greater or smaller the interquartile range multiplied by 1.5

Photo: ©Christiane Fischer Illampu Bolivia

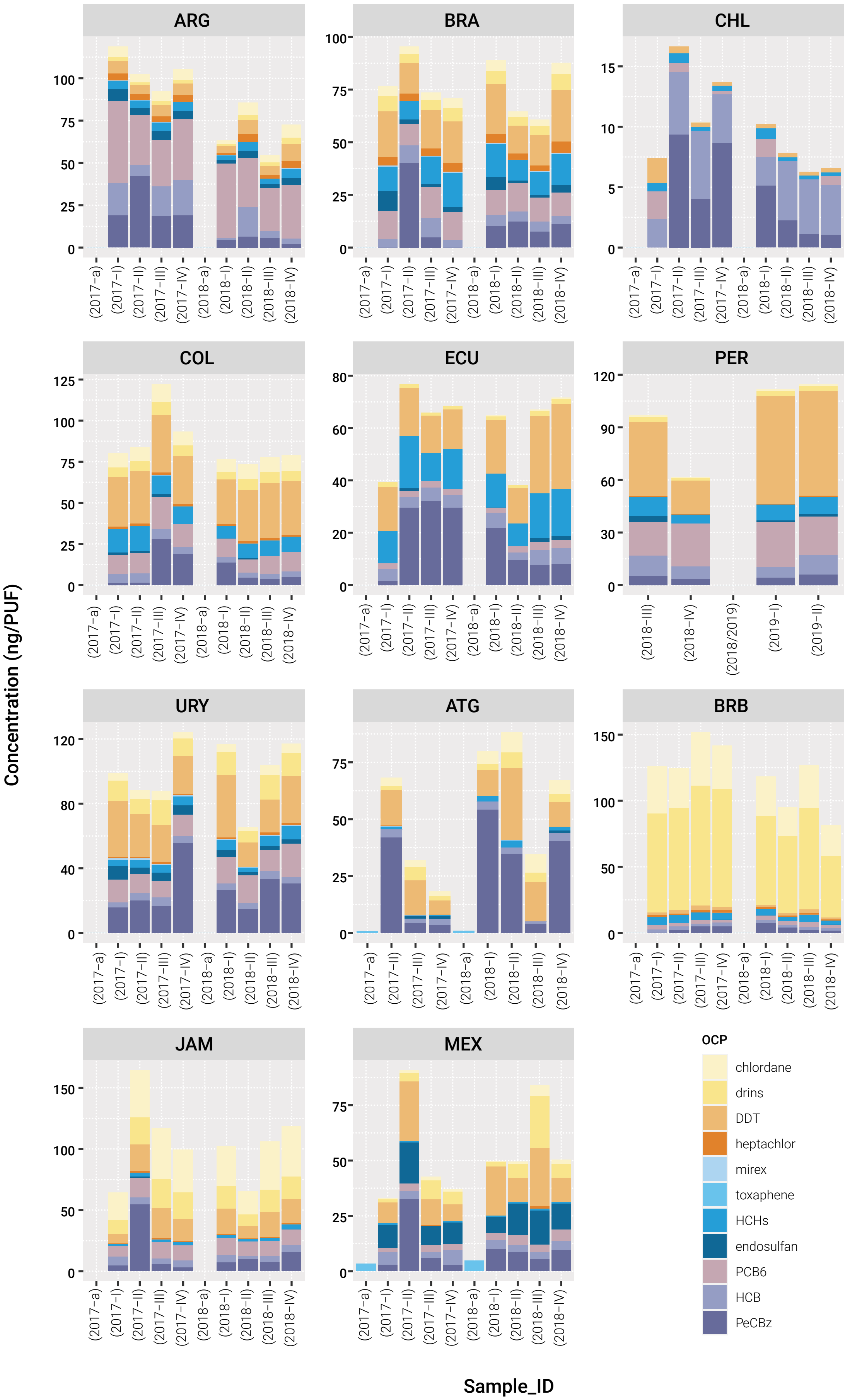


Figure 4: PAS/PUF: Stacked bar graphs for chlorinated POPs by country and sample (n=104)

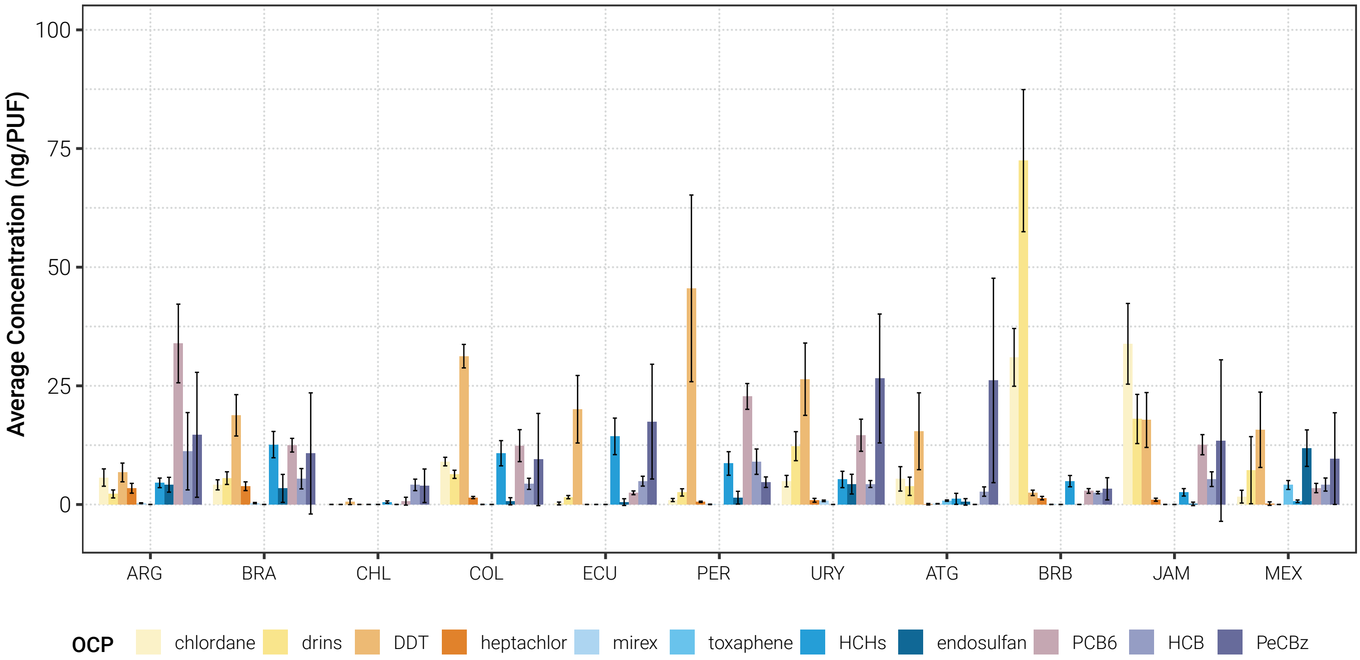
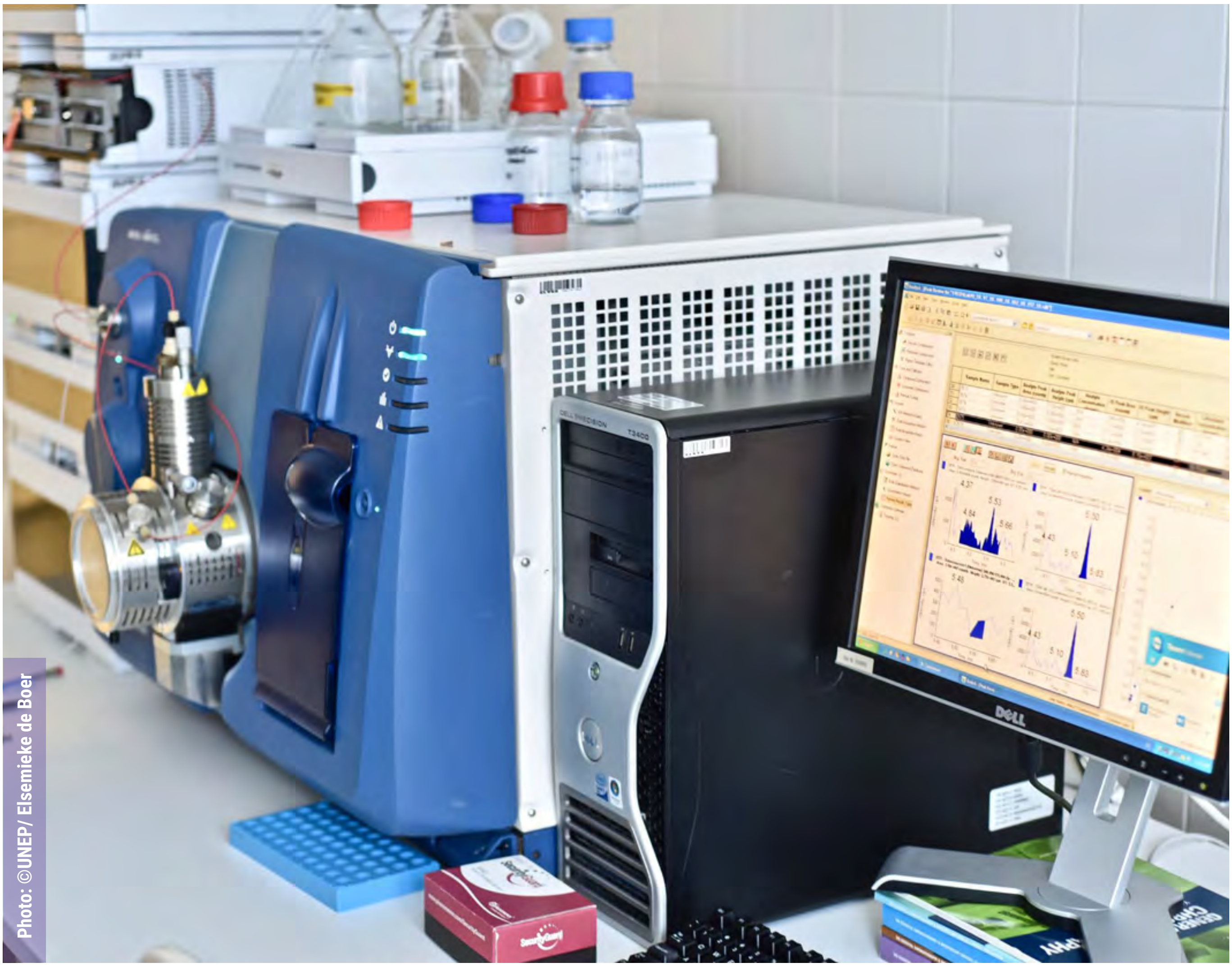


Figure 5: PAS/PUF: Mean values and SD for chlorinated POPs (n=104)



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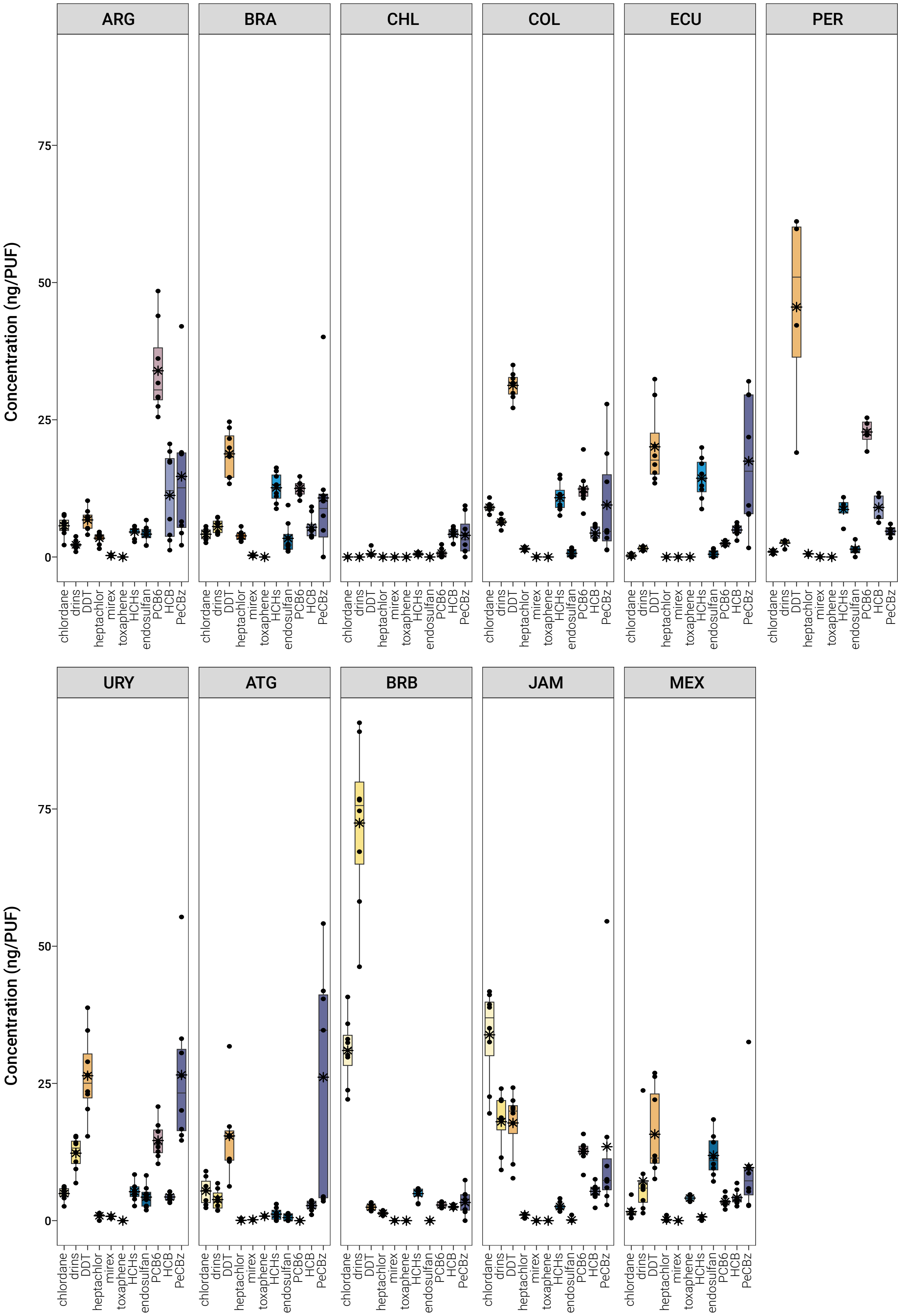

Figure 6: PAS/PUF: Unscaled boxplots for chlorinated POPs in air per country. Concentrations in ng/PUF (n=104). Note: y-axis zoomed to 100 ng/PUF

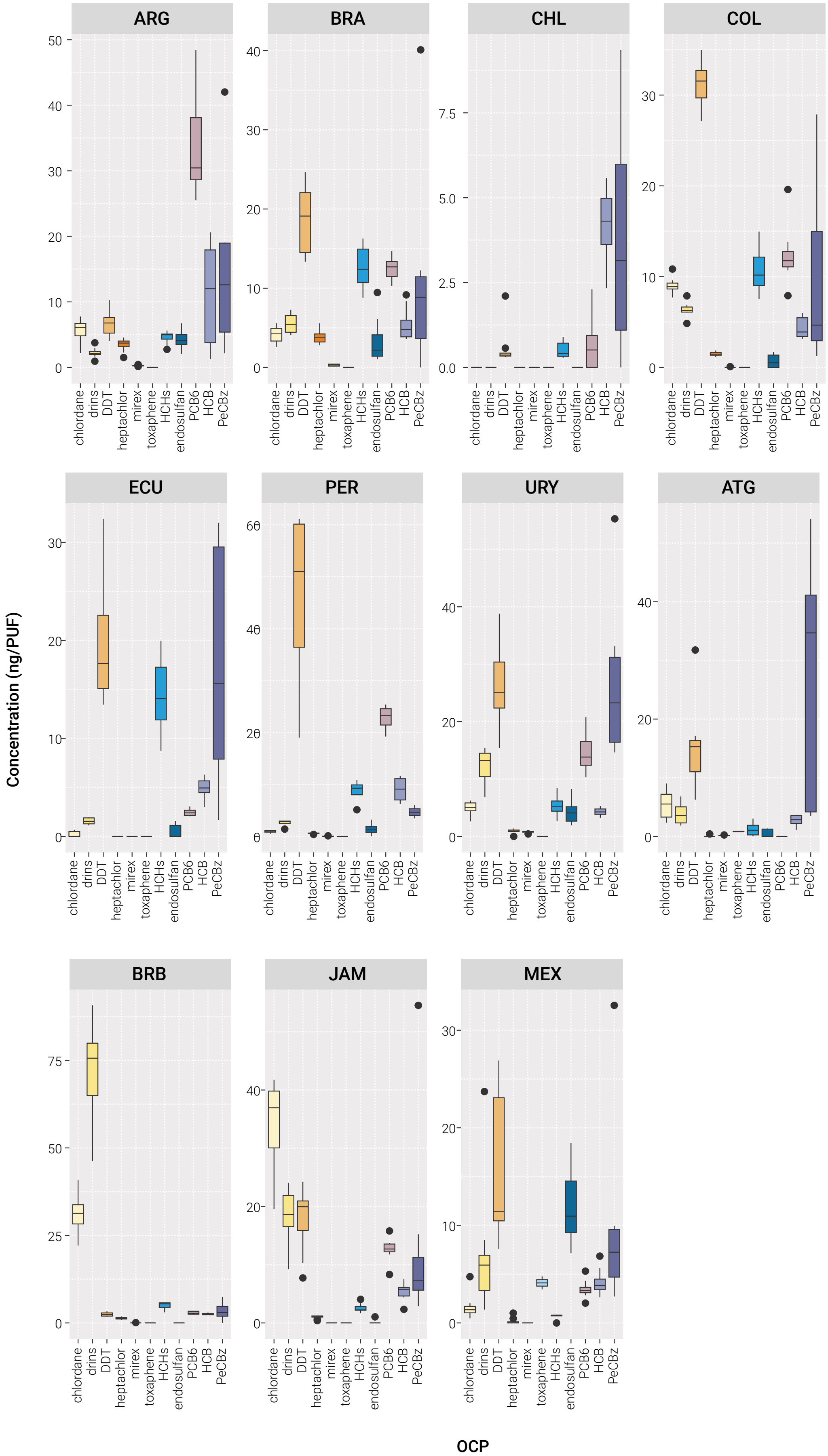

Figure 7: PAS/PUF: Scaled boxplots for sums of chlorinated POPs by country (n=104)

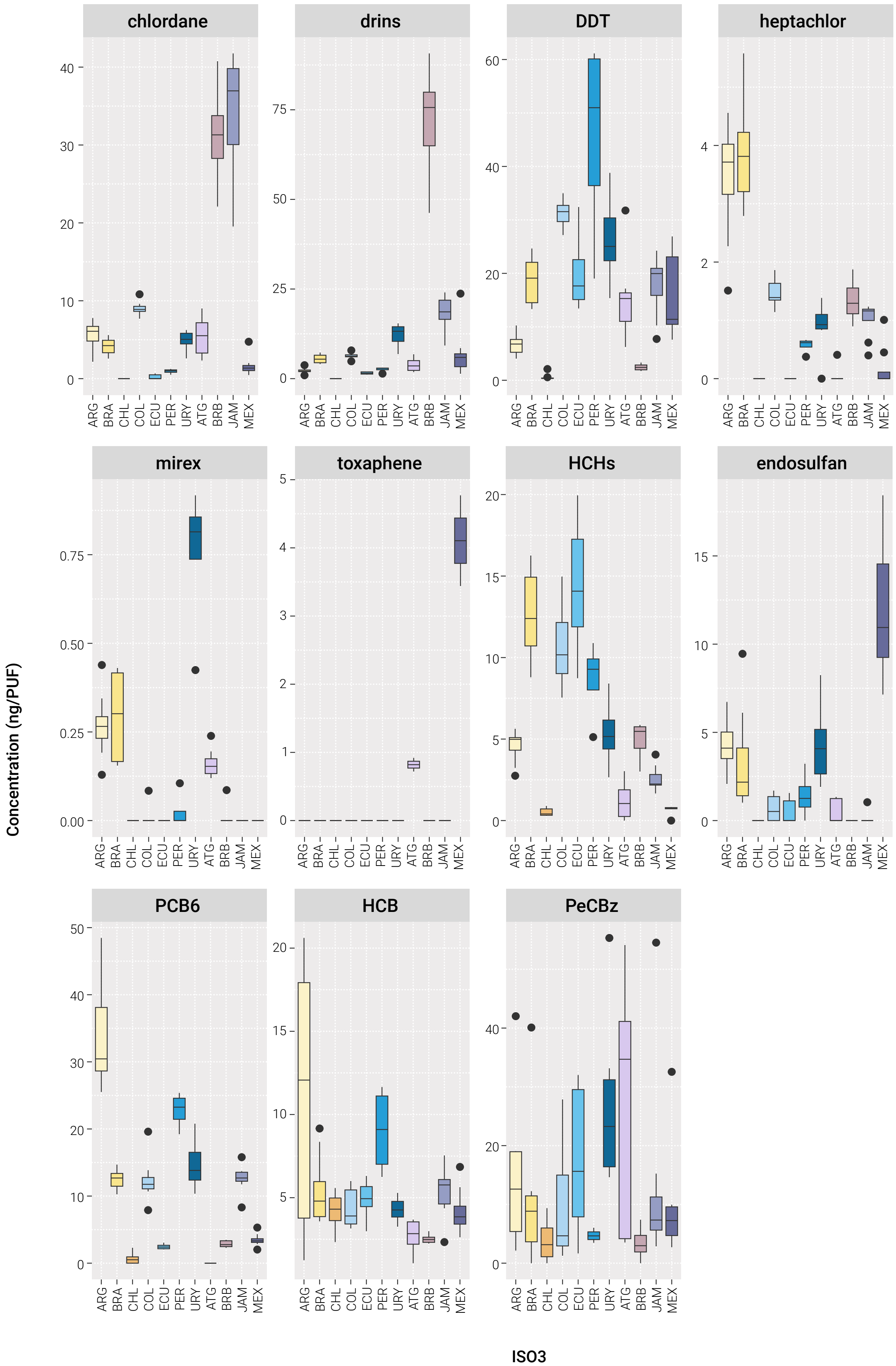

Figure 8: PAS/PUF: Scaled boxplots for country by chlorinated POPs (n=104)

4.2.2. Dioxin-like POPs

The number of PUFs available and analyzed for dl-POPs are shown in Table 11. In total, 53 results were available whereby quarterly sampling took place; however, for six countries, Antigua and Barbuda, Argentina, Chile, Ecuador, Jamaica, and Peru, seasonal PUFs were combined and analyzed as an annual sample (see sampling scheme in Table 4). Countries that indicated having national dioxin analytical capacities, single individual PUFs were analyzed by the expert laboratory, Barbados, Brazil, Jamaica, Peru, and Uruguay). These samples contain the season as a Roman number (I, II, III, or IV) in the Sample_ID. For these countries, the individual quarterly results were mathematically combined into an annual sample.

The results of the PUF extracts are detailed in Table S 6; the values refer to pg TEQ per number of PUFs that had been extracted together. For visualization and comparison, all values were recalculated to 1 PUF and one season, *i.e.*, three months. There were two TEQs presented and assessed; TEQ for PCDD/PCDF, referred to as TEQ_DF, and for dl-PCB, referred to as TEQ_PCB (see section 5.1).

Table 12 provides the mean, median, minimum and maximum values for each country and a graphical overview in Figure 9. It can be seen that the TEQ_DF was always higher, more than 3-fold, than the TEQ_PCB. The highest mean value for TEQ_DF was found in Jamaica (32.0 pg TEQ/PUF) and the highest TEQ_PCB in Peru (11.0 pg TEQ/PUF). The two countries had also the highest measured value for the respective TEQ.

Table 11: Number of analytical results for dl-POPs in PAS/PUFs

	ATG (N=2)	ARG (N=2)	BRB (N=10)	BRA (N=10)	CHL (N=2)	COL (N=2)	ECU (N=2)	JAM (N=2)	MEX (N=10)	PER (N=1)	URY (N=10)	Overall (N=53)
Year												
2017	1	1	5	5	1	1	1	1	5	5	5	26 (49%)
2018	1	1	5	5	1	1	1	1	5	1	5	27 (51%)
PUFs												
m	2	2	2	2	2	2	2	2	2	1	2	21 (40%)
s			8	8					8		8	32 (60%)
Sample type												
annual	2	2	2	2	2	2	2	2	2	1	2	21
quarterly			8	8					8		8	32

Table 12: PAS/PUF: results for dl-POPs with mean (with standard deviation, SD), median, minimum and maximum values (pg TEQ/PUF and 3 months)

	Central tendencies	ARG (N=2)	BRA (N=10)	CHL (N=2)	COL (N=2)	ECU (N=2)	PER (N=1)	URY (N=10)
TEQ_DF	Mean (SD)	5.11 (1.28)	7.68 (2.86)	1.31 (0.10)	3.97 (0.65)	1.46 (0.19)	19.7	14.7 (1.79)
	Median [Min, Max]	5.11 [4.21, 6.02]	6.96 [3.37, 13.1]	1.31 [0.61, 2.02]	3.97 [3.51, 4.43]	1.46 [1.32, 1.60]	19.7	15.1 [11.5, 17.4]
TEQ_PCB	Mean (SD)	5.16 (0.07)	2.84 (0.62)	0.31 (0.02)	2.36 (0.37)	0.51 (0.04)	11.0	5.36 (1.23)
	Median [Min, Max]	5.16 [5.11, 5.21]	2.87 [2.04, 3.94]	0.31 [0.30, 0.33]	2.36 [2.10, 2.62]	0.51 [0.48, 0.54]	11.0	5.43 [3.20, 7.01]

	Central tendencies	ATG (N=2)	BRB (N=10)	JAM (N=2)	MEX (N=10)	Overall (N=53)
TEQ_DF	Mean (SD)	0.242 (0.143)	13.6 (2.57)	32.0 (2.01)	8.10 (5.30)	10.4 (6.98)
	Median [Min, Max]	0.242 [0.141, 0.343]	14.0 [9.47, 17.7]	32.0 [30.6, 33.5]	7.58 [1.10, 17.5]	10.4 [0.141, 33.5]
TEQ_PCB	Mean (SD)	0.25 (0.001)	0.91 (0.173)	3.70 (0.34)	2.91 (1.06)	2.94 (2.16)
	Median [Min, Max]	0.25 [0.25, 0.26]	0.89 [0.67, 1.13]	3.70 [3.46, 3.94]	2.92 [1.08, 4.35]	2.62 [0.25, 11.0]

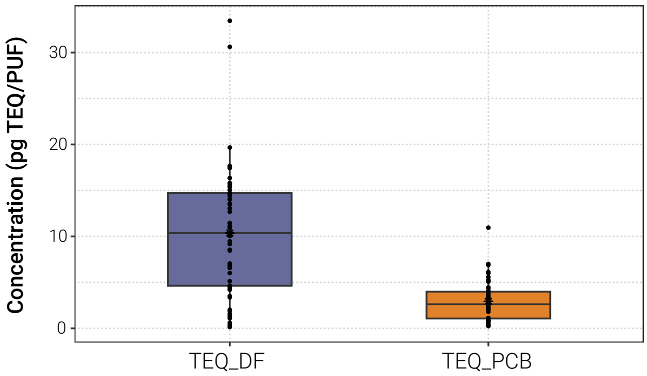

Figure 9: PAS/PUF: Box whisker plots for dl-POPs (as TEQ). Values normalized to 1 PUF and 3 months exposure

Graphical sketches visualize the findings. The stacked bar graphs show the contribution of the partial TEQs by sample (Figure 10). The scale of the combined TEQs shows quite consistent results within each country. Mexico with eight measurements and ten results is an exception. For countries having very low values, such as Antigua and Barbuda or Chile, the values for the total TEQ almost double; these differences are due to the handling of the chemical analytical results and many values for individual congeners below the LOQ.

The mean values and standard deviations for each country are shown in Figure 11.

For each country, the results for the TEQs are displayed in Figure 12, Figure 13, and Figure 14. It can be seen that the TEQ from PCDD/PCDF (TEQ_DF) is always higher than the TEQs from dl-PCB (TEQ_PCB), except for Argentina where the mean and median values for all four TEQs were 5 pg TEQ/PUF and 3 months.

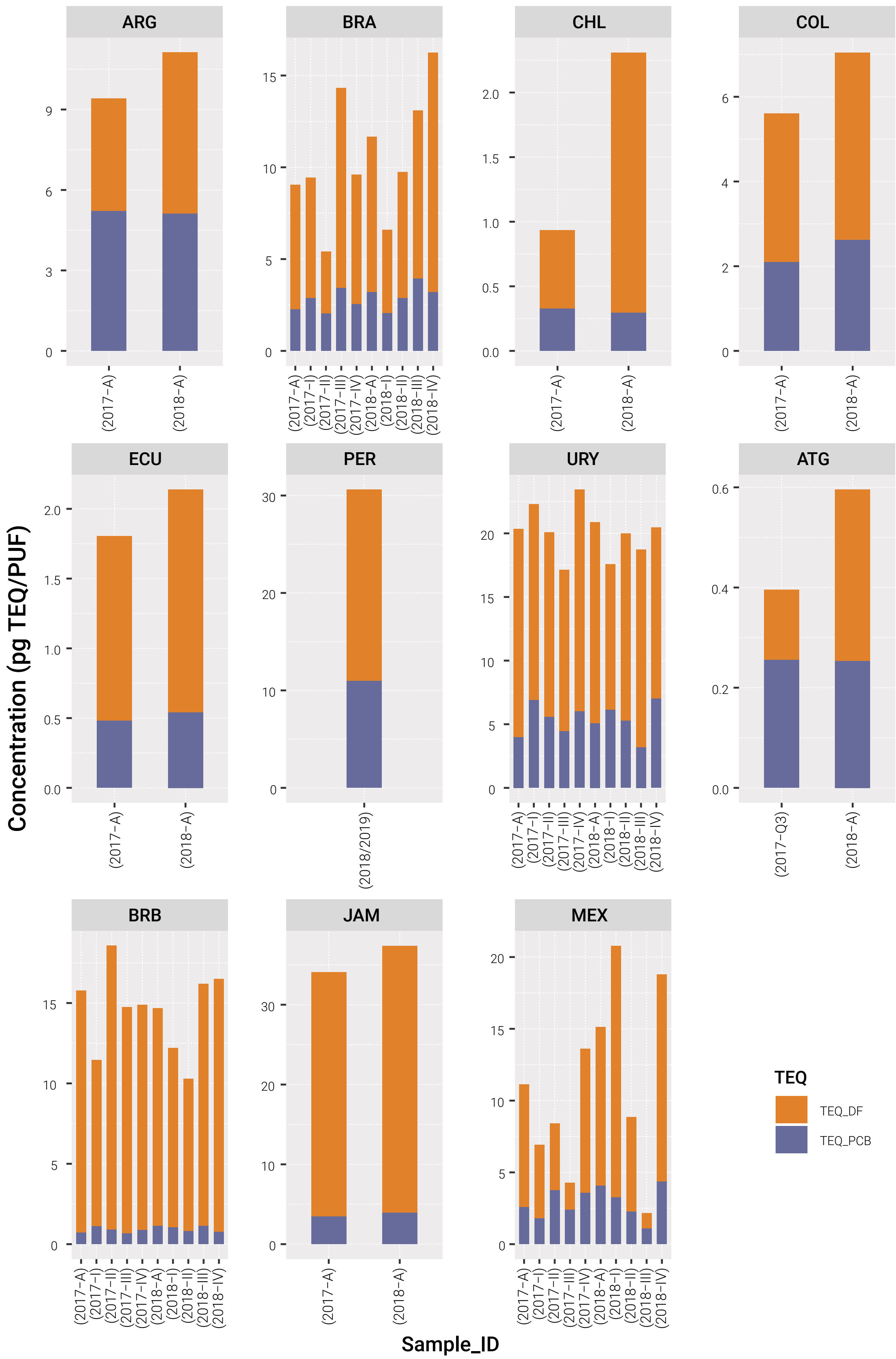

Figure 10: PAS/PUFs: Stacked bar graphs for dl-POPs as TEQ (n=53)

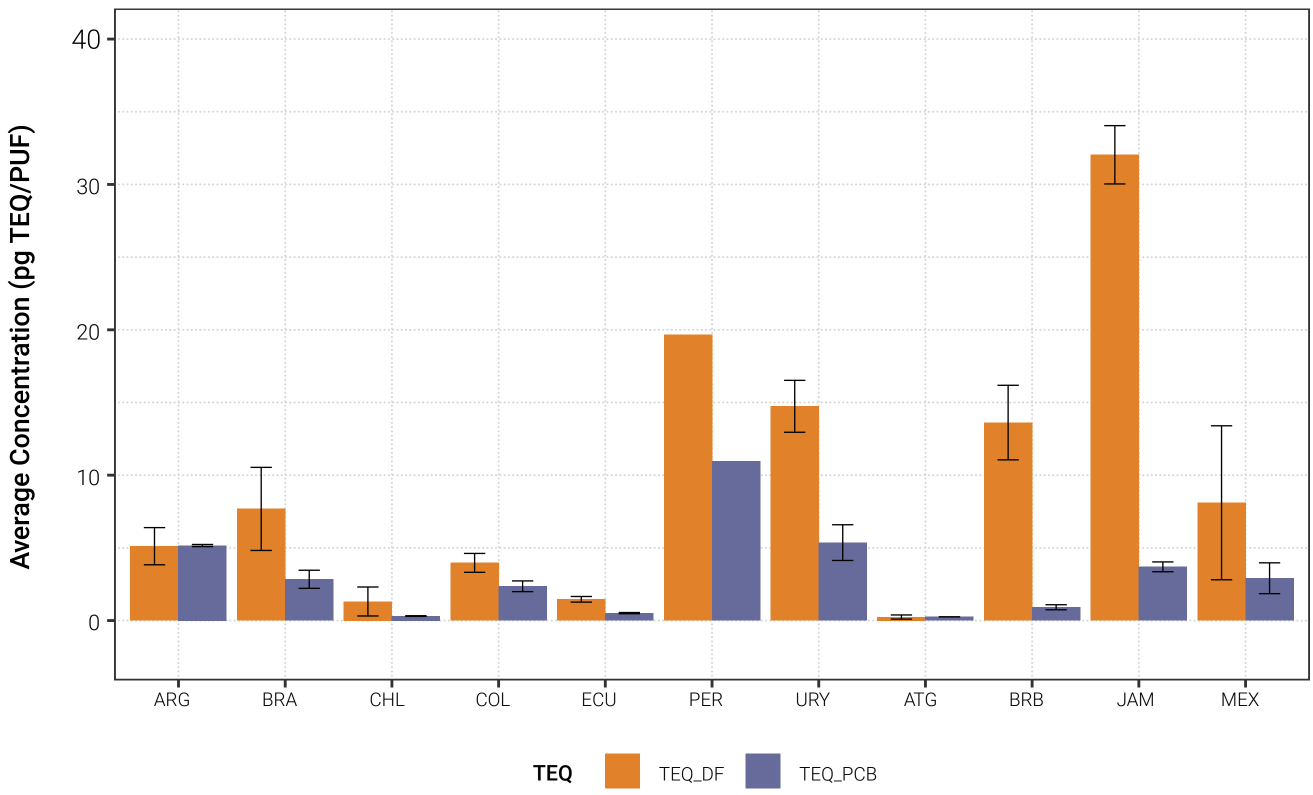

Figure 11: PAS/PUF: Mean values for dl-POPs and SD (as TEQ) for countries (n=53)

The Kruskal Wallis test gave significant differences between countries ($p=0.6 \times 10^{-6}$). The pairwise ranking test showed that there were only a few significant differences and these included Chile with Brazil (p=0.001), Uruguay (p=0.0013), and Mexico (p=0.0096) and Ecuador with Brazil, Uruguay, and Mexico, and Antigua and Barbuda with Barbados, Jamaica, and Mexico.

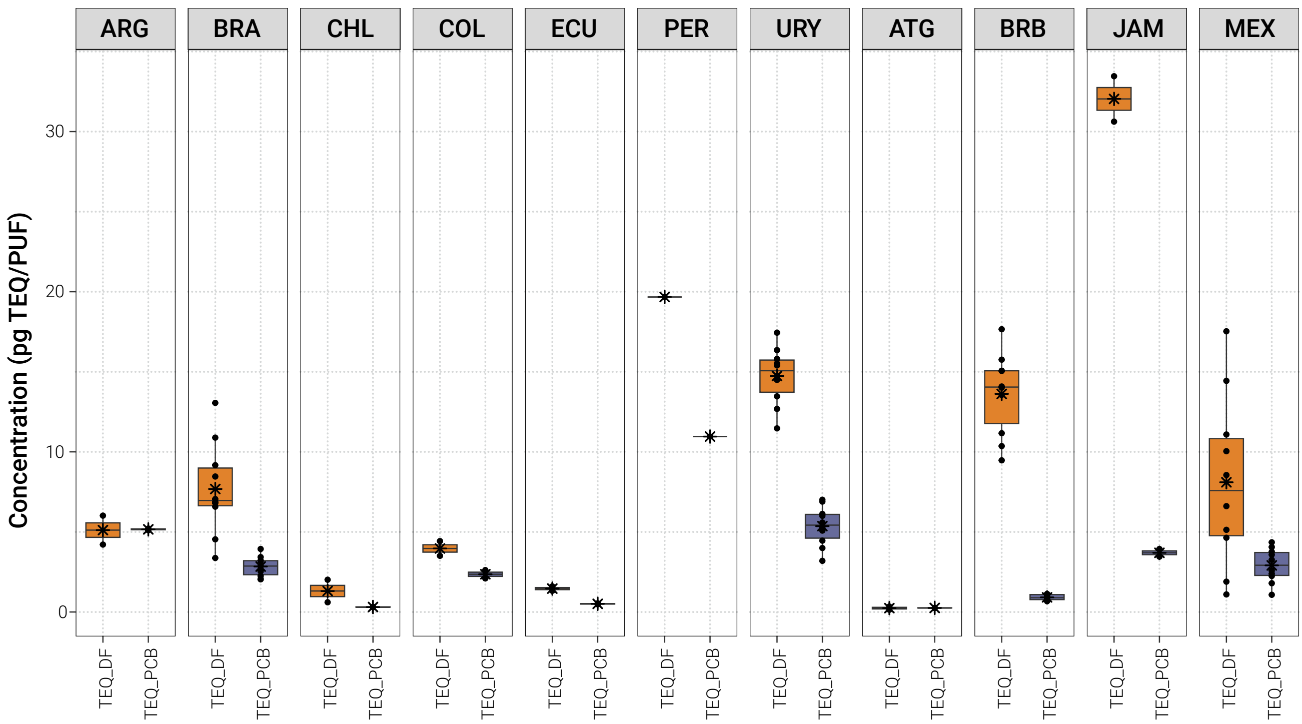

Figure 12: PAS/PUF: Box whisker plots for dl-POPs (as TEQ) per country

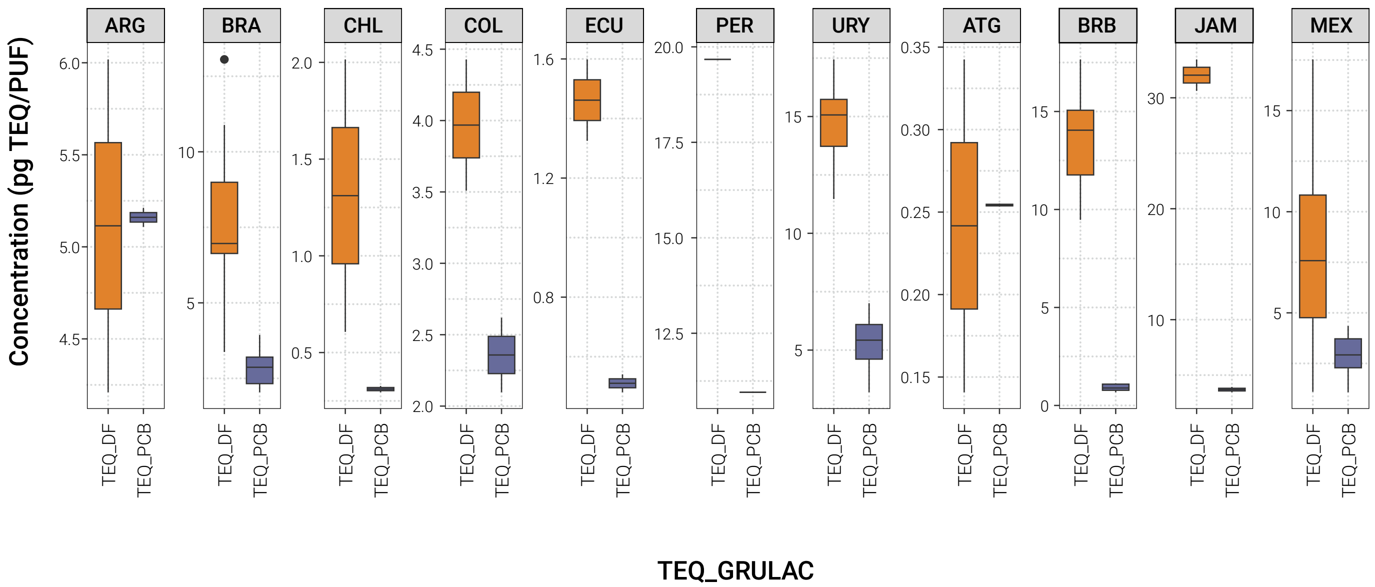

Figure 13: PAS/PUF: Scaled boxplots for concentrations of two TEQs by country

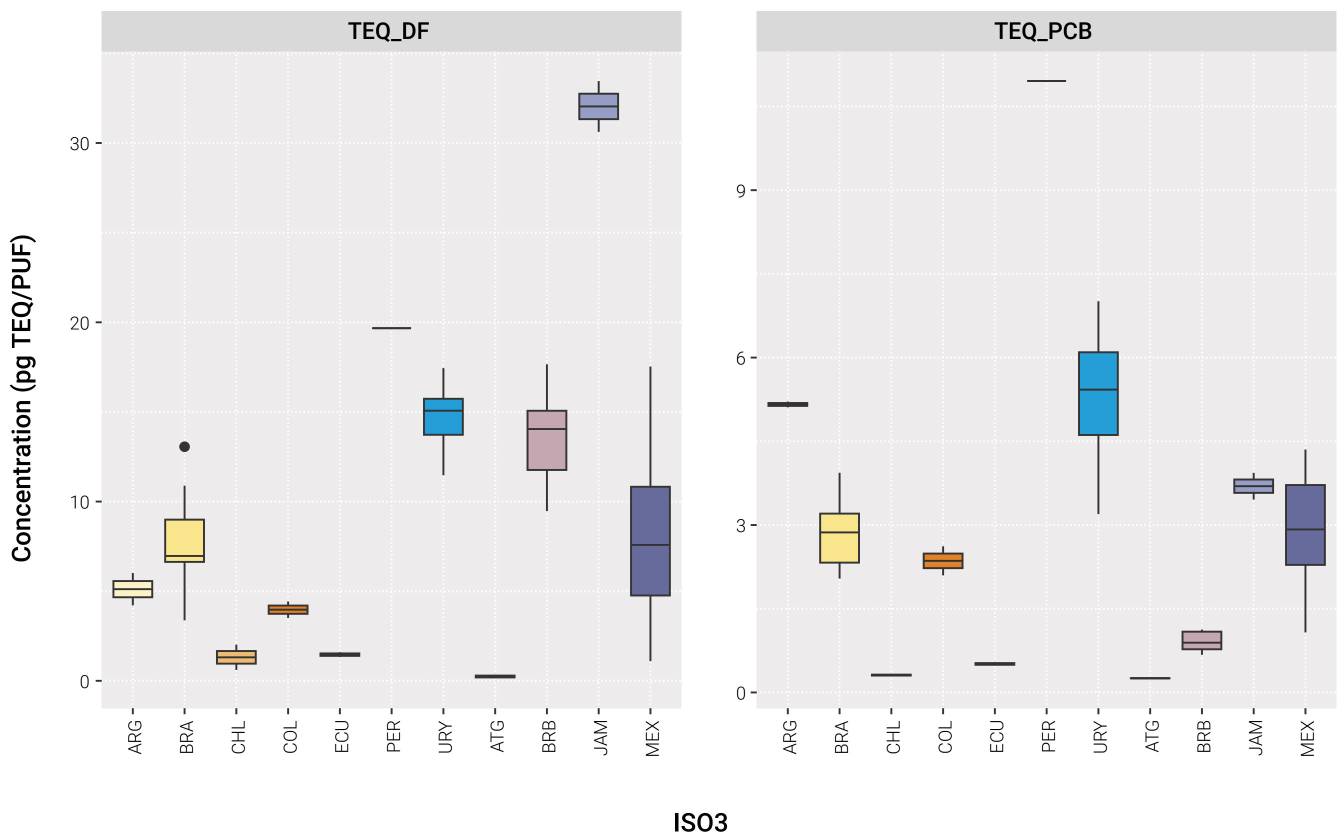

Figure 14: PAS/PUF: Scaled boxplots for concentrations of the two TEQs by POPs and for country

4.2.3. Brominated POPs

Brominated POPs (Br-POPs) included the PBDE (eight substances), PBB153 and three stereoisomers of HBCD). PBDE 209, which was listed in 2017 (Secretariat of the Stockholm Convention 2017), was not analyzed in the GRULAC region. In total, there were 82 PUFs analyzed. Most countries provided four PUFs in both years, 2017 and 2018. Peru had only two samples in 2019 for analysis of PBDE and PBB153 (Table 13).

The quantitative data are summarized in Table 14. $PBDE_8$ seemed to be almost absent in Chile. Antigua and Barbuda had only a few PBDE quantified. For the sum of $PBDE_8$, the mean concentrations in Mexico and Jamaica were highest but also Argentina was above the overall mean value (3.17 ng/PUF).

With respect to sum of the three HBCD isomers (HBCD), three countries, Jamaica, Argentina and Mexico, had median values above the overall median for GRULAC (1.24 ng/PUF). The overall mean value was much higher with 3.10 ng/PUF, indicating that the values were not normal distributed. Commonly, α-HCBD and γ-HBCD had higher values than β-HBCD.

PBB153 was hardly quantified and was found only in samples from Jamaica and Mexico with mean values of 0.008 ng/PUF (SD=0.02 ng/PUF) and 0.006 ng/PUF (SD=0.002 ng/PUF) and maxima of 0.067 ng/PUF and 0.048 ng/PUF, resp.

Table 13: Number of PUFs per country and year, analyzed for Br-POPs

Year →	2017 (N=39)	2018 (N=41)	Y019 (N=2)	Overall (N=82)
ATG	3	4		7
ARG	4	4		8
BRB	4	4		8
BRA	4	4		8
CHL	4	4		8
COL	4	4		8
ECU	4	4		8
JAM	4	4		8
MEX	4	4		8
PER		1	2	3
URY	4	4		8

The overview for the three Br-POPs is shown in Figure 15 and the mean values in Figure 16. The values in Mexico tend to be the highest, followed by Jamaica.

The sum values, as stacked bars for the three Br-POPs, for all samples analyzed are shown Figure 17. It can be seen that in some countries, $PBDE_8$ are dominating (Peru, Uruguay, Jamaica) whereas in other countries HBCD is more abundant (Argentina, Brazil, Chile, Colombia).

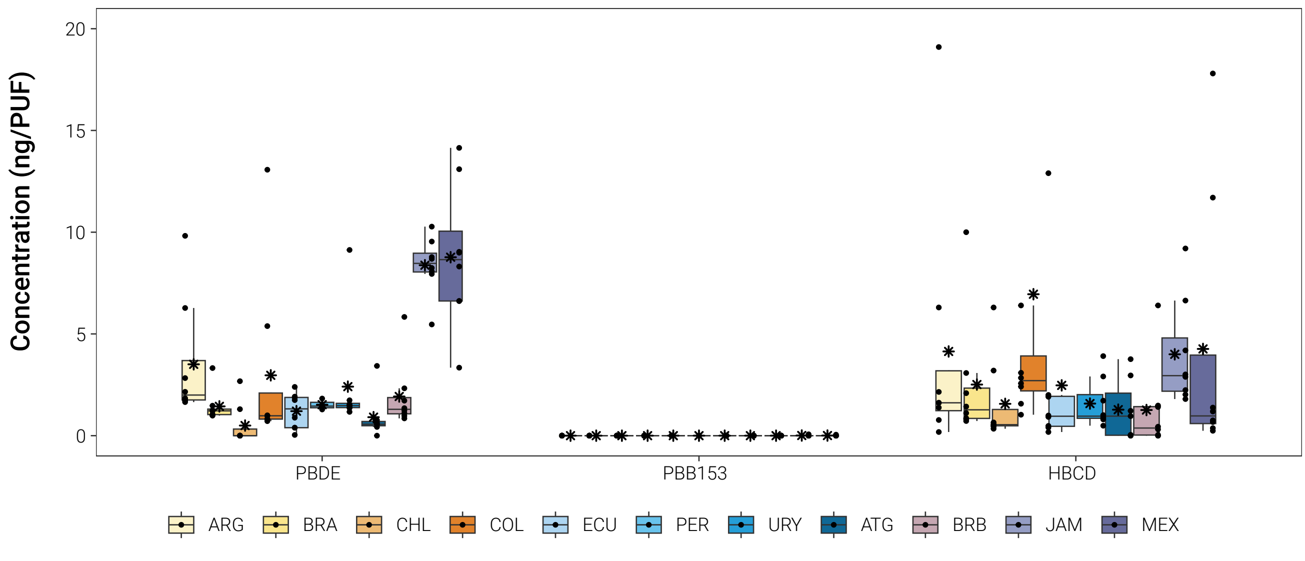

Figure 15: PAS/PUF: Box plots for brominated POPs: summary across all samples (n=82)

Table 14: Brominated POPs in PAS/PUF: Mean (with standard deviation, SD), median, minimum and maximum values (ng/PUF)

	PBDE		PBB153		HBCD	
Country	**Mean (SD)**	**Median [Min, Max]**	**Mean (SD)**	**Median [Min, Max]**	**Mean (SD)**	**Median [Min, Max]**
ARG (N=8)	3.51 (2.98)	2.00 [1.65, 9.82]	0	0 [0, 0]	4.14 (6.32)	1.62 [0.18, 19.1]
BRA (N=8)	1.44 (0.78)	1.22 [0.99, 3.32]	0	0 [0, 0]	2.51 (3.13)	1.27 [0.72, 10.0]
CHL (N=8)	0.50 (0.99)	0 [0, 2.68]	0	0 [0, 0]	1.56 (2.14)	0.540 [0.34, 6.30]
COL (N=8)	2.97 (4.38)	0.978 [0.71, 13.1]	0	0 [0, 0]	6.95 (11.7)	2.71 [1.03, 35.7]
ECU (N=8)	1.20 (0.88)	1.32 [0.04, 2.40]	0	0 [0, 0]	2.47 (4.27)	0.955 [0.18, 12.9]
PER (N=3)	1.52 (0.27)	1.45 [1.29, 1.82]	0	0 [0, 0]	NA (NA)	NA [NA, NA]
URY (N=8)	2.41 (2.72)	1.48 [1.17, 9.13]	0	0 [0, 0]	1.58 (1.21)	0.960 [0.49, 3.91]
ATG (N=7)	0.91 (1.14)	0.563 [0, 3.43]	0	0 [0, 0]	1.28 (1.52)	0.960 [0, 3.76]
BRB (N=8)	1.93 (1.65)	1.29 [0.85, 5.84]	0	0 [0, 0]	1.26 (2.16)	0.375 [0, 6.40]
JAM (N=8)	8.38 (1.41)	8.47 [5.47, 10.3]	0.008 (0.02)	0 [0, 0.0670]	4.00 (2.62)	2.95 [1.80, 9.20]
MEX (N=8)	8.77 (3.52)	8.65 [3.34, 14.1]	0.006 (0.02	0 [0, 0.0484]	4.26 (6.69)	0.970 [0.24, 17.8]
Overall (N=82)	3.17 (3.57)	1.48 [0, 14.1]	0.001 (0.01)	0 [0, 0.0670]	3.02 (5.22)	1.38 [0, 35.7]

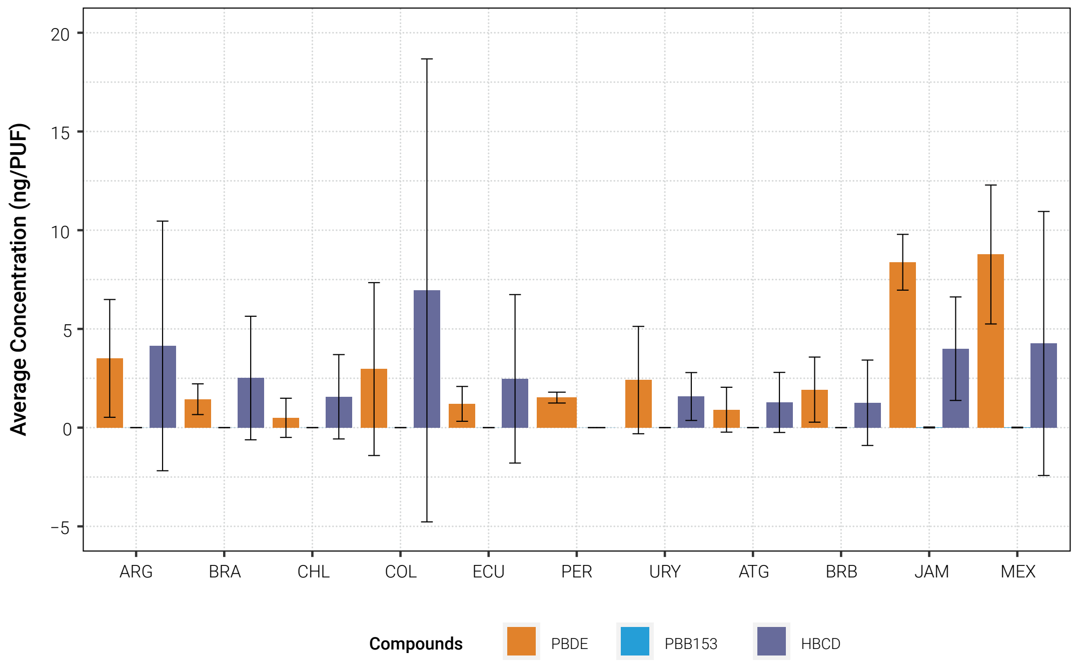

Figure 16: PAS/PUF: Mean values and SD for brominated POPs (n=82)

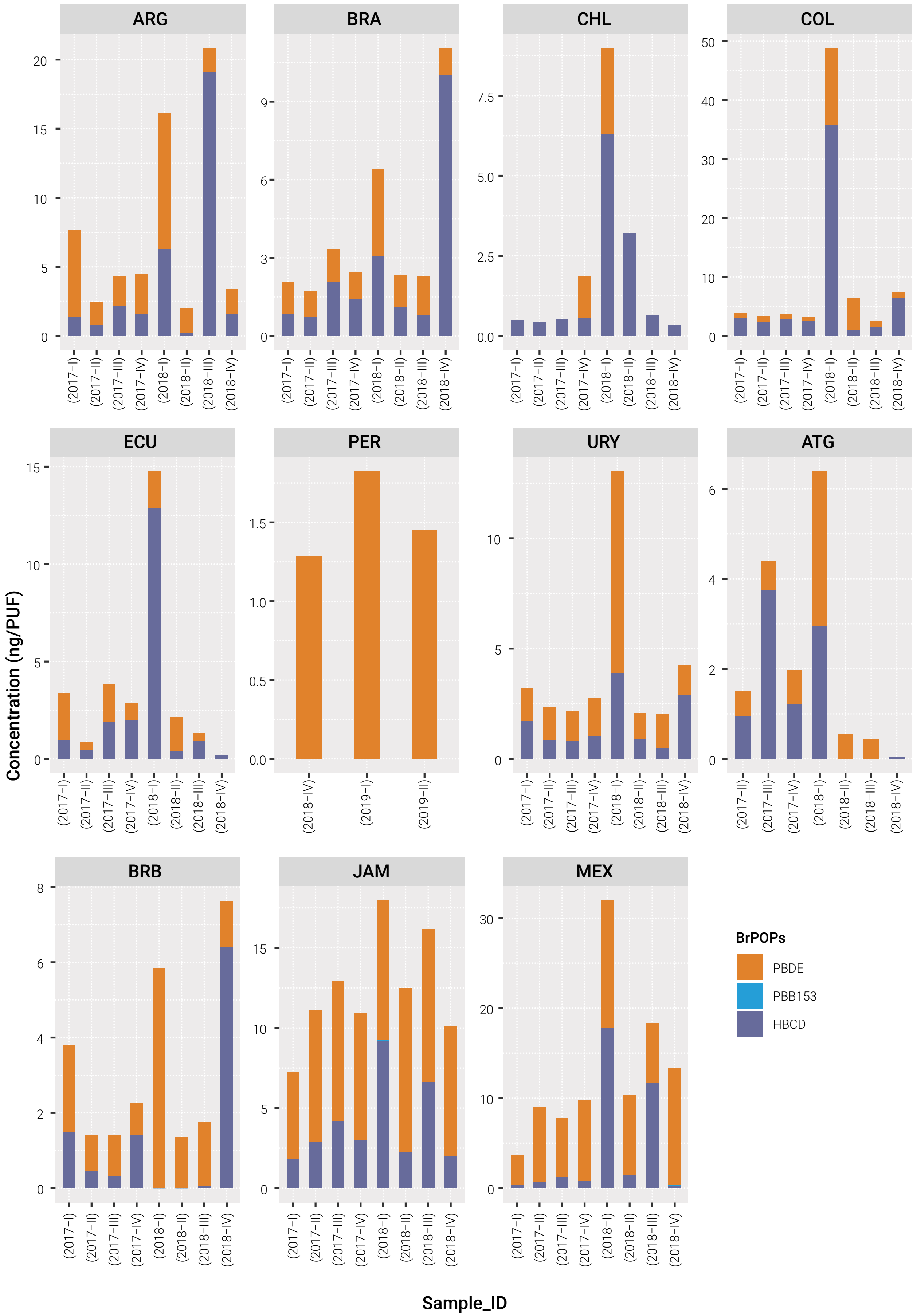

Figure 17: PAS/PUF: Stacked bar graphs for brominated POPs by country and sample (n=82)

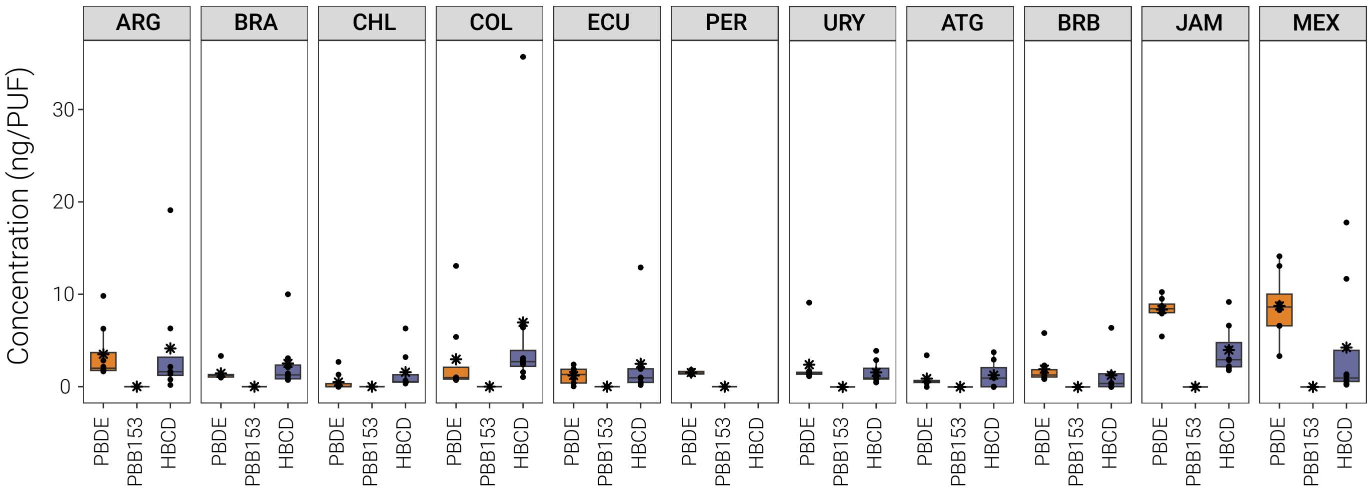

Figure 18: PAS/PUF: Unscaled boxplots for brominated POPs per country; y-axis zoomed to 40 ng/PUF. Concentrations in ng/PUF (n=82)

The boxplots in Figure 19 show that the ranges of values by POPs for each country and in Figure 20 for the three Br-POPs. In Peru, Jamaica, and Mexico, PBDE are dominating over HBCD whereas in Chile the latter had the higher values.

Statistically, the data were significantly different between the countries (p=0.014) but the pairwise assessment resulted in the fact that there was not a single country statistically different from another country; all p-values were greater than p=0.12

A Pearson correlation test revealed that the $PBDE_8$ were not correlated with HBCD nor with PBB153 (Figure 21).

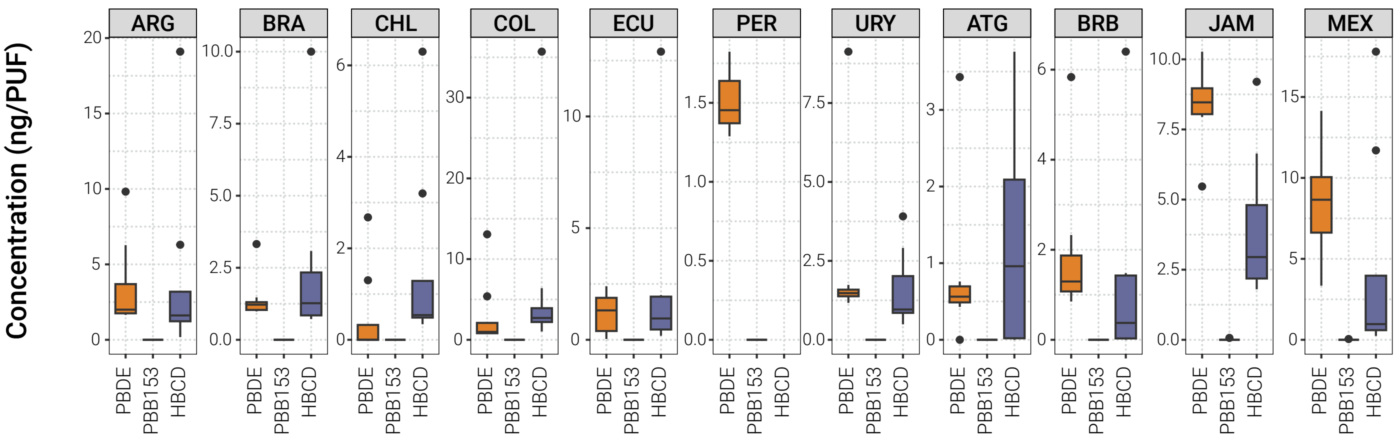

Figure 19: PAS/PUF: Scaled boxplots for sums of brominated POPs by country(n=82)

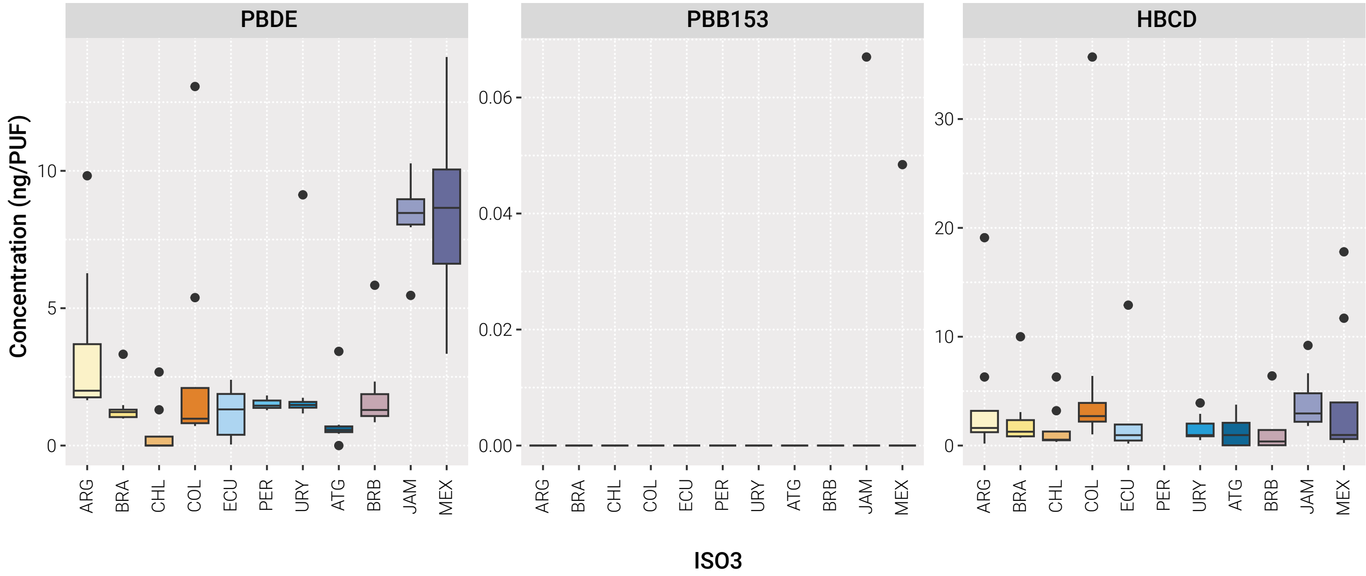

Figure 20: PAS/PUF: Scaled boxplots for country by brominated POPs (n=82)

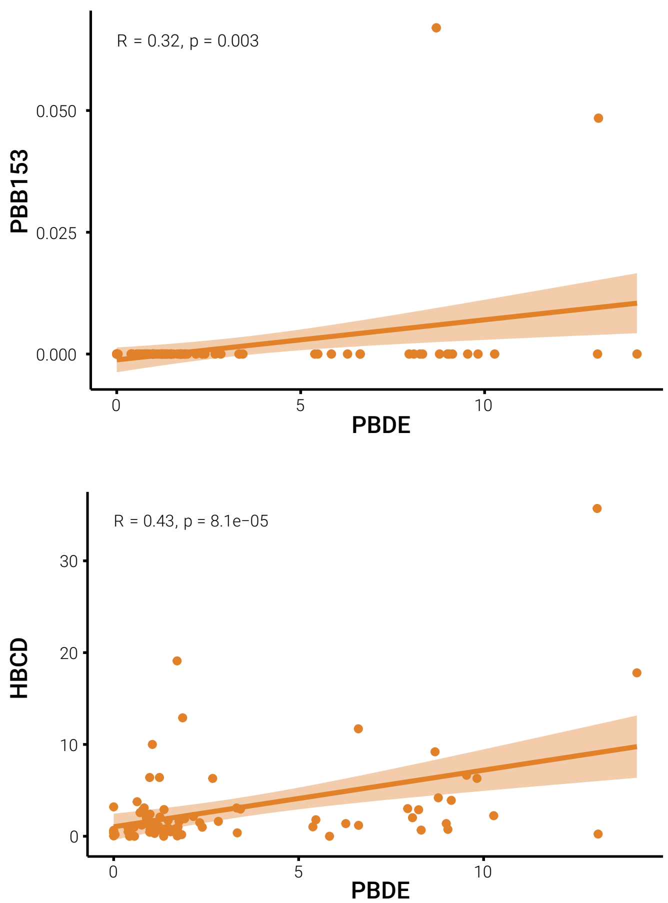

Figure 21: PAS/PUF: Pearson correlation between Br-POPs

4.2.4. Fluorinated POPs

The number of samples and assignment for each year to the eleven countries are shown in Table 15. The number per year includes an annual sample where the extracts from all quarterly samples of the same year were combined and reanalyzed; thus, a full set would consist of four quarterly and one annual sample, total of five. Exceptions were Uruguay, Colombia, and Antigua and Barbuda where quarterly samples were missing. Noteworthy that Peru started late with the sampling and was the only country that had samples exposed in 2019, but none in 2017 and only three samples in 2018.

Table 15: PAS/PUFs: Overview of samples analyzed for PFAS by year of sampling

ISO3	2017 (N=47)	2018 (N=52)	2019 (N=2)	Overall (N=101)
ATG	4	5		9
ARG	5	5		10
BRB	5	5		10
BRA	5	5		10
CHL	5	5		10
COL	4	4		8
ECU	5	5		10
JAM	5	5		10
MEX	5	5		10
PER		3	2	5
URY	4	5		9

In total, results for 101 samples have been reported. The results of the PUF extracts for PFAS are detailed in Table S 6; therein included are also samples that did not generate any quantitative result. Table 16 provides the mean, median, minimum and maximum values for each country. The values refer to pg per PUF and 1 quarter of the year, *i.e.*, 3-month exposure time. From the PFOS precursors, only FOSA could be quantified in the samples; FOSEs and FOSAs did not play a role. For details, see Camoiras González *et al*. (2021). Overall, the mean value of PFOS was higher than for PFOA but due to the smaller range of amounts, PFOA had the higher median value across the GRULAC. The samples from Peru had the highest mean and median values for ΣPFOS. PFOA values in Argentina, Brazil and Jamaica were above the median value (224 pg/PUF).

Graphical sketches provide the summary and comparison of results of chemical analyses for the indicator four PFAS. The overview on the amounts PFAS found in GRULAC samples is shown as box whisker plots in Figure 22. All data refer to 1 PUF and 3 months of exposure time and are given in pg/PUF. The measurements for each sample by country are displayed as stacked bars in Figure 23 and mean values with SD in Figure 24. For each country, the results are displayed in Figure 25. Scaled boxplots for either each country or each PFAS are shown in Figure 26 and Figure 27.

The pattern between countries were quite different: Countries with PFOS dominating over PFOA were Colombia and Peru, whereas higher percentages of PFOA were found in Antigua and Barbuda, Ecuador, and Mexico. Striking are the relatively high shares of FOSA in Brazil and Uruguay (Figure 26).

Between countries, Kruskal-Wallis chi-squared = 40.7, df = 10, there is a significant difference (p-value = 1.3 ×10^{-5}). Pairwise significant differences were obtained between CHL and many other countries in GRULAC; also, Jamaica and Mexico were significantly different from especially Argentina and Brazil.

Table 16: Four PFAS in PAS/PUF: Mean (with standard deviation, SD), median, minimum and maximum values (pg/PUF)

	PFOS		PFOA		PFHxS		FOSA	
Country	Mean (SD)	Median [Min, Max]	Mean (SD)	Median [Min, Max]	Mean (SD)	Median [Min, Max]	Mean (SD)	Median [Min, Max]
ARG (N=10)	260 (247)	303 [0, 666]	380 (155)	343 [197, 655]	22.7 (34.2)	0	41.9 (132)	0 [0, 419]
BRA (N=10)	495 (542)	257 [0, 1620]	328 (164)	337 [0, 649]	11.2 (15.3)	0	236 (389)	0 [0, 964]
CHL (N=10)	47.4 (23.0)	52.6 [0, 74.9]	74.6 (69.0)	68.2 [0, 251]	0	0	3.70 (11.7)	0 [0, 37.0]
COL (N=8)	1080 (316)	1190 [495, 1370]	279 (119)	239 [133, 482]	0	0	19.8 (31.4)	0 [0, 86.3]
ECU (N=10)	47.4 (28.6)	56.1 [0, 83.2]	200 (105)	176 [0, 383]	0	0	33.5 (30.9)	39.7 [0, 75.9]
PER (N=5)	1740 (484)	1790 [1150, 2260]	194 (45.7)	187 [138, 260]	40.8 (23.0)	48.5 [0, 56.5]	30.3 (20.2)	31.4 [0, 48.9]
URY (N=9)	222 (54.5)	202 [170, 323]	172 (35.7)	174 [108, 231]	3.86 (7.73)	0 [0, 19.5]	273 (355)	0 [0, 894]
ATG (N=9)	48.1 (57.3)	0 [0, 115]	319 (97.2)	371 [194, 472]	21.4 (25.7)	0 [0, 54.4]	5.55 (16.6)	0 [0, 49.9]
BRB (N=10)	272 (285)	171 [86.3, 1010]	250 (157)	173 [110, 572]	20.2 (5.16)	20.9 [13.1, 27.0]	8.30 (26.2)	0 [0, 83.0]
JAM (N=10)	228 (60.7)	219 [131, 372]	245 (49.6)	240 [155, 348]	0	0	11.0 (34.9)	0 [0, 110]
MEX (N=10)	96.6 (42.9)	88.8 [47.6, 190]	231 (90.2)	248 [0, 324]	0	0	3.83 (12.1)	0 [0, 38.3]
Overall (N=101)	339 (485)	170 [0, 2260]	245 (134)	224 [0, 655]	9.63 (18.6)	0 [0, 101]	61.4 (186)	0 [0, 964]

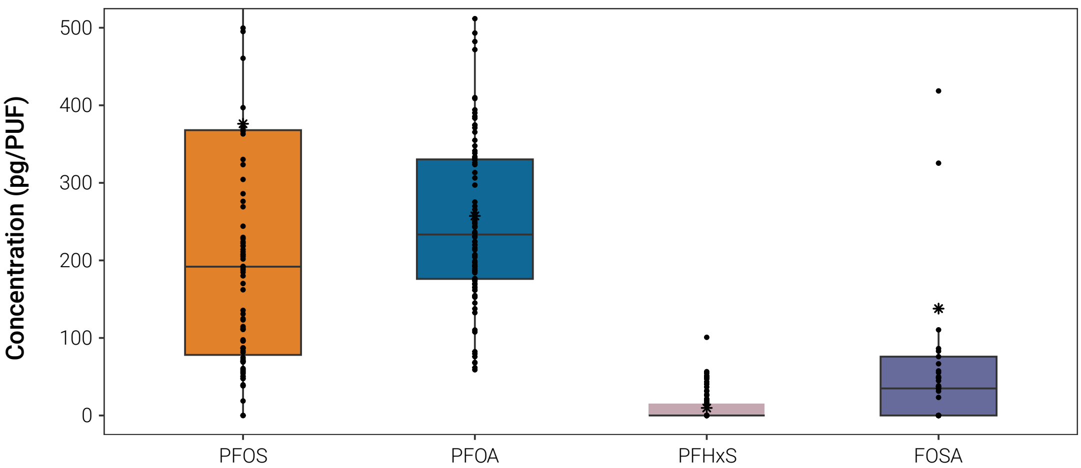

Figure 22: PAS/PUF: Summary of PFAS as Box whisker plots (n=101)

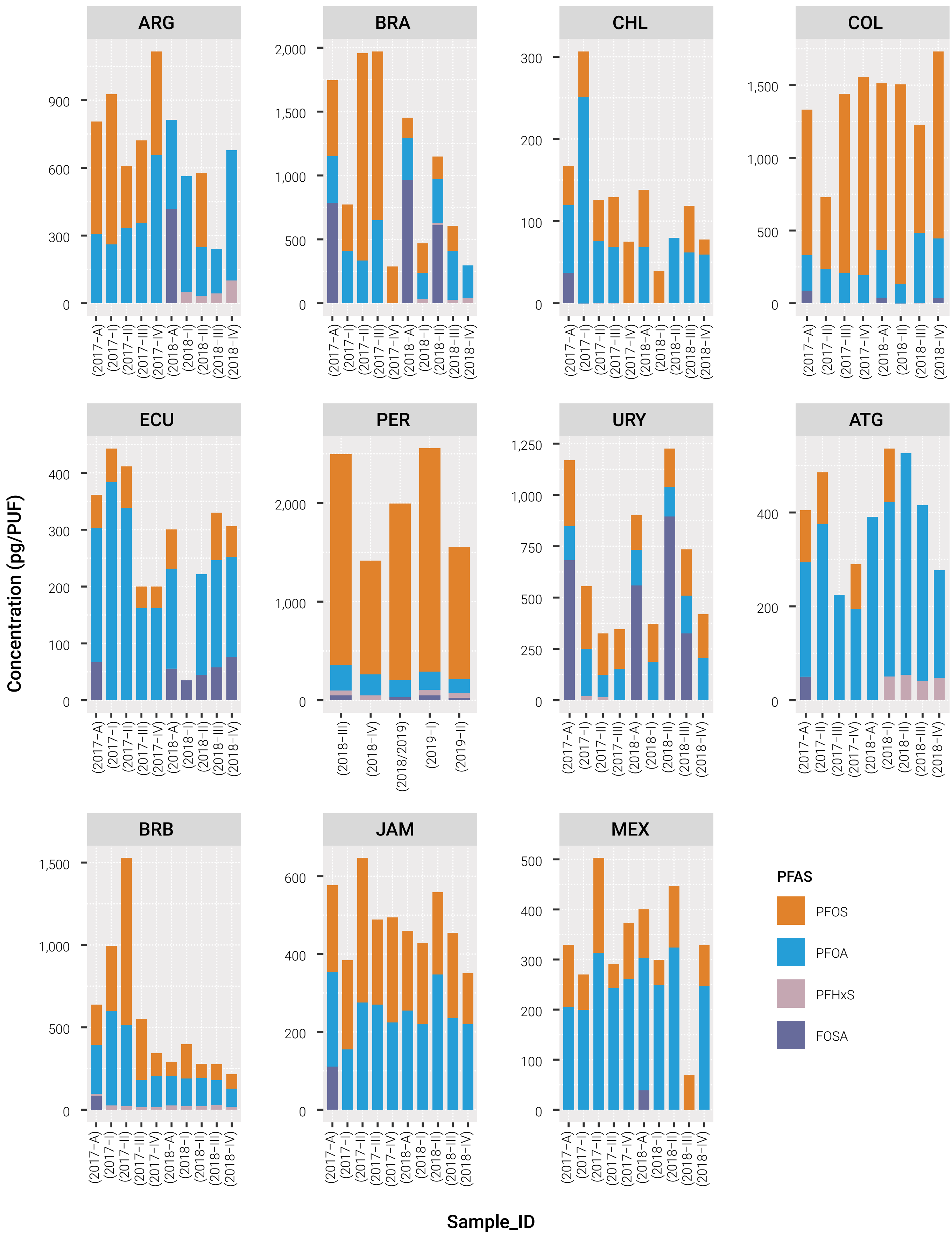

Figure 23: PAS/PUF: Stacked bar graphs for PFAS POPs by country and sample (n=101)

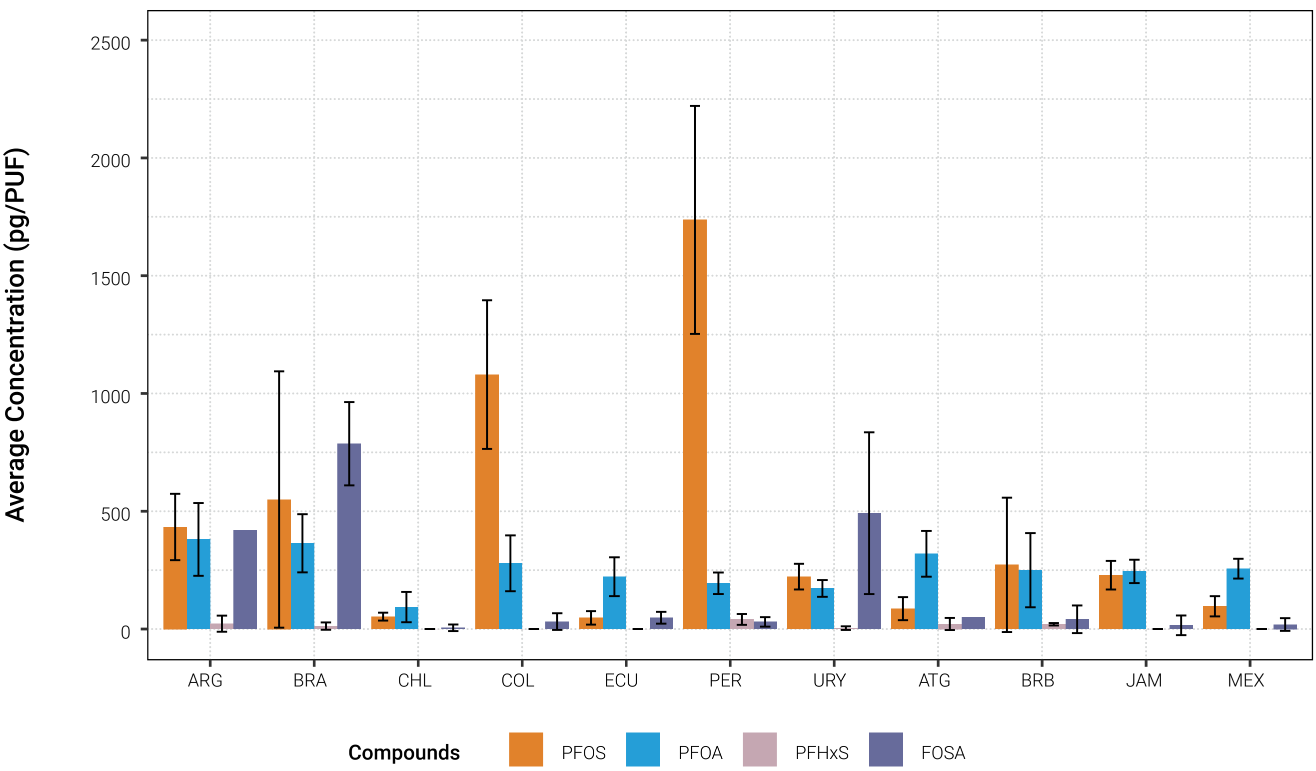

Figure 24: PAS/PUF: Mean values and SD for 4 PFAS (n=101)

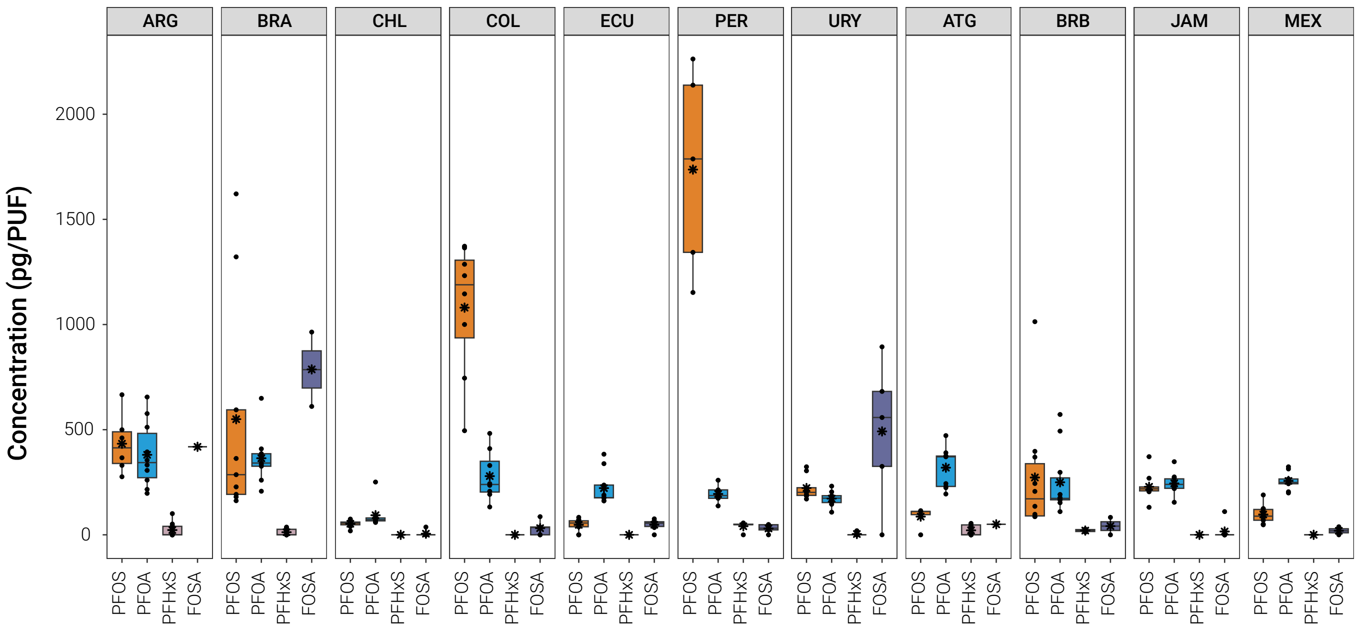

Figure 25: PAS/PUF: Unscaled for concentrations of 4 PFAS by country (n=101)

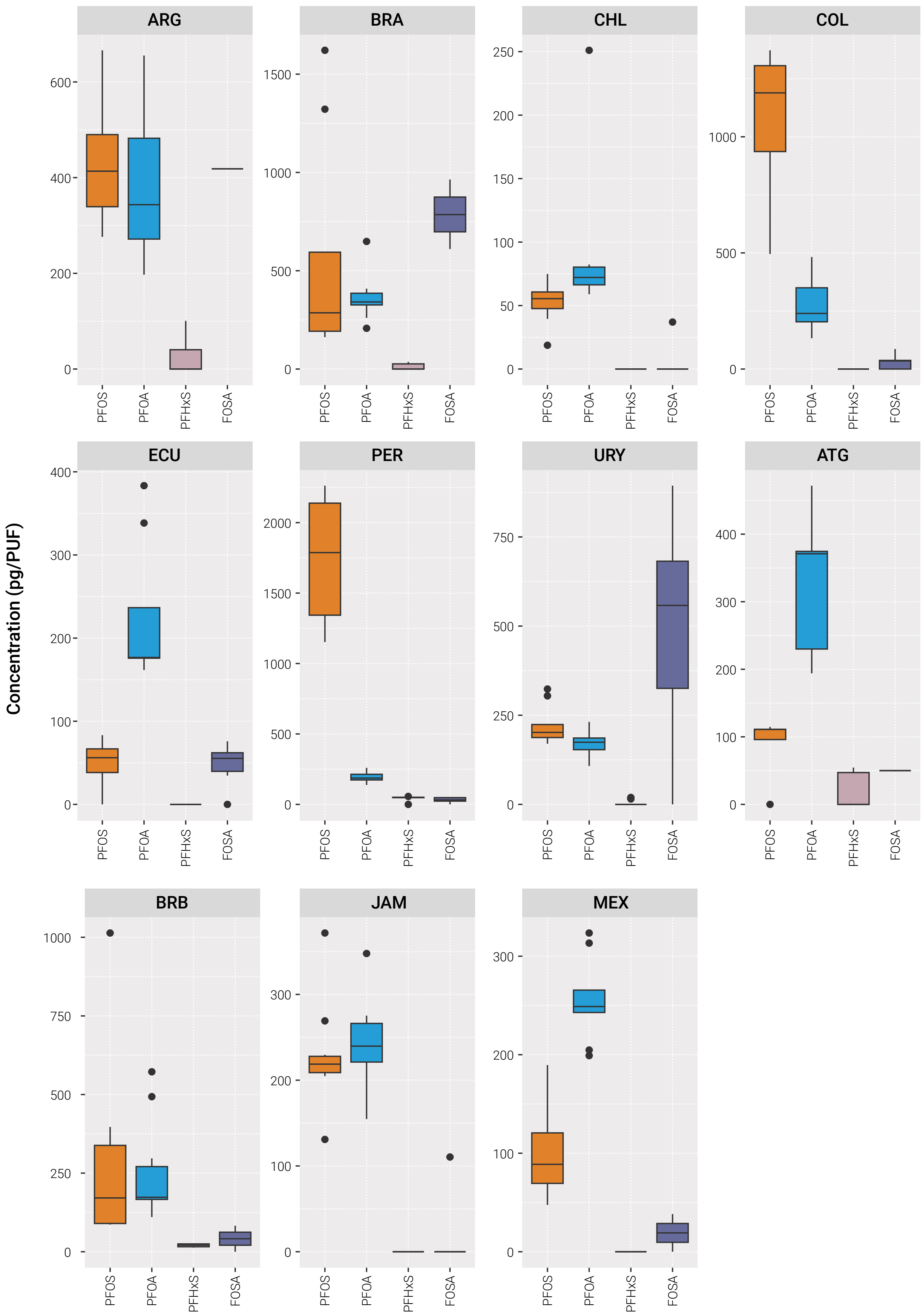

Figure 26: PAS/PUF: Scaled boxplots for concentrations of 4 PFAS by country (pg/PUF)

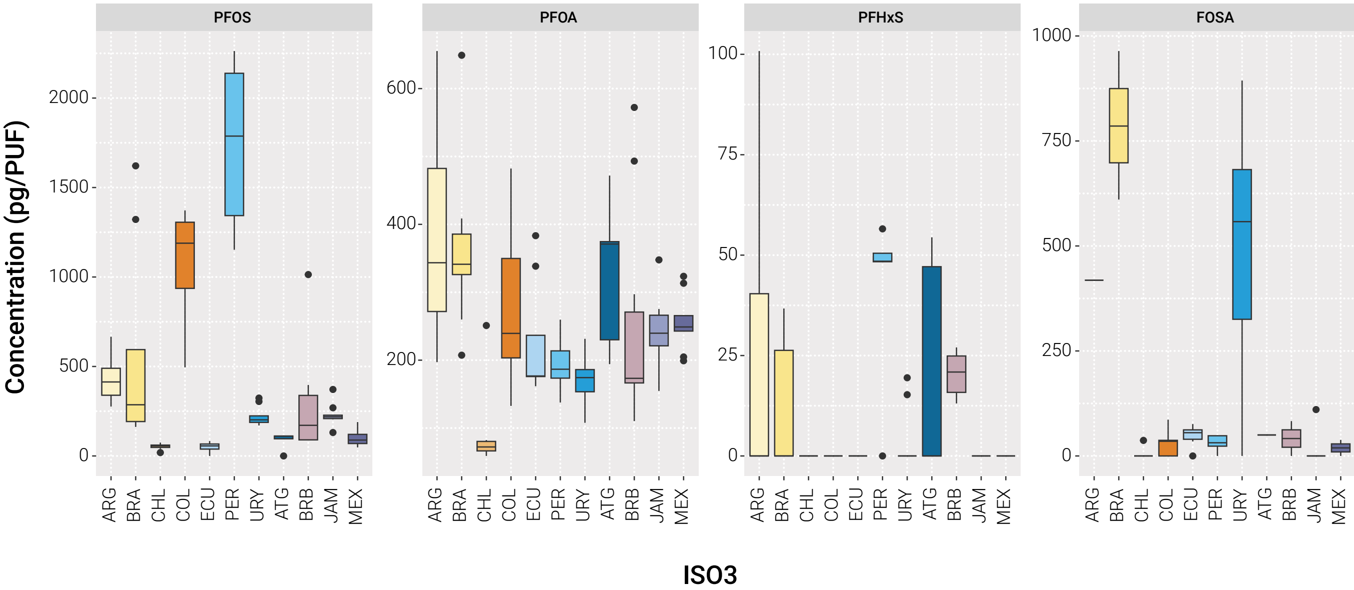

Figure 27: PAS/PUF: Scaled boxplots for concentrations according PFOS, PFOA, PFHxS, and FOSA by country (pg/PUF)

4.2.5. Ambient air with active sampler

Active air sampling (AAS) was performed in Brazil at the site of CESTB in São Paulo. Exposures were in spring 2019.

Only very few data could be generated due to deterioration of the PUFs or loss of sample extracts during clean-up. For PFAS analysis, only the glass fiber filter from two exposure periods were available and were combined. For HBCD, the filters PUFs, XAD and GFF from both exposures were combined and analyzed. The results are presented in Table 15 and visualized in Figure 28.

A comparison with the PAS/PUF results can be made only on the pattern for the PFAS and the dl-POPs. Whereas the PAS/PUF results revealed PFOS and PFOA at similar levels and FOSA dominating, the AAS showed less for PFOA and PFOS and FOSA at similar levels. PFHxS was not quantified in the AAS sample and also very low or below LOQ in the PAS/PUFs. For the dl-POPs, in the PAS/PUF measurements there was a 2-3-fold dominance of TEQ_DF over TEQ_PCB, whereas in the AAS, the PCDD/PCDF were about 10-times higher than the dl-PCB (as TEQ).

Table 17: Active air sampling: Results for PCB_6, HBCD, PFAS (pg/m³), and dl-POPs (fg TEQ/m³)

Sample_ID	PCB6	PBDE7	HBCD	PFOS	PFOA	PFHxS	FOSA	TEQ_DF	TEQ_PCB
BRA (2019-1+2)			0.37	0.89	0.63	<LOQ	0.99		
BRA (2019-1)	12.4	7.014						53.9	4.95
BRA (2019-2)	19.9	2.113						40.4	3.52

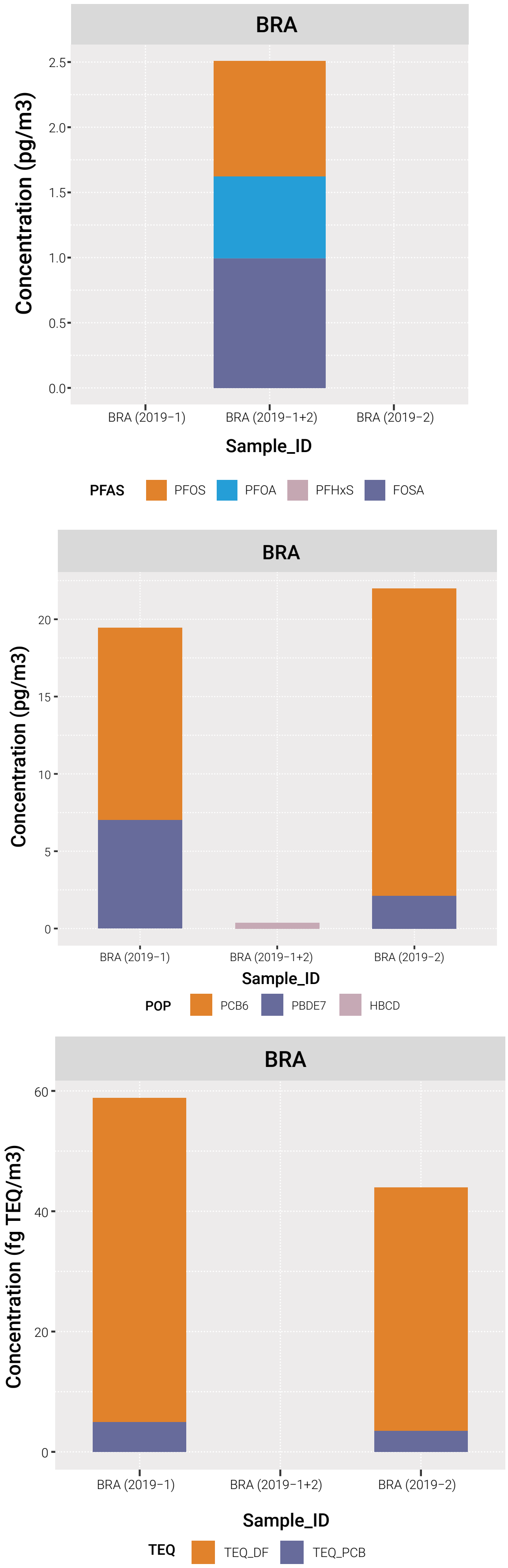

Figure 28: AAS GRULAC: Stacked bars for PCB_6, Br-POPs, PFAS and dl-POPs

4.3. Water

There were 46 water samples available for PFAS analysis. Of these, 40 samples were from the GMP2 water network and six were national samples, provided by Antigua and Barbuda (ATG), Jamaica (JAM), and Uruguay (URY) (Table 18). All five countries participating in the water sampling have provided eight samples over the two years (2017-2018), and in addition, ATG and URY submitted two samples each as national samples: JAM sent 2 more sample; thus, a total of 10 samples. All sampling followed the protocol and therefore are included in this section as a core matrix.

Table 18: PFAS in water: Number and origin of the water samples

	2017 (N=20)	2018 (N=22)	2019 (N=4)	Overall (N=46)
Source				
GMP2	20 (100%)	20 (90.9%)	0 (0%)	40 (87.0%)
Nat	0 (0%)	2 (9.1%)	4 (100%)	6 (13.0%)
WBC				
H	4 (20.0%)	0 (0%)	4 (100%)	8 (17.4%)
UM	16 (80.0%)	22 (100%)	0 (0%)	38 (82.6%)
LM	0 (0%)	0 (0%)	0 (0%)	0 (0%)
L	0 (0%)	0 (0%)	0 (0%)	0 (0%)
PD_Code				
PD<25	8 (40.0%)	4 (18.2%)	2 (50.0%)	14 (30.4%)
PD_25-90	8 (40.0%)	12 (54.5%)	0 (0%)	20 (43.5%)
PD_90-200	0 (0%)	0 (0%)	0 (0%)	0 (0%)
PD_200-330	4 (20.0%)	6 (27.3%)	2 (50.0%)	12 (26.1%)
PD_330-2000	0 (0%)	0 (0%)	0 (0%)	0 (0%)

The results of the 40 water samples under the original water project component of the GRULAC project for the sum of the three targeted PFAS and including the L-PFOS and br-PFOS isomers are detailed in Table S 9. These samples were included in a publication presenting and assessing all 144 samples under the UNEP/GEF GMP2 projects (Baabish, Sobhanei and Fiedler 2021). Table 19 provides the mean, median, minimum and maximum values of all water samples (N=46) for each country. The values refer to ng per liter. In all countries, PFOS concentrations were higher than PFOA; and PFHxS were lowest. Highest concentrations were found in Argentina and lowest in Ecuador and the Amazon region in Brazil (2017 samples, Figure 34). ATG, ARG and JAM had PFOA values above the overall mean value. In contrast to the other regions, the GRULAC results are quite homogeneous and there is only one outlier for L-PFOS. Br-PFOS was detected in almost all samples.

Table 19: PFAS in water: Mean (with standard deviation, SD), median, minimum and maximum values (ng/L)

POPs	Central tendencies	ARG (N=8)	BRA (N=8)	ECU (N=8)	JAM (N=10)	MEX (N=8)	ATG (N=2)	URY (N=2)	Overall (N=46)
SPFOS	Mean (SD)	3.35 (1.12)	1.63 (1.65)	0.52 (0.30)	1.54 (0.727)	0.76 (0.51)	1.75 (1.24)	0.40 (0.13)	1.52 (1.32)
	Median [Min, Max]	3.11 [1.86, 5.32]	1.33 [0.04, 4.08]	0.47 [0.20, 0.94]	1.65 [0.41, 2.57]	0.524 [0.34, 1.89]	1.75 [0.87, 2.63]	0.40 [0.30, 0.49]	0.99 [0.04, 5.32]
PFOA	Mean (SD)	1.01 (0.30)	0.42 (0.34)	0.24 (0.09)	0.75 (0.38)	0.56 (0.31)	2.11 (0.13)	0.143 (0.09)	0.65 (0.50)
	Median [Min, Max]	1.00 [0.65, 1.44]	0.40 [0.05, 0.86]	0.23 [0.15, 0.42]	0.82 [0.24, 1.34]	0.47 [0.33, 1.30]	2.11 [2.01, 2.20]	0.14 [0.08, 0.21]	0.49 [0.05, 2.20]
PFHxS	Mean (SD)	0.68 (0.18)	0.35 (0.37)	0.07 (0.06)	0.28 (0.19)	0.10 (0.03)	0.61 (0.18)	0.030 (0.04)	0.30 (0.29)
	Median [Min, Max]	0.65 [0.43, 0.95]	0.31 [0, 0.81]	0.05 [0.03, 0.17]	0.24 [0.10, 0.69]	0.09 [0.07, 0.16]	0.61 [0.48, 0.74]	0.030 [0, 0.06]	0.17 [0, 0.95]
L_PFOS	Mean (SD)	2.46 (0.93)	1.12 (1.08)	0.39 (0.23)	1.08 (0.55)	0.56 (0.44)	1.02 (0.65)	0.24 (0.11)	1.08 (0.96)
	Median [Min, Max]	2.31 [1.17, 4.16]	0.919 [0.04, 2.64]	0.36 [0.15, 0.77]	1.27 [0.22, 1.70]	0.39 [0.22, 1.58]	1.02 [0.56, 1.48]	0.243 [0.16, 0.32]	0.68 [0.05, 4.16]
br_PFOS	Mean (SD)	0.88 (0.30)	0.52 (0.57)	0.13 (0.09)	0.45 (0.23)	0.20 (0.10)	0.73 (0.59)	0.15 (0.02)	0.44 (0.40)
	Median [Min, Max]	0.99 [0.43, 1.17]	0.41 [0, 1.44]	0.12 [0.04, 0.24]	0.44 [0.19, 0.95]	0.18 [0.07, 0.37]	0.73 [0.31, 1.15]	0.15 [0.14, 0.17]	0.27 [0, 1.44]

Graphical sketches provide an overview on all samples analyzed from GRULAC as stacked bar plots in in Figure 29; the patterns are shown in Figure 30. Especially in Argentina, but also in Ecuador and Mexico, the patterns were quite homogeneous.

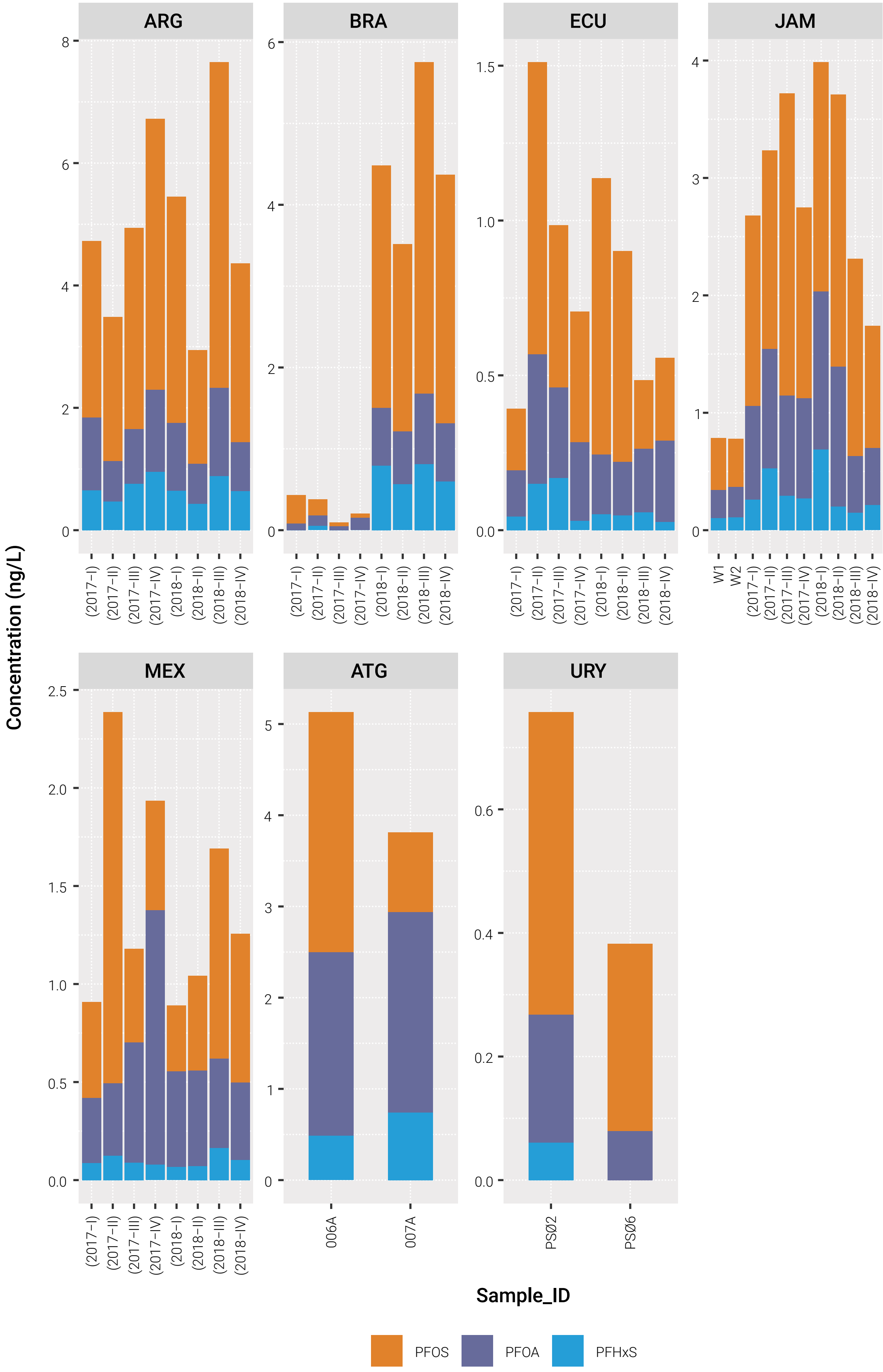

Figure 29: Water: Overview on PFAS concentrations by sample and country (stacked boxplots). Concentrations in ng/L

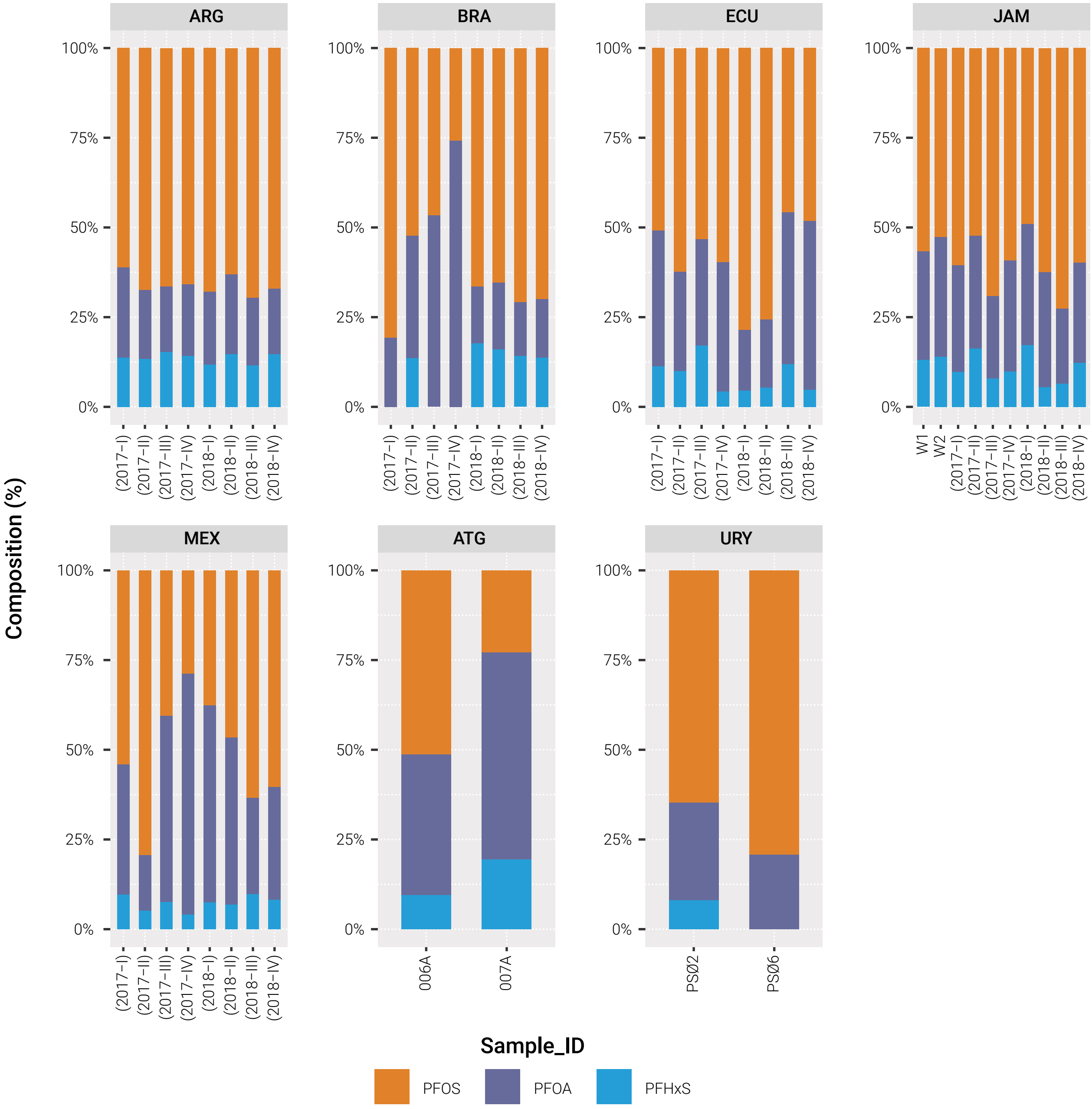

Figure 30: Water: Comparison of patters for three PFAS by sample as stacked barplots

The comparison of results of chemical analyses for PFAS as unscaled boxplots is shown in Figure 31 and mean values with standard deviation in Figure 32. Scaled boxplots in Figure 33 and Figure 34 visualize the results by country or by POPs, respectively.

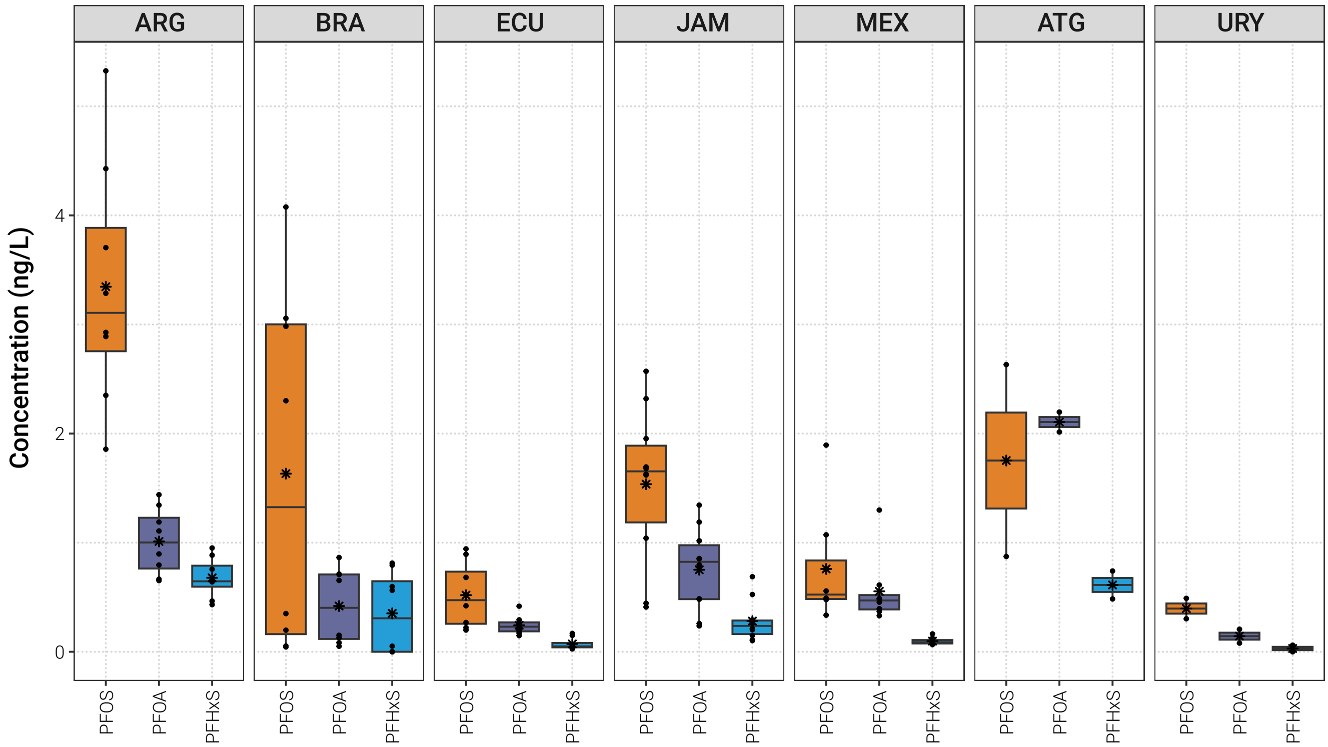

Figure 31: Water: Overview; box whisker plots and means with SD for each country (unscaled box plots). Concentrations in ng/L

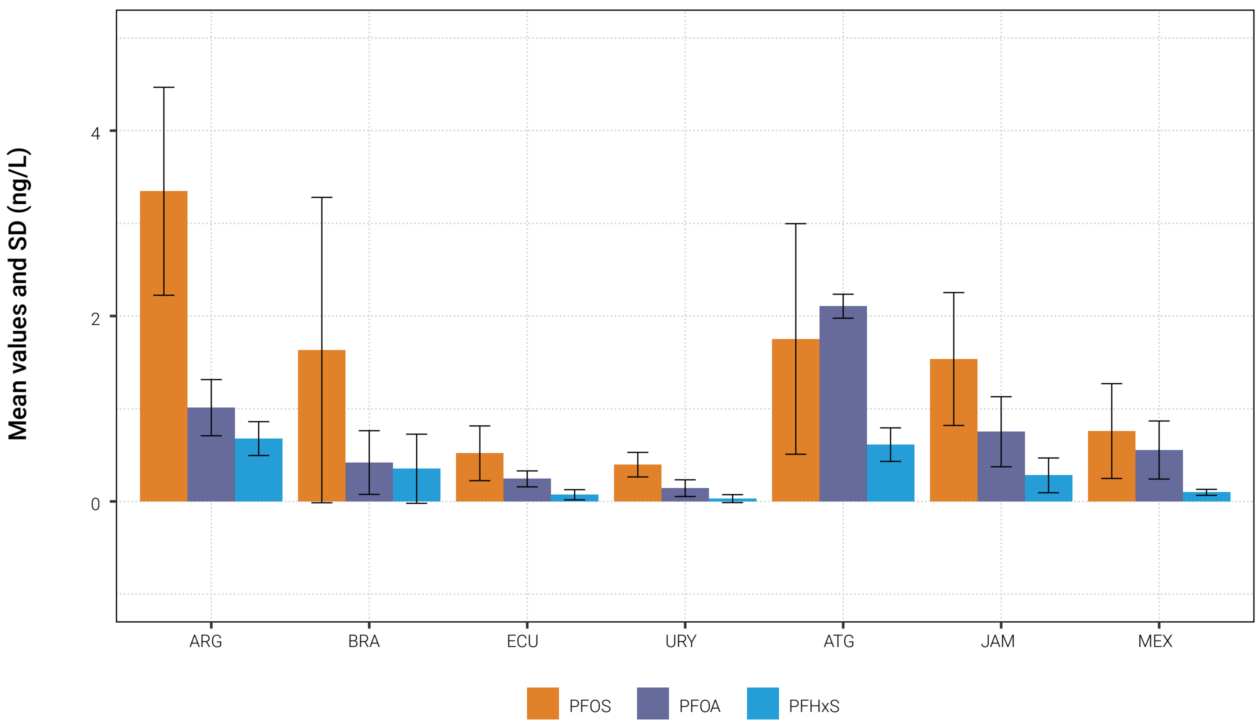

Figure 32: Water: Mean values and SD for three PFAS according to source

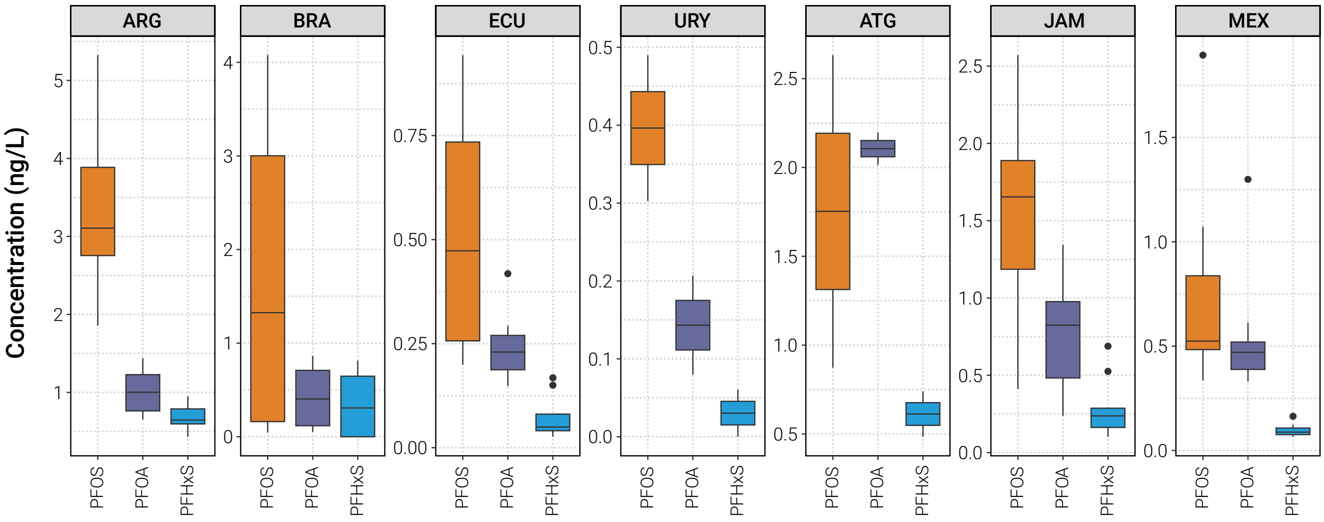

Figure 33: Water: Amounts of PFAS by country (ng/L)

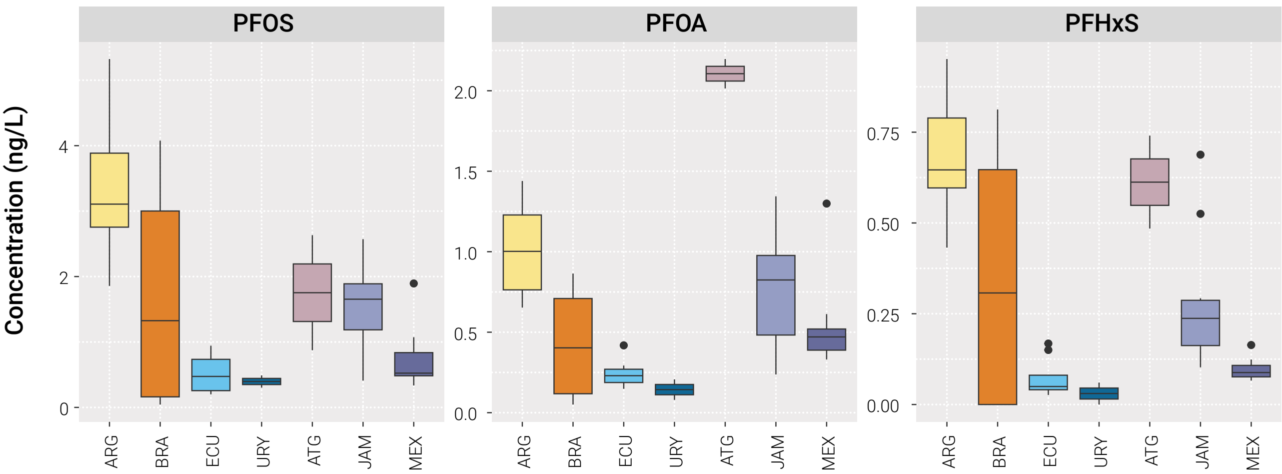

Figure 34: Water: Amounts according to PFOS, PFOA, PFHxS by country (ng/L)

The amounts of PFAS found in GRULAC according to countries and year, is shown in Figure 35. Four samples each were collected in both years in the five project countries. A comparison of the values obtained for 2017 and 2018 shows that for all countries, except Brazil, PFOS, PFOA and PFHxS had very comparable concentrations between the two years. For Brazil, the amounts for all PFASs were higher in 2018 than in 2017. The difference can be explained by the fact that the sampling location was changed from the remote Amazon delta in 2017 to a more industrialized area in the São Paulo state.

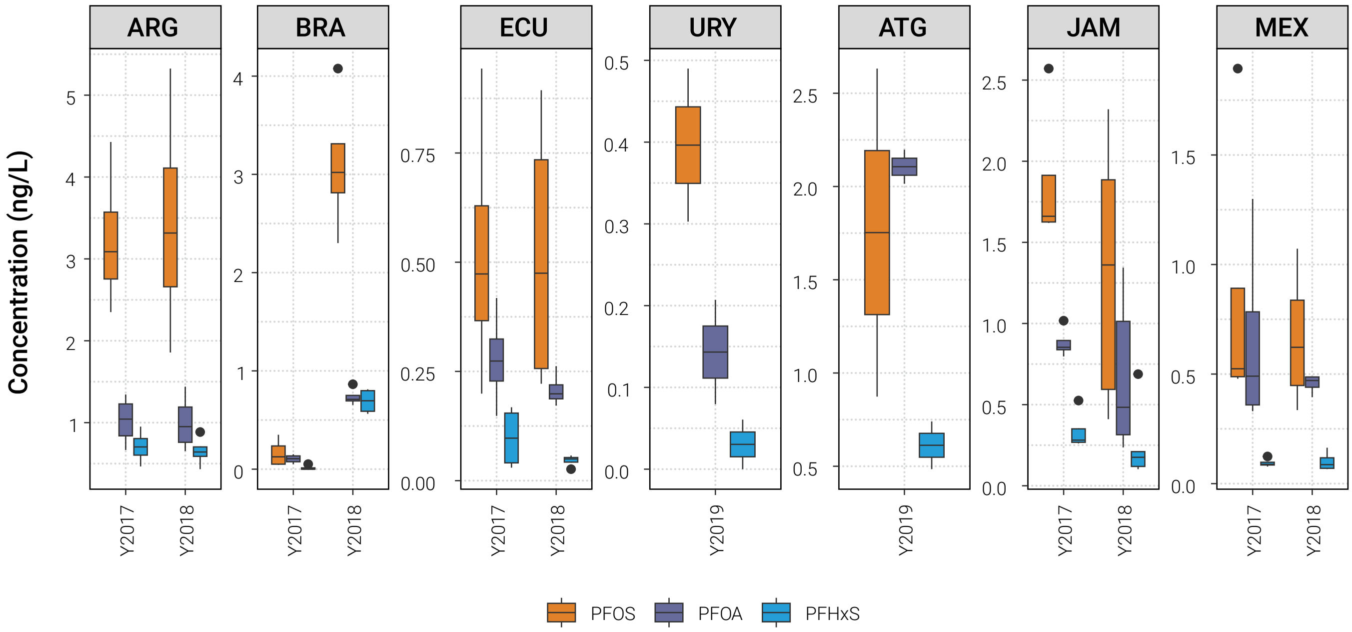

Figure 35: Water: Comparison of values for each country for PFAS concentrations (ng L^{-1}) according to Year

4.4. Human milk

Human milk samples were sent to the CVUA in Freiburg, Germany, for analysis of chlorinated and brominated POPs and to Örebro University for PFAS analysis. The results from GRULAC samples are summarized in Table 20 for Cl-POPs (including OCPs and PCB_6) and Br-POPs and in Table 21 for dl-POPs and PFAS. The concentrations of the quantified chlorinated and brominated POPs (as sums), the TEQs, and PFAS as barplots with a comparison between countries are shown in Figure 36.

Statistically, the values were not statistically different for any of these four groups of POPs, which are detailed below. The p-values were >0.1.

Table 20: Concentration of chlorinated and brominated POPs in human milk (ng/g lipid) for GRULAC national pools

POPs	ATG	ARG	BRB	COL	ECU	JAM	MEX	PER	URY	Overall (N=9)	
										Mean	Median
chlordane	3.28	2.96	16	3.82	1.77	5.63	3.57	0.582	3.42	4.55 (4.50)	3.42 [0.582, 16.0]
dieldrin	1.86	0.71	5.78	2.41	0.653	2.07	1.53	1.97	2.42	2.15 (1.51)	1.97 [0.653, 5.78]
DDT	56.9	139	92.6	71.6	339	89.6	560	187	41.7	175 (171)	92.6 [41.7, 560]
HCHs	2.09	8.47	4.14	0.74	1.36	1.15	2.94	7.96	15.9	4.98 (5.00)	2.94 [0.737, 15.9]
cis_Hepo	1.07	0.972	1.25	0.667	<0.5	0.788	1.02	0.733	1.88	0.930 (0.502)	0.972 [0, 1.88]
Mirex	<0.5	2.26	0.685	<0.5	<0.5	<0.5	<0.5	<0.5	2.94	0.654 (1.14)	0 [0, 2.94]
toxaphene	0.711	<0.50	0.618	<0.5	<0.5	0.59	<0.5	<0.5	<0.5	0.214 (0.322)	0 [0, 0.711]
HCB	4.5	6.53	3	4.01	5.38	3.33	6.14	3.1	7.11	4.79 (1.56)	4.50 [3.00, 7.11]
PCB6	11.1	16.7	19.3	5.91	3	16.4	4.46	12.7	10.9	11.1 (5.75)	11.1 [3.00, 19.3]
SCCP	30.6	32.5	38.3	33.4	20	45.8	28.4	114	33.9	41.9 (27.9)	33.4 [20.0, 114]
SPBDE6	13.8	0.744	5.04	0.586	0.60	7.18	11.6	1.62	0.393	4.62 (5.17)	1.62 [0.393, 13.8]
PBDE209	<0.50	1.16	0.54	0.10	0.16	0.25	0.914	2.4	0.57	0.677 (0.754)	0.538 [0, 2.40]
aHBCD	0.3	0.3	0.5	<0.5	1.25	0.5	0.6	0.7	<0.5	0.461 (0.384)	0.500 [0, 1.25]

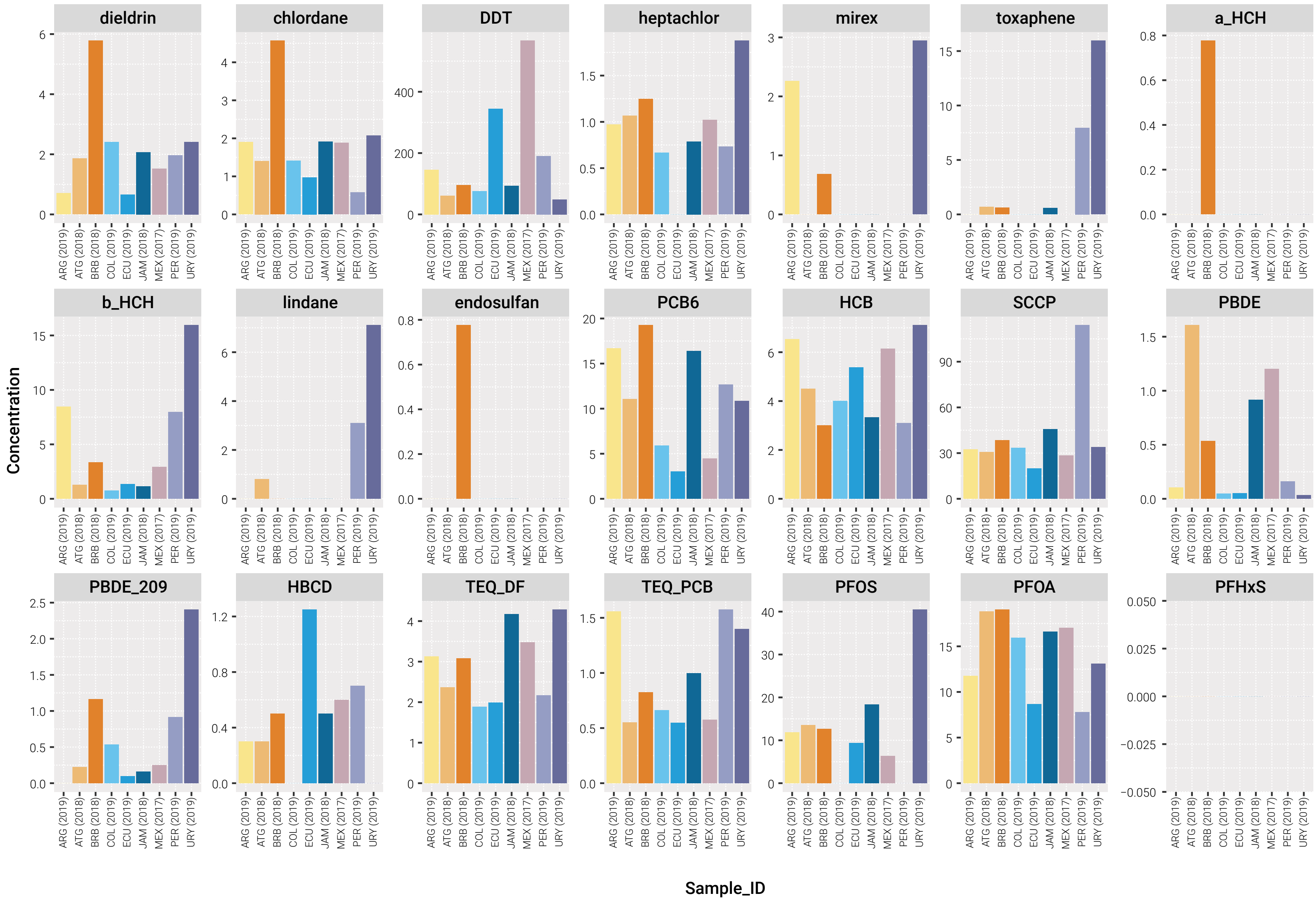

Figure 36: Human milk: Scaled barplots by POPs with concentrations for each country (pg TEQ/g lipid for the dl-POPs, pg/g f.w. for PFOS and PFOA; all other in ng/g lipid)

Among the chlorinated POPs, DDT had the highest concentrations in all countries, with Mexico having the highest value, see Figure S 1. Among the GRULAC countries, Barbados had the highest concentrations for drins, chlordane, and PCB_6. Heptachlor, HCB, mirex, and HCHs were highest in Uruguay. Antigua and Barbuda had the highest values for toxaphene and PBDE, Ecuador was highest for HBCD (Figure 51). The concentrations by country for the Cl-POPs without DDT are shown in Figure 36.

The concentrations of the Cl-POPs in the national pools of the GRULAC countries are shown as stacked bars in Figure 37. Figure 38 shows the distribution in the participating countries for each of the Cl-POPs. The scales on the y-axis show that DDT was dominating in all samples. A graph displaying the individual POPs is contained in the annex as Figure S1. From Figure 39, the POPs concentrations are shown by country but without DDT.

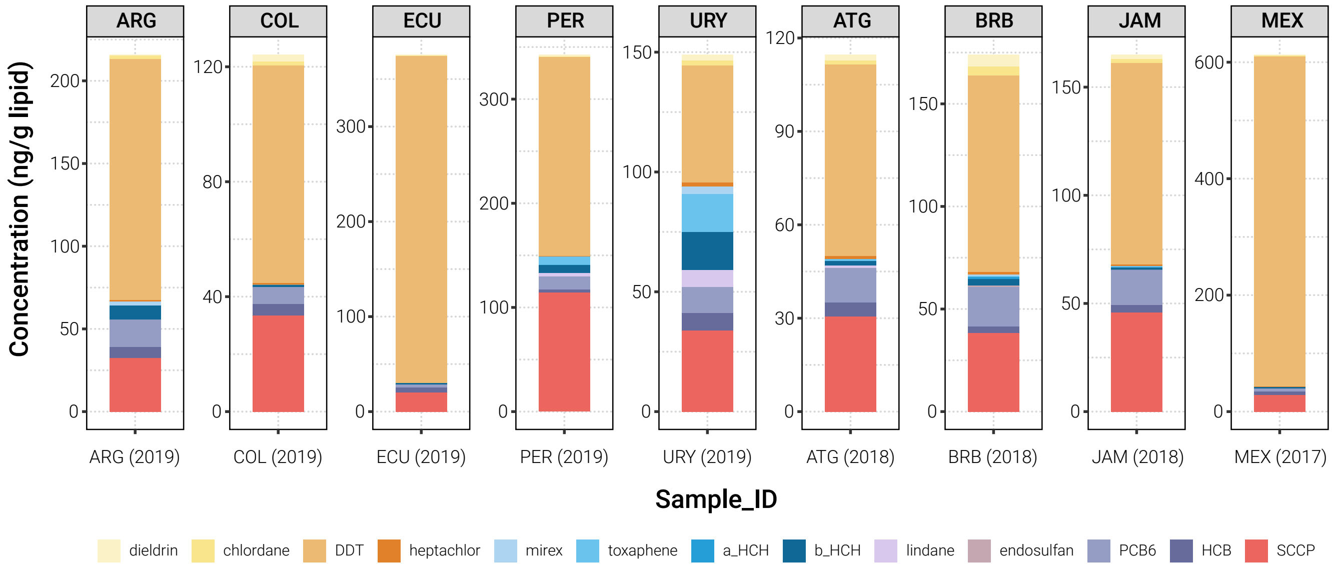

Figure 37: Human milk: Overview of Cl-POPs by POPs as stacked bars (ng/g lipid)

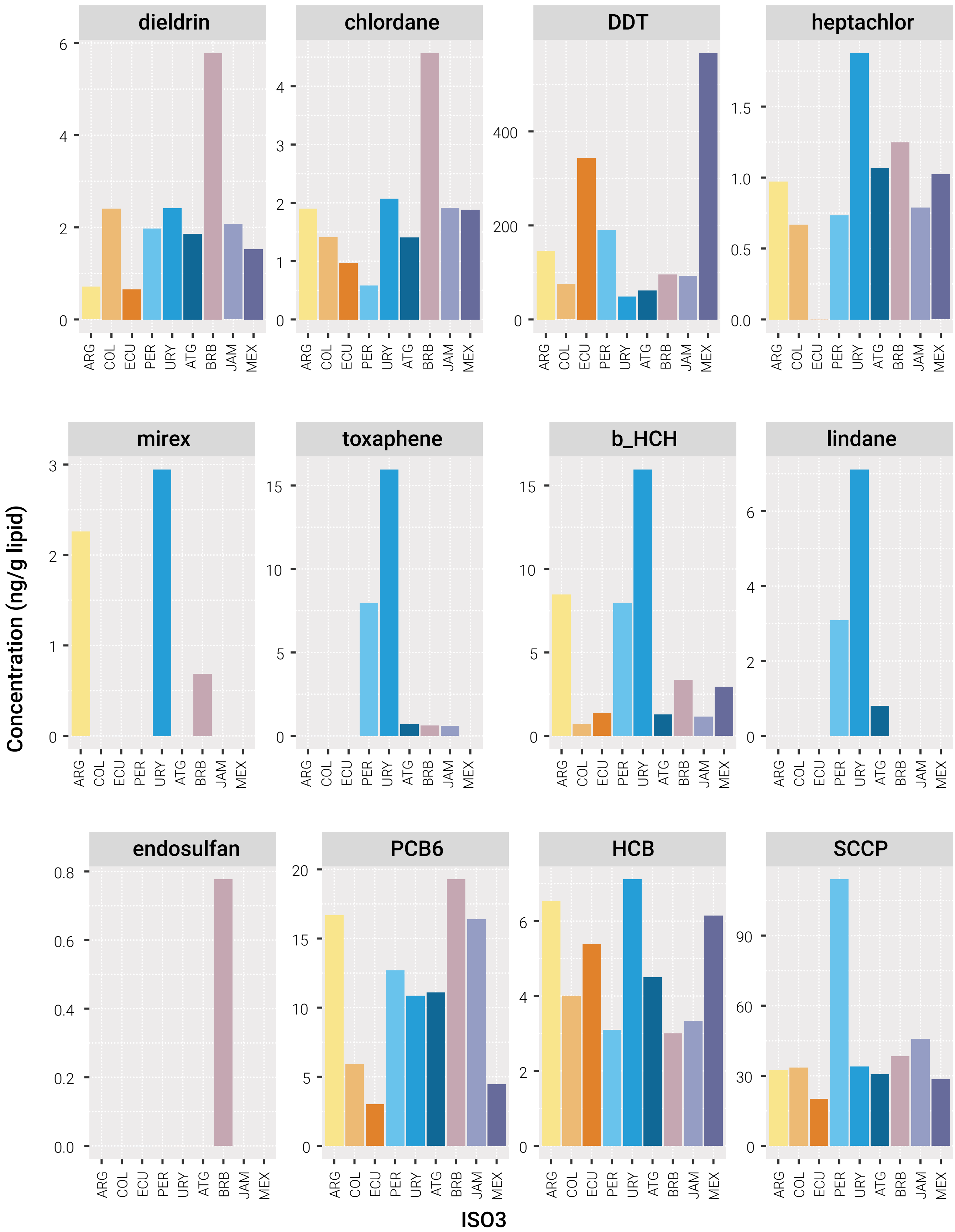

Figure 38: Human milk: Scaled barplots by Cl-POPs and occurrence by country and national pool

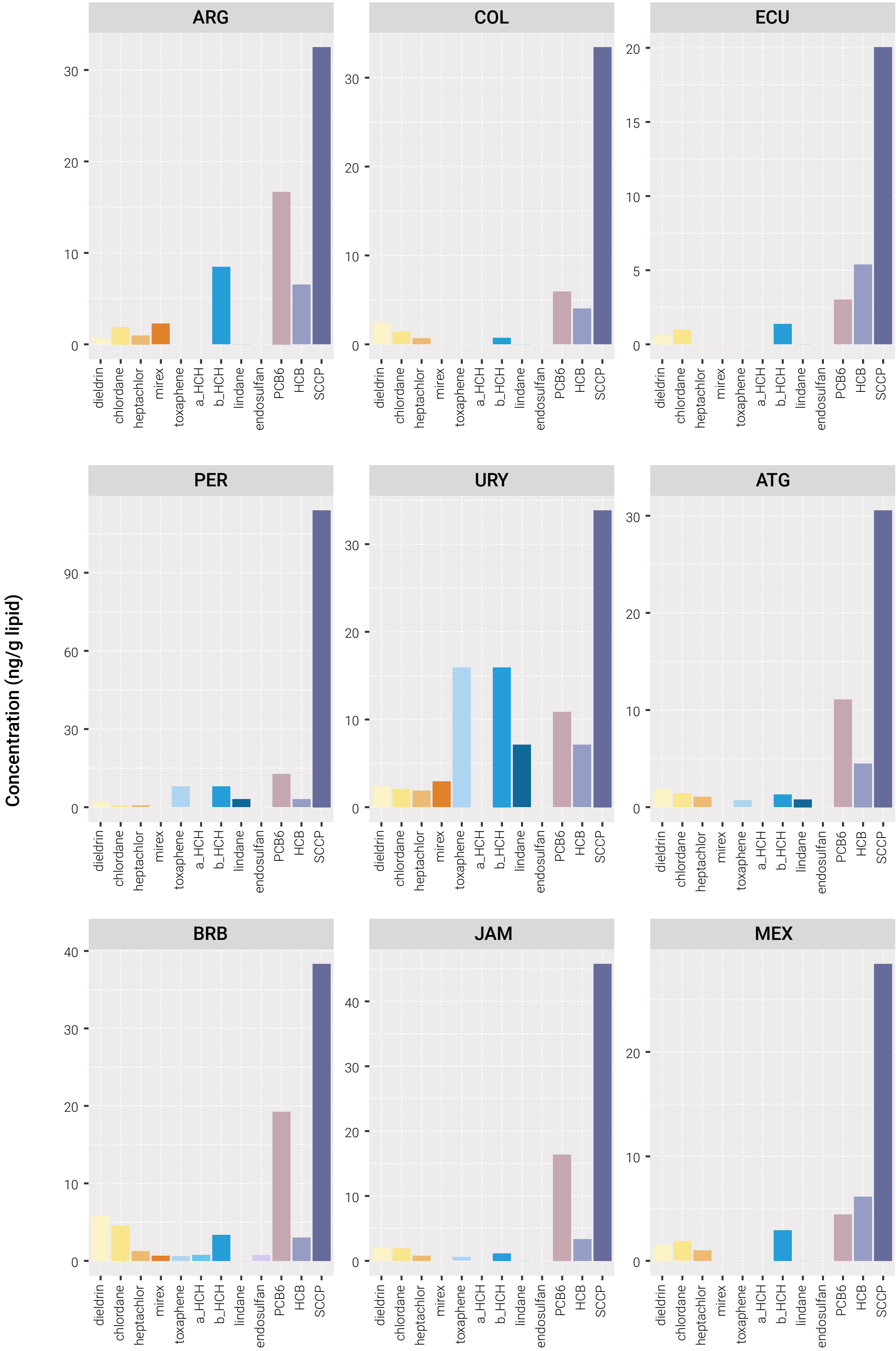

Figure 39: Human milk: Scaled barplots for Cl-POPs without DDT by country and national pool (ng/g lipid)

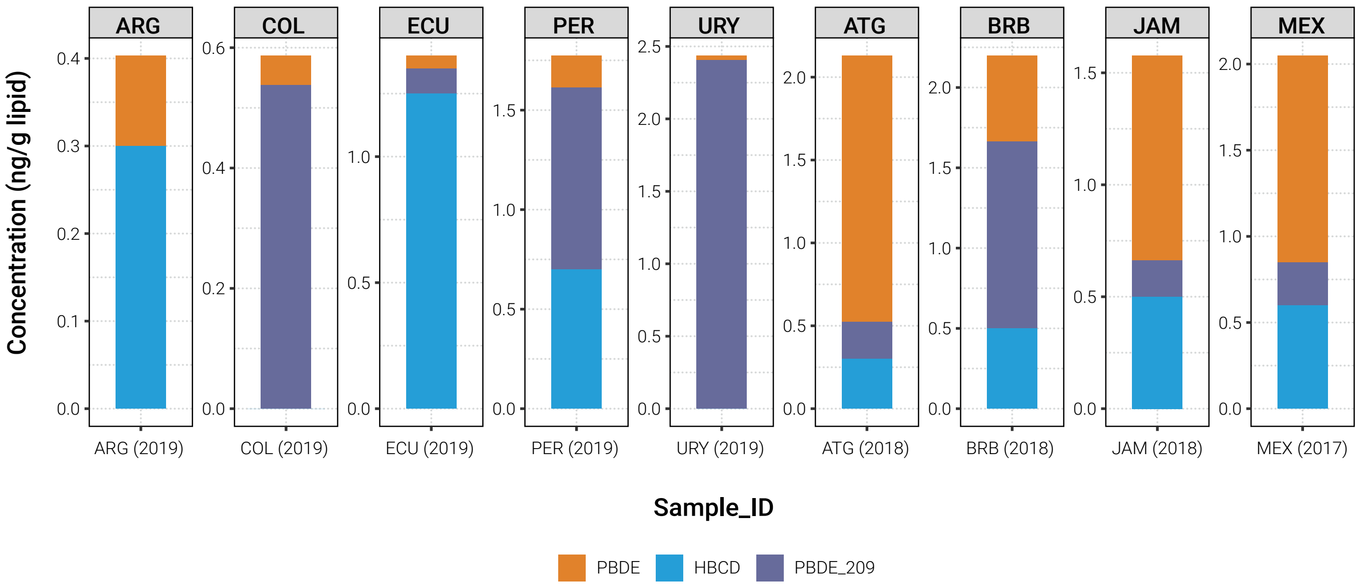

Figure 40: Human milk: Overview of Br-POPs in GRULAC national pools by POPs as stacked bars (ng/g lipid)

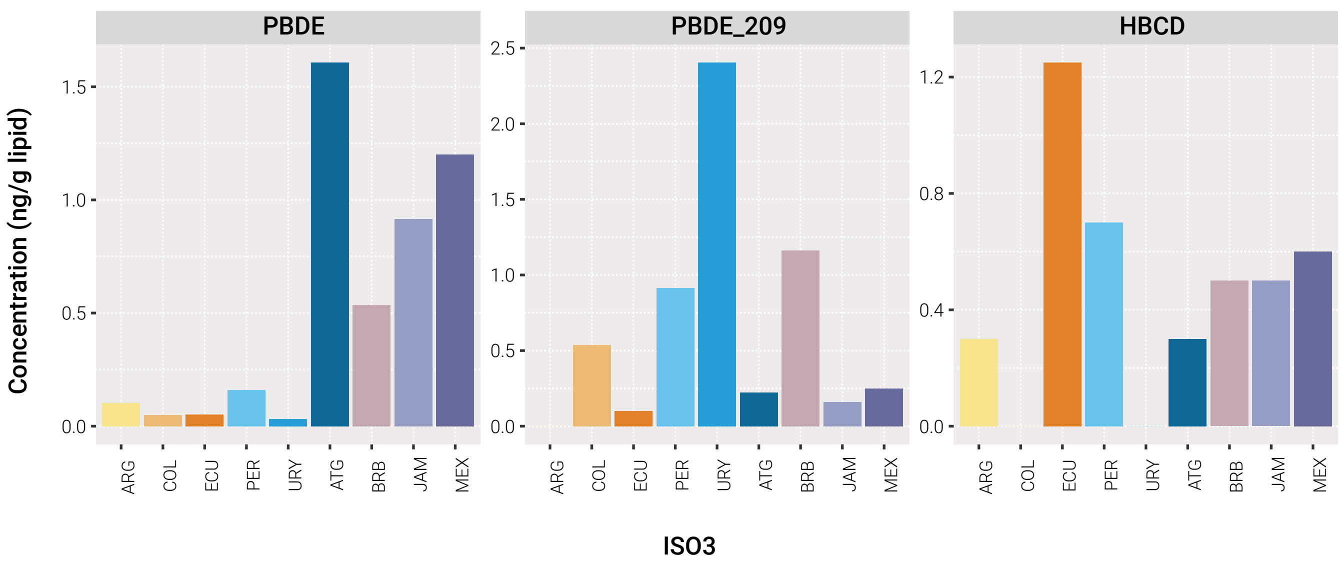

Figure 41: Human milk: Scaled barplots by Br POPs and occurrence by country and national pool

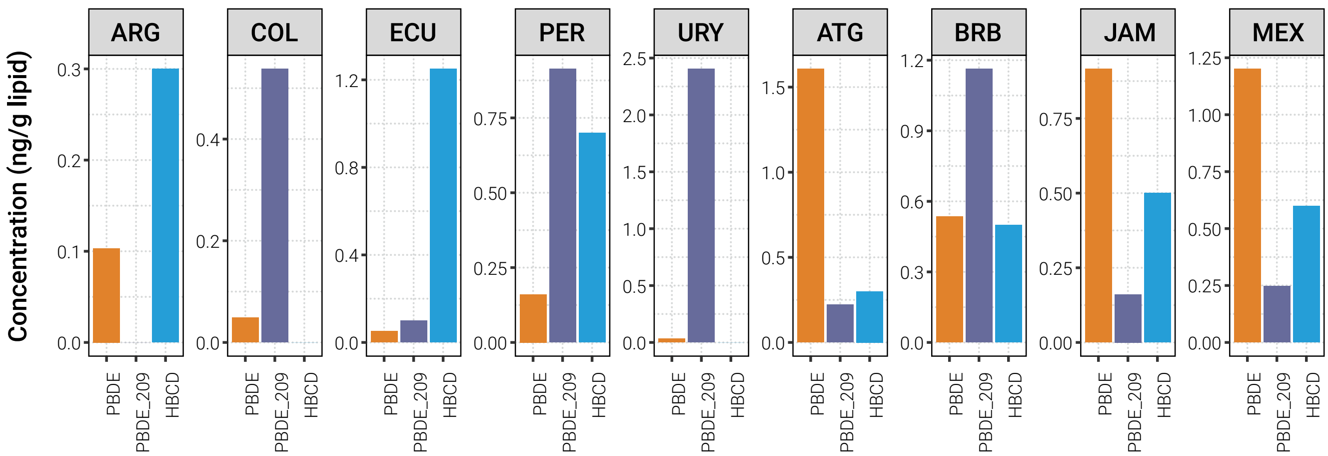

Figure 42: Human milk: Scaled barplots for Br-POPs by country and national pool (ng/g lipid)

With respect to the Br-POPs, the pattern of the is shown as stacked bars in Figure 40; quite distinct pattern can be seen with Argentina and Ecuador having the highest shares for HBCD whereas PBDE were dominating in Antigua and Barbuda but also in Jamaica and Mexico. High amounts of PBDE 209 were found in Colombia and Uruguay. Figure 41 and Figure 42 show the distribution in the participating countries for each of the Br-POPs.

With respect to dl-POPs and PFAS, the descriptive statistics are shown in Table 21. The TEQs from PCDD/PCDF (TEQ_DF) were always higher than the TEQ from dl-PCB (TEQ_PCB). The highest value for TEQ_DF was found in Uruguay; the highest TEQ_PCB was found in Peru; see also Figure 43, Figure 44 and Figure 45.

PFHxS was not quantified in any of the GRULAC pools. PFOS was not found in Columbia and Peru and the highest value encountered in Uruguay. PFOA was more evenly distributed and at lower level but quantified in all national pools (see Figure 46, Figure 47, and Figure 48).

Table 21: Concentration of dl-POPs in human milk (pg TEQ/g lipid) and PFAS (pg/g f.w.) for GRULAC national pools collected under the UNEP project from 2016 to 2019

POPs	ATG	ARG	BRB	COL	ECU	JAM	MEX	PER	URY	Overall (N=9)	
										Mean	Median
	pg TEQ/g lipid										
TEQPCDD/PCDF	2.37	3.13	3.08	1.89	1.99	4.18	3.48	2.17	4.29	2.95 (0.910)	3.08 [1.89, 4.29]
TEQPCB	0.552	1.56	0.83	0.66	0.55	1.00	0.58	1.58	1.4	0.97 (0.44)	0.83 [0.55, 1.58]
	pg/g f.w										
SPFOS	13.5	11.8	12.7	<6.2	9.36	18.4	6.32	<6.2	40.5	12.5 (12.1)	11.8 [0, 40.5]
PFOA	18.8	11.8	19	15.9	8.68	16.6	17.1	7.81	13.1	14.3 (4.19)	15.9 [7.81, 19.0]

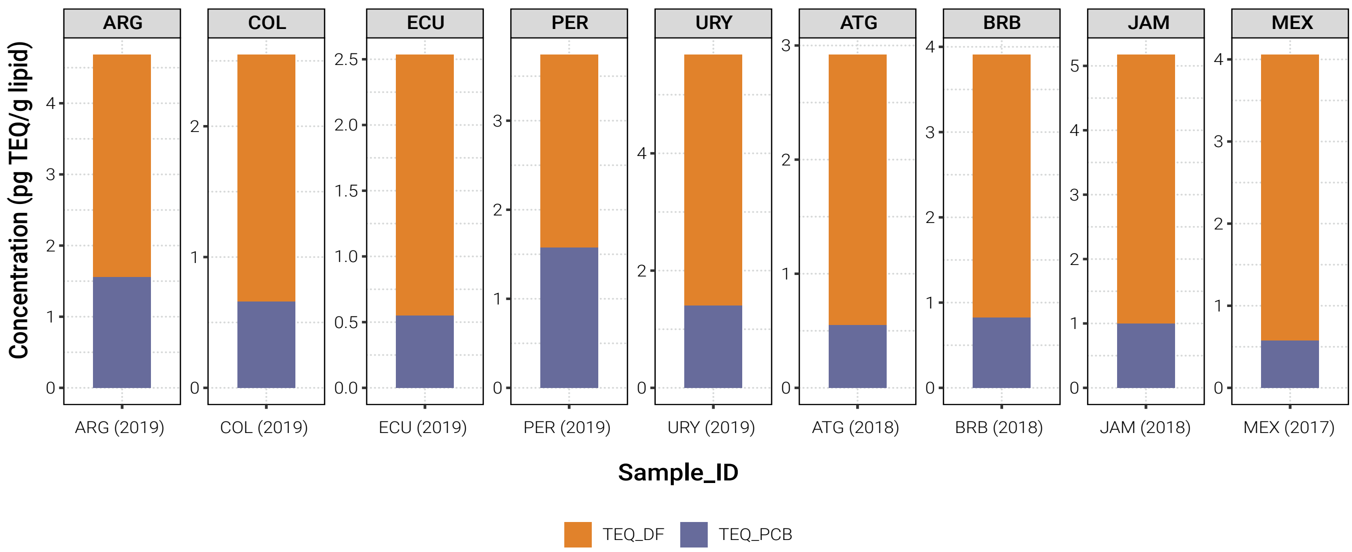

Figure 43: Human milk: Overview of dl-POPs in GRULAC national pools by POPs as stacked bars (pg TEQ/g lipid)

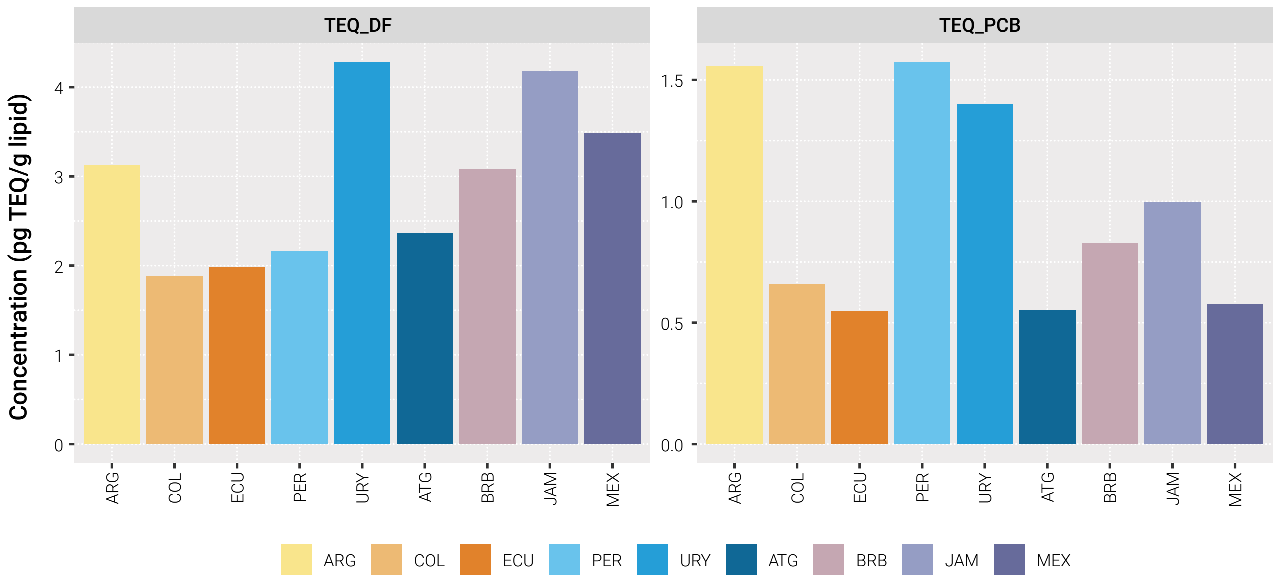

Figure 44: Human milk: Scaled barplots by dl-POPs and occurrence by country and national pool

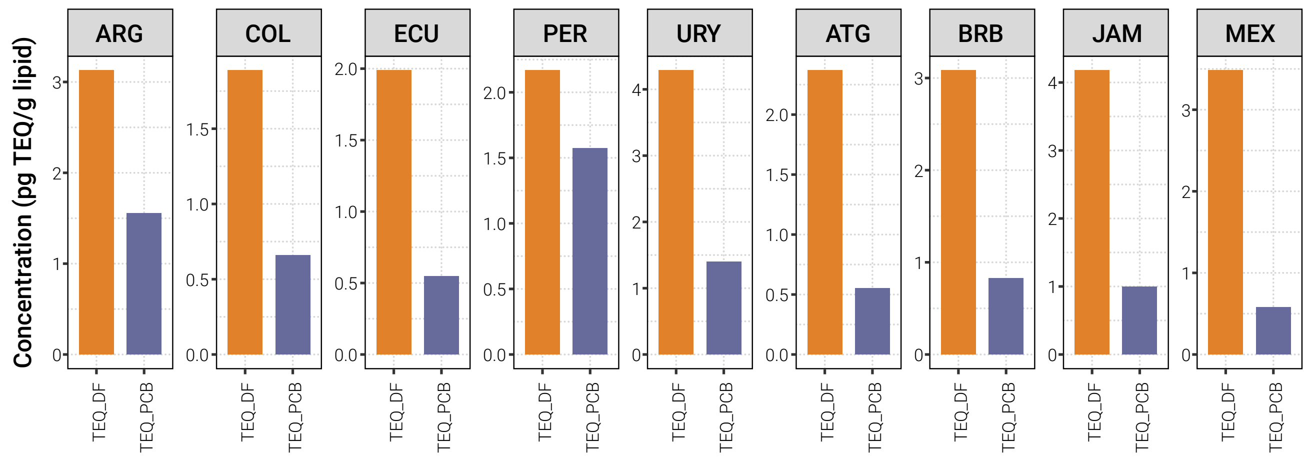

Figure 45: Human milk: Scaled barplots for dl-POPs by country and national pool (pg TEQ/g lipid)

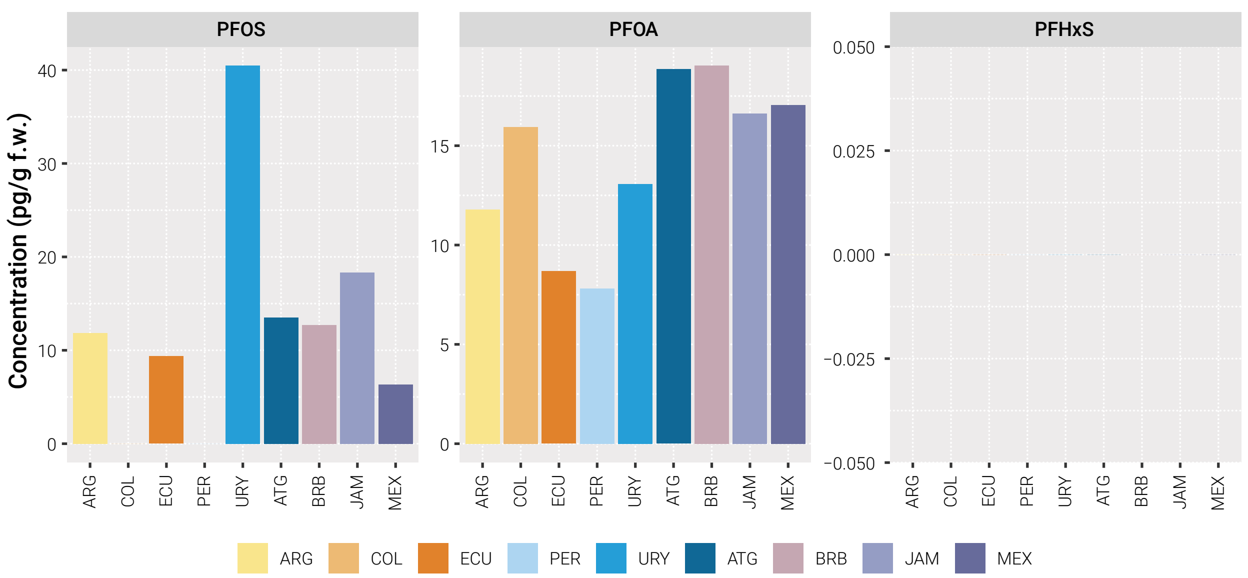

Figure 46: Human milk: Scaled barplots by PFAS and occurrence by country and national pool

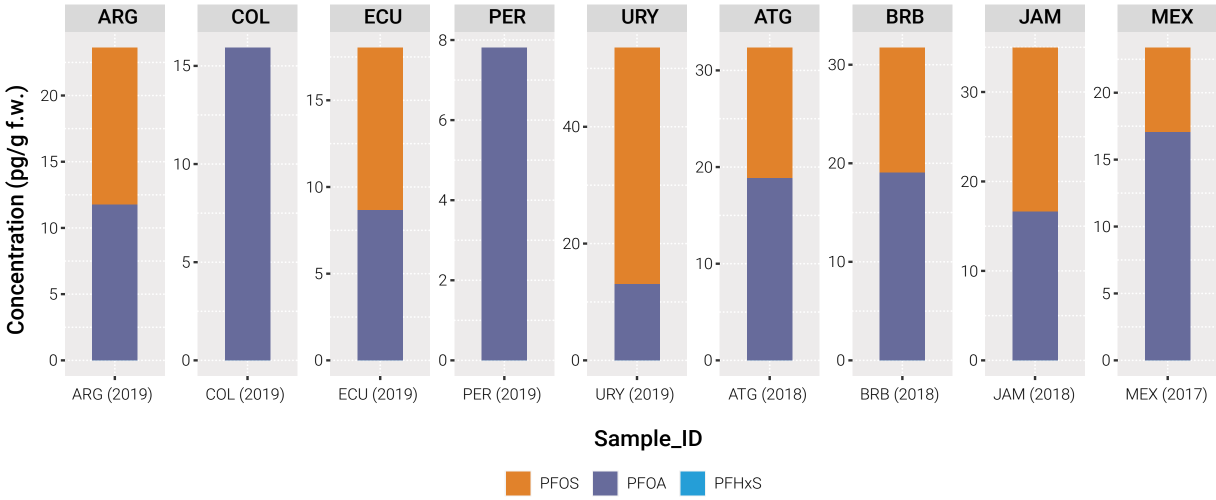

Figure 47: Human milk: Overview of PFAS in GRULAC national pools by POPs as stacked bars (pg/g f.w.)

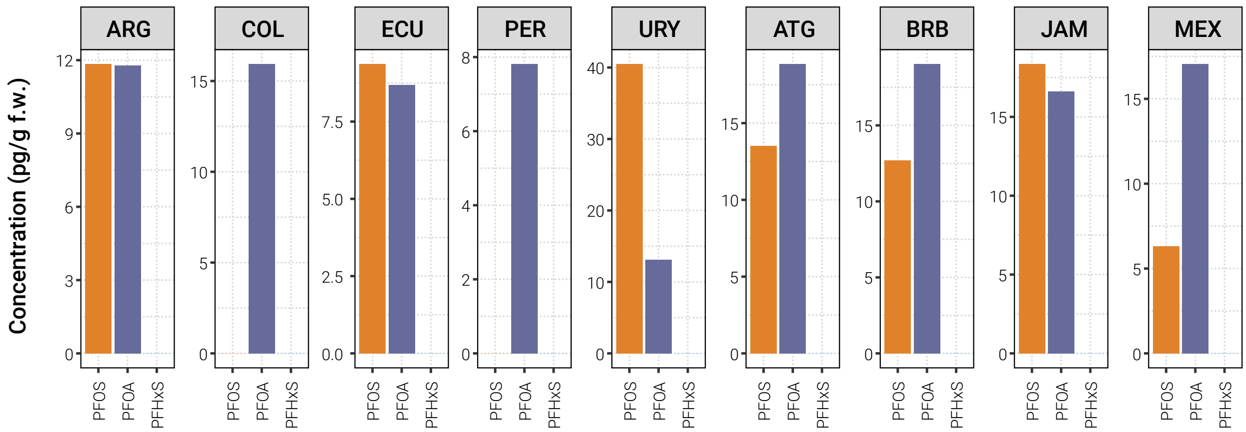

Figure 48: Human milk: Scaled barplots for PFAS by country and national pool (pg/g f.w)

SECTION 5

Capacity building activities and regional workshops

Photo: ©PIXABAY / ramicm

5. CAPACITY BUILDING ACTIVITIES AND REGIONAL WORKSHOPS

Activities related to the two rounds of interlaboratory assessments, are referred to in a separate report.

As much as possible, countries are encouraged to promote gender-responsive capacity building in line with the SDGs, the GEF gender policy, the Paris Agreement as well as various other international agreements.

5.1. Inception regional workshop

The inception workshop on the GEF-funded project "Continuing Regional Support for the POPs GMP under the Stockholm Convention in the Latin American and Caribbean Region (GRULAC)" and the "Training Workshop on the Tools and Methods to Include the Nine New POPs into the Global Monitoring Plan (GMP) for Persistent Organic Pollutants (POPs)" were held on 1-4 December 2015, Montevideo, Uruguay. The objective of this joint workshop was to present the results and outputs (*e.g.,* guidance documents) of the New POPs project into the GMP (1 December 2015) and to officially launch the GMP2 GRULAC the GEF GMP project in the LAC region project (1-4 December 2015) by defining roles and responsibilities of each partner, by discussing technical aspects of the project, and by agreeing on the programme and activities to be carried out in the project.

The workshops mainly delivered the following outputs:

- Good understanding of the context of the project, including the effectiveness evaluation of the Stockholm Convention and the outcomes of the GMP1 regional project in GRULAC
- Clarification of the roles and responsibilities of the participating countries and institutions
- Increased familiarity with the set-up, workplan, timeline, budget and activities of the GMP 2 project, including air sampling and analysis, human milk sampling and laboratory training
- Discussion and finalization of the drafted legal agreements between UNEP and the participating countries.

Documents, presentations, and the report of the workshop are available on the UNEP website (UNEP 2015c).

5.2. Mid-term regional workshop

The midterm workshop was held on 11-13 June 2018, in Bogota, Colombia.

The midterm workshop aims to strengthen communication among core partners on the progress of the 2nd phase of the POPs global monitoring plan (GMP2) in the GRULAC Region, and to discuss about future needs, opportunities, and challenges beyond GMP2, as well as the sustainable monitoring of POPs on nation, regional and global level.

Documents, presentations and the report of the workshop are available online (Basel Convention Coordination Center and Stockholm Conventions Regional Centre for Latin America and the Caribbean 2017).

5.3. Regional results workshops

5.3.1. Air and water

The regional results virtual meeting for air and water of the GEF/UNEP GMP2 project in the GRULAC Region was held on 9 October 2020. The main objectives of the meeting were:

- Explain the analytical results on the levels of POPs in air and water shared with project countries.
- Provide clarifications on data, if any.
- Discuss on including the data in national project final reports

5.3.2. Human milk and national samples

The regional results virtual meeting for human milk and national samples of the GEF/UNEP GMP2 project in the GRULAC Region was held on 22 November 2021. The main objectives of the meeting were:

- Explain the analytical results on the levels of POPs in human milk and national samples shared with project countries.
- Provide clarifications on data, if any.
- Discuss on including the data in national project final reports

5.4. Laboratory trainings

Under the GEF GMP2 projects, one-week training on the analysis of core media was provided to national laboratories in six countries. Due to COVID-19, some planned trainings could not be conducted, and a few others were delivered virtually (Table 22).

Table 22: Trainings in project countries planed and progress made.

Region	No. of trainings planned	No. of trainings conducted	No. of countries participated	No. of female participants	No. of male participants
GRULAC	11	10	11	47	41

5.5. Comparison of results from national laboratories and expert laboratories

The project offered sampling material and technical assistance to all participants to undertake chemical analyses in their national laboratories. During this project, national laboratories have been trained by one of the expert laboratories – CSIC or MTM Örebro University – according to the laboratories needs based on available instrumentation (see section 6.4). In this section, the results obtained from the PAS/PUF, water, and human milk monitoring by national laboratories and expert laboratories are compared. Nationally generated data are contained in chapter 4.2 and expert laboratory data in chapter 5. The performance of all laboratories was checked through two rounds of interlaboratory assessments and can be found in two reports by UNEP (Fiedler, van der Veen and de Boer 2017; Fiedler, van der Veen and de Boer 2021a) and publications in the peer-reviewed literature (Fiedler, van der Veen and de Boer 2020b; de Boer, van der Veen and Fiedler 2022; Fiedler, van der Veen and de Boer 2022a; Fiedler, van der Veen and de Boer 2022b; van der Veen, Fiedler and de Boer 2023).

The comparison of results has not been thoroughly assessed and is presented in the following graphics according to the data provided. In the graphics, the Sample_ID for the parallel samples have identical year and season codes but the ISO3 abbreviations for samples analyzed by expert laboratories are all upper case letters and those analyzed by national laboratories have all lower case letters.

Colombia (nine samples) and Ecuador (eight samples) had undertaken national analysis of OCPs and PCB in PAS/PUF and Ecuador in human milk. The results of the analyses for each sample and by laboratory are shown in as box whisker plots in Figure 49 and the results of the individual samples for each POPs and sample in Figure 50. Finally, Figure 51 shows the results as stacked bars and scaled to 100%, which represents the pattern. The figures show that there are large discrepancies between results. For the PUF results in both countries, the expert laboratory had higher values (see especially Figure 49). The same observation was made for the human milk sample where the national laboratory did not find quantifiable values. An exemption was for heptachlor where the national laboratory quantified the POPs whereas the expert laboratory had all values below the LOD (Figure 50). The discrepancy is most obvious for the scale of the POPs since the pattern in Figure 51 resemble some similarities. Interestingly, the results of the various laboratories form distinct ellipses (Figure 52).

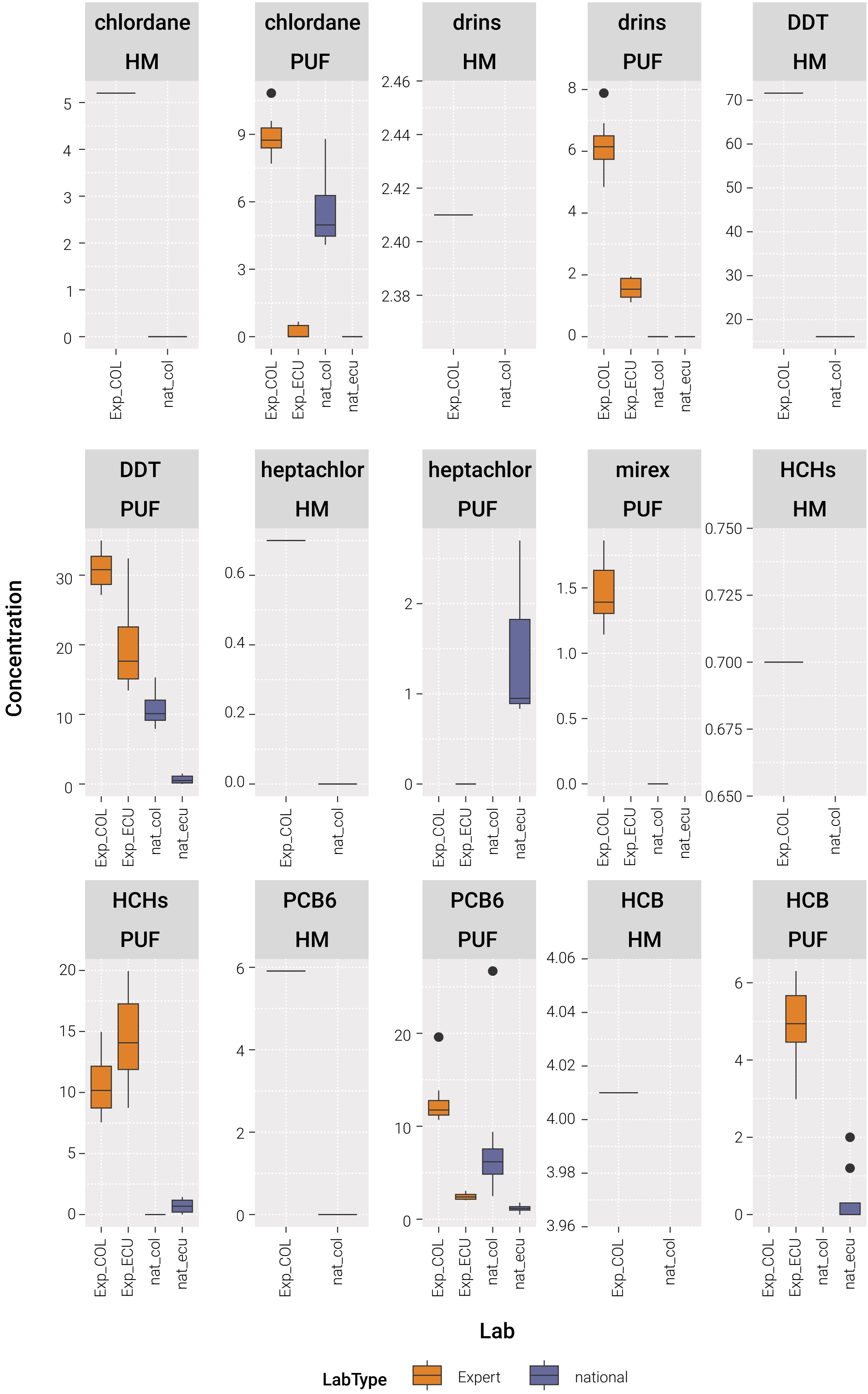

Figure 49: National *vs*. expert laboratory analysis for OCPs/PCB_6 as scaled box plots by POPs and matrix

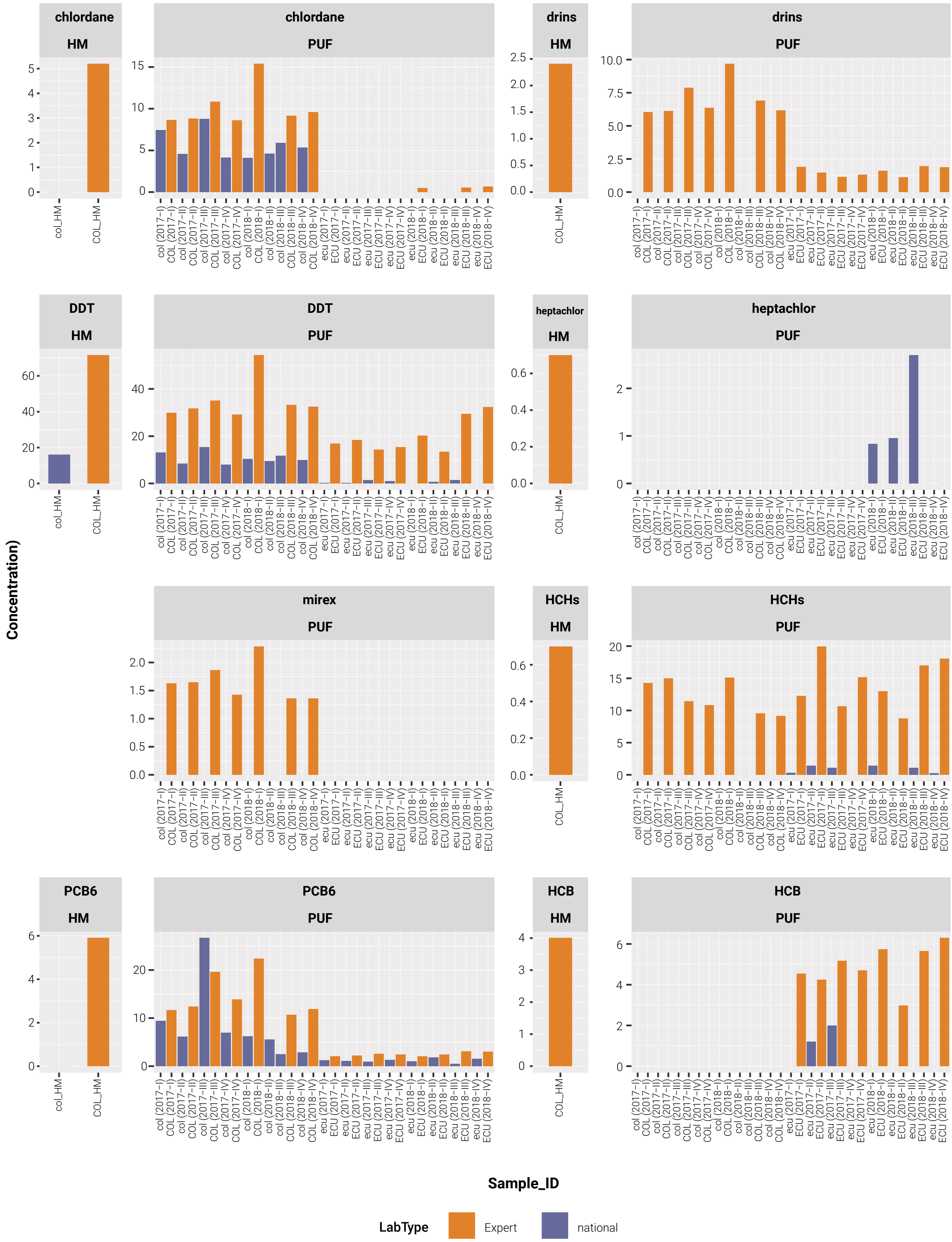

Figure 50: National *vs*. expert laboratory analysis for OCPs/PCB_6 by Sample_ID as stacked bars

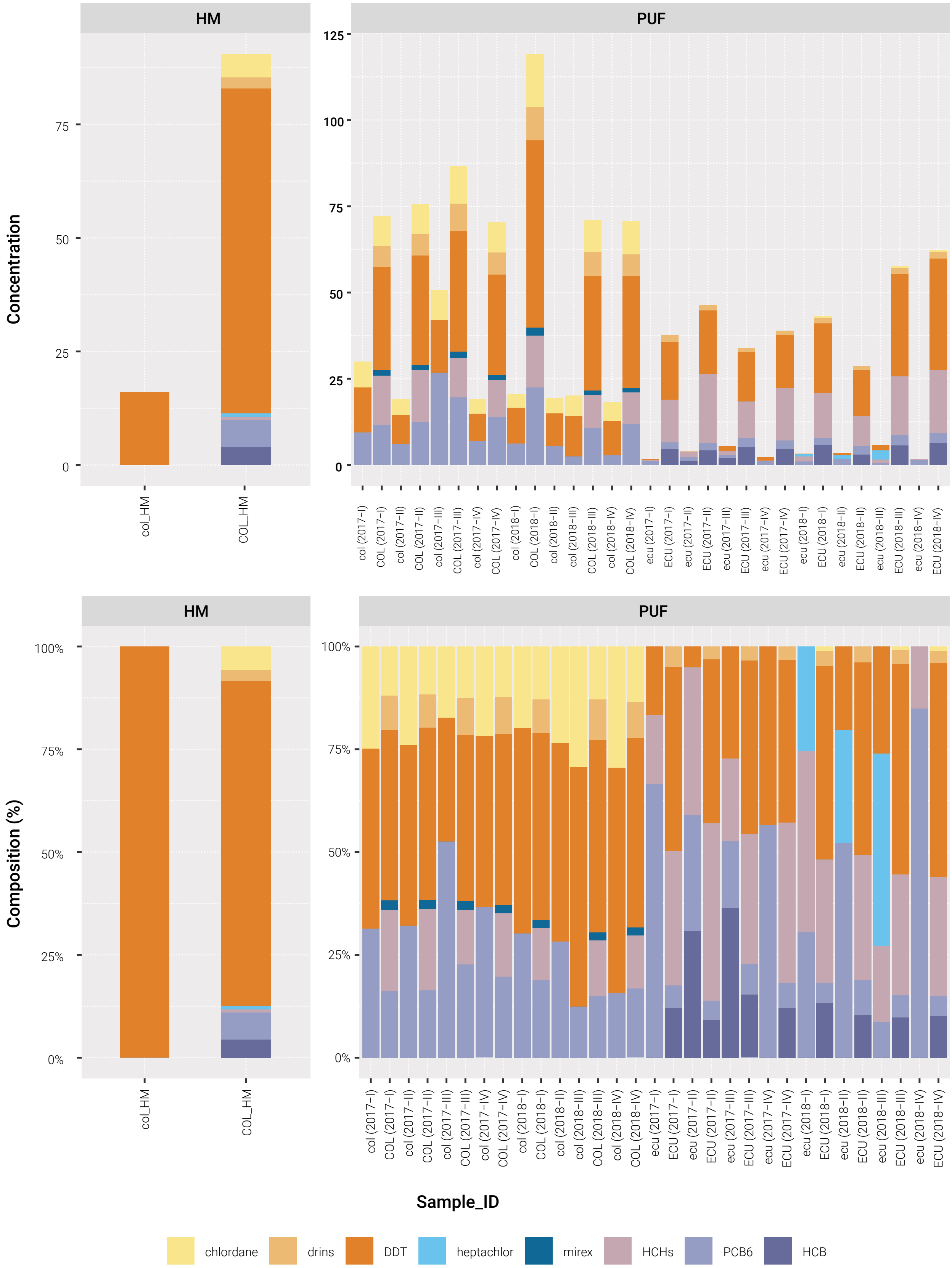

Figure 51: National *vs*. expert laboratory analysis for OCPs/PCB_6 by Sample_ID and laboratory type

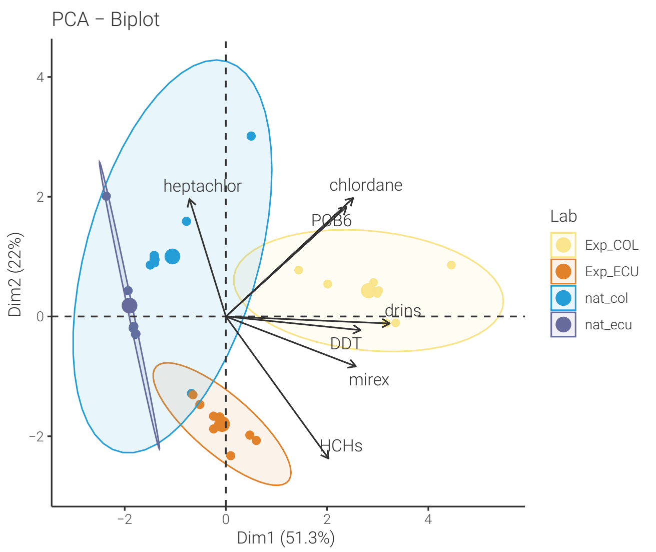

Figure 52: PCA for national and expert laboratory analysis by laboratory

Argentina had undertaken national laboratory analysis for PFAs in water. Unfortunately, the laboratory was not able to quantify PFOA and PFHxS but was successful with the isomeric identification (Figure 53). These values were higher than the results by the expert laboratory; however, they show the same trend and the capability of the national laboratory in PFAS analysis Since not all the three PFAS could be quantified, the patterns differ largely (Figure 54).

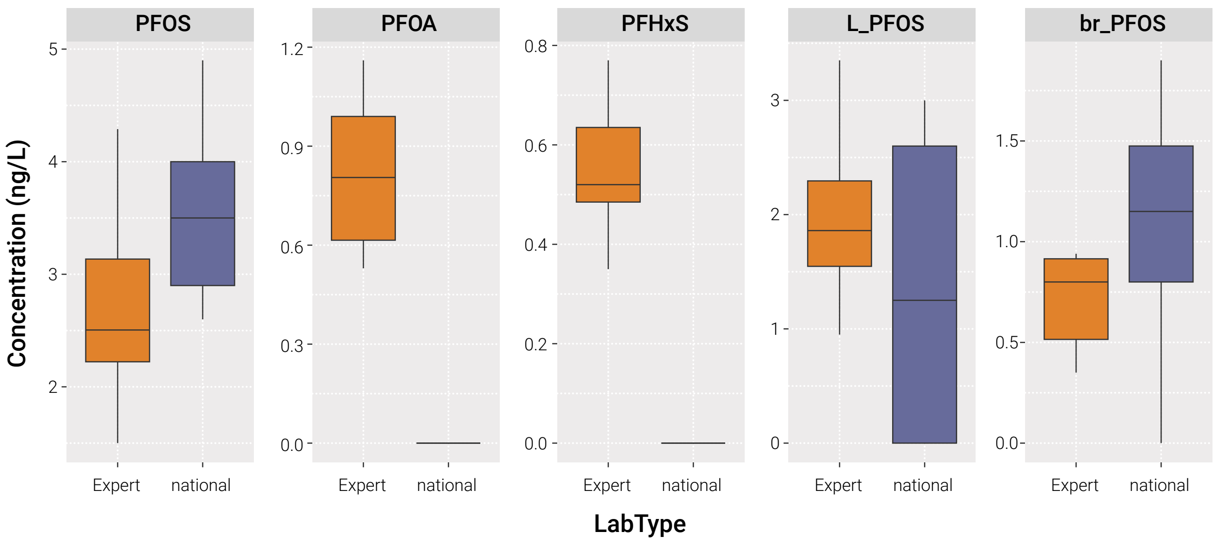

Figure 53: Argentina, PFOS in water: Comparison of results as box whisker plots from national laboratory and expert laboratory by PFAS

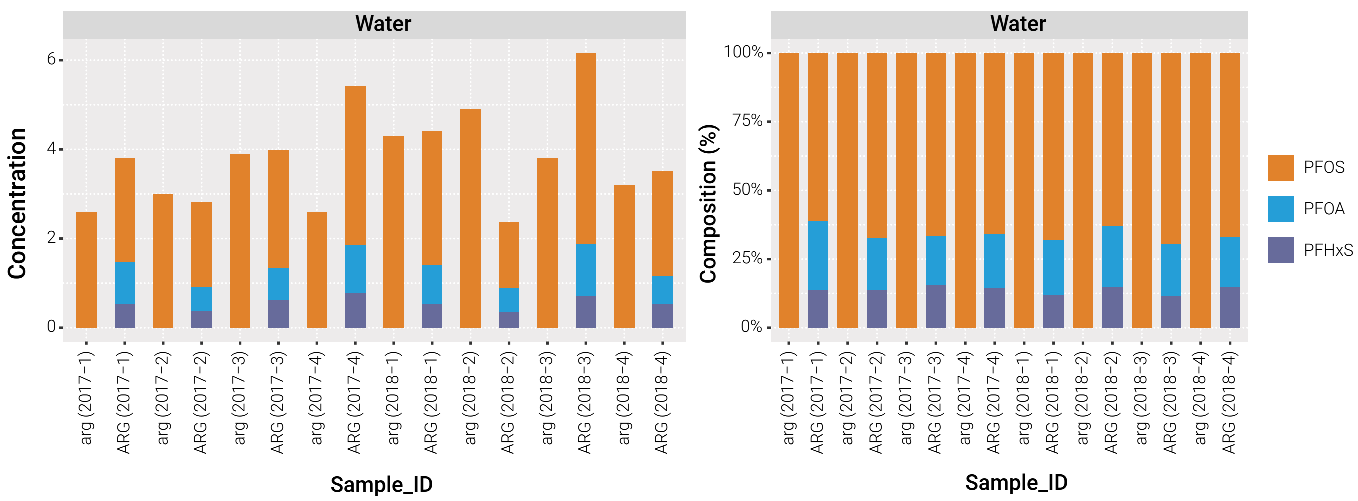

Figure 54: Argentina, PFOS in water: Comparison of results by scale and pattern as stacked bars

SECTION 6

Sustainability plans

Photo: ©UNEP / Victor Estellano

6. SUSTAINABILITY PLANS

6.1. National sustainability plans

The following national sustainability plans are an extract of the plans submitted by project countries in their national reports.

6.1.1. Argentina

La estrecha y permanente cooperación de INTI con el Centro Regional del Convenio de Estocolmo para América Latina y el Caribe con sede en el Laboratorio Tecnológico del Uruguay (LATU), el Centro regional de capacitación y transferencia de tecnología del Convenio de Basilea para América del Sur (CRBAS) con sede en el Instituto Nacional de Tecnología Industrial (INTI), y PNUMA permitió el desarrollo del proyecto a lo largo de toda su duración. Debido a esa cooperación se pudo alcanzar un alto grado de cumplimiento de los objetivos del proyecto.

Argentina está interesada en utilizar los datos generados por el Proyecto, como son el nivel de COP en matrices ambientales abióticas y bióticas, y aquellas capacidades desarrolladas mediante las diversas actividades del Proyecto para:

- Actualizar políticas nacionales, las disposiciones jurídicas y los mecanismos reglamentarios relacionados con la gestión racional de los COP;
- Establecer programas nacionales de vigilancia de los COP;
- En los futuros proyectos relacionados, identificar prioridades para los planes nacionales de aplicación y la presentación de informes de iniciativa;
- Desarrollar material de comunicación para los responsables de la formulación de políticas y otros actores clave como Industria, ONGs, trabajadores de la salud;
- Ejecutar actividades de gestión racional sustentable de COP sobre prioridades regionales comunes.

En este camino INTI realizó en octubre de 2020 una presentación ante el Ministerio de Ambiente y Desarrollo Sustentable sobre el plan mundial de vigilancia de COP informando los avances del proyecto y exponiendo la información obtenida.

6.1.2. Barbados

It is anticipated that the knowledge and experience gained will be used to establish a national POPs monitoring programme, which will involve setting-up sampling locations across the island, having the samples analysed locally to maintain the skills gained during the project and monitoring trends and devising any necessary interventions. Moreover, the data generated from the local monitoring network could provide an impetus for decision-makers to prioritize policies and regulatory mechanisms related to the sound management of POPs. Additionally, the data can help Barbados to fulfil its reporting obligations under the Stockholm Convention for the management of persistent organic pollutants and to develop communication material for policymakers and other key stakeholder groups.

6.1.3. Colombia

Desde la ratificación del Convenio de Estocolmo por parte de Colombia mediante la Ley 1196 de 2008, el país ha trabajado para alcanzar los objetivos previstos, relacionados con la identificación, prevención, reducción y eliminación de los contaminantes orgánicos persistentes y sus residuos. Aunque se habían desarrollado estudios desde 2003, el proceso de formulación del primer plan nacional de aplicación (PNA) del Convenio de Estocolmo inició en el año 2007 y finalizó en julio del año 2010.

Desde entonces el país ha trabajado de manera sostenida en el cumplimiento del Convenio y sus artículos, por lo cual se presentó la necesidad de actualizarlo al año 2017. En esta actualización se plantearon estrategias y actividades estructuradas en cuatro planes de acción específicos:

- **Plaguicidas COP**, cuyo objetivo principal es evitar el uso de los plaguicidas COP en Colombia a través de la creación de una cultura de prevención y garantizar la eliminación segura de los plaguicidas COP incautados u obsoletos. Para lograrlo se planeó: a) propiciar que, en cultivos priorizados, los usuarios actúen preventivamente, apliquen buenas prácticas y promuevan el uso de sustancias alternativas a los plaguicidas COP; b) eliminar de manera ambientalmente segura, en el marco de la gestión integral, las existencias de los plaguicidas COP incautados o asociados a sitios contaminados; y c) fortalecer el Sistema IVC (inspección, vigilancia y control) mejorando la identificación y el monitoreo para evitar el ingreso de plaguicidas COP en los puertos y pasos fronterizos clave del país.

- **PCB**, cuyo objetivo principal es eliminar los bifenilos policlorados (PCB) existentes en el país, a través de su manejo ambientalmente seguro y racional. Para lograrlo se planeó: a) identificar, marcar y eliminar los equipos, aceites y residuos contaminados con PCB existentes en Colombia; y b) fortalecer la capacidad de los actores involucrados en la gestión integral y manejo ambientalmente seguro de los PCB para garantizar su eliminación.

- **COP no intencionales**, cuyo objetivo principal es prevenir, controlar y reducir las emisiones de COP no intencionales en el país a través de del desarrollo de una política y un marco normativo acorde a las necesidades identificadas, así como la implementación de mejores prácticas ambientales (MPA) y mejores técnicas disponibles (MTD), un mejoramiento en la gestión integral de residuos y la toma de conciencia y educación por parte de todos los actores involucrados. Para lograrlo se planeó: a) generar el marco normativo y de política necesario para la implementación de las MPA y MTD, un mejoramiento en la gestión integral de residuos y la toma de conciencia y educación por parte de todos los actores involucrados; y b) realizar el control y seguimiento a la prevención y reducción de emisiones de COP no intencionales, en concordancia con las políticas y el marco regulatorio definidos para ello.

- **COP de uso industrial**, cuyo objetivo principal es promover la gestión integral de los COP de uso industrial a través de la identificación de los elementos que los contienen en su ciclo de vida, y garantizar su manejo ambientalmente seguro. Para lograrlo se planeó: a) Identificar los elementos (productos, artículos y residuos) que contienen sustancias COP de uso industrial en Colombia; y b) promover el manejo ambientalmente seguro de las sustancias COP de uso industrial y los elementos que las contienen (productos, artículos y residuos).

Los planes nacionales de aplicación anteriores cuentan con actividades específicas previstas para lograr su cumplimiento e implementación a nivel nacional. Estas, junto con el contexto nacional relativo a los COP, se describe en detalle en el documento "Plan nacional de aplicación sobre contaminantes orgánicos persistentes" emitido por el Ministerio de Ambiente y Desarrollo Sostenible en el año 2017 (disponible en: https://quimicos,minambiente,gov-,co/wpcontent/uploads/2021/05/PNI_Actualizado_Colombia_2017_Espanol,pdf).

6.1.4. Mexico

La sostenibilidad del Laboratorio del INECC está garantizada dado que se encuentra establecida en la Ley General de Cambio Climático y en el Estatuto Orgánico del Instituto Nacional de Ecología y Cambio Climático, que a la letra dice:

- Art. 22, Fracción II. Asegurar la operación óptima y actualización de la instrumentación analítica de los laboratorios del INECC en materia de residuos, sustancias tóxicas, contaminantes atmosféricos y parámetros meteorológicos, y

- Art. 22, Fracción III. Funcionar como laboratorio de referencia en materia de análisis y calibración de equipo de medición de contaminantes atmosféricos, residuos, suelos, sedimentos, y ecotoxicología.

Por otro lado, el 14 de octubre de 2020, se publicó el "Programa Institucional del Instituto Nacional de Ecología y Cambio Climático 2020-2024", que establece la correcta operación del laboratorio del INECC durante la Administración Federal 2019-2024. Tal como se indica a continuación:

- Estrategia 2.4 Operar los laboratorios de referencia, proporcionando servicios y colaborando con organismos, órdenes de gobierno y academia en el desarrollo de investigaciones que generen conocimiento para la gestión pública de protección de la salud de la población, el ambiente y el clima.

    - Acción puntual 2.4.1. Fortalecer las capacidades de los laboratorios para el muestreo y análisis de contaminantes ambientales, sustancias químicas y residuos; la calibración de equipos de medición de contaminantes atmosféricos, y la detección e identificación de organismos genéticamente modificados (OGM), mediante el mantenimiento continuo de sus instalaciones.

    - Acción puntual 2.4.2 Proporcionar servicios de análisis de especies de interés ambiental y climático, sustancias químicas, residuos y OGM, para apoyar investigaciones científicas sobre contaminación y salud ambiental y la gestión pública para la protección de la salud, el ambiente y el clima.

    - Acción puntual 2.4.3. Asegurar la confiabilidad de las mediciones y la calidad de los datos que se utilizan para la gestión ambiental local proporcionando servicios de calibración de equipo de medición de contaminantes atmosféricos.

- Acción puntual 2.4.4. Apoyar la gestión pública para la protección de la salud de la población y el ambiente mediante la documentación de presencia y distribución de especies químicas en el ambiente, así como de la exposición de seres humanos, organismos y ecosistemas a éstas.

- Acción puntual 2.4.5. Apoyar la gestión pública de protección de la salud, el ambiente y el clima mediante el desarrollo, implementación y difusión de procedimientos operativos estandarizados para medir y evaluar especies químicas de interés ambiental y climático.

6.2. Involvement in other monitoring activities and networks

The following information on involvement in other monitoring activities and networks are an extract of the information submitted by project countries in their national reports.

6.2.1. Argentina

El laboratorio de referencia de Argentina (INTI) participa en proyectos internacionales de la OIEA-ARCAL (Organismo Internacional de Energía Atómica - Acuerdo Regional de Cooperación para la Promoción de la Ciencia y la Tecnología Nucleares en América Latina y el Caribe). Los mismos persiguen el objetivo de estudiar el grado de exposición a los COP de la población latinoamericana, utilizando como indicador la presencia de estos contaminantes en leche humana, suelos y agua. Además, se busca vincular dicha situación con factores ambientales, sociales, laborales y de residencia, de modo de establecer criterios que puedan ser utilizados por los distintos actores relacionados a la temática. Y como fin último, identificar los principales grupos de riesgo y establecer políticas de protección a dicha exposición.

La participación se ha completado en el proyecto RLA 5069, y actualmente se está desarrollando la colaboración en los proyectos RLA 5081 y RLA 5080, todos dependientes de la organización ARCAL. El proyecto RLA 5081 tiene por objetivo el estudio de la presencia de COP, micotoxinas, drogas veterinarias en alimentos y el fortalecimiento de los planes nacionales sistemáticos de control de residuos. Mientras que el proyecto RLA 5080 tiene como objetivo mejorar la inocuidad alimentaria a través de políticas efectivas, inclusivas, objetivas y transparentes, basadas en el riesgo para garantizar la salud pública, el comercio nacional e internacional y la protección del medio ambiente y reducir el impacto del cambio climático en la región de Latino América y el Caribe.

6.2.2. Barbados

Barbados is also involved in the monitoring of POPs under the Global Atmospheric Passive Sampling (GAPS), which involves the deployment and collection of sampling media conducted quarterly. The collected media were sent overseas and analysed by Environment Canada. The GAPS network is a global research survey that monitors the presence of Persistent Organic Pollutants and other chemicals in the air. The data obtained will allow for a comparison of sites around the world.

6.2.3. Colombia

Se conoce que en el país tienen (o han tenido) presencia las siguientes iniciativas para el monitoreo de COP:

- Red de vigilancia para la conservación y protección de las aguas marinas y costeras de Colombia (RedCAM) liderada por el INVEMAR, Esta red no es específica para COP, sin embargo, incluye dentro de las sustancias de interés que monitorea algunos plaguicidas COP.

- Red de monitoreo pasivo atmosférico global (GAPS) a través de la Universidad Nacional – Sede Manizales.

- Red de Monitoreo de COP en Colombia.

- Red de Monitoreo pasivo atmosférico de América Latina (LAPAN).

- Proyecto MONET-Aqua.

- Programa MILK-WHO.

No obstante, no existe en el país una red centralizada de monitoreo que reúna toda la información o sirva como punto focal y de encuentro para cada una de las iniciativas relacionadas con contaminantes orgánicos persistentes, ya que estas, en su mayoría, trabajan de manera independiente.

El plan nacional de aplicación contempla dentro de sus planes de acción actividades relacionadas con el monitoreo de COP, tales como el fortalecimiento de la capacidad instalada en los laboratorios para identificar, cuantificar y caracterizar estos contaminantes en matrices de interés, así como mejorar las competencias de las autoridades respectivas para el monitoreo, inspección, vigilancia y control de estas sustancias y su manejo ambientalmente adecuado.

Adicionalmente, el Ministerio de Ambiente y Desarrollo Sostenible ha ejecutado proyectos de implementación nacional a través del Programa de las Naciones Unidas para el Desarrollo (PNUD) con financiación del Fondo para el Medio Ambiente Mundial (FMAM), que se mencionan a continuación:

- Proyecto 84851/71268: Desarrollo de la capacidad para la gestión y eliminación ambientalmente adecuada de PCB (abril 2013 – junio 2018),
- Proyecto 98842/94749: Reducción de las liberaciones de los COP no intencionales y mercurio provenientes de la gestión de residuos hospitalarios, RAEE, procesamiento de chatarra metálica y quemas de biomasa (septiembre 2016 – a la fecha)
- Proyecto 112906/115174: Fortalecimiento de la capacidad nacional para gestionar los COP industriales en el marco de las directrices nacionales e internacionales sobre la gestión de sustancias químicas y desechos peligrosos (estimado para iniciar en enero 2022)

6.2.4. Mexico

Actualmente el gobierno de México no participa en otras redes de supervisión o medición de contaminantes orgánicos persistentes. Cabe señalar que existen ejercicios académicos y proyectos de investigación en donde de forma intermitente se han realizado mediciones de COP en algunos sitios de México, tal como el Programa de Canadá de monitoreo atmosférico pasivo global (GAPS, por sus siglas en inglés).

6.3. Regional monitoring under the Stockholm Convention arrangements for GMP

The PAS/PUF data generated by the expert laboratories in the UNEP/GEF GMP2 projects (UNEP 2024a) and presented in nanogram or picogram per PUF have been converted into volumes using the model developed by Harner (2016). These converted data have been submitted to the GMP data warehouse (Secretariat of the Stockholm Convention n.d. a) where they were aggregated to annual values according to the procedures established for the regional and global reports under the Convention.

Data from this project have been made available for the BRS GMP data warehouse and can be retrieved from a dashboard developed by UNEP Chemicals and Health Branch UNEP n.d.).

Photo: ©UNEP / Elsemieke de Boer

SECTION 7

Conclusion

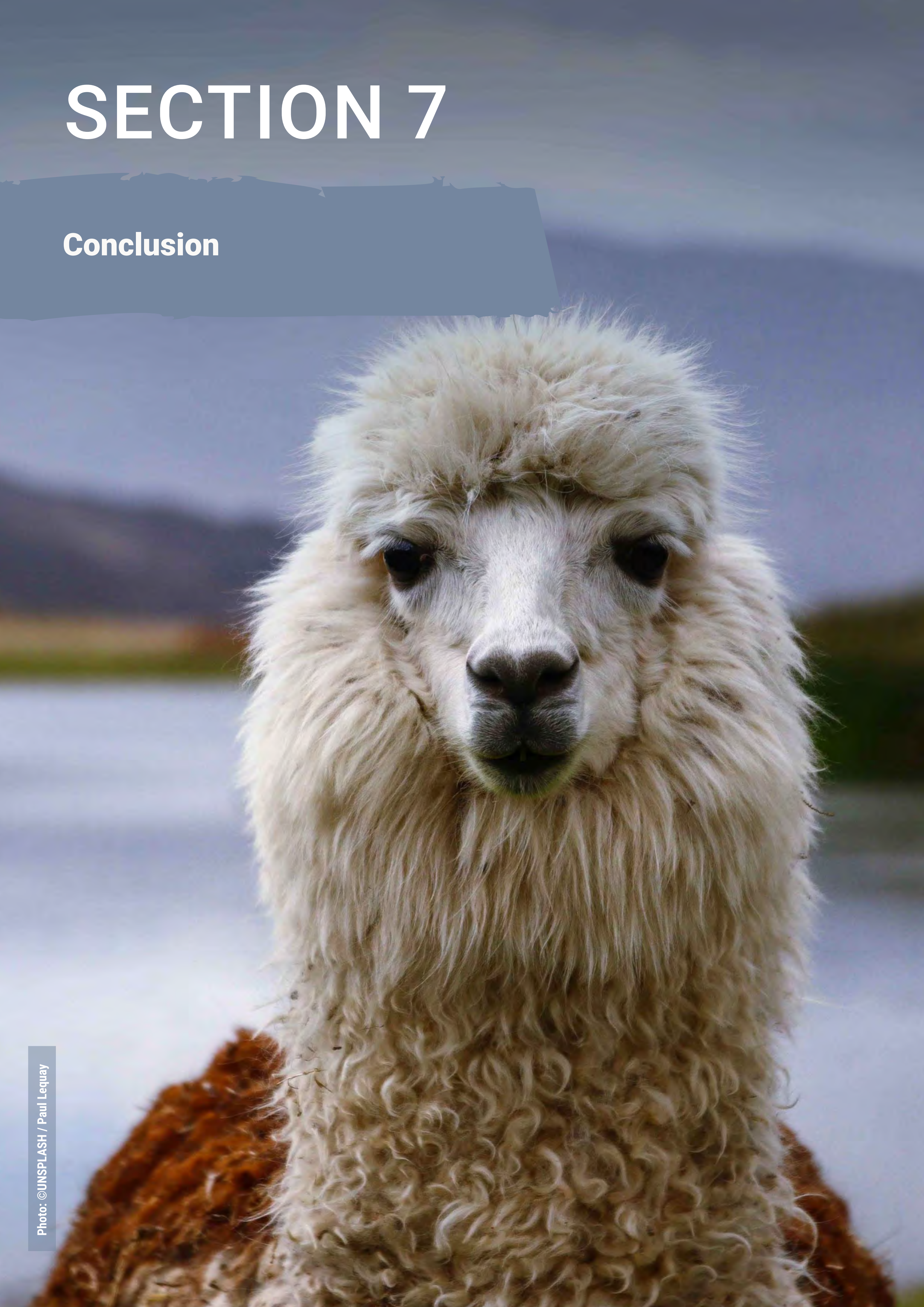

Photo: ©UNSPLASH / Paul Lequay

7. CONCLUSION

Environmental and human monitoring of POPs plays a crucial role in assessing the environmental and human exposure to these toxic chemicals, safeguarding the health of humans and the environment, and providing pivotal information to the effectiveness evaluation and implementation of the Stockholm Convention.

The UNEP/GEF POPs GMP project on POPs monitoring in GRULAC has generated a wealth of information. This report attempts to present and summarize the set-up of the regional project and includes presentation of the main actors, characterize the sampling sites and other organizational structures. The report also highlights the quantitative findings for all samples analyzed for POPs. This report is limited to the core matrices as defined in the guidance document for the global monitoring plan and includes the POPs listed in the Stockholm Convention (UNEP 2021). Results of POPs monitoring in other matrices conducted at the national level, including for example sediment and food, are included in the project national reports and publications of national and international researchers.

Through this project, POPs in core matrices including air, water and human milk were sampled in parallel in four UN regions covering 42 projects countries worldwide. In order to assess these regional data, it is recommended to compare the findings presented here with the findings from the other three (sister) regional reports addressing Africa, Asia, and the Pacific Islands countries as well as the sectoral reports summarizing the air, water and human milk (UNEP 2023b; UNEP 2024a; UNEP 2024b; UNEP 2024c; UNEP 2024d; UNEP 2024e).

Valuable insights were generated, reflecting the extend of POPs concentrations in the three core matrices in the region and enabling comparison in the global context. Background levels of POPs have been confirmed to be widespread in the environment in the region. POPs were also detected in all the human milk samples collected. The site-specific information and the chemical measurements serve as a data reservoir for future assessments by the Parties of the Stockholm Convention but also for researchers conducting environmental or human monitoring.

Although the background information provided basic understanding of the extend of POPs levels in core matrices, significant data gaps still exist in most GRULAC countries particularly for new POPs. This challenge is attributed to the limited regional and national capacities and associated analytical difficulties of complex compounds. The capacity building activities conducted under the project, including trainings in national laboratories, two rounds of interlaboratory assessments, development of protocols and training courses, have contributed to strengthened national analytical knowledge and skills. With more POPs listed under the Stockholm Convention, regional collaboration and global coordination are critical to continue strengthening regional capacities and enable sustainable data generation on environmental existence and human exposure to POPs.

Project countries have developed sustainability plans, emphasizing key areas of mutual interest. These encompass continuing POPs monitoring; capacity building to improve data quality and comparability and to facilitate data interpretation and utilization. Additionally, the plans mentioned the integration of data generation into policy-making processes, including the development and updating of national implementation plans under the Stockholm Convention. There is also a focus on understanding the key messages derived from data interpretation, gaining enhanced knowledge on health impacts and environmental risks, and establishing a sustainable modality for POPs monitoring including the continuation of financial and technical assistance, as well as fostering increased regional collaboration.

Finally, data and information gathered under the project are also shared with the Secretariat of the Stockholm Convention to support the effectiveness evaluation of the Convention and are contained in thematic reports and project publications.

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8. APPENDIX

8.1. Responsible people in the GRULAC region

Table S 1: GRULAC: Members and the responsibilities of the national teams

Country	Responsibility	Person (name)	Gender	Affiliation	E-mail
Antigua and Barbuda	Coordinator	Linroy Christian	Male	Department Analytical Service	Linroyc@gmail.com, Linroy.Christian@ab.gov.ag
	Air				
	Water	NA			
	Human milk	Linroy Christian	Male		
Argentina	Coordinator	Leila Devia	Female	National Institute of Industrial Technology	
	Air	Adriana Rosso	Female		adrosso@inti.gob.ar
	Water	Maria Jimena Etcheverry	Female		metcheverry@inti.gob.ar
	Human milk	Adriana Rosso	Female		adrosso@inti.gob.ar
Barbados	Coordinator	Philip Pile	Male	Environmental Protection Department	Philip.Pile@epd.gov.bb
	Air	Emma Smith	Female	The University of the West Indies	emma.smith@cavehill.uwi.edu
	Water	NA			
	Human milk	Emma Smith	Female		emma.smith@cavehill.uwi.edu
Brazil	Coordinator	Maria Yumiko Tominaga	Female	Environmental Company of the San Pablo State (CETESB)	mytominaga@sp.gov.br
	Air				
	Water				
	Human milk	No sample		FIOCRUZ	
Chile	Coordinator	Cecilia Aburto	Female	Environmental Ministry	CAburto@mma.gob.cl
	Air	Katia Ramirez	Female	Environmental Science Center (EULA)- Concepción University	kramirez@udec.cl
	Water	NA			
	Human milk	No sample			
Colombia	Coordinator	Gustavo A. Peñuela Mesa	Male	Antioquia University	gustavo.penuela@udea.edu.co
	Air	Boris Avila	Male		boris.avila@udea.edu.co
	Water	NA			
	Human milk	Boris Avila	Male		boris.avila@udea.edu.co
Ecuador	Coordinator	Ana Tello	Female	Ministry of Environment, Water, Technology	ana.tello@ambiente.gob.ec
	Air				
	Water				
	Human milk				
Jamaica	Coordinator	Paul Maragh	Male	Pesticide Research Laboratory, Department of Chemistry, University of the West Indies	pmaragh16@yahoo.com
	Air				
	Water				
	Human milk				
Mexico	Coordinator	Arturo Gavilán	Male	National Institute of Ecology and Climate Change (INECC)	arturo.gavilan@inecc.gob.mx
	Air				
	Water	María del Carmen Valenzuela	Female	University of the West Indies	camava9@gmail.com
	Human milk				
Peru	Coordinator	Soledad Osorio	Female	National Health Directorate, Ministry of Health of Peru (DIGESA)	sosorio03@hotmail.com
	Air				
	Water	NA			
	Human milk	Soledad Osorio	Female		sosorio03@hotmail.com
Uruguay	Coordinator	Gabriela Medina	Female	Environmental Ministry	gmedina.uruguay@gmail.com
	Air	Magdalena Hill	Female	Environmental Ministry	magdalena.hill@ambiente.gub.uy
	Water	NA			
	Human milk	Carmen Ciganda	Female	Health Ministry	cciganda@msp.gub.uy

8.2. Locations of air and water sampling sites

Table S 2: Locations of air sampling sites (PAS/PUF)

Country	Physical Address	Alt (m)	Latitude	Longitude
Antigua and Barbuda	Parroquia de Saint Peter, Antigua y Barbuda	43	17.0770	-61.7602
Argentina	INTI. Colectora Norte de, Av. Gral. Paz 5445, B1650 San Martín, Buenos Aires, Argentina	24	-34.5075	-58.5149
Barbados	Caribbean Institute of Meteorology and Hydrology, Barbados	153	13.1489	-59.6247
Brazil	CETESB. Av. Prof. Frederico Hermann Jr., 345 - São Paulo - SP	820	-23.5535	-46.67275
Chile	Tomé, Región Bío Bío, Chile (Tome pueblo costero a 23km de distancia de Concepción)	171	-36.6633	-72.9636
Colombia	Universidad de Antioquia. Cl. 62 #52-59, Medellín, Antioquia, Colombia	1479	6.26	-75.5677
Ecuador	José Joaquín Olmedo & Juan José Flores, Quito 170401, Ecuador	2742	-0.419	-78.5423
Jamaica	25 Dominica Dr, Kingston, Jamaica	89	18.007	-76.7913
Mexico	Loma Dorada, 81217 Los Mochis, México (proximo a la Uniiversidad de Occidente)	19	25.8144	-108.962
Peru	R1, Comas 15316, Lima, Perú	149	-11.9124	-77.0553
Uruguay	Facultad de Agronomía, Av. Garzon 780, Montevideo, Uruguay	43	-34.837	-56.2224

Table S 3: Geographical locations for water samples under UNEP/GMP2 GRULAC project

Country	Site name	Latitude (decimal)	Longitude (decimal)
Argentina	Rio de la Plata	-34.705	-58.21433
Brazil	Amazon River (Location 1, year 2017)	-3.15008333	-58.487111
	São Vicente channel (Location 2, year 2018)	-23.9356666	-46.3911667
Ecuador	Babahoyo River	-2.185972	-79.867778
Jamaica	Hunts Bay River, Causeway Bridge	17.983439	-76.828574
Mexico	Ohuira Bay	25.6569333	-109.035725

8.3. Monitoring results from expert laboratories

8.3.1. Ambient air

Table S 4: Concentration of OCPs in PAS/PUFs (ng/PUF)

Sample_ID	Chlordane	Drins	DDT	Heptachlor	HCHs	Mirex	Endosulfan	HCB	PeCBz
ATG (2017-II)	3.68	1.86	15.55	0.41	1.04	0.19	-	3.68	41.85
ATG (2017-III)	2.89	5.87	15.29	-	-	0.15	1.34	1.88	4.39
ATG (2017-IV)	2.33	1.84	6.24	-	0.50	0.12	1.32	2.53	3.53
ATG (2018-I)	5.52	2.73	11.26	-	2.35	0.15	-	3.63	54.13
ATG (2018-II)	9.01	6.81	31.76	-	3.03	0.24	-	2.84	34.69
ATG (2018-III)	8.08	4.19	17.15	-	-	0.12	-	1.06	3.95
ATG (2018-IV)	6.28	3.56	10.78	-	1.43	0.14	1.17	3.46	40.41
ARG (2017-I)	6.44	2.07	7.41	4.17	5.08	0.27	6.72	19.22	18.93
ARG (2017-II)	4.98	1.64	5.26	3.48	4.68	0.25	5.84	6.90	42.02
ARG (2017-III)	5.87	2.22	6.76	3.46	5.01	0.28	5.31	17.24	18.75
ARG (2017-IV)	6.29	2.12	6.80	3.95	5.12	0.27	4.92	20.61	19.06
ARG (2018-I)	2.18	0.94	4.06	1.51	2.75	0.13	2.11	1.24	4.36

Table S 4: (continued)

Sample_ID	Chlordane	Drins	DDT	Heptachlor	HCHs	Mirex	Endosulfan	HCB	PeCBz
ARG (2018-II)	7.53	2.97	8.32	4.56	4.95	0.34	4.13	17.49	6.46
ARG (2018-III)	4.37	2.07	5.15	2.27	3.24	0.19	2.08	4.02	5.73
ARG (2018-IV)	7.78	3.76	10.26	3.97	5.63	0.44	5.86	3.04	2.14
BRB (2017-I)	35.88	74.65	2.33	1.47	5.86	-	-	2.58	-
BRB (2017-II)	30.18	76.85	3.05	1.17	5.74	-	-	2.71	2.04
BRB (2017-III)	40.76	90.71	3.32	1.82	5.81	0.09	-	2.24	4.79
BRB (2017-IV)	33.07	89.09	2.48	1.87	5.26	-	-	2.98	4.71
BRB (2018-I)	29.78	67.22	1.96	1.29	4.87	-	-	2.39	7.38
BRB (2018-II)	22.10	58.15	1.94	0.96	3.13	-	-	2.33	3.91
BRB (2018-III)	32.42	76.61	2.79	1.30	5.68	-	-	2.59	2.01
BRB (2018-IV)	23.77	46.26	1.72	0.90	3.01	-	-	2.26	1.59
BRA (2017-I)	4.89	7.18	21.57	4.16	11.61	0.43	9.45	3.93	-
BRA (2017-II)	3.39	4.51	14.53	3.32	8.79	0.17	2.02	8.35	40.09
BRA (2017-III)	3.74	4.66	18.31	3.53	13.18	0.16	1.35	9.16	4.85
BRA (2017-IV)	4.73	6.32	19.90	4.09	16.26	0.43	2.34	3.57	-
BRA (2018-I)	5.03	6.20	23.56	4.43	15.66	0.40	7.22	5.17	10.18
BRA (2018-II)	2.58	4.08	13.33	2.79	9.69	0.16	1.43	4.83	12.24
BRA (2018-III)	3.17	4.22	14.46	2.87	11.05	0.21	1.02	4.76	7.51
BRA (2018-IV)	5.59	7.27	24.64	5.58	14.69	0.41	4.76	3.65	11.18
CHL (2017-I)	-	-	2.10	-	0.69	-	-	2.33	-
CHL (2017-II)	-	-	0.57	-	0.79	-	-	5.17	9.36
CHL (2017-III)	-	-	0.36	-	0.37	-	-	5.58	4.05
CHL (2017-IV)	-	-	0.30	-	0.45	-	-	4.04	8.63
CHL (2018-I)	-	-	0.34	-	0.90	-	-	2.38	5.11
CHL (2018-II)	-	-	0.37	-	0.29	-	-	4.92	2.24
CHL (2018-III)	-	-	0.32	-	0.31	-	-	4.53	1.11
CHL (2018-IV)	-	-	0.36	-	0.33	-	-	4.09	1.06
COL (2017-I)	8.64	6.04	29.86	1.63	14.28	-	1.38	5.39	1.26
COL (2017-II)	8.84	6.11	31.72	1.65	14.97	-	1.35	5.69	1.33
COL (2017-III)	10.83	7.88	34.98	1.86	11.44	0.08	1.70	6.00	27.86
COL (2017-IV)	8.63	6.36	29.17	1.42	10.80	-	-	4.33	18.84
COL (2018-I)	7.70	4.85	27.16	1.14	7.55	-	-	3.38	13.70
COL (2018-I)	8.95	6.57	31.37	1.32	8.70	-	1.03	3.15	4.46
COL (2018-III)	9.18	6.91	33.27	1.36	9.53	-	-	3.43	3.47
COL (2018-IV)	9.60	6.18	32.53	1.36	9.12	-	-	3.47	4.85
ECU (2017-I)	-	1.90	16.84	-	12.29	-	-	4.54	1.66
ECU (2017-II)	-	1.46	18.46	-	19.95	-	1.00	4.24	29.52
ECU (2017-III)	-	1.16	14.29	-	10.67	-	-	5.18	32.01

Table S 4: (continued)

Sample_ID	Chlordane	Drins	DDT	Heptachlor	HCHs	Mirex	Endosulfan	HCB	PeCBz
ECU (2017-IV)	-	1.32	15.36	-	15.15	-	-	4.70	29.58
ECU (2018-I)	0.48	1.61	20.25	-	13.00	-	-	5.73	21.85
ECU (2018-II)	-	1.11	13.44	-	8.74	-	-	2.99	9.40
ECU (2018-III)	0.55	1.95	29.52	-	17.00	-	1.56	5.64	7.74
ECU (2018-IV)	0.67	1.88	32.41	-	18.05	-	1.46	6.30	7.93
JAM (2017-I)	22.59	11.48	7.73	0.62	1.66	-	-	7.54	4.47
JAM (2017-II)	38.85	21.83	21.87	1.23	3.38	-	1.04	5.84	54.53
JAM (2017-III)	41.76	24.05	24.23	1.20	2.06	-	-	4.37	6.01
JAM (2017-IV)	35.06	22.07	17.75	1.15	2.64	-	-	5.69	2.87
JAM (2018-I)	32.54	18.76	20.64	1.12	2.24	-	-	6.14	7.14
JAM (2018-II)	19.53	9.24	10.26	0.40	2.25	-	-	2.33	9.94
JAM (2018-III)	39.37	18.23	20.34	1.18	2.22	-	-	4.71	7.53
JAM (2018-IV)	41.14	18.49	19.57	1.19	4.05	-	-	6.07	15.23
MEX (2017-I)	0.47	1.37	9.60	-	0.73	-	13.01	5.63	2.84
MEX (2017-II)	1.36	3.71	26.90	-	0.80	-	28.96	3.63	32.55
MEX (2017-III)	1.59	8.53	>66	0.45	-	-	13.22	2.62	5.87
MEX (2017-IV)	1.34	5.64	>43	-	0.72	-	9.53	6.85	2.71
MEX (2018-I)	0.51	2.24	22.03	-	0.75	-	7.14	4.11	9.95
MEX (2018-II)	1.21	6.40	>45	-	0.76	-	20.42	3.25	8.63
MEX (2018-III)	4.74	23.72	>138	1.01	0.83	-	24.35	3.46	5.31
MEX (2018-IV)	2.02	6.21	>43	-	0.79	-	16.38	4.06	9.46
PER (2018-III)	0.92	3.02	42.21	0.60	10.89	-	3.22	11.65	5.09
PER (2018-IV)	0.50	1.40	19.02	0.38	5.12	-	-	7.26	3.47
PER (2019-I)	1.26	2.93	61.14	0.64	8.97	-	1.02	6.25	4.20
PER (2019-II)	1.08	2.83	59.78	0.67	9.59	0.11	1.50	10.93	6.03
URY (2017-I)	4.58	12.45	34.65	1.11	3.90	0.79	10.66	3.25	15.56
URY (2017-II)	5.44	9.41	26.55	0.87	4.87	0.84	4.92	4.61	20.08
URY (2017-III)	5.76	15.41	23.04	0.98	4.56	0.84	4.93	5.28	16.67
URY (2017-IV)	4.10	10.74	23.52	0.83	5.44	0.74	5.90	4.36	55.33
URY (2018-I)	4.66	14.24	38.79	0.86	6.15	0.74	5.50	4.16	26.43
URY (2018-II)	2.61	6.85	15.37	-	2.66	0.42	1.91	3.64	14.62
URY (2018-III)	6.24	15.21	20.33	1.38	6.20	0.92	2.69	5.29	33.16
URY (2018-IV)	6.02	13.98	28.95	1.10	8.41	0.90	3.54	3.90	30.56

Table S 5: Concentration of toxaphene in PAS/PUFs (ng/4 PUF)

Year	Sample	Σtoxaphene (ng/4 PUF)	Parlar-26	Parlar-50	Parlar-62
2017	ARG (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	ARG (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	BRB (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	BRB (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	BRA (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	BRA (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	CHL (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	CHL (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	COL (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	COL (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	ECU (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	ECU (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	JAM (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	JAM (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2017	URY (2017-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018	URY (2018-I+II+III+IV)	<LOQ	<0.50	<1.00	<0.50
2018-2019	PER (2018-III+IV + 2019 I+II)	<LOQ	<0.50	<1.00	<0.50
2018	MEX (2018-I+II+III+IV)	19.1	5.65	9.08	4.33
2017	MEX (2017-I+II+III+IV)	13.8	4.40	6.39	2.96
2018	ATG (2018-I+II+III+IV)	3.68	1.07	1.72	0.89
2017	ATG (2017-II+III+IV) 3 PUFs	2.16	0.58	1.06	0.51

Table S 6: Concentration of PCB_6 in PAS/PUFs (ng/PUF) LOQ: 0.20 ng/PUF or 0.25 ng/PUF per congener

Country	ISO-3	Sample ID	PCB6 (ng/PUF)
Antigua and Barbuda	ATG	ATG (2017-II)	<LOQ
	ATG	ATG (2017-III)	<LOQ
	ATG	ATG (2017-IV)	<LOQ
	ATG	ATG (2018-I)	<LOQ
	ATG	ATG (2018-II)	<LOQ
	ATG	ATG (2018-III)	<LOQ
	ATG	ATG (2018-IV)	<LOQ
Argentina	ARG	ARG (2017-I)	48.5
	ARG	ARG (2017-II)	29.2
	ARG	ARG (2017-III)	27.4
	ARG	ARG (2017-IV)	36.2
	ARG	ARG (2018-I)	43.9
	ARG	ARG (2018-II)	29.0
	ARG	ARG (2018-III)	25.5
	ARG	ARG (2018-IV)	31.7
Barbados	BRB	BRB (2017-I)	3.31
	BRB	BRB (2017-II)	2.82
	BRB	BRB (2017-III)	2.52
	BRB	BRB (2017-IV)	2.30
	BRB	BRB (2018-I)	3.44
	BRB	BRB (2018-II)	2.70
	BRB	BRB (2018-III)	3.47
	BRB	BRB (2018-IV)	2.28
Brazil	BRA	BRA (2017-I)	13.4
	BRA	BRA (2017-II)	10.3
	BRA	BRA (2017-III)	14.7
	BRA	BRA (2017-IV)	13.3
	BRA	BRA (2018-I)	12.1
	BRA	BRA (2018-II)	13.4
	BRA	BRA (2018-III)	11.5
	BRA	BRA (2018-IV)	11.3
Chile	CHL	CHL (2017-I)	2.30
	CHL	CHL (2017-II)	0.76
	CHL	CHL (2017-III)	<LOQ
	CHL	CHL (2017-IV)	0.29
	CHL	CHL (2018-I)	1.50
	CHL	CHL (2018-II)	<LOQ
	CHL	CHL (2018-III)	<LOQ
	CHL	CHL (2018-IV)	0.74
Colombia	COL	COL (2017-I)	11.6
	COL	COL (2017-II)	12.4
	COL	COL (2017-III)	19.6
	COL	COL (2017-IV)	13.8
	COL	COL (2018-I)	11.2
	COL	COL (2018-II)	7.90
	COL	COL (2018-III)	10.7
	COL	COL (2018-IV)	11.9
Ecuador	ECU	ECU (2017-I)	2.05
	ECU	ECU (2017-II)	2.18
	ECU	ECU (2017-III)	2.55
	ECU	ECU (2017-IV)	2.39
	ECU	ECU (2018-I)	2.05
	ECU	ECU (2018-II)	2.41
	ECU	ECU (2018-III)	3.05
	ECU	ECU (2018-IV)	3.02
Jamaica	JAM	JAM (2017-I)	8.31
	JAM	JAM (2017-II)	15.8
	JAM	JAM (2017-III)	13.5
	JAM	JAM (2017-IV)	12.4
	JAM	JAM (2018-I)	13.7
	JAM	JAM (2018-II)	11.8
	JAM	JAM (2018-III)	12.5
	JAM	JAM (2018-IV)	12.9
Mexico	MEX	MEX (2017-I)	2.03
	MEX	MEX (2017-II)	3.42
	MEX	MEX (2017-III)	3.37
	MEX	MEX (2017-IV)	2.84
	MEX	MEX (2018-I)	3.18
	MEX	MEX (2018-II)	4.32
	MEX	MEX (2018-III)	3.28
	MEX	MEX (2018-IV)	5.31
Uruguay	URY	URY (2017-I)	14.2
	URY	URY (2017-II)	11.8
	URY	URY (2017-III)	10.4
	URY	URY (2017-IV)	13.4
	URY	URY (2018-I)	16.2
	URY	URY (2018-II)	17.4
	URY	URY (2018-III)	12.6
	URY	URY (2018-IV)	20.8

Table S 7: Concentration of dl-POPs in PAS/PUFs (pg TEQ/PUF)

Country	ISO-3	Sample ID	Unit	PCDD/PCDF	PCB	total
Antigua and Barbuda	ATG	ATG (2017-II+III+IV)	pg TEQ/3 PUF	0.42	0.77	1.2
	ATG	ATG (2018-I+II+III+IV)	pg TEQ/4 PUF	1.4	1.0	2.4
Argentina	ARG	ARG (2017-I+II+III+IV)	pg TEQ/4 PUF	17	21	38
	ARG	ARG (2018-I+II+III+IV)	pg TEQ/4 PUF	24	20	45
Barbados	BRB	BRB (2017-I)	pg TEQ/PUF	10	1.1	11
	BRB	BRB (2017-II)	pg TEQ/PUF	18	0.91	19
	BRB	BRB (2017-III)	pg TEQ/PUF	14	0.67	15
	BRB	BRB (2017-IV)	pg TEQ/PUF	14	0.87	15
	BRB	BRB (2017-I+II+III+IV)	pg TEQ/4 PUF	60	2.9	63
	BRB	BRB (2018-I)	pg TEQ/PUF	11	1.0	12
	BRB	BRB (2018-II)	pg TEQ/PUF	9.5	0.82	10
	BRB	BRB (2018-III)	pg TEQ/PUF	15	1.1	16
	BRB	BRB (2018-IV)	pg TEQ/PUF	16	0.76	17
	BRB	BRB (2018-I+II+III+IV)	pg TEQ/4 PUF	54	4.5	59
Brazil	BRA	BRA (2017-I)	pg TEQ/PUF	6.6	2.9	9.4
	BRA	BRA (2017-II)	pg TEQ/PUF	3.4	2.0	5.4
	BRA	BRA (2017-III)	pg TEQ/PUF	11	3.4	14
	BRA	BRA (2017-IV)	pg TEQ/PUF	7.1	2.5	9.6
	BRA	BRA (2017-I+II+III+IV)	pg TEQ/4 PUF	27	9.0	36
	BRA	BRA (2018-I)	pg TEQ/PUF	4.5	2.1	6.6
	BRA	BRA (2018-II)	pg TEQ/PUF	6.9	2.9	9.7
	BRA	BRA (2018-III)	pg TEQ/PUF	9.2	3.9	13
	BRA	BRA (2018-IV)	pg TEQ/PUF	13	3.2	16
	BRA	BRA (2018-I+II+III+IV)	pg TEQ/4 PUF	34	13	47
Chile	CHL	CHL (2017-I+II+III+IV)	pg TEQ/4 PUF	2.4	1.3	3.7
	CHL	CHL (2018-I+II+III+IV)	pg TEQ/4 PUF	8.1	1.2	9.2
Colombia	COL	COL (2017-I+II+III+IV)	pg TEQ/4 PUF	14	8.4	22
	COL	COL (2018-I+II+III+IV)	pg TEQ/4 PUF	18	10	28
Ecuador	ECU	ECU (2017-I+II+III+IV)	pg TEQ/4 PUF	5.3	1.9	7.2
	ECU	ECU (2018-I+II+III+IV)	pg TEQ/4 PUF	6.4	2.2	8.6
Jamaica	JAM	JAM (2017-I+II+III+IV)	pg TEQ/4 PUF	122	14	136
	JAM	JAM (2018-I+II+III+IV)	pg TEQ/4 PUF	134	16	150

Table S 7: (continued)

Country	ISO-3	Sample ID	Unit	PCDD/PCDF	PCB	total
Mexico	MEX	MEX (2017-I)	pg TEQ/PUF	5.1	1.8	6.9
	MEX	MEX (2017-II)	pg TEQ/PUF	4.6	3.8	8.4
	MEX	MEX (2017-III)	pg TEQ/PUF	1.9	2.4	4.3
	MEX	MEX (2017-IV)	pg TEQ/PUF	10	3.6	14
	MEX	MEX (2017-I+II+III+IV)	pg TEQ/4 PUF	34	10	45
	MEX	MEX (2018-I)	pg TEQ/PUF	18	3.3	21
	MEX	MEX (2018-II)	pg TEQ/PUF	6.6	2.2	8.9
	MEX	MEX (2018-III)	pg TEQ/PUF	1.1	1.1	2.2
	MEX	MEX (2018-IV)	pg TEQ/PUF	14	4.4	19
	MEX	MEX (2018-I+II+III+IV)	pg TEQ/4 PUF	44	16	61
Uruguay	URY	URY (2017-I)	pg TEQ/PUF	15	6.9	22
	URY	URY (2017-II)	pg TEQ/PUF	14	5.6	20
	URY	URY (2017-III)	pg TEQ/PUF	13	4.5	17
	URY	URY (2017-IV)	pg TEQ/PUF	17	6.0	23
	URY	URY (2017-I+II+III+IV)	pg TEQ/4 PUF	65	16	81
	URY	URY (2018-I)	pg TEQ/PUF	11	6.1	18
	URY	URY (2018-II)	pg TEQ/PUF	15	5.3	20
	URY	URY (2018-III)	pg TEQ/PUF	16	3.2	19
	URY	URY (2018-IV)	pg TEQ/PUF	13	7.0	20
	URY	URY (2018-I+II+III+IV)	pg TEQ/4 PUF	63	20	84

Table S 8: Concentration of PFAS in PAS/PUFs (pg/# PUF). Values <LOQ are shaded with grey color; NR=not reported are shaded with light red color

Country	Sample ID	Unit	L-PFOS	br-PFOS	SPFOS	L-PFOA	L-PFHxS	FOSA
Argentina	ARG (2017-I)	pg/1 PUF	462	204	666	260	<12	NR
	ARG (2017-I+II+III+IV)	pg/4 PUF	1,281	718	1,999	1,225	<12	NR
	ARG (2017-II)	pg/1 PUF	276	<5.2	276	332	<12	NR
	ARG (2017-III)	pg/1 PUF	257	109	366	355	<12	NR
	ARG (2017-IV)	pg/1 PUF	279	181	461	655	<12	NR
	ARG (2018-I)	pg/1 PUF	NR	NR	NR	512	51	NR
	ARG (2018-I+II+III+IV)	pg/4 PUF	NR	NR	NR	1,577	<12	1,674
	ARG (2018-II)	pg/1 PUF	205	125	330	216	31	NR
	ARG (2018-III)	pg/1 PUF	NR	NR	NR	197	43	NR
	ARG (2018-IV)	pg/1 PUF	NR	NR	NR	576	101	NR

Table S 8: (continued)

Country	Sample ID	Unit	L-PFOS	br-PFOS	SPFOS	L-PFOA	L-PFHxS	FOSA
Antigua and Barbuda	ATG (2017-II)	pg/1 PUF	90	21	111	375	<12	NR
	ATG (2017-II+III+IV)	pg/3 PUF	205	128	334	730	<12	150
	ATG (2017-III)	pg/1 PUF	<12	<5.2	<12	224	<12	NR
	ATG (2017-IV)	pg/1 PUF	58	38	96	194	<12	NR
	ATG (2018-I)	pg/1 PUF	115	<5.2	115	371	51	NR
	ATG (2018-II)	pg/1 PUF	NR	NR	NR	472	54	NR
	ATG (2018-II+III+IV)	pg/4 PUF	NR	NR	NR	1,561	<12	NR
	ATG (2018-III)	pg/1 PUF	NR	NR	NR	374	40	NR
	ATG (2018-IV)	pg/1 PUF	NR	NR	NR	230	47	NR
Brazil	BRA (2017-I)	pg/1 PUF	224	139	363	409	<12	NR
	BRA (2017-I+II+III+IV)	pg/4 PUF	1,677	700	2,377	1,462	<12	3,142
	BRA (2017-II)	pg/1 PUF	1,168	453	1,621	334	<12	NR
	BRA (2017-III)	pg/1 PUF	866	456	1,322	649	<12	NR
	BRA (2017-IV)	pg/1 PUF	172	114	286	NR	<12	NR
	BRA (2018-I)	pg/1 PUF	146	82	228	207	32	NR
	BRA (2018-I+II+III+IV)	pg/4 PUF	499	150	649	1,304	NR	3,856
	BRA (2018-II)	pg/1 PUF	127	53	180	341	17	611
	BRA (2018-III)	pg/1 PUF	138	55	192	386	26	NR
	BRA (2018-IV)	pg/1 PUF	NR	NR	NR	260	37	NR
Barbados	BRB (2017-I)	pg/1 PUF	269	128	397	572	26	NR
	BRB (2017-I+II+III+IV)	pg/4 PUF	674	302	976	1,189	52	332
	BRB (2017-II)	pg/1 PUF	784	230	1,014	493	21	NR
	BRB (2017-III)	pg/1 PUF	278	91	370	166	15	NR
	BRB (2017-IV)	pg/1 PUF	97	38	136	192	14	NR
	BRB (2018-I)	pg/1 PUF	166	40	207	169	21	NR
	BRB (2018-I+II+III+IV)	pg/4 PUF	234	111	345	705	105	<25
	BRB (2018-II)	pg/1 PUF	57	30	87	170	21	NR
	BRB (2018-III)	pg/1 PUF	63	35	98	153	27	NR
	BRB (2018-IV)	pg/1 PUF	65	22	87	110	17	NR
Chile	CHL (2017-I)	pg/1 PUF	46	9	55	251	<12	<25
	CHL (2017-I+II+III+IV)	pg/4 PUF	137	53	190	329	<12	148
	CHL (2017-II)	pg/1 PUF	31	19	50	76	<12	<25
	CHL (2017-III)	pg/1 PUF	43	18	61	68	<12	<25
	CHL (2017-IV)	pg/1 PUF	49	26	75	NR	<12	<25
	CHL (2018-I)	pg/1 PUF	31	9	40	NR	<12	NR
	CHL (2018-I+II+III+IV)	pg/4 PUF	197	84	281	272	<12	NR
	CHL (2018-II)	pg/1 PUF	NR	NR	NR	80	<12	NR
	CHL (2018-III)	pg/1 PUF	45	12	57	62	<12	<25
	CHL (2018-IV)	pg/1 PUF	13	6	19	59	<12	<25
Colombia	COL (2017-I)	pg/1 PUF	NR	NR	NR	NR	NR	NR
	COL (2017-I+II+III+IV)	pg/4 PUF	2,274	1,727	4,001	974	<12	345
	COL (2017-II)	pg/1 PUF	323	172	495	235	<12	NR
	COL (2017-III)	pg/1 PUF	577	655	1,232	207	<12	NR
	COL (2017-IV)	pg/1 PUF	874	490	1,364	192	<12	NR
	COL (2018-II)	pg/1 PUF	786	586	1,372	133	<12	<25
	COL (2018-II+III+IV)	pg/3 PUF	2,148	1,289	3,437	989	<12	112
	COL (2018-III)	pg/1 PUF	444	301	745	482	<12	<25
	COL (2018-IV)	pg/1 PUF	710	577	1,287	410	<12	35

Table S 8 (continued)

Country	Sample ID	Unit	L-PFOS	br-PFOS	SPFOS	L-PFOA	L-PFHxS	FOSA
Ecuador	ECU (2017-I)	pg/1 PUF	36	24	60	383	<12	NR
	ECU (2017-I+II+III+IV)	pg/4 PUF	189	44	233	946	<12	267
	ECU (2017-II)	pg/1 PUF	57	16	73	338	<12	NR
	ECU (2017-III)	pg/1 PUF	38	<5.2	38	162	<12	<25
	ECU (2017-IV)	pg/1 PUF	38	<5.2	38	162	<12	NR
	ECU (2018-I)	pg/1 PUF	<12	<5.2	<12	NR	<12	35
	ECU (2018-I+II+III+IV)	pg/4 PUF	224	52	277	703	<12	221
	ECU (2018-II)	pg/1 PUF	<12	<5.2	<12	177	<12	45
	ECU (2018-III)	pg/1 PUF	54	29	83	189	<12	58
	ECU (2018-IV)	pg/1 PUF	37	17	54	176	<12	76
Jamaica	JAM (2017-I)	pg/1 PUF	146	83	230	155	<12	<25
	JAM (2017-I+II+III+IV)	pg/4 PUF	648	240	888	977	<12	442
	JAM (2017-II)	pg/1 PUF	256	116	372	275	<12	NR
	JAM (2017-III)	pg/1 PUF	190	28	219	270	<12	NR
	JAM (2017-IV)	pg/1 PUF	149	120	269	224	<12	NR
	JAM (2018-I)	pg/1 PUF	169	39	208	220	<12	<25
	JAM (2018-I+II+III+IV)	pg/4 PUF	650	169	819	1,019	<12	<25
	JAM (2018-II)	pg/1 PUF	166	46	211	348	<12	<25
	JAM (2018-III)	pg/1 PUF	163	56	219	235	<12	<25
	JAM (2018-IV)	pg/1 PUF	125	6	131	220	<12	<25
Mexico	MEX (2017-I)	pg/1 PUF	46	25	71	199	<12	NR
	MEX (2017-I+II+III+IV)	pg/4 PUF	345	154	499	819	<12	NR
	MEX (2017-II)	pg/1 PUF	166	23	190	313	<12	NR
	MEX (2017-III)	pg/1 PUF	35	13	48	243	<12	NR
	MEX (2017-IV)	pg/1 PUF	96	17	113	261	<12	NR
	MEX (2018-I)	pg/1 PUF	51	<5.2	51	249	<12	NR
	MEX (2018-I+II+III+IV)	pg/4 PUF	259	126	385	1,062	<12	153
	MEX (2018-II)	pg/1 PUF	80	43	123	324	<12	NR
	MEX (2018-III)	pg/1 PUF	54	15	69	NR	<12	<25
	MEX (2018-IV)	pg/1 PUF	65	17	81	247	<12	NR
Peru	PER (2018-III)	pg/1 PUF	1,536	602	2,138	260	48	49
	PER (2018-III+IV 2019-I+II)	pg/4 PUF	5,260	1,889	7,150	694	<12	126
	PER (2018-IV)	pg/1 PUF	851	302	1,152	214	48	<25
	PER (2019-I)	pg/1 PUF	1,554	709	2,263	187	57	48
	PER (2019-II)	pg/1 PUF	946	397	1,343	138	50	23
Uruguay	URY (2017-I)	pg/1 PUF	217	88	304	231	19	<25
	URY (2017-I+II+III)	pg/3 PUF	637	333	970	494	<12	2,046
	URY (2017-II)	pg/1 PUF	125	77	202	108	15	NR
	URY (2017-III)	pg/1 PUF	192	<5.2	192	153	<12	NR
	URY (2018-I)	pg/1 PUF	125	60	185	186	<12	NR
	URY (2018-I+II+III+IV)	pg/4 PUF	439	242	681	697	<12	2,232
	URY (2018-II)	pg/1 PUF	123	64	187	145	<12	894
	URY (2018-III)	pg/1 PUF	164	60	224	184	<12	325
	URY (2018-IV)	pg/1 PUF	138	76	214	204	<12	NR

Table S 9: Concentration of BFR in PAS/PUFs (ng/PUF) LOQ for HBCD: 0.03 ng/PUF per isomer

Country	ISO3	Sample ID	PBDE(8)	PBB 153	HBCD	Country	ISO3	Sample ID	PBDE(8)	PBB 153	HBCD
Antigua and Barbuda	ATG	ATG (2017-II)	0.55	<0.03	0.96	Ecuador	ECU	ECU (2017-I)	2.40	<0.03	0.99
	ATG	ATG (2017-III)	0.63	<0.03	3.76		ECU	ECU (2017-II)	0.39	<0.03	0.30
	ATG	ATG (2017-IV)	0.76	<0.03	1.22		ECU	ECU (2017-III)	1.92	<0.03	1.91
	ATG	ATG (2018-I)	3.43	<0.03	2.96		ECU	ECU (2017-IV)	0.88	<0.03	2.00
	ATG	ATG (2018-II)	0.56	<0.03	<LOQ		ECU	ECU (2018-I)	1.87	<0.03	12.9
	ATG	ATG (2018-III)	0.43	<0.03	<LOQ		ECU	ECU (2018-II)	1.75	<0.03	0.40
	ATG	ATG (2018-IV)	0.00	<0.03	<LOQ		ECU	ECU (2018-III)	0.39	<0.03	0.92
Argentina	ARG	ARG (2017-I)	6.27	<0.03	1.38		ECU	ECU (2018-IV)	0.04	<0.03	0.18
	ARG	ARG (2017-II)	1.65	<0.03	0.68	Jamaica	JAM	JAM (2017-I)	5.47	<0.03	1.80
	ARG	ARG (2017-III)	2.16	<0.03	2.15		JAM	JAM (2017-II)	8.24	<0.03	2.89
	ARG	ARG (2017-IV)	2.83	<0.03	1.62		JAM	JAM (2017-III)	8.78	<0.03	4.19
	ARG	ARG (2018-I)	9.82	<0.03	6.30		JAM	JAM (2017-IV)	7.95	<0.03	3.01
	ARG	ARG (2018-II)	1.84	<0.03	0.11		JAM	JAM (2018-I)	8.69	0.07	9.20
	ARG	ARG (2018-III)	1.71	<0.03	19.1		JAM	JAM (2018-II)	10.3	<0.03	2.16
	ARG	ARG (2018-IV)	1.77	<0.03	1.52		JAM	JAM (2018-III)	9.54	<0.03	6.64
Barbados	BRB	BRB (2017-I)	2.33	<0.03	1.40		JAM	JAM (2018-IV)	8.08	<0.03	2.02
	BRB	BRB (2017-II)	0.98	<0.03	0.44	Mexico	MEX	MEX (2017-I)	3.34	<0.03	0.30
	BRB	BRB (2017-III)	1.11	<0.03	0.22		MEX	MEX (2017-II)	8.31	<0.03	0.67
	BRB	BRB (2017-IV)	0.85	<0.03	1.41		MEX	MEX (2017-III)	6.62	<0.03	1.19
	BRB	BRB (2018-I)	5.84	<0.03	<LOQ		MEX	MEX (2017-IV)	9.04	<0.03	0.75
	BRB	BRB (2018-II)	1.35	<0.03	<LOQ		MEX	MEX (2018-I)	14.1	<0.03	17.8
	BRB	BRB (2018-III)	1.72	<0.03	<LOQ		MEX	MEX (2018-II)	8.99	<0.03	1.38
	BRB	BRB (2018-IV)	1.24	<0.03	6.40		MEX	MEX (2018-III)	6.62	<0.03	11.7
Brazil	BRA	BRA (2017-I)	1.23	<0.03	0.86		MEX	MEX (2018-IV)	13.1	0.05	0.14
	BRA	BRA (2017-II)	0.98	<0.03	0.63	Peru	PER	PER (2018-IV)	1.29	<0.03	
	BRA	BRA (2017-III)	1.25	<0.03	2.09		PER	PER (2019-I)	1.82	<0.03	
	BRA	BRA (2017-IV)	1.01	<0.03	1.43		PER	PER (2019-II)	1.45	<0.03	
	BRA	BRA (2018-I)	3.32	<0.03	3.08	Uruguay	URY	URY (2017-I)	1.47	<0.03	1.72
	BRA	BRA (2018-II)	1.21	<0.03	1.11		URY	URY (2017-II)	1.48	<0.03	0.77
	BRA	BRA (2018-III)	1.47	<0.03	0.81		URY	URY (2017-III)	1.38	<0.03	0.80
	BRA	BRA (2018-IV)	1.05	<0.03	10.0		URY	URY (2017-IV)	1.74	<0.03	1.01
Chile	CHL	CHL (2017-I)	0.00	<0.03	0.42		URY	URY (2018-I)	9.13	<0.03	3.91
	CHL	CHL (2017-II)	0.00	<0.03	0.37		URY	URY (2018-II)	1.17	<0.03	0.91
	CHL	CHL (2017-III)	0.00	<0.03	0.51		URY	URY (2018-III)	1.54	<0.03	0.49
	CHL	CHL (2017-IV)	1.30	<0.03	0.57		URY	URY (2018-IV)	1.36	<0.03	2.91
	CHL	CHL (2018-I)	2.68	<0.03	6.30						
	CHL	CHL (2018-II)	0.00	<0.03	3.20						
	CHL	CHL (2018-III)	0.00	<0.03	0.65						
	CHL	CHL (2018-IV)	0.00	<0.03	0.34						
Colombia	COL	COL (2017-I)	0.83	<0.03	3.09						
	COL	COL (2017-II)	0.98	<0.03	2.41						
	COL	COL (2017-III)	0.78	<0.03	2.84						
	COL	COL (2017-IV)	0.71	<0.03	2.57						
	COL	COL (2018-I)	13.07	<0.03	35.7						
	COL	COL (2018-II)	5.39	<0.03	1.03						
	COL	COL (2018-III)	1.00	<0.03	1.57						
	COL	COL (2018-IV)	0.97	<0.03	6.40						

8.3.2. Water

Table S10: Concentration of PFAS in water: L-PFOS, br-PFOS, ΣPFOS, PFOA and PFHxS (ng/L) for GRULAC samples collected under the UNEP project in the years 2017 and 2018.

Year		2017 Concentration (ng L-1)					2018 Concentration (ng L-1)				
ISO3	Season	L-PFOS	br-PFOS	ΣPFOS	PFOA	PFHxS	L-PFOS	br-PFOS	ΣPFOS	PFOA	PFHxS
ARG	I	1.98	0.35	2.33	0.96	0.52	2.18	0.81	2.99	0.89	0.52
	II	1.48	0.41	1.90	0.54	0.38	0.95	0.55	1.50	0.53	0.35
	III	1.74	0.91	2.65	0.72	0.61	3.35	0.94	4.29	1.16	0.71
	IV	2.64	0.93	3.57	1.08	0.77	1.57	0.79	2.36	0.64	0.52
BRA	I	0.26	0.02	0.28	0.07	0.01	1.72	0.68	2.41	0.57	0.64
	II	0.13	0.03	0.16	0.10	0.04	1.22	0.64	1.86	0.53	0.45
	III	0.04	0.01	0.05	0.04	0.02	2.13	1.16	3.29	0.70	0.66
	IV	0.04	0.01	0.06	0.12	0.01	1.67	0.80	2.46	0.57	0.48
ECU	I	0.12	0.04	0.16	0.12	0.04	0.54	0.18	0.72	0.16	0.04
	II	0.62	0.14	0.76	0.34	0.12	0.36	0.19	0.55	0.14	0.04
	III	0.26	0.17	0.42	0.24	0.14	0.12	0.06	0.18	0.17	0.05
	IV	0.31	0.04	0.34	0.21	0.02	0.19	0.03	0.22	0.21	0.02
JAM	I	1.14	0.17	1.31	0.64	0.21	1.11	0.47	1.58	1.08	0.55
	II	1.03	0.34	1.37	0.82	0.42	1.37	0.50	1.87	0.96	0.16
	III	1.31	0.76	2.07	0.69	0.24	0.92	0.43	1.35	0.39	0.12
	IV	1.02	0.29	1.31	0.69	0.22	0.47	0.37	0.84	0.39	0.17
MEX	I	0.34	0.06	0.40	0.27	0.07	0.18	0.09	0.27	0.39	0.05
	II	1.27	0.25	1.53	0.30	0.10	0.26	0.13	0.39	0.39	0.06
	III	0.27	0.11	0.39	0.49	0.07	0.56	0.30	0.86	0.37	0.13
	IV	0.29	0.16	0.45	1.05	0.06	0.45	0.16	0.61	0.32	0.08

8.3.3. Human milk

Table S11: Concentration of quantified chlorinated and brominated POPs in human milk (ng/g lipid) for GRULAC national pools

Country ISO-3	ATG	ARG	BRB	COL	ECU	JAM	MEX	PER	URY
Sampling year	**2018**	**2019**	**2018**	**2019**	**2019**	**2018**	**2017**	**2019**	**2019**
Sample ID	**ATG (2018)**	**ARG (2019)**	**BRB (2018)**	**COL (2019)**	**ECU (2019)**	**JAM (2018)**	**MEX (2017)**	**PER (2019)**	**URY (2019)**
Unit	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**
Sum drins	1.86	0.71	5.78	2.41	0.65	2.07	1.53	1.97	2.42
Sum chlordane	4.7	4.9	19.2	5.2	2.7	6.9	5.5	1.2	5.5
Sum DDT	56.9	139.3	92.6	71.6	338.9	89.6	560.4	187.5	41.7
Sum heptachlor	1.1	1.0	1.2	0.7	0.0	0.8	1.0	0.7	1.9
Sum toxaphene	0.71	0.0	0.62	0.0	0.0	0.59	0.0	0.0	0.0
HCB	4.50	6.53	3.00	4.01	5.38	3.33	6.14	3.10	7.11
Mirex	<LOQ	2.3	0.7	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	2.9
Sum HCH	2.1	8.5	4.1	0.7	1.4	1.2	2.9	8.0	15.9
PeCBz	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.6	<LOQ	<LOQ
Sum endosulfan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlordecone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

Country ISO-3	ATG	ARG	BRB	COL	ECU	JAM	MEX	PER	URY
Sampling year	**2018**	**2019**	**2018**	**2019**	**2019**	**2018**	**2017**	**2019**	**2019**
Sample ID	**ATG (2018)**	**ARG (2019)**	**BRB (2018)**	**COL (2019)**	**ECU (2019)**	**JAM (2018)**	**MEX (2017)**	**PER (2019)**	**URY (2019)**
Unit	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**
pp'-Dicofol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
HCBD									
PCP	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Pentachloroan-isole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sum PCP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB(6)	11.1	16.7	19.3	5.91	3.00	16.4	4.46	12.7	10.9

Table S12: Concentration of dl-POPs in human milk (pg/g lipid) for GRULAC national pools collected under the UNEP project from 2016 to 2019

Country ISO-3	ATG	ARG	BRB	COL	ECU	JAM	MEX	PER	URY
Sampling year	**2018**	**2019**	**2018**	**2019**	**2019**	**2018**	**2017**	**2019**	**2019**
Sample ID	**ATG (2018)**	**ARG (2019)**	**BRB (2018)**	**COL (2019)**	**ECU (2019)**	**JAM (2018)**	**MEX (2017)**	**PER (2019)**	**URY (2019)**
Unit	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**	**pg/g lipid**
TEQPCDD	1.79	2.03	2.46	1.24	1.34	3.32	2.17	1.30	2.67
TEQPCDF	0.58	1.10	0.63	0.65	0.65	0.86	1.31	0.87	1.62
TEQPCDD/ PCDF	2.37	3.13	3.08	1.89	1.99	4.18	3.48	2.17	4.29
TEQPCB	0.55	1.56	0.83	0.66	0.55	1.00	0.58	1.58	1.40
TEQtotal	2.92	4.68	3.91	2.55	2.54	5.18	4.06	3.74	5.69

Table S13: Concentration of BFRs in human milk (ng/g lipid) for GRULAC national pools collected under the UNEP project from 2016 to 2019

Country ISO-3	ATG	ARG	BRB	COL	ECU	JAM	MEX	PER	URY
Sampling year	**2018**	**2019**	**2018**	**2019**	**2019**	**2018**	**2017**	**2019**	**2019**
Sample ID	**ATG (2018)**	**ARG (2019)**	**BRB (2018)**	**COL (2019)**	**ECU (2019)**	**JAM (2018)**	**MEX (2017)**	**PER (2019)**	**URY (2019)**
Unit	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**	**ng/g lipid**
Sum PBDE(8)	13.8	0.74	5.04	0.59	0.60	7.18	11.6	1.62	0.39
Sum HBCD	0.3	0.3	0.5	0.0	1.3	0.5	0.6	0.7	0.0
PBB 153	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

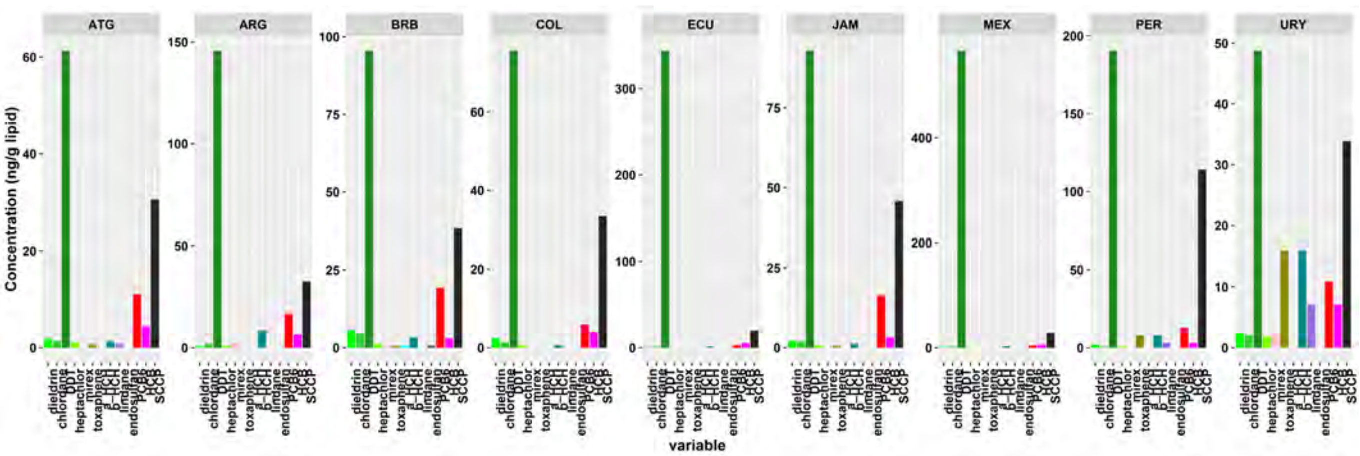

Figure S1: Human milk: Scaled barplots by POPs with concentrations for each country (pg TEQ/g lipid for the dl-POPs, pg/g f.w. for PFOS and PFOA; all other in ng/g lipid)

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