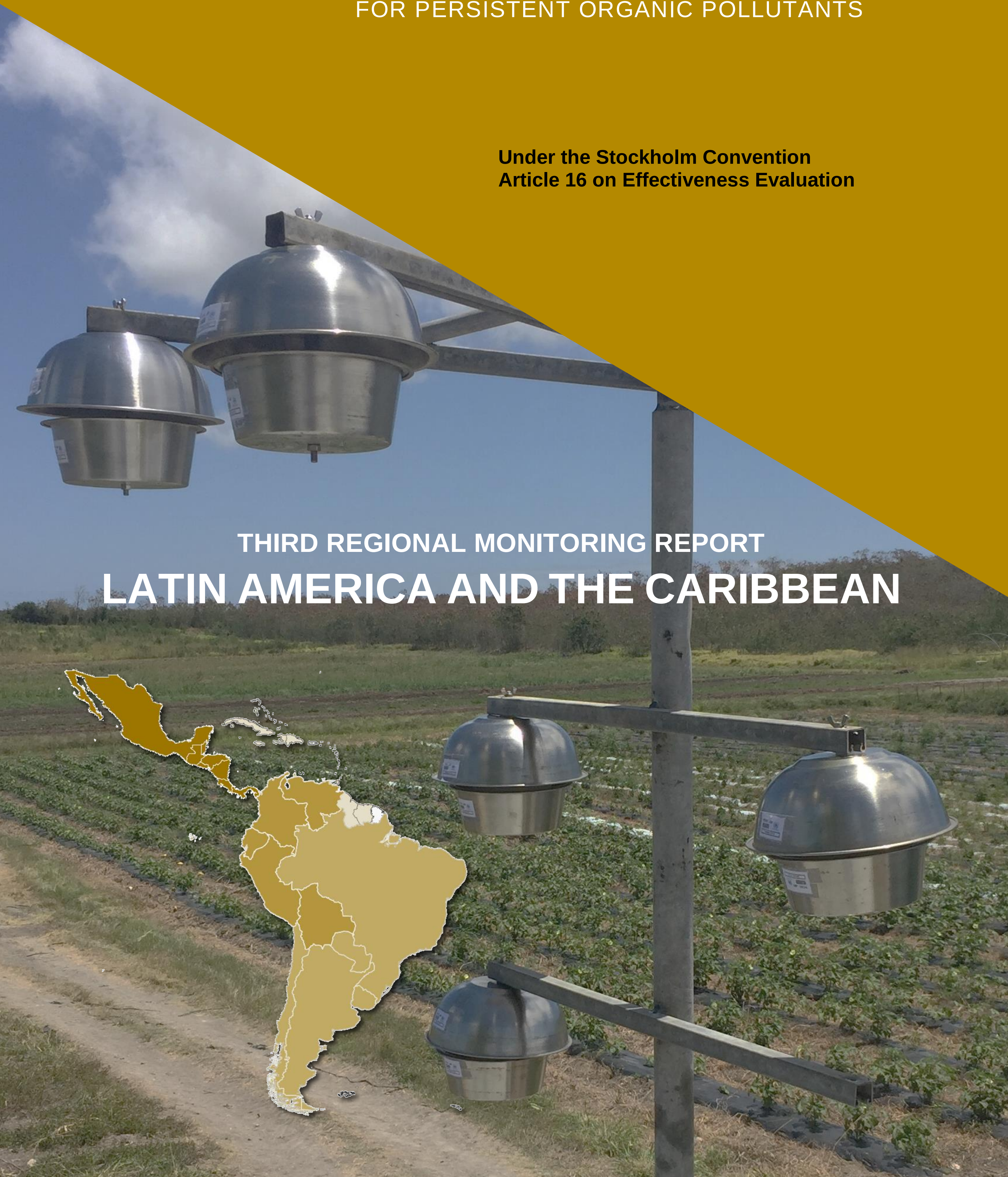
GLOBAL MONITORING PLAN

FOR PERSISTENT ORGANIC POLLUTANTS

Under the Stockholm Convention
Article 16 on Effectiveness Evaluation



THIRD REGIONAL MONITORING REPORT

LATIN AMERICA AND THE CARIBBEAN

THIRD REGIONAL MONITORING REPORT
REGION OF LATIN AMERICA AND THE CARIBBEAN
Global Monitoring Plan for Persistent Organic Pollutants

Stockholm Convention on Persistent Organic Pollutants

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ACKNOWLEDGEMENTS

Air monitoring activities are implemented in the five UN regions in cooperation with strategic partners: The Arctic Monitoring and Assessment Programme (AMAP), the Global Atmospheric Passive Sampling (GAPS) Network, the East Asia Air Monitoring Program, the European Monitoring and Evaluation Programme (EMEP), the Integrated Atmospheric Deposition Network (IADN) and the MONET Programme of the Research Centre for Toxic Compounds in the Environment (RECETOX).

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PREFACE

As was mentioned in the second report, persistent organic pollutants (POPs) are a group of chemicals that have toxic properties, resist degradation in the environment, bioaccumulate through food chains in the fatty tissue of living organisms and are transported long distances through moving air masses, water currents and migratory species, within and across international boundaries. POPs belong to three main groups, however some of the chemicals fit into more than one of these three general categories:

- Pesticides used in agricultural applications
- Industrial chemicals used in various applications
- Chemicals generated unintentionally as a result of incomplete combustion and/or chemical reactions

Twelve POPs were initially listed in the Stockholm Convention. In general, these 'legacy' POPs were first produced and/or used several decades ago, their persistence, bioaccumulative properties and potential for long-range transport are well studied, and they have been globally banned or restricted since 2004. Since then, 18 chemicals had been listed in the Stockholm Convention between 2009 and 2019. Table 1 summarize the 30 POPs listed in the Convention up to January 2021 in alphabetic order; along with their acronym; the Conference of the Parties at which the listing of the chemicals took place; the category of the chemicals and the Annex in which they are classified.

Table 1. Persistent Organic Pollutants listed in the Stockholm Convention

	Chemical Substance	Acronym	Conference of the Parties and year	Category	Annex
1	Aldrin		Legacy' POPs	P	A
2	Alpha-hexachlorocyclohexane	α-HCH	COP-4, 2009	P	A
3	Beta-hexachlorocyclohexane	ß-HCH	COP-4, 2009	P	A
4	Chlordane		Legacy' POPs	P	A
5	Chlordecone		COP-4, 2009	P	A
6	Decabromodiphenyl ether	Deca-BDE	COP-8, 2017	I	A
7	Dicofol		COP-9, 2019	P	A
8	Dichlorodiphenyltrichloroethane	DDT	Legacy' POPs	P	B
9	Dieldrin		Legacy' POPs	P	A
10	Endosulfan		COP-5, 2011	P	A
11	Endrin		Legacy' POPs	P	A
12	Gamma-hexachlorocyclohexane	ץ-HCH	COP-4, 2009	P	A
13	Heptachlor		Legacy' POPs	P	B
14	Hexabromobiphenyl	HBB	COP-4, 2009	P	A
15	Hexabromocyclododecane	HBCD	COP-6, 2013	I	A
16	Hexabromodiphenyl ether and heptabromodiphenyl ether	PBDE	COP-4, 2009	P	A
17	Hexachlorobenzene	HCB	Legacy' POPs	I, P, UP	A y C
18	Hexachlorobutadiene	HCBD	COP-7, 2015 and COP-8, 2017	I, UP	A y C
19	Mirex		Legacy' POPs	P	A
20	Pentachlorobenzene	PeCB	COP-9, 2019	I, P, UP	A y C
21	Pentachlorophenol, its salts and esters	PCP	COP-7, 2015	P	A
22	Perfluorooctane sulfonic acid	PFOS	COP-4, 2009	I, P	B
23	Perfluorooctanoic acid	PFOA	COP-9, 2099	I	A
24	Polychlorinated biphenyls	PCB	Legacy' POPs	I, UP	A y C
25	Polychlorinated dibenzo-para-dioxins	PCDD	Legacy' POPs	UP	C
26	Polychlorinated dibenzofurans	PCDF	Legacy' POPs	UP	C
27	Polychlorinated naphthalenes	PCN	COP-7, 2015	I, UP	A y C
28	Short-chain chlorinated paraffins	SCCPs	COP-8, 2017	I	A
29	Tetrabromodiphenyl ether and pentabromodiphenyl ether	PBDE	COP-4, 2009	P	A
30	Toxaphene		Legacy' POPs	P	A

P = Pesticide I = Industrial UP = Unintentional Production
Annex A = Elimination Annex B = Restriction Annex C = Unintentional Production

Article 16 of the Stockholm Convention requires the Conference of the Parties to evaluate periodically whether the Convention is an effective tool in achieving the objective of protecting human health and the environment from persistent organic pollutants. This evaluation is based on comparable and consistent monitoring data on the presence of POPs in the environment and in humans, as well as information from the national reports under Article 15 and non-compliance information under Article 17. The global monitoring plan for POPs, which has been put in place under the Convention, is a key component of the effectiveness evaluation and provides harmonized framework to identify changes in concentrations of POPs over time, as well as information on their regional and global environmental transport.

The present monitoring report presents synthesized information from the first, second and third phases of the global monitoring plan and provides the current findings on POPs concentrations in the Latin America and the Caribbean Region, including baseline concentrations of 13 POPs measured for the first time in the Region, changes in levels overtime and trends where available.

ABBREVIATIONS AND ACRONYMS

BCCC-SCRC	Basel Convention Coordinating Centre, Stockholm Convention Regional Centre for Latin America and the Caribbean
BDE	Bromine Diphenyl Ethers
BRS	Basel, Rotterdam and Stockholm Conventions
CEC	Commission for Environmental Cooperation
COP	Conference of the Parties
CSIC-IDAEA	Higher Council for Scientific Research - Institute of Environmental Assessment and Water Research (Barcelona)
CVUA	Chemical and Veterinary Analysis of Food
Deca-BDE	Decabromodiphenyl ether
DDD	Dichloro diphenyl dichloroethane
DDD/DDE	Metabolites of DDT
DDE	Dichloro diphenyl dichloroethylene
DDT	Dichlorodiphenyltrichloroethane
dLPCBs	Dioxin-like PCBs
DWH	Data Warehouse
ECCC	Environment and Climate Change Canada
ECLAC	Economic Commission for Latin America and the Caribbean
EPA	U.S. Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Statistics of the Food and Agriculture Organization
fg/m^3	Femtogram per cubic meter
FIRMS	Fire Information for Re-source Management System
GAPS	Global Atmospheric Passive Sampling
GCG	Global Coordination Group
GDP	Gross Domestic Product
GEF	Global Environment Facility
GMP	Global Monitoring Plan
GRULAC	Group of Latin American and Caribbean
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCBD	Hexabromocyclododecane
HCH	Hexachlorocyclohexane
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Path Model
ID	Identification
I-TEQ	International Toxicity Equivalent
kg	Kilogram
LAC	Latin America and the Caribbean
LANCE	National Space Weather Laboratory - UNAM
LAPAN	Latin American Passive Atmosphere Network
LOD	Limit of Detection
LOQ	Limit of Quantification
LRTAP	Long-range Transport of Atmospheric Pollutants
m	Meter
MODIS	Moderate Resolution Imaging Spectroradiometer

MTM	Man Technology - Environment Research Center (Örebro University, Sweden)
No	Number of Samples
NASA	National Aeronautics and Space Administration
NAFTA	North American Free Trade Agreement
NC	Not Classified
ND	Not Detected
ng/m^3	Nanogram per cubic meter
NGOs	Non-Governmental Organizations
NIP(s)	National Implementation Plan(s)
NOAA	National Oceanic and Atmospheric Administration
OAS	Organization of American States
OC	Organochlorines
OECD	Organization for Economic Cooperation and Development
PAHO	Pan American Health Organization
PAS	Passive Air Samplers
PBB	Hexabromobiphenyl
PBDEs	Polybrominated Diphenyl Ethers
PCA	Pentachloroanisole
PCBs	Polychlorinated Biphenyls
PCDDs	Polychlorinated Dibenzo-p-dioxins
PCDFs	Polychlorinated Dibenzofurans
PCN	Polychlorinated naphthalenes
PCP	Pentachlorophenol
PeCB	Pentachlorobenzene
PeCDF	Pentachlorodibenzofuran
PFHxS	Perfluorohexane Sulfonic Acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
pg/m^3	Picograms per cubic meter
POPs	Persistent Organic Pollutants
PUF	Polyurethane Foam
QA/QC	Quality Assurance and Quality Control
RAP	Regional Action Plan
RECETOX	Research Centre for Environmental Chemistry and Ecotoxicology
ROG	Regional Organization Group (of GRULAC)
SAICM	Strategic Approach to International Chemicals Management
SCCPs	Short-chain chlorinated paraffins
SOP	Standard operating procedure
TCDD	Tetrachlorodibenzo-p-dioxin
TEF	Toxic equivalency factor
TEQ	Toxicity Equivalents
ULOQ	Result below/under limit of quantification.
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UTC	Coordinated Universal Time
VIIRS	Visible Infrared Imaging Radiometers
WHO	World Health Organization
XAD	Styrene/divinylbenzene-co-polymer resin

GLOSSARY OF TERMS

Activity	Any program or other activity or project that generates data or information on the levels of POPs in the environment or in humans (biological indicators) that can contribute to the effectiveness evaluation under Article 16 of the Stockholm Convention.
Convention	It refers to the Stockholm Convention on Persistent Organic Pollutants
Background Area	Area located far from identified point sources that can represent natural levels.
Core matrices	These are the matrices identified by the Conference of the Parties to the Stockholm Convention as core for the first and second evaluation: Abiotic: ambient air and water; Biotic: (human) mother's milk and / or human blood.
I L-1	Instrumentation level 1 capable of analyzing PCDD/PCDF and dioxin-like PCB at ultra-trace concentrations: must be a high-resolution mass spectrometer in combination with a capillary column.
I L-2	Instrumentation level 2 capable of analyzing all POPs: (capillary column and a mass-selective detector).
I L-3	Instrumentation level 3 capable of analyzing all POPs without PCDD/PCDF and dioxin like PCB (capillary column and an electron capture detector).
I L-4	Instrumentation level 4 not capable to do congener-specific PCB analysis (no capillary column, no electron capture detector or mass selective detector).
Intercomparisons	Participation in national and international intercalibration activities such as ring-tests, laboratory performance testing schemes, among others.
LOD	Limit of detection. The lowest concentration at which a compound can be detected; it is defined as that corresponding to a signal three times the noise.
LOQ	Limit of quantification. The lowest concentration that can quantitatively be determined is three times higher than LOD. Compounds found at levels between LOD and LOQ can be reported as present, or possibly as being present at an estimated concentration, but in the latter case the result has to be clearly marked as being below LOQ.
MDL	Method detection limit. The MDL considers the whole method including sampling, sample treatment and instrumental analysis. It is determined by the background amounts on field blanks.
PHASE 1	Activities to support the Article 16 effectiveness evaluation that will be conducted by the Conference of the Parties at its fourth meeting, information collected between 2000 and 2007 (also termed as first evaluation).
PHASE 2	Activities to support the Article 16 effectiveness evaluation that will be conducted by the Conference of the Parties at its seventh meeting, information collected between 2009 and 2013.
PHASE 3	Activities to support the Article 16 effectiveness evaluation that will be conducted by the Conference of the Parties at its eight meeting, information collected between 2016 and 2019.
Program	Institutionalized activity to carry out repetitive measurements according to an agreed method, including forecasting the necessary funding for a specified time.

EXECUTIVE SUMMARY

This document is the Third Regional POPs Monitoring Report in the abiotic and biotic core matrices in the GRULAC region. It includes Pops' concentrations comparisons between sites, countries and time periods 2005-2012 and 2013-2019; trend analysis where available; baseline levels of emerging and candidate POPs, and the first back trajectory analysis of selected sites.

For the implementation of the Global Monitoring Plan two regional workshops were carried out in GRULAC region in 2015 and 2018; and because of the COVID-19 Pandemic the development of the regional report, was accomplished by virtual meetings supported by the consulting group. For collecting available information on core matrices and other media, questionnaires were sent to focal points in 32 GRULAC countries. Data coming from monitoring programs were obtained mainly from UNEP/GEF GMP II projects, GAPS and LAPAN air monitoring networks, WHO Human milk survey and MONET-Aqua.

The GRULAC regional organization group (ROG GRULAC) delivers the current report according to the ROG objectives established in Decision SC-3/19. The main objectives of the regional organization groups (ROG) are to define and implement the regional strategy for information gathering, including capacity building and establishment of strategic partnerships in order to fill the identified data gaps, and to prepare the regional monitoring report as contribution to the effectiveness evaluation.

OVERVIEW OF THE REGION

The Latin America and the Caribbean Region includes 46 countries, dependent territories and overseas departments, of which 33 are members of the Group of Latin American and Caribbean Countries (GRULAC) and 31 have ratified the Stockholm Convention. Divided into four subregions, each having special features of development and rich biodiversity, it faces many social environmental problems including pollution and persistent organic pollutants. There are notable differences in socio-economic development in the region. Most of its population lives in urban areas and has tripled in size between 1950 and 2019, the urbanization process is increasing as well as the demand for ecosystem services, reducing our collective resilience and the ability to respond to critical health situations, increase inequalities and worsening socio-environmental degradation.

The main environmental problems are threats related to environmental degradation, such as, climate change, loss of biodiversity, deforestation, lack of sanitation, air pollution, the contamination of bodies of water and the alteration of water supplies. Practices of biomass burning emissions contribute to increasing concentrations of greenhouse gases and aerosols and the use of pesticides is increasing the insect resistance; and contaminating a large part of the exposed population, especially the most vulnerable, such as traditional populations, such as indigenous, riverine, and afro-descendants workers who depend on the land for their safe food. Also rates of poor health indicators are increasing and chances of reemerging infectious diseases is a real risk.

CONTRIBUTING/COLLABORATION PROGRAMS

The programs contributing data to the present report were UNEP/GEF GMP II projects, the Global Atmospheric Passive Sampling (GAPS), Latin American Passive Atmosphere Monitoring Network (LAPAN), the United Nations Environment Programme-WHO human milk survey and MONET-Aqua. Additional information was provided by Colombia POPs monitoring network.

UNEP/GEF GMP II projects (named Air-GEF in the DWH) and GAPS program used polyurethane foam (PUF) passive samplers and LAPAN used hydrophobic polyaromatic resin (XAD) samplers, which have varying deployment times and temporal resolution. The analyses were conducted by CSIC-IDAEA and the Sweden MTM laboratory for Air-GEF and water samples from PNUMA/GEF GMP II projects; ECCC for GAPS program samples; RECETOX for LAPAN and MONET-Aqua samples; and by CVUA laboratory Freiburg in Germany, for WHO milk samples.

MAIN FINDINGS

Air Results

The analysis of the POPs in air matrix involved 83 parameters measured by three monitoring programs and 19 countries of which nine maintained monitoring sites that allowed the evaluation of concentrations' changes. It showed great variability of data and low recurrence in sites' monitoring. The highest median values are generally present in urban sites of the three programs and the maximum values in Air-GEF program. The Southern Cone followed by the Caribbean presented most of the maximum median values.

Medians of the data for the period 2004-2012 were compared with those of 2013-2018. In general, an increase in concentration is observed in the period 2013-2018 for the groups: Cyclodienes, DDT, PCBs with TEF, HCH, and BDE; and a decrease for PCB, PCDD and PCDF, and PeCB. In addition, the highest median values are presented by the Air-GEF program. Baseline concentration were measured for the first time for 13 POPs, involving new and emerging substances and the candidate PFHxS to be included in the Stockholm Convention.

The countries that showed an increase in the largest number of groups of compounds were Uruguay, followed by Antigua and Barbuda and Brazil; all under Air-GEF program. In contrast, Brazil under LAPAN program, and Colombia and Mexico under GAPS program, show a decrease in most of the parameters of all groups.

In summary, the Air-GEF program shows an increase in concentration for most of the parameters of the groups: Cyclodienes, except for Endosulphanes; DDT and isomers, HCB, HCH and PCBs with TEF, BDE and congeners and TEQ of Dioxins; and decrease for: PCB and D and F. With respect to parameters measured within the same period 2016 to 2018: PeCB presents an increase and PBB generally presents data with values below the LDC. The maximum values are presented mainly in St. James, Barbados, followed by Montevideo, Uruguay and in third place, Los Mochis, Mexico.

GAPS program presents significant reductions in most of the parameters of the groups: Cyclodienes, PCB, HCH and BDE; measured at urban and NC sites. The remote sites present an increase in most of the parameters of: Cyclodienes, PCB and HCH. In general, urban sites present the highest median values, however the NC site Sonora, Mexico 2014 stands out for its extreme values in most of the parameters.

Regarding LAPAN Program, urban sites presented the highest concentration values compared to NC and Remote sites and increases in concentration values in the period 2013 to 2016, compared to 2010-2012 mainly in non-recurring sites, that is, sites that only measured in the period 2013-2016. Only Aldrin, HCB and BDE 153 showed a decrease in concentration in the three groups of sites. The maximum and extreme values of all the parameters are presented mainly in Brazil, followed by Argentina and Colombia in third place.

Human Milk Results

For this third evaluation, the MILK-WHO survey provided data from 2001 to 2019 and 14 participating countries. However, only nine have participated in more than one round and seven of them also participated in the sixth round (2015 to 2019) and were the foundation for concentrations comparisons.

The parameters analyzed in Milk samples during 2015-2019 period were 108 of which 13 parameters were analyzed for the first time and constitute the baseline for future evaluations. These also include emerging substances and candidate POP under review to be included in the Convention PFHxS.

From the 108 parameters measured, regional comparisons showed that most of them presented decreases in concentration; 20 parameters presented values ULOQ or zero and some had never presented values above the LOQ in any country in the region; only three showed slight increases at regional level Alpha-HBCD, Cis-Heptachlor Epoxide and the Sum of 2 Heptachlor Epoxides. The Caribbean followed by the Southern Cone presented most of the maximum median values.

Comparisons of concentrations per parameter and countries with repeated participation in the milk survey showed in general, that six parameters from 4 groups increased their concentrations levels in three or more countries, not being significant for the PCDD AND PCDF group and significant for the others:

- Insecticides Cyclodiene group: Cis-Heptachlor epoxide and Sum 2 Heptachlor Epoxides.
- Polychlorinated Biphenyls with TEFs: PCB 77
- PCDD AND PCDF: 1,2,3,4,7,8-HxCDF and 1,2,3,7,8-PeCDF
- Hexabromocyclododecane: Alpha-HBCD

The countries that showed significant increases in the largest number of groups of compounds were Barbados and Jamaica.

Repeated participation of the countries in Human milk survey is needed in the region to better understand the exposure of vulnerable groups as indicators to protect the future generations, as stated in the Millennium Goals and the Stockholm Convention.

Water Results

Baseline concentrations of the three target substances under the Stockholm Convention surveillance PFOS, PFOA and PFHxS in 6 sites, where the monitoring took place in 2017 and 2018, were achieved. Regional statistical analysis of the 6 UNEP/GEF GMP sites in GRULAC showed median PFOS data concentration values higher than those of PFOA and PFHxS; and increases in 2018 median values compared to those of 2017 for the three substances, possibly due to the change of site in Brazil.

Comparisons between sites, parameters and years showed that the maximum median values were presented in Rio de la Plata Argentina 2017 and 2018 follow by São Paulo São Vicente channel, Brazil 2018 and Hunts Bay River, Jamaica 2017 for the three substances, and minimum values in Amazon River Brazil 2017 follow by Daule and Babahoyo River Junction, Ecuador 2017-2018. Increases in concentrations were observed for PFOS and decreases for PFOA and PFHxS in 2018 in the four sites that measured two years Rio de la Plata Argentina, Daule and Babahoyo River Junction Ecuador, Hunts Bay River Jamaica and Ohuira Bay in Mexico. Higher concentrations were detected for the three parameters in São Paulo São Vicente channel, Brazil 2018 site compared to Amazon River Brazil 2017.

With respect to the 47 parameters measured in 2016 by the Monet-Aqua program, concentration’s comparisons generally show a higher concentration in Peñol-Guatapé Reservoir, Antioquia Colombia than in Llanquihue lake, Los Lagos Chile for most parameters.

LEVELS OF PERSISTENT ORGANIC POLLUTANTS IN OTHER MEDIA

Various countries of the region reported in theirs NIPs the presence of persistent organic pollutants in media other than the core media. Sampling information relative to soil and sediment was supplied by Antigua & Barbuda; on human adipose tissue was reported by Mexico; Brazil reported several studies relative to persistent organic pollutants in human media; Colombia reported POPs monitoring in costal water and sediments; Barbados reported the routine monitoring of groundwater and several countries reported studies in different biotic species like eggs, fish, bivalves and food, among others (Countries’ NIPs). But none of them reported trends over time.

EVIDENCE OF TEMPORAL TRENDS AND LONG-RANGE TRANSPORT

To detect changes in concentrations with some reliability, the temporal and spatial resolutions must be taken into consideration to properly design a regional monitoring program and measurements must be sustained in the selected sites. It is worth to mention that from the 93 monitoring sites of GRULAC, 57% operated for only one year. The inconsistency of site locations in the countries, lack of regular participation by the countries and data variability did not allow the analysis of significant trends.

The evaluation of short range transport in the region was carried out through the search for scientific articles and the application of back trajectory analysis and the HYSPLIT-NOAA model in three sites of the region that presented most of the maximum median values of the Region in air and human milk matrices. Most of the scientific articles identified refer mainly to other parts of the world, evidencing the little attention that the region has received on this issue. There are local back trajectory studies mainly from Mexico, in the early 2000s and recent ones from Colombia and the Caribbean. It was not possible to apply the HYSPLIT-NOAA model to more sites in the region due to the lack of financial resources for its application.

The results of the back trajectory analysis and the HYSPLIT-NOAA model applied in the sampling sites located in Barbados, Jamaica and Uruguay throughout 2018 indicated that:

Barbados: pathways of potential pollutant emissions are due to the areas closest to the monitoring site, including marine emissions and smaller vessels.

Jamaica: pathways of possible pollutant emissions are due to the areas close to the monitoring site at the local and regional level. The routes of the trajectories pass over Haiti, the Dominican Republic, Puerto Rico and the Caribbean islands of Montserrat, Guadeloupe and Dominica among others.

Uruguay: pathways of possible pollutant emissions are due to the areas close to the monitoring site at the local and regional level. Seventy percent of the routes of the trajectories pass over the southern parts of Brazil and Paraguay, and the Atlantic; and the rest over Argentina and a minimum portion of Chile.

Likewise, satellite images of the fires reported during 2018 were reviewed. They indicate that there was an important contribution from these events that may be generating some persistent pollutants. It is highly recommended to review these contributions in detail to identify the type of burning (vegetation or waste, among others) that was taking place in the region.

GAPS

There are significant data gaps in some subregions such as Mesoamerica, specifically in Central America, in particular to establish significant spatial and temporal trends of persistent organic pollutants in the core media. There is a need to sustain and expand the existing monitoring networks, which should begin with national efforts to promote regionally managed monitoring programs. Monitoring capabilities exist in at least nine countries within the region. The region, however, needs to create sound scientific monitoring programs using local resources, as all the existing programs are supported mainly by external funding, which limits their long term support and sustainability. The commitment of countries to sustain monitoring programs should be based on their national interest in having public policy management instruments to reduce the risk of exposure to these substances and on their willingness to establish a regional structure able to support monitoring programs on a long-term basis.

More research is needed to assess the risks of exposure to persistent organic pollutants through atmospheric transport within the region’s boundaries. The most important information gap in the region is the absence of continuous and sustainable monitoring programs and subsequent atmospheric modeling capacity that are limiting factors to establishing significant temporal and spatial trends.

CAPACITY BUILDING NEEDS

There has been capacity building through programs and projects, but the challenge that countries now have is to develop capacity for the new POPs. When many countries had made investments to acquire equipment for the first POPs, now better technology is required to evaluate the new POPs, which implies new investments. This means a problem for the region.

Capacity building in areas such as the design and implementation of monitoring programs, the need for highly trained experts in the analysis of persistent organic pollutants, specially the new and emerging substances, together with aid for improving laboratory facilities, and capacity building for data management, analysis and interpretation, and modelling would help to establish solid programs within the region. Building these capabilities and stimulating synergies seem to be the way to proceed to create a sustainable monitoring program.

FUTURE MONITORING PROGRAMS

Future regional effectiveness evaluations could benefit from on-going programs; however, a stronger commitment is needed from the region to build continuous and sustainable programs. Capacity, both for monitoring and analysis needs to be enhanced. The existing ROG group could play a key role in stimulating synergies for the development of national monitoring programs that contribute to a regional network; however, provision of financial support should be envisaged from countries of the Region.

Future monitoring of human milk should consider the ethical and technical challenges. These studies should also consider actions to better understand the exposure of vulnerable groups as indicators to protect future generations, as stated in the Millennium Development Goals, sustainable development indicators and the Stockholm Convention.

CONCLUSIONS AND RECOMMENDATIONS

GRULAC has been collaborating with strategic partners since 2000, delivering data for the three GMP evaluations. However, the inconsistency of site locations in the countries, lack of regular countries' participation and data variability do not allow the analysis of significant trends. Air monitoring programs in the Region are still supported by external financing.

Main monitoring findings showed that: Analysis of 13 new and emerging POPs were performed for the first time in Air and Human milk and constitute the baseline for future evaluations; air concentrations from monitoring sites of legacy POPs depend mainly from the particular characteristics of the site as well as the meteorological influences; human milk monitoring showed decreases in most of the parameters' concentrations and water delivered baseline concentrations of the three target substances.

This first analysis of back trajectories in the three selected sites shows that to understand the transport processes to the monitoring site, it is necessary to have temporally disaggregated data to establish seasonality in order to be able to relate and understand the values of the observed concentrations with possible sources that could contribute to those values. Likewise, this information will allow evaluating these sources in a second stage and defining local or regional reduction or mitigation actions.

It can be concluded that more systematic studies should be designed and implemented to address this issue within the GRULAC region. Passive air monitoring and active sampling could be used for modeling the transport of POPs between source and receptor areas. It is recommended that POPs modeling capabilities and training should be stimulated within the region.

As was mentioned in the first report, "the Latin America and Caribbean region should formalize a coordinating structure to develop a Regional Action Plan (RAP). This would enable countries to evaluate options available and actions necessary to meet the requirements of the Stockholm Convention for persistent organic pollutant monitoring; develop a regional monitoring program with indication of scope, limitations, costs and benefits; and identify requirements for capacity-building and access to external assistance.

It is imperative to forge synergies between countries. Interaction between governments, academic institutions, industry and non-governmental organizations will be required, both at the national and regional levels, to build a successful strategy to face the challenge of monitoring persistent organic pollutants levels in the core media of the global monitoring plan".

1. INTRODUCTION

The Global Monitoring Plan (GMP) was developed in response to the need of the Conference of the Parties of the Stockholm Convention of comparable global monitoring data on the presence of Persistent Organic Pollutants (POPs), to evaluate the effectiveness of the convention. In accordance with the mandate of article 16 of the Convention, the GMP objective provides *a harmonized organizational framework for the collection of comparable monitoring data on the presence of the POPs listed in Annexes A, B and C of the Convention in order to identify trends in levels over time as well as to provide information on their regional and global environmental transport* (UNEP/POPS/COP.6/INF/31/Add.1)**.**

The Conference of the Parties (COP) agreed at its first meeting in 2004 (Decision SC-1/13) *to initiate arrangements to provide itself with comparable monitoring data on which to base its evaluation of the effectiveness of the Convention and Requests the Secretariat to develop a background scoping paper for a global monitoring plan for consideration by the Conference of the Parties at its second meeting* (UNEP-POPS-COP.1-SC-1.13). In its second meeting in 2006, the COP decided (Decision SC-2/13) to complete the first effectiveness evaluation at its fourth meeting to be held in 2009. The decision included an agreement to implement the elements of a Global Monitoring Plan and the establishment of a Provisional Ad-hoc Technical Working Group (TWG) to elaborate elements of the plan and its implementation.

At its sixth meeting in May 2013, the Conference of the Parties, by decision SC-6/23 on the global monitoring plan for effectiveness evaluation, adopted the amended global monitoring plan for persistent organic pollutants (UNEP/POPS/COP.6/INF/31/Add.1) and the amended implementation plan for the global monitoring plan (UNEP/POPS/COP.6/INF/31/Add.2). It also adopted the Guidance on the Global Monitoring Plan for Persistent Organic Pollutants, which has been updated in 2013 (UNEP/POPS/COP.6/INF/31) and 2019 (UNEP/POPS/COP.9/INF/36), to address the sampling and analysis of the newly listed POPs, providing a useful basis for monitoring of these chemicals in the second and third phases of the global monitoring plan, as well as for harmonized data collection, storage and handling.

Three worldwide implementations of the Global Monitoring plan have been undertaken by cooperative arrangements with existing programs and by monitoring activities to supplement existing information in order to obtain comparable abiotic (air, water) and biotic (human blood and breast milk) data from all regions to support the effectiveness evaluation.

The first implementation was carried out in all five United Nations regions to have comparable data and baseline information for future evaluations. It was called the first phase and compiled data from 2000 -2008 on the presence of the 12 legacy POPs from existing monitoring programs. A Global monitoring report under the global monitoring plan for effectiveness evaluation was approved in COP4, 2009. *The overall conclusion reached was that there are data on air and human milk or blood in all five United Nations regions that can be used as a baseline for future evaluations. All regions noted, however, that data were missing in some significant subregions* (UNEP/POPS/COP.4/33).

The second implementation, called second phase of the GMP (2009-2014), compiled data on abiotic (air/water) and biotic (human breast milk) core matrices, from existing monitoring programs, from the GEF-funded UNEP/GEF GMP I projects and the Strategic Approach to International Chemicals Management (SAICM), which were implemented in 32 countries in the Africa, Latin America and the Caribbean (GRULAC), and the Pacific Islands regions from 2009 to 2012 to cover gaps of information.

Their report, Second Global Monitoring Report, was approved in COP8, 2017. It compared data from the first and second implementations and provided the first indication of changes in concentrations of the 12 legacy POPs and baseline information on the POPs listed in COPs 4, 5 y 6 (2009-2013). Also, it addresses aspects relevant to long range transport of POPs and climate effects and the assessment of Perfluorooctane Sulfonic Acid (PFOS) concentrations in water that was included for the first time (UNEP/POPS/COP.8/INF/38).

The third implementation finalized in 2019. It also compiles data on the same core matrices from existing monitoring programs and from the GEF-funded UNEP/GEF GMP II projects that were implemented in 42 countries in the Africa, Asia, Pacific Islands and Latin America and the Caribbean (GRULAC) regions from 2016 to 2019.

This third report integrates information from the three implementations and presents the current findings on POPs concentrations in the GRULAC Region. While the first monitoring report, provided information on the baseline concentrations of the 12 legacy POPs and the second monitoring report presented first indications as to the changes in concentrations of the chemicals initially listed in the Convention, as well as baseline information on the newly listed POPs, this third monitoring report additionally offers analysis of trends, baseline information of POPs in water media and of candidate POP Perfluorohexane sulfonic acid in all core matrices and back trajectory analysis of specific sites.

In GRULAC region, long term viability of existing monitoring programs like the global monitoring programs GAPS and WHO milk survey were essential to evaluate POPs' changes in levels overtime. Also, the continued operation of the regional air monitoring LAPAN network and the recurrent operation of national sites under the UNEP/GEF GMP projects were pillars for this third evaluation. DWH GMP played a very important role in supporting the collection, processing, storing and presentation of monitoring data.

2. DESCRIPTION OF THE REGION

The Latin America and the Caribbean region comprises 46 countries (Figure 1), dependent territories and overseas departments, of which 33 are members of the Group of Latin American and Caribbean Countries (GRULAC). But only 31 have ratified the Stockholm Convention; Haiti is a signatory and Grenada is not a party. The region covers an extensive area, stretching from the Bahamas and Mexico to Argentina and Chile. It covers 21,951,000 square kilometers (8,475,000 square miles). To the west, it is bounded by the Pacific Ocean and to the east by the Atlantic Ocean and the Caribbean Sea.

Figure 1. Countries of the Latin American and Caribbean region

GRULAC is one of the five Regional Groups of the United Nations, its 33 Member States are distributed in the American continent, as well as in some islands of the Caribbean. Its members contribute with 17% of all members of the United Nations.

The Group, like all regional groups, is a non-binding dialogue group where issues related to regional and international affairs are discussed (Agam et al, 1999). In addition, the Group works to help allocate seats in United Nations agencies by nominating candidates from the region (GRULAC, 2019).

The GRULAC Region is divided into four sub-regions (See Figure 2): Mesoamerica (made up of 8 countries), the Caribbean (made up of 15 countries), the Andes (made up of 5 countries) and the Southern Cone (made up of 5 countries), each one with special characteristics and rich biodiversity. Its topography ranges from tropical islands to mountain ranges and high plateaus, rainforests, deserts, and plains. The Southern Cone subregion occupies 62% of the Group's surface, followed by Andean with 23%, Mesoamerica 12%, and the Caribbean with just 3% of the total territory (Table 2).

Figure 2. Subregions of the GRULAC Region

Source: Created by the authors.

Table 2. Summary of the GRULAC subregions (2018)

Subregions	Countries	Population (millions of inhabitants)	Surface (thousands of km^2)	GDP (billion US dollars)
Mesoamerica	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama	175.4	2,486.7	1,489.4
Andean	Bolivia, Colombia, Ecuador, Peru y Venezuela	138.9	4,694.0	851.0
Southern Cone	Argentina, Brazil, Chile, Paraguay, Uruguay	283.1	12,635.8	2,803.7
Caribbean	Antigua & Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago	40.1	598.3	266.9

Source: Created by the authors with data from World Bank, 2020a.

In 2018, the Latin American and Caribbean region had around 640 million inhabitants, of which 18% live in rural populations (ECLAC, 2019a).

It should be noted that in 1950 only 41% of the population of Latin America and the Caribbean lived in urban areas, but today more than 80% do so. (A. Bárcena et al, 2020). This urbanization is most pronounced in South America, where approximately 346 million people (83% of the population) lived in urban areas in 2015. Also, the rate of urbanization is fastest in the Caribbean, where 62% of the population resided in urban areas at the beginning of the millennium, reaching 70% in 2015 and with a projection of 74% by 2025 (UNEP, 2016).

Although this urbanization process has had favorable economic and social consequences, the increase in productivity reflected in a greater dynamism in productive activities, the development of services and the use of economies of scale, it has also given rise to negative externalities such as: atmospheric pollution, biodiversity loss, environmental degradation, the generation of greenhouse gases, road accidents, road congestion, health problems, water pollution, increased use of chemical products, among others, that erode the bases of support of economic dynamism. That is why in most cases, the concentration of people, as well as the production patterns associated with urbanization, exacerbate environmental degradation (UNEP, 2016). “The population of Latin America and the Caribbean, which more than tripled in size between 1950 and 2019, is projected to peak at just below 768 million around 2058 and decline thereafter to about 680 million in 2100” (UN, 2019).

Furthermore, Latin America is home to 29-45 million indigenous people according to several studies that provided estimates for around 2010 (CRS, 2020). The World Bank stated in a report that “official data on indigenous people are not conclusive, as many technical and sociological difficulties persist in census data”; nevertheless, official numbers provided by the national censuses establish 41.81 million (World Bank, 2015).

According to Economic Commission for Latin America and the Caribbean (ECLAC) estimates in 2014, 44.8 million people in Latin America were indigenous, representing 8.3% of the total. The countries with the highest percentage of indigenous population are Bolivia (62.2%), Guatemala (41%), Peru (24%), Mexico (15.1%), Panama (12.3%) and Chile (11%). In numbers, Mexico had 17 million, Peru 7.5, Bolivia 6.2 and Guatemala 5.9 million (ECLAC, 2014 a, b) (UN, 2018a).

Also, in numerical terms of the indigenous population, UNESCO reported in 2019 that Mexico had 12 million, Guatemala 5.8, Bolivia 4.2 and Peru 4 (UNESCO, 2019a). Unlike what happens in other more populated regions of the world, more than half of these people, 52.2%, currently live in urban areas (ILO, 2020).

World Bank (2018) informed that one in four Latin Americans identifies as Afro-descendant, comprising 133 million people, most of whom are concentrated in Brazil, Venezuela, Colombia, Cuba, Mexico and Ecuador (World Bank, 2018).

As already mentioned, the countries of Latin America and the Caribbean are among the richest in the world in terms of biodiversity. Only South America has almost half of the terrestrial biodiversity and more than a quarter of its forests. The Mesoamerican coastline preserves the longest coral reefs in the Western Hemisphere, and the entire region has 700 million hectares of potentially arable land, 570 million hectares of grasslands, more than 800 million hectares of forest and about 27% of the fresh water available in the world (UNDP, 2010).

According to the United Nations Environment, Latin America, and the Caribbean (LAC) conserves a large part of its biodiversity. Six of the world's most biodiverse countries are in this region: Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela. Also, Costa Rica has 6% of the world biodiversity (Butler, 2016). It also points out that it is home to the most biodiverse habitat in the world, the Amazon rainforest (UNEP, 2012) (UNEP-WCMC, 2016).

It is estimated that the total protected areas in Latin America and the Caribbean, important places of terrestrial, freshwater and marine biodiversity, cover more than 2,042 million hectares. It is important to mention that Latin America and the Caribbean have positioned themselves as leaders in marine conservation; from 2010 to 2015 the total marine protected areas rose from 3.56% to 20.15% in relation to the total marine areas in the region (ECLAC, 2020a).

Likewise, of the 20 largest protected areas in the world, six are in the region: the Amazon forest in Colombia, with 32 million hectares; the Alto Orinoco - Casiquiare Biosphere Reserve in Venezuela, with 8.4 million hectares; the Javari Valley in Roraima - indigenous area in Brazil, with 8.3 million hectares; the Yanomami area, in Brazil, with

7.75 million hectares; the Pacific zone in Colombia, with 7.4 million hectares, and the south of the state of Bolívar in Venezuela, with 7.3 million hectares.

Other natural resources that the region possesses are the abundant forest resources. It is estimated that the total area of forest in the region amounts to 935.5 million hectares, which corresponds to 46.4% of its total area. This is equivalent to 23.4% of the total forest area in the world. Five countries in the region have 80% of the total forest area: Brazil with 53%, Peru with 8%, Mexico with 7%, Colombia and Bolivia with 6% (COFLAC, 2017).

Due to its diversity of ecosystems, its climate varies enormously, having an average annual rainfall of 1,600 millimeters and an average runoff of 400 thousand cubic meters per second, concentrating almost a third of the world's water resources. This means that while its average availability of water per inhabitant reaches almost 22 thousand cubic meters per inhabitant per year, at the world level this value is only a little more than 6 thousand (IDB, 2018).

The diversity differences in the region are evident as it encompasses the world's largest hydrographic basin (the Amazon), the largest transboundary aquifer (the Guaraní) and the driest desert (the Atacama). In this region, about 290,000 million cubic meters of water are extracted per year for domestic and productive uses, which is 2.2% of the available resources. The main use corresponds to irrigated agriculture, with extractions that are equivalent on average to 70% of the total flow extracted. Thus, for example, in South America the demand for agriculture represents between 60 and 92% of uses / extractions (UNESCO, 2019b).

Governance

In recent decades, development has increased, driven mainly by commodity prices and trade growth in the region, which has helped reduce poverty and advance in the reduction of inequality. It also led to increases in public spending, improvements in social protection, education and health services and the initiation of structural reforms. Nevertheless, governments in the region did not take sufficient advantage of the opportunities this development offered to ensure that growth becomes sustainable and truly inclusive (OECD, 2020).

Productivity has not improved significantly, while inequality, despite economic progress, remains very high, measured in income or other welfare outcomes. Public investment represented only 1.6% of GDP in the region in 2017, about half of what was invested on average in OECD countries. In general, access and quality of public services vary widely, and those who can afford it often opt for private providers (OECD, 2020).

To improve the governance of the region, the countries have fostered alliances between them: MERCOSUR (Southern Common Market), AdP (Pacific Alliance), CAN (Andean Community of Nations), CARICOM (Caribbean Community), UNASUR (Union of Nations South America), SICA (Central American Integration System), ALBA (Bolivarian Alliance for the Peoples of Our America) and CELAC (Community of Latin American and Caribbean States).

However, the countries of Latin America and the Caribbean continue facing challenges in the design and execution of public policies that promote good governance and inclusive societies. To maintain inclusive growth, Latin America and the Caribbean must continue to promote the implementation of public sector reforms that pursue equality for all (OECD, 2020).

Economy

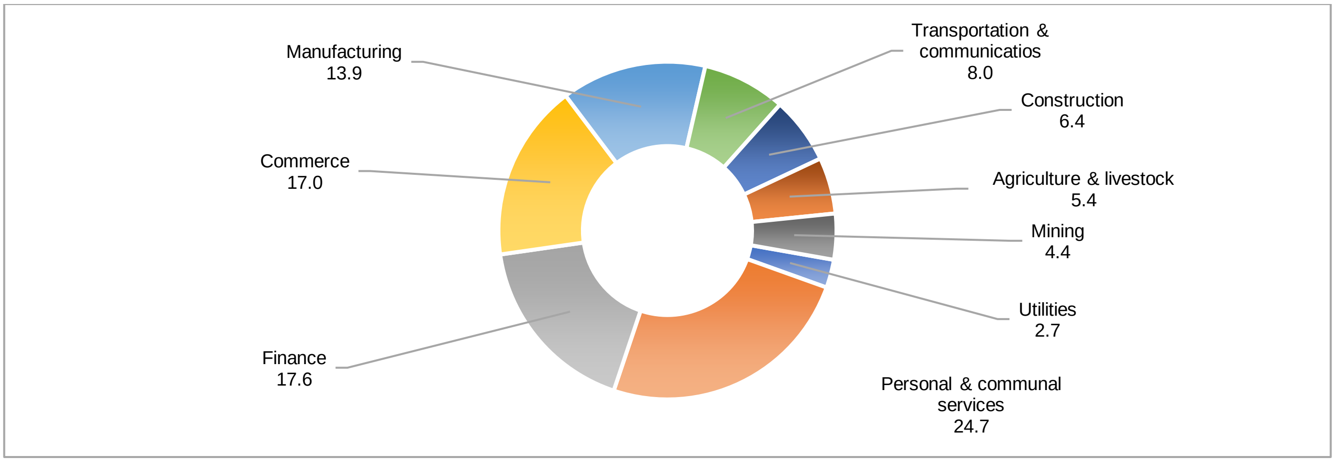
Latin America and the Caribbean is a vulnerable region to the global economic climate. The world economy has weakened. Investment flows to and from Organization for Economic Co-operation and Development (OECD) countries have also declined significantly since 2015, while volatility in financial markets has increased.

This international deterioration is affecting the economies of Latin America, many of which are vulnerable to global trade and investment flows. In fact, ECLAC estimates that the global slowdown will have negative repercussions in most of the countries of the region. In addition, Climate Change is also a threat, especially for countries like Brazil, which are highly dependent on agribusiness.

The decline in the economic outlook for the region is evident. After a good regional performance that lasted several years, economic activity in Latin America has been growing below the OECD average since 2014, and average regional GDP growth is currently on a downward trend of 1.3% in 2017 to 0.9% in 2018 and, according to ECLAC estimates, to 0.5% in 2019 (ECLAC, 2019a).

Regarding the breakdown of economic activity and its contribution to the added value of GDP in 2018, professional services, financial intermediation and trade are those that paid about 60% of the total product (Figure 3). On the other hand, the manufacturing industry did so with 14%, followed by transportation and communications with 8%. It is noteworthy that the agricultural sector only contributed a little more than 5% (ECLAC, 2019b).

Figure 3. Percentage of GDP by economic activity at current prices in Latin America



Source: ECLAC, 2019b.

An important factor in the economy is exports. In Latin America and the Caribbean, ECLAC (2019) indicates that the ten main products in this area according to their participation in total regional GDP are:

- Crude oil
- Passenger motor vehicles, except buses
- Soy
- Mineral and copper concentrates
- Other parts for motor vehicles, except motorcycles
- Trucks and vans, including ambulance vehicles
- Statistical machines that calculate based on punched cards or tapes
- Iron ore and its concentrates (except roasted iron pyrites)
- Refined copper, including remelted
- Oilseed cakes and flours and other vegetable oil residues

Likewise, in the ranking of the first 20 largest world economies according to the World Economic Forum, only 2 countries in Latin America and the Caribbean occupy a place: since 2018 Brazil occupied the 9th position, but has recently been removed from this position, while Mexico is in the fifteenth place worldwide and second in Latin America (World Economic Forum, 2018).

Considering the international context, as noted by the World Bank, and after several years of slow growth in the region, the economy of Latin America and the Caribbean is facing a new setback as the COVID-19 pandemic hits the global economy. In addition to the fact that most of the countries in the region have forced social isolation and restricted the movement of people to avoid contagion, reducing economic productivity and increasing uncertainty about how economic growth will be affected in the coming years.

Also, ECLAC, 2020 established “The world is facing a humanitarian and health crisis without precedent in the last century. The coronavirus disease (COVID-19) pandemic has battered economies already weakened by slow growth and mounting inequality. The region of Latin America and the Caribbean faces this crisis from a situation of social economic growth that is insufficient to reduce poverty and increase employment at the pace needed by its societies” (ECLAC, 2020b).

To this, according to the World Bank, there are external shocks, which vary in impact from one country to another. For example, demand from China and developed countries, limited by the pandemic, will fall dramatically, affecting commodity exporters in South America, as well as exporters of manufactured goods and services in Central America and the Caribbean. Flight restrictions are already affecting the Caribbean tourism sector, a major source of income for many small island states.

Thus, the unprecedented nature of the COVID-19 pandemic could change, even dramatically, the forecasts of economic performance in 2020. For this reason, the World Bank Group is promoting measures to help countries in their development efforts to strengthen their response to the pandemic, including increasing disease surveillance, improving public health interventions, and supporting the private sector to maintain operations and jobs. (World Bank, 2020b).

ENVIRONMENTAL PROBLEMS

The environmental problems that stand out in the region are deforestation with its consequent increase in erosion, mainly in areas of the Amazon in Brazil loss of biodiversity, lack of sanitation, climate disaster, especially floods, and forest fires, with high levels of air pollution. The Brazilian Amazon lost 87,762 km² to deforestation and fires, the loss of the largest area of the decade (INPE, 2021). Additionally, in various Latin American cities air pollution has as a main source the increase of vehicular fleet with high pollutant emission load in urban areas and population concentration, mainly in megacities such as the Metropolitan Area of the Valley of Mexico; the contamination of bodies of water, mainly where illegal or artisanal activities are established, such as illegal gold mining in Peru (Nikolau, 2016); and the alteration of water supplies due to increased temperatures or soil degradation, destroying water systems such as that of the Andes, since they lead to the disappearance of glaciers (Centero & Lajous, 2018).

Despite the fact that the Latin American and Caribbean region has the world's largest reserves of arable land, unplanned urban sprawl, erosion, unsustainable land use, loss of nutrients, chemical pollution, overgrazing and deforestation have caused the degradation of more than 300 million hectares of what was once productive agricultural land which represents 16% of the entire agricultural land of the world. The land management activities that have contributed the most to such land degradation are mechanized agriculture, overgrazing, and urban sprawl and industry (UNEP, 2016.).

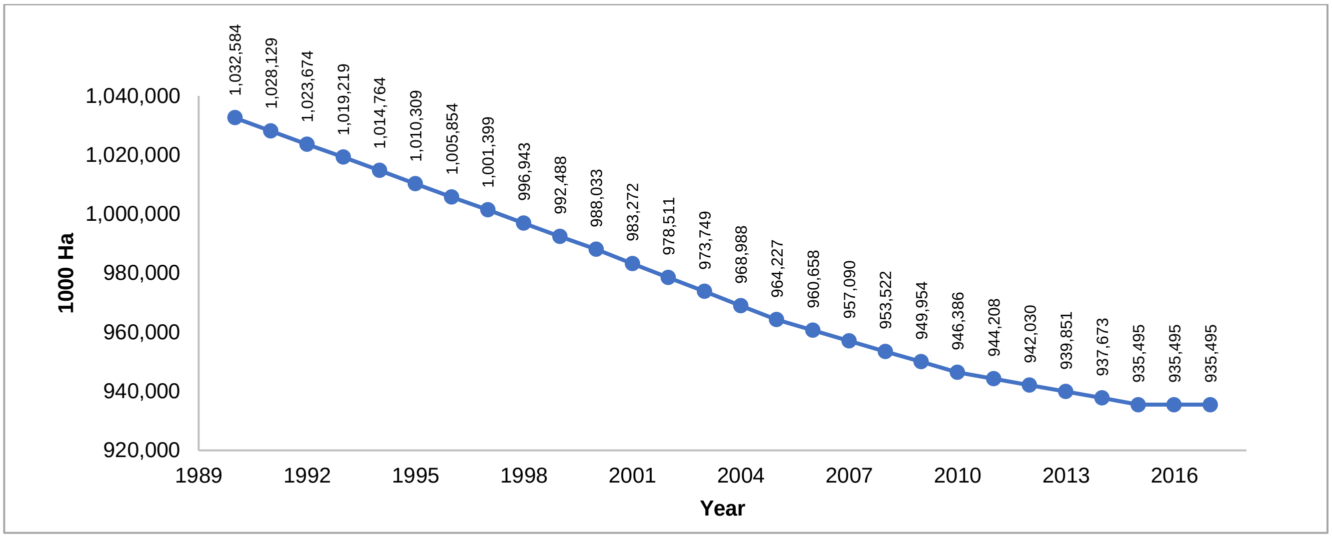
In the Andean region, commodity-driven change in land cover strongly affects water supply, impacting the livelihoods of millions of people who live downstream and depend on water from the Andes. In the case of the Caribbean, the rate of urbanization is faster than in the other subregions; in most cases, the concentration of people and the production patterns associated with urbanization exacerbate environmental degradation (UNEP, 2016).

When reviewing particular problems of some of the GRULAC countries, 18% of the territory of Mexico is affected by chemical degradation; Guatemala has water erosion in 12% of the country; in El Salvador 75% of the territory is affected by erosion; Costa Rica has 19.8% of overexploited soils; in Nicaragua moderate to extreme erosion affects 58.9% of the country; in Panama 21 thousand km2 of land are affected by drought and degradation. Also, there is evidence of damage in Argentina by water erosion in around 250 thousand km2, increased each year by 2.5 thousand km2; in addition, 81.5% of its arid and semi-arid surfaces already have some level of desertification. Likewise, 15.72% of the surface of Brazil is susceptible to desertification, and Chile is affected by desertification in 62.6% of its entire territory (UNEP, 2016).

It is important to note that native forests, grasslands, and other natural habitats are burned after being cleared to provide more land for agriculture. Emissions from this practice contribute to increasing concentrations of greenhouse gases and aerosols.

In Latin America and the Caribbean (LAC) 4.7 million hectares of forest area were lost between 2000 and 2005, which represents 65% of global deforestation. Additionally, it is estimated that Colombia lost almost 425,000 hectares of tree cover in 2017 and the Peruvian Amazon lost more than 143,000 hectares that same year (PNUDLAC, 2020). In 28 years, the loss of forest lands has been about 97 million hectares as shown in figure 4 (FAOSTAT, 2020).

Figure 4. Loss of forest land in Latin America



Source: Created by the authors with data from FAOSTAT, 2020.

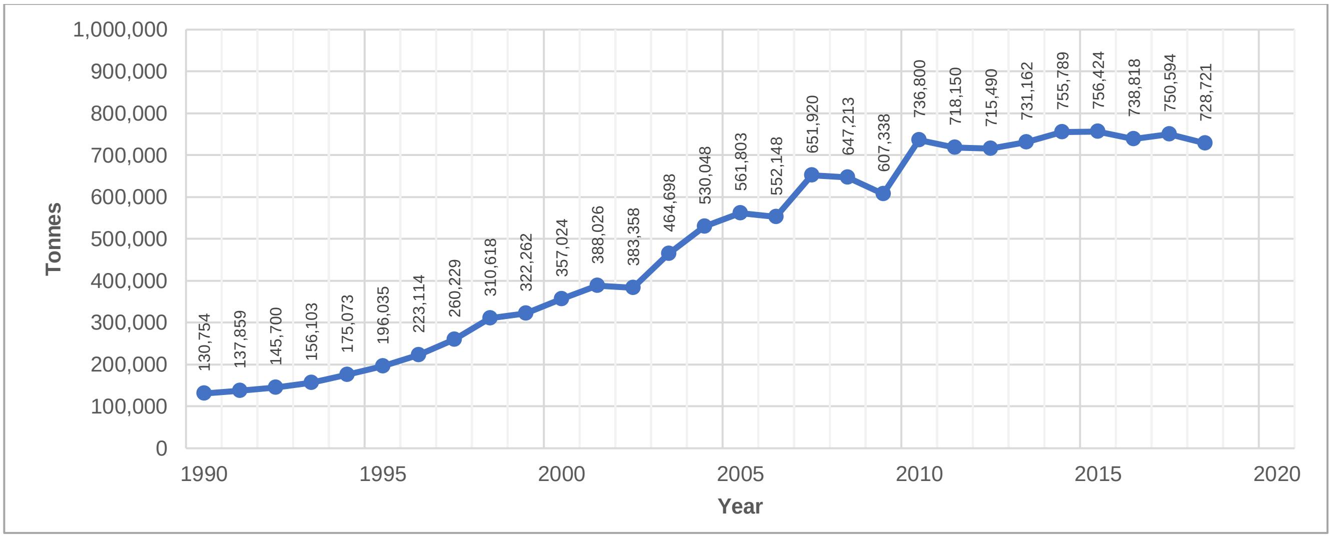
The loss of habitat has socio-economic impacts, and with deforestation the conditions of reproduction of mosquitoes that are vectors of diseases such as Malaria, Dengue, Zika and Chikungunya improve, likewise, higher temperatures are also associated with frequent and more violent outbreaks of diseases that affect the health of thousands of human beings.

USE OF PESTICIDES IN THE GRULAC REGION

The use of pesticides in the region has been increasing since 1990, going from 130.8 thousand tons in that year to about 728.7 thousand tons in 2018 (Figure 5).

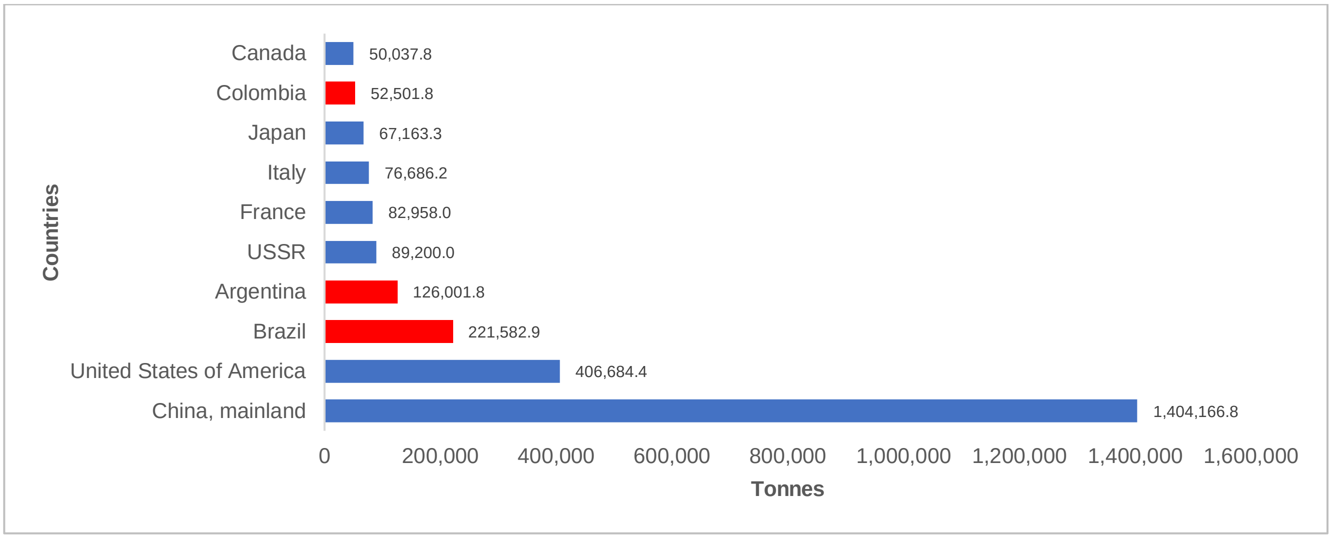
Globally in 2018, Brazil ranked third in the use of pesticides with 221,583 tons; the first place was occupied by China with 1,404,167 tons, then the United States with 406,684 tons (Figure 6).

Figure 5. Pesticide use in Latin America and the Caribbean



Source: Created by the authors with data from FAOSTAT, 2020.

Figure 6. Countries with the highest use of pesticides in 2018



Source: Created by the authors with data from FAOSTAT, 2020.

Regarding the use of fertilizers, the World Bank registered that for each hectare of arable land worldwide, in 2016 an average of 200.7 kilograms of fertilizer was used, in a total of 7,546,392 km2 of agricultural land in that year. Countries with the highest consumption of fertilizers per hectare of arable land are Uruguay with 1731.6 kg/ha, Brazil (534.9), Colombia (525.5), Cuba (475.5) and Mexico (290.3) (World Bank, 2020c).

PUBLIC HEALTH

Concerning the health of the population of Latin America and the Caribbean, at least 125 million of the region's residents do not have access to health services. This is worse for members of indigenous groups and afro-descendants. Infectious diseases continue to cause death in the region, but chronic noncommunicable diseases are becoming a major cause of morbidity and mortality (Bliss, 2009, Lotufo, 2015 & 2018).

Rates of poor health indicators such as obesity, smoking, parasitoses, communicable diseases, such as Tuberculosis and other risks are increasing at an alarming rate. Effective disease surveillance remains a challenge in the region. The emigration of health professionals, the limited placement of health centers in rural and low-income areas, and the restricted dedication of resources to emergency preparedness hinder the effectiveness of regional health systems.

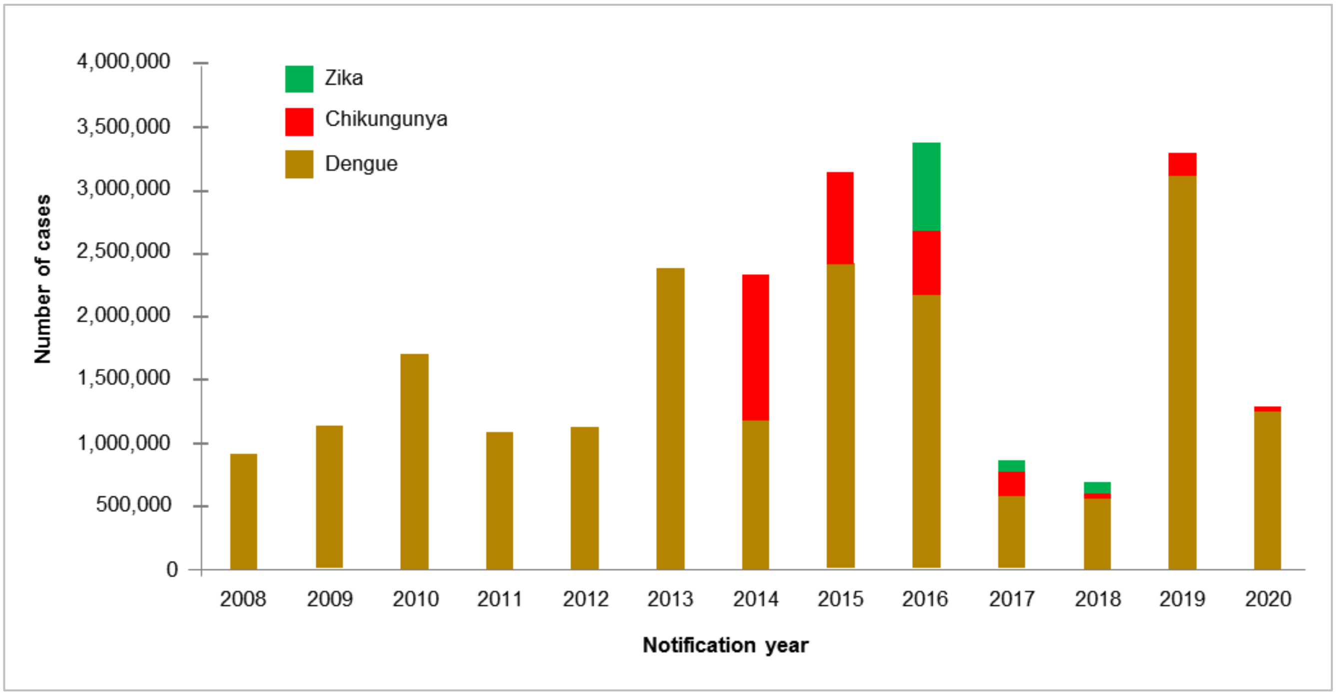
In addition, many regions of Latin America lack hospitals equipped to treat the 5 main diseases that occur in the region: heart disease or stroke, diabetes, high cholesterol, hypertension and injuries (Corpart, 2017).

Population growth, the spread of human settlements to remote areas, unsustainable agricultural practices, and climate change increase the chances of new infectious diseases emerging. Even diseases that were already controlled or eliminated are rebounding, as is the case of Chikungunya, Zika, Malaria, Yellow fever and Measles, Figure 7 (PAHO, 2020).

In addition to the diseases present in the region, the population is exposed every day to various chemical products, through exposure routes such as ingestion, inhalation, skin contact and through the umbilical cord to the fetus. There are some harmless and even beneficial chemicals, but others are a threat to our health and the environment. Chemical production continues to increase and, with it, the potential for chemical exposure, without compliance with environmental legislation.

Chemical substances such as heavy metals, pesticides, solvents, paints, detergents, kerosene, and others lead to unintentional poisonings at home and in the workplace. Unintentional poisonings are estimated to cause 193,000 deaths a year, most of which are the result of preventable chemical exposures (WHO, 2016).

Figure 7. Distribution of dengue, Chikungunya and Zika cases by reporting year



Source: Region of the Americas, 2008-2020. (PAHO, 2020).

The list of chemicals classified as human carcinogens with sufficient or limited evidence is long. Occupational carcinogens are estimated to cause between 2% and 8% of all cancers. For the general population, an estimated 14% of lung cancers are attributable to ambient air pollution, 17% to household air pollution, 2% to secondhand smoke, and 7% to occupational carcinogens. The mortality rate according to the Statistical Yearbook of Latin America and the Caribbean in the period 2015-2020 is 6% in Latin America and 7.7% for the Caribbean (WHO, 2016).

3. ORGANIZATION

The Regional Organization Group of Latin American and Caribbean countries, ROG-GRULAC, was founded in 2007 in response to decision SC-3/19, which establishes that Parties are invited to nominate candidates to integrate the Regional Organization Groups that would facilitate the regional implementation of the Global Monitoring Plan, PVM. (POPS COP 3.SC-3/19, 2007)

The ROG-GRULAC began activities in January 2008, at the Inception Workshop held in Mexico. In this workshop the responsibilities of each member, the representatives of the region for the Global Coordination Group (GCG) and the ROG coordinator were established. Likewise, strategy, tasks and schedule were agreed to carry out the collection of information, and the drafting of the first regional monitoring report, which was delivered in March 2009.

Since the first assessment to date, two global monitoring programs have provided information to the GRULAC region: the WHO Breast Milk Study and the GAPS Atmospheric Passive Sampling Program.

Since the second evaluation, projects have been implemented to generate information and strengthen the capacities of the regions called UNEP/GEF GMP, for its acronym in English. These projects have mainly been supported by the Secretariat, UNEP and the GEF; in addition to other donor countries, institutions such as SAICM and expert laboratories. In addition, GRULAC implemented a regional passive ambient air sampling project called LAPAN.

3.1. Meetings and workshops that support the activities of the Global Monitoring Plan in Latin America and the Caribbean

The first phase of the GMP was carried out in the period 2007 to 2009, including the collection of information and the corresponding regional reports. The global report was presented at COP 4, 2009, concluding that levels of POPs found could serve as a baseline for future evaluations.

The second phase of the GMP was implemented in the 2009-2014 period, and in November 2014 the Global Coordination Group (GCG) met to review the progress made by the regions in monitoring POPs during this second phase of the GMP. Regarding the GRULAC region, although 18 of the 33 countries that comprise the region contributed data to the report, these data were not consistent and sufficient to be able to assess trends and long-range transport. The need to create incentives for countries that have not yet participated in the GMP was highlighted, as well as the need to continue with the capacity building as a basis for the establishment of regional monitoring systems and also to continue with the air monitoring in the same existing sites to be able to perform future trend analysis (GCG, 2014).

At the GCG meeting in October 2015, the first steps towards the third phase of the GMP were outlined. The reestablishment of the ROGs, confirming the participation of their members for the implementation of the third phase and communication in the regions was emphasized. Relevant ongoing activities were also presented, specifically an overview of the UNEP/GEF GMP II regional projects for Africa, Asia, GRULAC and the Pacific Islands that generally started activities in early 2016. With the exception of GRULAC which started activities with its regional inception workshop held at the Basel Convention Coordinating Centre, Stockholm Convention Regional Centre for Latin America and the Caribbean (BCCC-SCRC) of Uruguay in December 2015 (GCG, 2015).

In the aforementioned Initiation Workshop of the UNEP/GEF GMP II Projects "Support for the Implementation of the Global Monitoring Plan for Persistent Organic Pollutants in Latin American and the Caribbean countries " organized by the BCCC-SCRC in Uruguay, the objective of these projects was presented: to strengthen the capacities of the region to implement a Global Monitoring Plan for POPs, creating the conditions for a sustainable monitoring of the 23 POPs listed by the Stockholm Convention at the time of project approval.

Likewise, people responsible for the air, water and milk programs of the participating countries were established, as well as the laboratories that would carry out the analysis of said samples in each country. The main activities of the project, the roles of the organizations, expert laboratories and participating countries were discussed (Workshop Report, 2015).

In addition, dates were agreed for the main activities of the project, the budget was discussed and clarified, and finally a schedule of activities was established with the commitments of each of the interested parties (countries, agencies, experts), objectives and observations (Workshop Report, 2015).

The projects would have a duration of four years and each project should ensure the conditions for successful implementation, developing capacities to strengthen national monitoring of POPs and generating data for the third evaluation.

Representatives of 11 GRULAC countries participated in this Workshop, as well as representatives of the United Nations Environment Program (UNEP), the Secretariat of the Basel, Rotterdam and Stockholm Conventions (BRS Secretariat), the United Nations Institute for Training and Research (UNITAR, for its acronym in English), as well as representatives of reference laboratories such as CSIC - Spain and experts from the University of Örebro (Workshop Report, 2015).

In October 2016 the GCG met again. In this meeting, the main activities and times for the development of the Report of the third phase of the GMP were defined; a schedule was also established that, due to the situation of the COVID-19 pandemic, became obsolete (GCG, 2016).

Also, at this meeting the regions presented their ongoing monitoring activities. The GRULAC region reported that air monitoring would be carried out by three programs: GAPS; the UNEP/GEF GMP project that would include 11 countries in the region (passive sampling) and an active sample; and LAPAN. The sampling of PFOS in water would be carried out in 5 sites within the same project, and the sampling of human milk in 12 countries (11 covered by the UNEP/GEF GMP project) and Costa Rica financed by the Secretariat (GCG, 2016).

In general, again of the 33 countries of the region, only 11 would participate with air samples and 12 with milk samples. The lack of good communication within the region and the limited supply of official information (mainly depending on academia and international studies) were also challenges in the implementation of the GMP in the region (GCG, 2016).

At its eighth meeting in 2017 (COP-8), the Conference of the Parties of the Stockholm Convention welcomed the Second Global Monitoring Report, which marked the end of the second phase of implementation of the Global Monitoring Plan and requested the Regional Organization Groups (ROGs) and the Global Coordination Group (GCG) to continue implementing the Global Monitoring Plan. This COP-8 marked the first evaluation of the effectiveness of the Stockholm Convention carried out in accordance with the adopted framework.

The GCG and ROGs meeting held in May 2018 in Brno, Czech Republic focused on reviewing the progress of the work on the implementation of the third phase of the GMP, including updating the Guidance document to consider the new listed POPs and considerations on monitoring the target matrices and data management (GCG, 2018). Regional strategies were also reviewed including monitoring arrangements and timelines to complete the third regional monitoring reports for its presentation at COP-10.

The ROG GRULAC presented the data generating activities for the third monitoring report in GRULAC. The GAPS network with the participation of 7 countries in the region and 9 monitoring sites: Argentina, Brazil (2), Bolivia, Chile, Colombia, Costa Rica and Mexico (2). The project financed by UNEP/GEF with 11 countries: Antigua and Barbuda, Argentina, Barbados, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico, Peru and Uruguay, with a passive air site in each country and two years of monitoring during 2017 and 2018, as well as an active air sampling in Brazil. The project also includes five water sampling sites (PFOS) in Argentina, Brazil, Ecuador, Jamaica and Mexico. The breast milk survey that was underway in 11 project countries, in which Haiti and Costa Rica also participate through the collaboration of the WHO/BRS Secretariats (GCG, 2018).

Other programs include LAPAN which covered 13 countries: Antigua and Barbuda, Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Honduras, Panama, Peru, Uruguay and Venezuela and 61 sites for passive air sampling. The ARCAL project "Improving the management of pollution by POPs to reduce the impact on people and the environment" that covers 10 countries: Argentina, Bolivia, Chile, Colombia, Costa Rica, Dominican Republic, Guatemala, Mexico, Paraguay and Uruguay. Samples include food, water, and breast milk (individual samples). The monitoring results were expected by the end of 2019, provided by national laboratories using the same methodologies. And finally, the national programs that were expected to contribute data to GMP-3 were the PRONAME (Mexico) and CETESB (Brazil) programs (GCG, 2018).

In July 2018, the Intermediate Regional Workshop of the UNEP/GEF GMP II project was held in Colombia. The national coordinators of the projects participated in this workshop: Coordinator/Head of air-water or Coordinator of breast milk from each of the eleven countries associated with the project, representatives of: the BRS Secretariat, UNEP, expert laboratories, WHO, representatives of the GAPS and LAPAN programs, the members of the GCG and Regional Coordinator of the UNEP/ GEF GMP II project, BCCC-SCRC.

The intermediate workshop was held to strengthen collaboration between project partners that support implementation in the GRULAC Region. The Global POPs Monitoring Plan was launched in early 2016 and by mid-2018, the progress of the sampling activities was consistent with the action plan. Experts from the laboratories in charge of abiotic air samples, CSIC of Spain and of PFOS in water, MTM of Sweden; reported progress and difficulties in customs due to the sending of samples to the CSIC.

The expert from the reference laboratory CVUA Freiburg / Germany, in charge of the WHO breast milk study, presented advances and historical analytical results of the breast milk survey, which show that some POPs such as PCDD/F, PCBs and DDT are considerably above safety limits. Based on these results, the importance of risk assessment was emphasized, and it was strongly recommended to identify a “safety standard”. To visualize the complete picture of exposure to POPs, continuous monitoring and analysis of new POPs was proposed (Workshop Report, 2018).

Regarding progress in capacity building, it was reported that 5 out of 11 countries have already received the training and that the instruments and materials for said capacity had already been supplied.

Likewise, the work of the three regional monitoring networks was presented: the GAP project financed by the Canadian government, the passive sampling atmosphere network of Latin America (LAPAN) financed by the Brazilian government and the ARCAL project in Argentina. Two countries Brazil and Jamaica presented the progress in their national activities. The organization and preliminary results of the third and fourth rounds of interlaboratory evaluation were also presented. The needs and arrangements to complete the sampling activities, draft national and regional reports, opportunities and challenges of POPs beyond GMP-2 were discussed and finally the participating countries were informed of the provisional planning for the sustainable monitoring of POPs and proposals on future steps to comply with the monitoring obligations of the new POPs (Workshop Report, 2018).

In October 2019, the GCG met again in Geneva to review the arrangements and tools in place for the preparation of the third regional monitoring reports and to update the GMP Guidance. The topics discussed were progress in the implementation of the Global Monitoring Plan third phase; the availability of data for its incorporation in regional reports; data management, analysis and interpretation; ongoing strategic alliances and planned activities for GMP-4, as well as relevant information for updating the GMP Guidance document and finally, considerations for sustainability.

Likewise, UNEP Chemicals organized a consultation on strategies to strengthen support mechanisms for POPs’ monitoring within the framework of the GEF GMP projects.

The progress in GRULAC region was presented by the ROG coordinator who presented information on the following ongoing activities in GRULAC:

- The GAPS network that covered 7 countries in the region: Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica and Mexico
- The UNEP/GEF GMP II projects that covered 11 countries: Antigua and Barbuda, Argentina, Barbados, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico, Peru and Uruguay, with a passive air site in each country and two years of monitoring, as well as active air sampling in Brazil. The project also includes five water sampling sites (PFOS) in Argentina, Brazil, Ecuador, Jamaica and Mexico
- The breast milk survey also under way by the same UNEP/GEF GMP II projects.
- LAPAN with 61 sites for passive air sampling in 13 countries: Antigua and Barbuda, Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Honduras, Panama, Peru, Uruguay and Venezuela; and
- The ARCAL Project “Improvement of Pollution Management by POPs to reduce the impact on people and the environment” that covered 10 countries: Argentina, Bolivia, Chile, Colombia, Costa Rica, Dominican Republic, Guatemala, Mexico, Paraguay and Uruguay, with samples that include food, water and breast milk (individual samples)

Likewise, it was reported that no relevant national information was collected through the survey sent to GRULAC by the ROG, therefore, most of the information for the PVM-3 report would be based on the results of ongoing regional programs, which were expected to be available through the GMP data warehouse (GCG, 2019).

3.2. Coordination of activities in the region

The main objective of the regional organization groups as established in their Mandate, annexed to decision SC-3/19, is to define and implement the strategy for the collection of regional information, including facilitating the improvement of technical and analytical capacities, and to produce regional monitoring reports. Among their duties are the following (POPS COP 3.SC-3/19, 2007):

a) Definition of it make up
b) Identifying where existing suitable monitoring data are and are not available
c) Developing a regional strategy for implementation of the global monitoring plan
d) Establishing and promoting regional, subregional and interregional monitoring networks wherever possible
e) Coordinating with the Parties involved sampling and analytical arrangements
f) Ensuring compliance with protocols for quality assurance and quality control, noting the examples described in the amended preliminary version of the guidance on the global monitoring plan for persistent organic pollutants for sample collection and analytical methodologies; for data archiving and accessibility; and trend analysis methodologies to ensure quality and allow comparability of data
g) For maintaining the interaction with other regional organization groups and the Secretariat as appropriate
h) Identifying capacity-building needs in its region
i) Assisting, for the purpose of addressing gaps, in the preparation of project proposals, including through partnerships
j) Preparing a summary of experiences in implementing the duties assigned in subparagraphs (h) and (i) above for transmittal to the coordinating group via the Secretariat
k) Preparing regional reports including, where appropriate, information from Antarctica
l) Encouraging transparency of communication and information dissemination within and between regions, noting the need for stakeholder involvement.

In the case of ROG-GRULAC, the composition of its members is reestablished and updated as of 2013, remaining the division of responsibilities of the six members of ROG GRULAC from the second phase of implementation of the Global Monitoring Plan, to facilitate communication with the countries of the region. This organization is presented in table 3 Division of responsibilities among the members of ROG-GRULAC; where the names of the members and the countries for which they are responsible are also included.

Table 3. Division of responsibilities among ROG-GRULAC members

GUYANA **Ms. Trecia David**	**BRAZIL** **Ms. Sandra De Souza Hacon**	**URUGUAY** **Ms. Alejandra Torre**	**COSTA RICA** **Mr. Rigoberto Blanco Sáenz**	**ECUADOR** **Ms. Carola Resabala Zambrano**	**MEXICO** **Mr. Arturo Gavilán**
Parties	Parties	Parties	Parties	Parties	Parties
Guyana	Brazil	Uruguay	Costa Rica	Ecuador	Mexico
Dominica	Venezuela	Argentina	Honduras	Peru	Bahamas
Saint Kitts & Nevis	Antigua & Barbuda	Chile	Nicaragua	Panama	Dominican Rep
Saint Lucia	Trinidad & Tobago	Paraguay	Belize	Colombia	Barbados
Saint Vincent & the Grenadines	Suriname	Cuba	Guatemala	Bolivia	Jamaica
			El Salvador		Signatories: Haiti

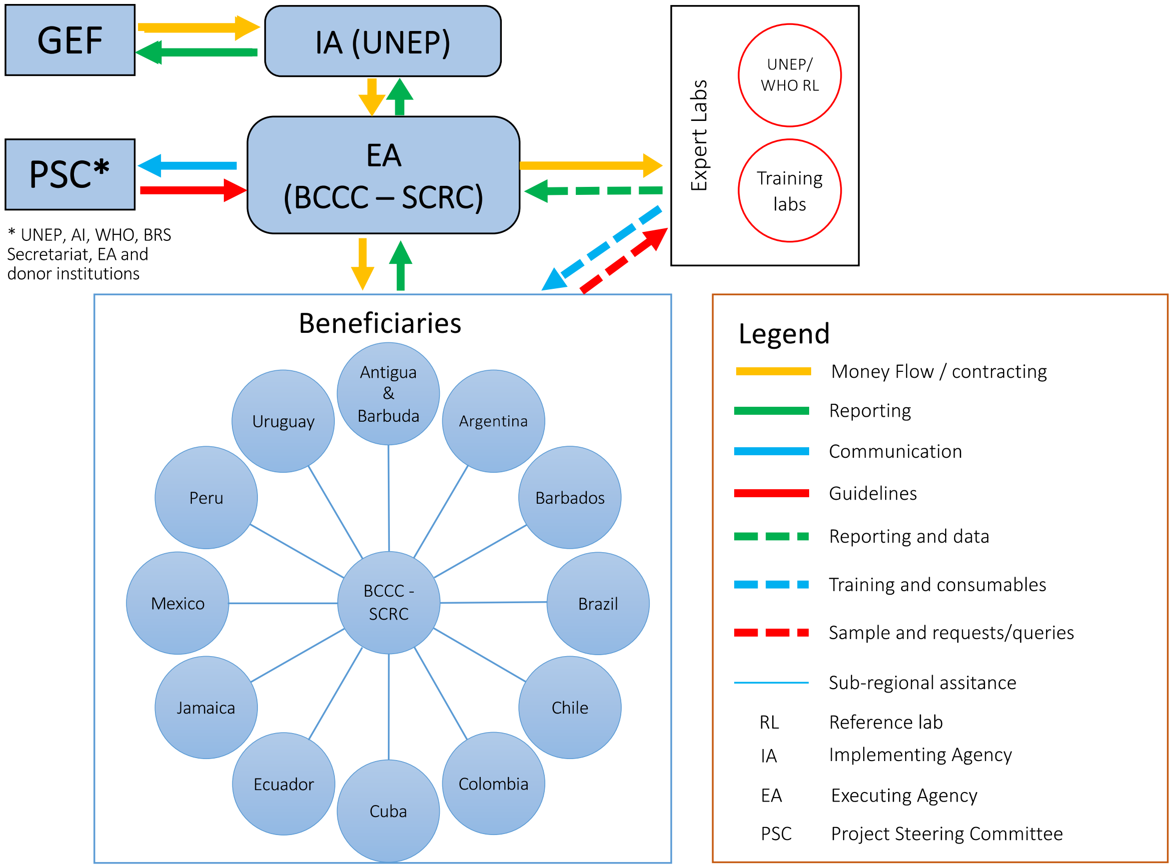
To apply the global surveillance plan in the region and in order to obtain reliable information required to evaluate the presence of chemicals included in Annexes A, B and C of the Stockholm Convention, as well as their transport in the environment at regional level, the ROG-GRULAC, from the beginning of its administration, agreed to collect information taking into account the provisions of article 16 of the Stockholm Convention. It was established that the Parties should make arrangements to obtain comparable monitoring data and that the strategies to collect the data should be applied using existing programs and mechanisms to the extent possible.

Likewise, to strengthen the technical and analytical capacities of the countries of the region and obtain quality information on exposure to POPs, the ROG has promoted among the countries of the region, with the support of UNEP and in close collaboration with the Secretariat of the Stockholm Convention, projects called "Support in the Implementation of the Global Monitoring Program for Persistent Organic Compounds (POPs) for the countries of Latin America and the Caribbean."

To date, two sets of projects have been implemented with financial assistance mainly from the Global Environment Facility (GEF), the Secretariat of the Stockholm Convention, contributions from the Strategic Approach to International Chemicals Management (SAICM) Trust Fund and from the European Union and governments like Norway. The first called UNEP/GEF GMP I, for its acronym in English, which was implemented from 2009 to 2012 and provided support to 12 countries in GRULAC and the second UNEP/GEF GMP II from 2016 to 2021, which provided support to 11 countries.

The Basel Convention Coordinating Centre and Stockholm Convention Regional Centre for Latin America and the Caribbean in Uruguay (BCCC-SCRC) has coordinated the implementation stages of the projects Support for the Implementation of the Global Monitoring Plan for Persistent Organic Pollutants (POPs) in Latin American and the Caribbean countries, providing assistance to the 11 implementing countries that, in this third phase from 2016 to 2019, were: Antigua and Barbuda, Argentina, Barbados, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico, Peru and Uruguay. It is worth mentioning that Argentina and Colombia did not participate in UNEP/GEF GMP I and were added to the UNEP/ GEF GMP II projects. Figure 8 presents the organization diagram.

Figure 8. Decision Making Flowchart and Organigram of GRULAC (UNEP/GEF GMP II projects)



Source: POPs GMP II GRULAC CEO Endorsement Request_16.12.2014.

This regional center, BCCC-SCRC, managed the project funds for the GRULAC region, distributed the resources, and assisted the participating countries. The 50% of the funds were awarded after the signing of the memorandum of understanding to equip the laboratories with all materials, solvents, standards, consumables and to start the project. The 30% or 35% was delivered after the first year and the first 3 activity reports, and 20% or 15% will be delivered at the end of the projects, after the submission of the final report.

The regional center follows the countries' work plan and sends reminders when the deadline is approaching. The center managed the funds for Ecuador, Peru, Chile and Uruguay. (Mid Term Review, 2019).

This latest UNEP/GEF GMP II project was implemented in close collaboration with the Spanish Council for Scientific Research, CSIC-IDAEA, Barcelona (Spain); UNEP-WHO Reference Laboratory; CVUA, Freiburg (Germany); and it also receives support from the BRS Convention Secretariat and the World Health Organization.

Through these UNEP/GEF GMP projects, the GRULAC region has received: resources for the sampling and analysis of POPs in the air, water and breast milk target matrices and in other matrices of national interest; capacity building at national level on the sampling and analysis of POPs, which includes the development of Standard Operating Procedures and training in national laboratories; and participation in interlaboratory evaluations of biannual POPs.

3.3. Strategy used to collect information

Once the ROG GRULAC was re-established, nominated their members who would represent it in the GCG and agreed the division of responsibilities for communication with the countries, as well as the organization and planning of the coordination activities of the UNEP/GEF II projects; the strategy on how to receive and use the information for the third report was developed and is described below.

First, possible sources of information in the region that could be useful to compile the information available on the target matrices of the GMP and compounds, POPs, required were identified. Three sources were identified:

1. World Programs (GAPs, AQUA GAPs and WHO)
2. Regional Programs (UNEP / GEF projects, LAPAN, ARCAL)
3. National Programs (PRONAME, CETESB, others to be confirmed)

Second, the Secretariat was asked, at the 2018 GCG and ROGs meeting held in Brno, to communicate officially with the Focal Points, introducing the ROG members, to establish contact with the countries of the region in order to find out if there were ongoing national programs that would provide data to the GMP.

Third, a questionnaire was prepared by the ROG-GRULAC considering the activities of the GMP. This questionnaire was sent since the end of 2019 by the members of ROG GRULAC according to their responsibilities. It was sent through the Focal Points requesting relevant information for the GMP and the effectiveness evaluation of the Stockholm Convention.

Of the 45 contacts from 32 GRULAC countries identified by the Secretariat, responses were only received from 9 countries: Argentina, Brazil, Ecuador, El Salvador, Colombia, Costa Rica, Panama, Paraguay and Uruguay. However, none of them provided data for the GMP; they only confirmed their participation in existing regional and global projects, or information of monitoring in other matrices or substances. None of them recognize national monitoring programs of the target matrices and compounds in progress.

Since no relevant national information was collected through the survey sent to GRULAC countries by the ROG, at the 2019 GCG meeting it was agreed that the information available for the GMP-3 report would be based mainly on the results of the global and regional ongoing programs.

The data from the global and regional programs identified in the region comply with the quality control and assurance requirements and follow the protocols established in the Guidance of the GMP and are incorporated, by the administrators of said programs, into the official Data Warehouse of the Global Monitoring Program, (GMP DWH), https://dmc.pops-gmp.org.

However, regarding the collection of information from local and national programs, ROG-GRULAC once again requested the secretariat to confirm with the focal points their obligations under the Stockholm Convention, requiring the submission of any available data to ROG-GRULAC. To date, no further information has been received.

It was also decided that the formats established by the official data repository, GMP DWH, would be used to supply the data. The evaluation of the available data would be carried out according to the data selection and data quality criteria described in the GMP Guidance. And finally, the official data repository, GMP DWH, would be used for data storage and archiving.

In conclusion, the ROG GRULAC members decided to use for the third evaluation only the GRULAC program information contained in the official data repository of the Global Monitoring Program (GMP DWH), https://dmc.pops-gmp.org; administered by the RECETOX Center (Research Center for Toxic Compounds in the Environment). In this site the data of the four target matrices of each region are harmonized: ambient air, human tissues (breast milk and blood) and surface water; and tools are provided for its visualization, management and analysis.

For this third evaluation and regarding the ambient air matrix, the UNEP / GEF GMP II project was strategically relevant to support two existing programs that provided information at the regional level:

- Global Atmospheric Passive Sampling network (GAPS)
- Latin American Passive Atmospheric Sampling Network (LAPAN)

The GAPs network was established in 2005 to measure to POPs listed in the Stockholm Convention and is run by a central laboratory at Environment and Climate Change Canada (ECCC, https://www.canada.ca/en/environment-climate-change/services/air-pollution/monitoring-networks-data/global-atmospheric-passive-sampling.html). This network implemented a special initiative in 2012, with the support of UNEP, to address the lack of information on emerging pollutants, candidates and new POPs in the GRULAC region. Data from 2014 to 2016 of eight GRULAC countries is available in the GMP DWH.

LAPAN's goal is to collect new air sample data, assess local and global sources of these pollutants, produce long-term temporary studies, and improve regional airborne sampling and analysis capacity. The data collected from LAPAN between 2010 and 2013 were included in the Second Surveillance Report of the GRULAC Region and for the third evaluation, data from 2015 to 2017 are available from eleven countries.

The availability of ambient air information incorporated into the data warehouse, GMP DWH, is summarized in chapter 4, where it is presented by monitoring program, participating countries, monitoring year and number of available parameters.

Regarding human tissues (human milk and blood), Brazil has been participating in WHO studies since 1992 and twelve countries since 2001, mainly with support from the UNEP/GEF GMP projects. To supply data for the GMP-3, support was again provided through these projects to 12 countries that were scheduled to participate; however, due to local problems related to the code of ethics, Brazil, Costa Rica and Chile did not deliver samples.

Concerning this information, it was agreed that for this evaluation only the data on breast milk from the year 2001 and later would be considered. Likewise, it was agreed that the blood data would not be considered in this third evaluation since there are no recent data and only there are blood data from the period 1997 to 2001 that were already considered in the reports of previous evaluations. The availability of information on human milk is also presented in chapter 4. In relation to human blood, table 4 presents the available information.

Table 4. Availability of Human Blood information, GMP DWH

Blood parameters						
Program	Country	1997	1998	1999	2000	2001
GMP 1	Brazil	11	11	3	2	1

In terms of surface water, the region has, for the third evaluation, information from the MONET-Aqua program whose samples were analyzed by the RECETOX center and with samples from 6 countries of the UNEP/GEF GMP projects: Argentina, Brazil, Ecuador, Jamaica, Mexico and Uruguay; whose samples were analyzed by MTM of Sweden. The availability of surface water information is presented in Chapter 4.

It is important to note that in the case of the air matrix, each of the programs establishes its own procedures to carry out its work, which includes different laboratories for each program. The samples from the LAPAN program are analyzed by the RECETOX; GAPS program samples are analyzed by the ECCC and Air-GEF samples resulting from UNEP/GEF GMP projects are analyzed by CSIC-IDAEA and PFOS by MTM.

Since the use of different analytical laboratories is a major source of variance, the ROG concluded that it would be very difficult to achieved comparability among programs. Therefore, efforts were focused on promoting comparability within the same programs over time for both the present and the future. While this conclusion means that direct comparability between regions will generally be very limited, significant exceptions are evident, for example, when a program operates in multiple regions using a centralized analytical laboratory serving all regions, such as the case of the human milk study coordinated by the WHO (World Health Organization) that exclusively uses the CVUA laboratory in Freiburg, Germany, or the GAPS program.

3.4. Implementation plans developed and applied in the region based on the global framework

Article 7 of the Stockholm Convention establishes that "each party shall develop and endeavor to implement a plan for the implementation of its obligations under this Convention; transmit its implementation plan to the Conference of the Parties within two years of the date on which this Convention enters into force for it; and will review and update, as appropriate, its implementation plan on a periodic basis and in the manner specified by a decision of the Conference of the Parties " (UN, 2018b). To date, 30 GRULAC countries have submitted their initial plan, but only two have complied with all the required amendments, as shown in table 5.

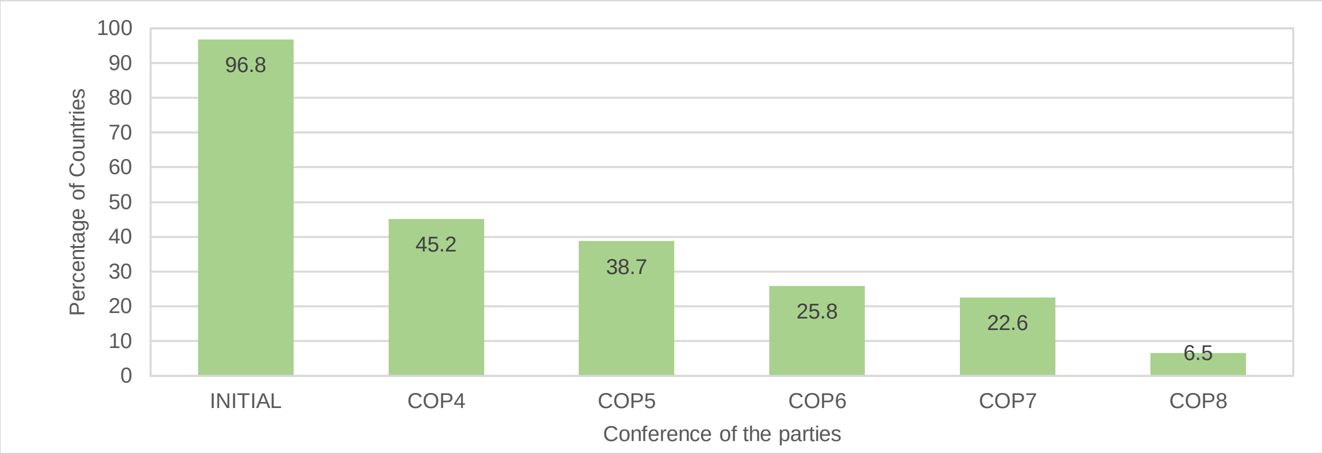
Table 5. National Implementation Plans amended by GRULAC parties (NIP, 2004-2018)

Party	Initial NIP	NIP amended according to the COP				
		COP 4	COP 5	COP 6	COP 7	COP 8
Antigua & Barbuda	1					
Argentina	1	1	1			
Bahamas						
Barbados	1					
Belize	1					
Bolivia (Plurinational State of)	1					
Brazil	1	1	1			
Chile	1				1	
Colombia	1	1	1	1	1	
Costa Rica	1	1	1			
Cuba	1					
Dominica	1					
Dominican Republic	1					
Ecuador	1					
El Salvador	1	1				
Guatemala	1	1	1	1		
Guyana	1					
Honduras	1	1	1			
Jamaica	1					
Mexico	1	1	1	1		
Nicaragua	1					
Panama	1	1	1	1	1	1
Paraguay	1	1	1	1	1	
Peru	1					
Saint Lucia	1					
Saint Vincent & the Grenadines	1					
San Cristóbal y Nieves	1	1	1	1	1	
Suriname	1	1				
Trinidad & Tobago	1	1	1	1	1	1
Uruguay	1	1	1	1	1	
Venezuela (Bolivarian Rep. of)	1					
TOTAL	30	14	12	8	7	2

Figure 9 also shows how compliance in the delivery of amendments to the National Implementation Plans (NIP) has decreased since the percentage of countries that meet the Conferences of the Parties' (COPs) requirements has also decreased.

In relation to article 11 of the Convention, research, development and surveillance, three countries show the capacity to implement monitoring programs (Brazil, Colombia and Mexico), but only two countries (Argentina and Mexico) clearly establish the future planning of national POPs monitoring programs in their NIPs. The other countries report participation in regional or world programs, other activities related to surveillance such as: emissions' inventories, PRTR implementation, releases sampling, among others; monitoring activities through the promotion of research and others are evaluating the implementation of monitoring at national level, but there is no scheduled date yet. The same situation occurs in the National Reports, the status of which is described below.

Figure 9. Percentages of countries that met COPs NIPs amendments



Article 15 of the Stockholm Convention establishes that "Each Party shall report to the Conference of the Parties on the measures it has taken to implement the provisions of this Convention and on the effectiveness of such measures in meeting the objectives of the Convention." (UN, 2018b). The periodicity of these national reports is every four years in accordance with the provisions of the first meeting of the Conference of the Parties, decision SC-1/22 (POPS COP 1.SC-1/22, 2005).

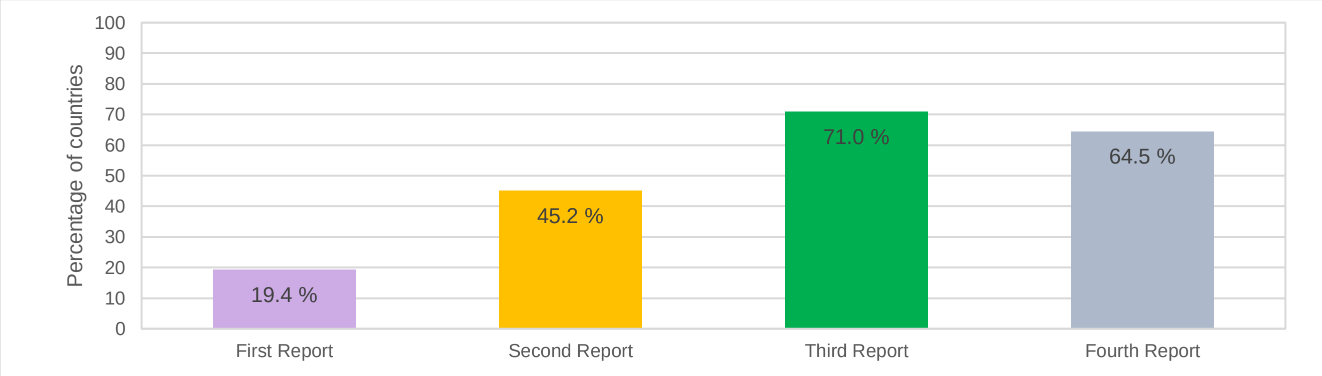
The dates of presentation of these reports in the GRULAC region are indicated in table 6, where it is observed that 6 countries have not presented any report and that only 4 countries have presented all the reports. The general status of compliance of the countries in the region is presented in figure 10. where an improvement is observed since more than 50% of the countries of the region presented the reports of cycles 3 and 4.

Table 6. Status of submission of National Reports in the GRULAC Region

Party	Cycle (due date on report submission)			
	1 (30/12/2006)	2 (31/10/2010)	3 (31/08/2014)	4 (31/08/2018)
Antigua & Barbuda	17/02/2009		03/05/2016	
Argentina	15/08/2008	29/10/2010	29/08/2014	08/01/2019
Bahamas				
Barbados				
Belize				
Bolivia (Plurinational State of)			15/03/2016	31/08/2018
Brazil	17/04/2007	11/04/2010	09/09/2014	31/08/2018
Chile	28/12/2006	27/10/2010		27/08/2018
Colombia		11/05/2010	02/09/2014	31/08/2018
Costa Rica	22/12/2006	29/10/2010	10/12/2014	05/09/2018
Cuba			10/05/2016	05/09/2018
Dominica				
Dominican Republic				
Ecuador		12/12/2010	01/09/2014	30/10/2018
El Salvador			01/09/2014	30/08/2018
Guatemala		12/03/2010	29/08/2014	
Guyana			13/04/2016	29/08/2018
Honduras		27/01/2012	31/08/2015	
Jamaica			03/05/2016	
Mexico	28/07/2007	29/10/2010	29/08/2014	09/11/2018
Nicaragua			30/04/2016	01/09/2018
Panama		28/10/2010		
Paraguay		08/02/2011	01/05/2016	02/10/2020
Peru		25/01/2012	12/09/2014	29/08/2018
Saint Kitts & Nevis			09/05/2016	13/12/2018
Saint Lucia			06/05/2016	30/01/2020
Saint Vincent & the Grenadines				
Suriname				16/08/2019
Trinidad & Tobago			18/12/2014	27/08/2018
Uruguay		30/10/2010	30/08/2014	11/01/2019
Venezuela (Bolivarian Rep. of)		29/10/2010	25/05/2015	04/09/2018
TOTAL	6	14	22	20

Source: http://ers.pops.int/eRSodataReports2/ReportSC_Submit_Status.html.

Figure 10. Percentages of countries that complied with the presentation of National Reports



Figures 11 and 12 show respectively the number of NIPs submitted by each country and the number of national reports. In the case of NIPs, the number 1 corresponds to the initial NIPs. Note that 50% of the countries have only submitted the initial NIP.

Figure 11. Number of NIPs submitted by each country

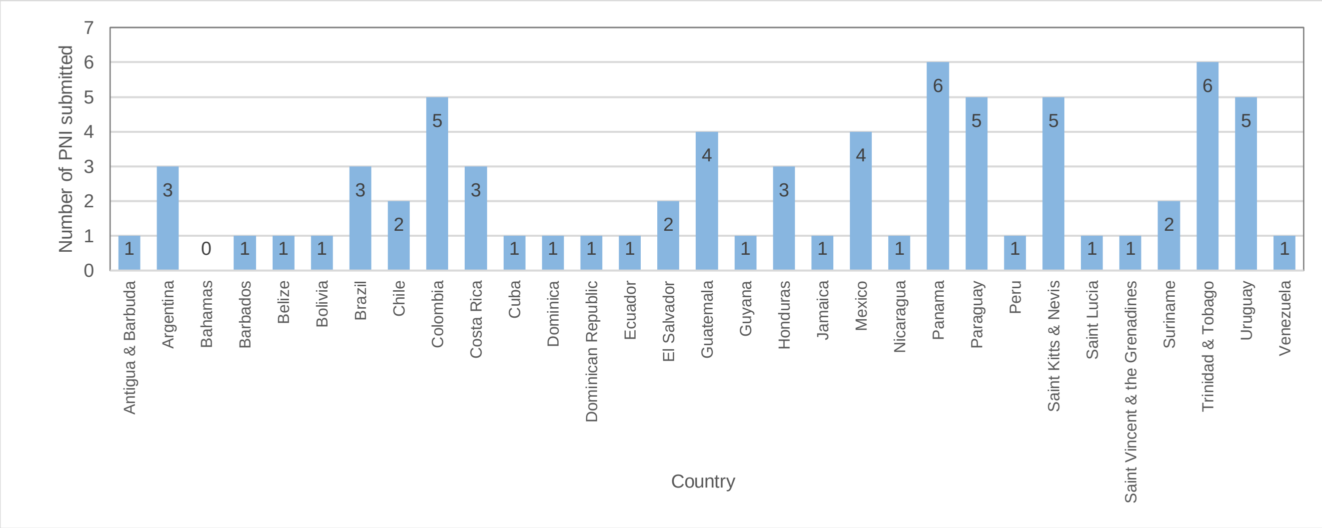
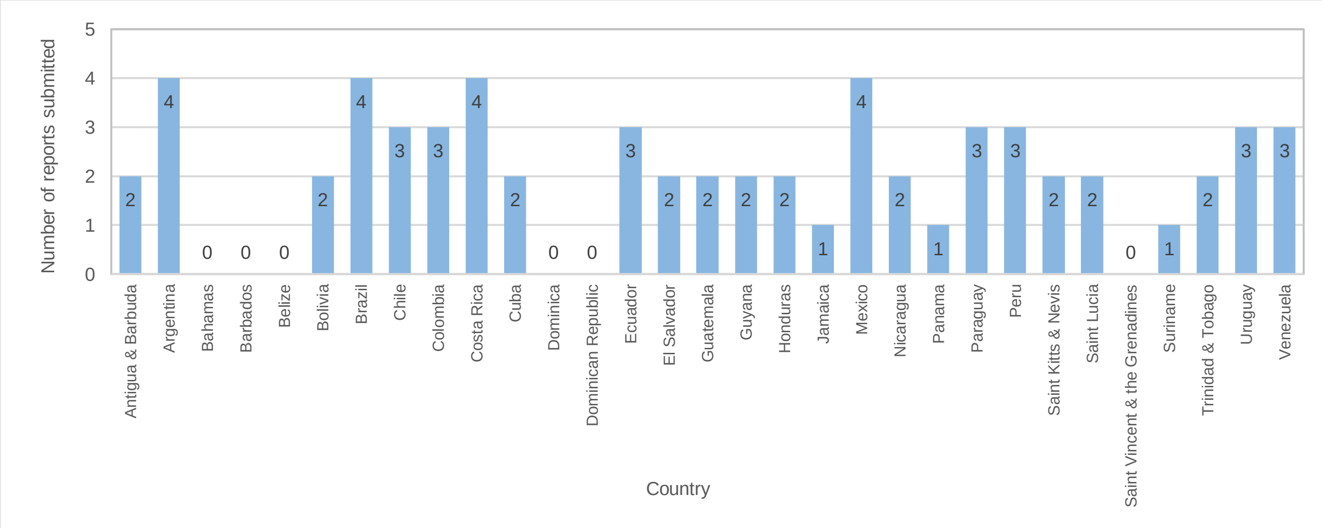


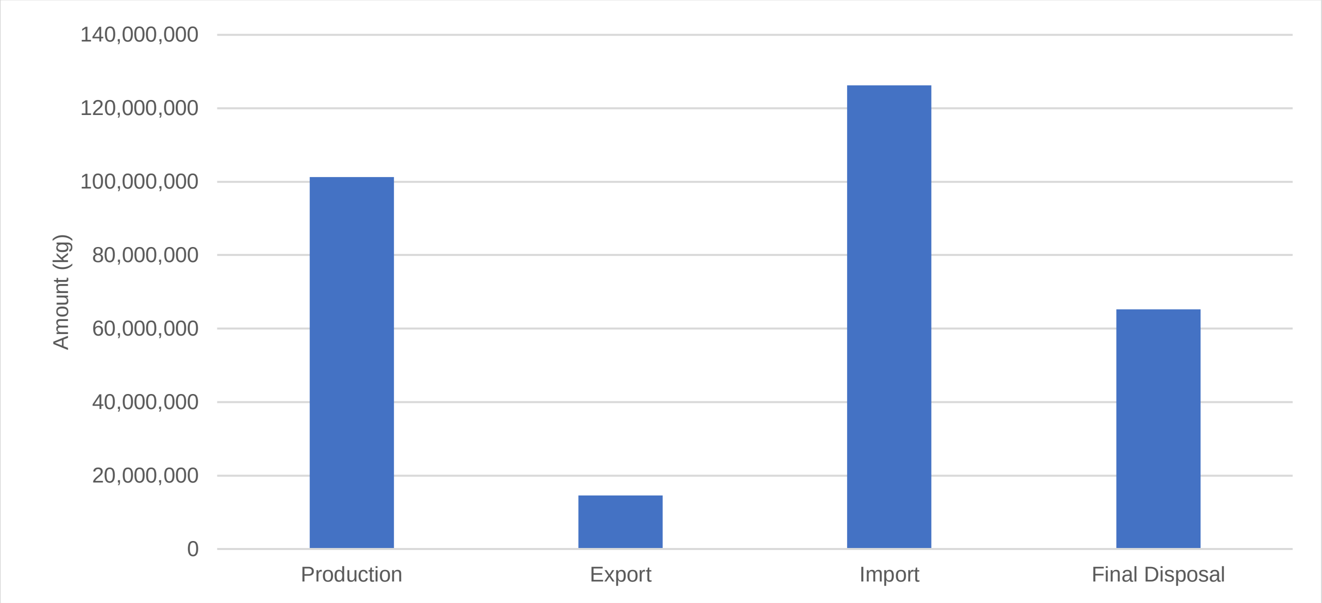
Figure 12. Number of National Reports presented by each country



Likewise, in the case of National Reports, 60% of the countries that have submitted reports have only submitted 1 or 2 reports. From the information of 20 countries of the fourth reporting cycle (2014-2018) it can be deduced that:

- Only two countries Brazil and Mexico Produce POPs.
- Seven countries report exports
- Ten countries report imports
- Ten countries report final disposal of POPs

Figure 13. Totals of production, export, import and final disposal of POPs



Source: http://www.pops.int/Countries/Reporting/ReportingDatabase/tabid/7477/Default.aspx.

4. METHODOLOGY FOR SAMPLING, ANALYSIS AND HANDLING OF DATA

In GRULAC Region there are global monitoring programs running since the first application of the Global Monitoring Plan (GMP) for the biotic and abiotic target matrices that were evaluated and selected for the reliability of their sampling and analysis procedures and the capacity of their laboratories. These procedures have provided the guideline for the development of standard operating procedures for sampling and analysis that are used in the region and have supported the GMP Guidance.

To date, as described in Chapter 3, there are three levels of information sources in the region:

1) World Programs (GAPS and WHO)
2) Regional Programs (UNEP/GEF, LAPAN projects, Monet Aqua, ARCAL RLA / 5/069 project)
3) National Programs (PRONAME, CETESB, and the Colombian POPs Monitoring Network)

However, the official data repository of the Global Monitoring Plan (GMP DWH), https://dmc.pops-gmp.org, has only incorporated information from: the global GAPS and WHO programs; the regional networks for UNEP/GEF projects and LAPAN; and the Colombian POPs Monitoring Network, which presents local data on PCDD and PCDF and PCBs. From this last network, it is unknown if the procedures used for the sampling and analysis of POPs are compatible with the procedures recommended in the GMP Guidance and if its objectives are aligned with said plan.

As of January 4, 2021 there were data from 111 air monitoring sites of these programs incorporated into the DWH, of which 6 are doubled because they are mirror sites, and 19 countries participate, to evaluate the ambient air matrix in periods of time between the years 2004 to the year 2018; 9 water monitoring sites in 8 countries, with information from 2014-2015 and 2016-2019; and human milk data from 14 countries that have participated in one or more of the six rounds of the WHO breast milk study, conducted between 1992 and 2019 (Annex 1).

4.1. Strategy for gathering new information

The strategy of the ROG GRULAC to collect new information consisted of developing and sending a questionnaire to 32 countries in the region to find out the information generated, at the national level, on concentrations of POPs in the target matrices of the GMP, their analytical capacities and actions related to the monitoring of POPs that are planned to be implemented in the future. However, responses were only received from 9 countries, of which 2 only reported their analytical capabilities and the remaining 7 reported participation in global programs and in UNEP / GEF GMP projects. Although some carry out POPs monitoring mainly in food, soils, marine waters and sediments among other matrices, none reported an ongoing national program related to the target matrices and POPs, and that applied the Guidance of the GMP.

Due to the above and as described in Chapter 3, the members of ROG GRULAC decided to use for the third evaluation only the information from GRULAC contained in the official data repository of the Global Monitoring Plan. The evaluation of the available data, as has been commented, was carried out in accordance with the criteria and data quality described in the GMP Guidance.

With the exception of the monitoring data from Colombia, the monitoring programs that contributed data to GRULAC have their objectives aligned with the objectives of the GMP, which includes the selection of target matrices (air, water, and breast milk) and substances the definition of monitoring sites, sampling frequency, sampling procedures and analytical methods.

To guarantee the representation of these programs in both time and space, the database was reviewed, separating it by target matrix and by program. The procedure followed to manage this database is described in section 4.3 Data Management.

Regarding the biotic and abiotic target matrices, for this third evaluation phase, the region meets the criteria established in the Guidance on the required number of passive air sampling sites, as well as active sampling. Because the Guidance establishes that, to represent each region there must be at least one active site and a network of 10 to 15 air passive sampling sites, and in the GRULAC region for the third evaluation an active sampling site and 10 passive sampling sites were deployed under the UNEP/GEF GMP II project that supplied data to the GMP DWH. However, the active site data was not incorporated into the DWH.

According to the GMP Guidance, the objective of the ambient air sampling network is to obtain representative data to assess baselines and changes in time and space and regional and global transport of POPs. Where "representative" is interpreted as a sufficient number of sampling sites to draw general conclusions about trends in POPs and long-range transport. Complete geographic coverage for a particular region or continent is not economically feasible and would require an extremely dense sampling network and prior research work to assess regional variability of ambient air concentrations of POPs. (Draft UNEP Guide, 2019)

The selection of sites to sample POPs in Air has been carried out in accordance with the protocols established in the GMP Guidance for POPs, which establishes that the combination of several active long-term sampling sites complemented with a greater number of passive sampling sites will produce a cost-effective program with flexibility to address the objectives of the GMP. Regional availability of laboratories and consideration of sources and air transport routes will influence the spatial Configuration and density of the network. (Draft UNEP Guide, 2019)

Regarding human tissues (maternal milk and blood), as discussed in Chapter 3, since 1992, Brazil has been participating in the studies; in 2004, Haiti was integrated; and, as of 2007, 12 more countries began to be integrated, giving a total of 14 participating countries, mainly with support from the UNEP/GEF GMP, MILK WHO, WHO projects and the Secretariat of the Stockholm Convention. In the sixth round 2015-2019, also discussed in chapter 3, support was provided through these projects to 12 of the 14 countries, however, due to local problems, Brazil, Costa Rica and Chile did not deliver samples. Thus, the GMP DWH repository only has data from 9 countries for this round. The protocol recommends taking a pooled sample of breast milk for every 50 million inhabitants. In the case of countries like Brazil and Mexico, which exceed 100 million inhabitants, more combined samples should be taken. However, despite the fact that Brazil requested to submit more than one sample, this could not be carried out. In the case of this sixth WHO breast milk round, each country submitted a single pooled sample.

Regarding the water matrix, the results of this third evaluation will be used to determine Regional baseline levels of PFOS, PFOA and candidate PFHxS in water, due to the limited information available. To carry out this sampling, two methodologies have been applied in the region: passive sampling through exposure for several months of a sorbent material, and direct sampling, which is recommended by the GMP Guidance for water monitoring (Weiss et al., 2015). The sampling frequency should be realistic in terms of the number of samples (costs and logistics), but still represent a statistically valid set of samples to fulfill the purpose of monitoring. Generally, 4 samples are taken per year at each selected site, but the number of samples depends on the method and the objective set. Surface water samples could be used to view temporal and regional variations and the sampling frequency should be high enough to filter out short-term variability (e.g., precipitation events).

In the previous reports of the Monitoring Plan in the Latin American and the Caribbean region, an evaluation of the transport of POPs was not carried out. This analysis is now intended to be included in this report, as it allows for a better understanding of POP concentrations and trends at a particular site through an assessment of transport routes on a local and if possible, on a regional scale. To do this, it requires an understanding of local (mesoscale) as well as large-scale (synoptic) air transport routes to the site. This is achieved through local meteorological measurements to characterize mesoscale influences, as well as the use of Lagrangian or Eulerian transport models to reconstruct large-scale transport routes to the site. It is also important that, for water soluble POPs, ocean and river transport and air-water exchange are considered, especially for coastal sites.

This last evaluation is not intended to be carried out in this report. A common transport route analysis tool that can facilitate the detection and interpretation of trends in concentrations of POPs in the air is based on the analysis of the return path of the aerial parcels. In this approach, the air transport path to a site during sampling is reconstructed from the observed wind fields (Draft UNEP Guide, 2019).

Following, the information available by matrices and programs is reviewed, according to the procedure described in section 4.3. The analysis and results will be reported in Chapter 6.

4.1.1. AIR

Ambient air is one of the GMP target matrices to determine trends and long-range POPs transport. Therefore, since 2004, in the GRULAC region, 107 parameters have been monitored with passive air samplers and 106 sites have been deployed in 19 countries by the following three programs:

- Global Atmospheric Passive Sampling (GAPS)
- Global Monitoring Plan (GMP) for Persistent Organic Pollutants (POPs), in the countries of Latin America and the Caribbean (AIR - GEF, by the acronym used in the DWH)
- Latin American Passive Atmospheric Monitoring Network (LAPAN)

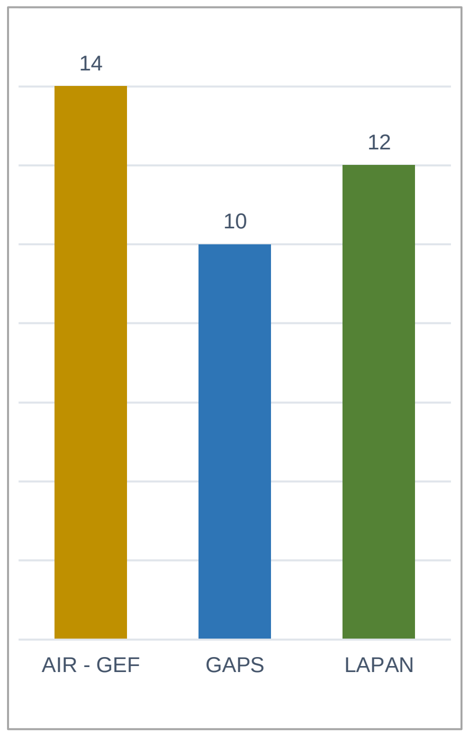
This section describes each of these programs, including the location and description of the monitoring sites and parameters sampled per year. It should be mentioned, as explained in Chapter 3, that the data from each of these programs will be handled and analyzed separately due to the differences in their procedures, and to guarantee the homogeneity and representativeness of the data in the comparisons between sites and the calculation of trend.

Programs that provided data by country. In the review of the GMP DWH database, it is found that the air sampling of the referred programs was carried out in 19 countries; being UNEP/GEF GMP II (AIR - GEF) applied in 14 countries; GAPS in 10 countries and LAPAN in 12 countries over 15 years of monitoring (see Table 7 and Figure 14). In Figure 14, it can be seen that AIR -GEF is the program applied in more countries followed by LAPAN.

Table 7. Countries and Programs that provided POPs' air data

No.	Country	AIR - GEF	GAPS	LAPAN
1	Antigua & Barbuda			
2	Argentina			
3	Bahamas			
4	Barbados			
5	Bolivia			
6	Brazil			
7	Chile			
8	Colombia			
9	Costa Rica			
10	Cuba			
11	Ecuador			
12	Haiti			
13	Honduras			
14	Jamaica			
15	Mexico			
16	Panama			
17	Peru			
18	Uruguay			
19	Venezuela			

Figure 14. Number of countries per program



Location of sites. The following map (Figure 15) shows the location of the sites of the three mentioned programs. These sites are cataloged as 22 remote, 6 rural, 43 urban, and 29 unclassified. Table 8 lists the 6 mirror sites and the corresponding programs, that is, sites where samplers from two different programs were placed in parallel.

Figure 15. Air monitoring sites' location

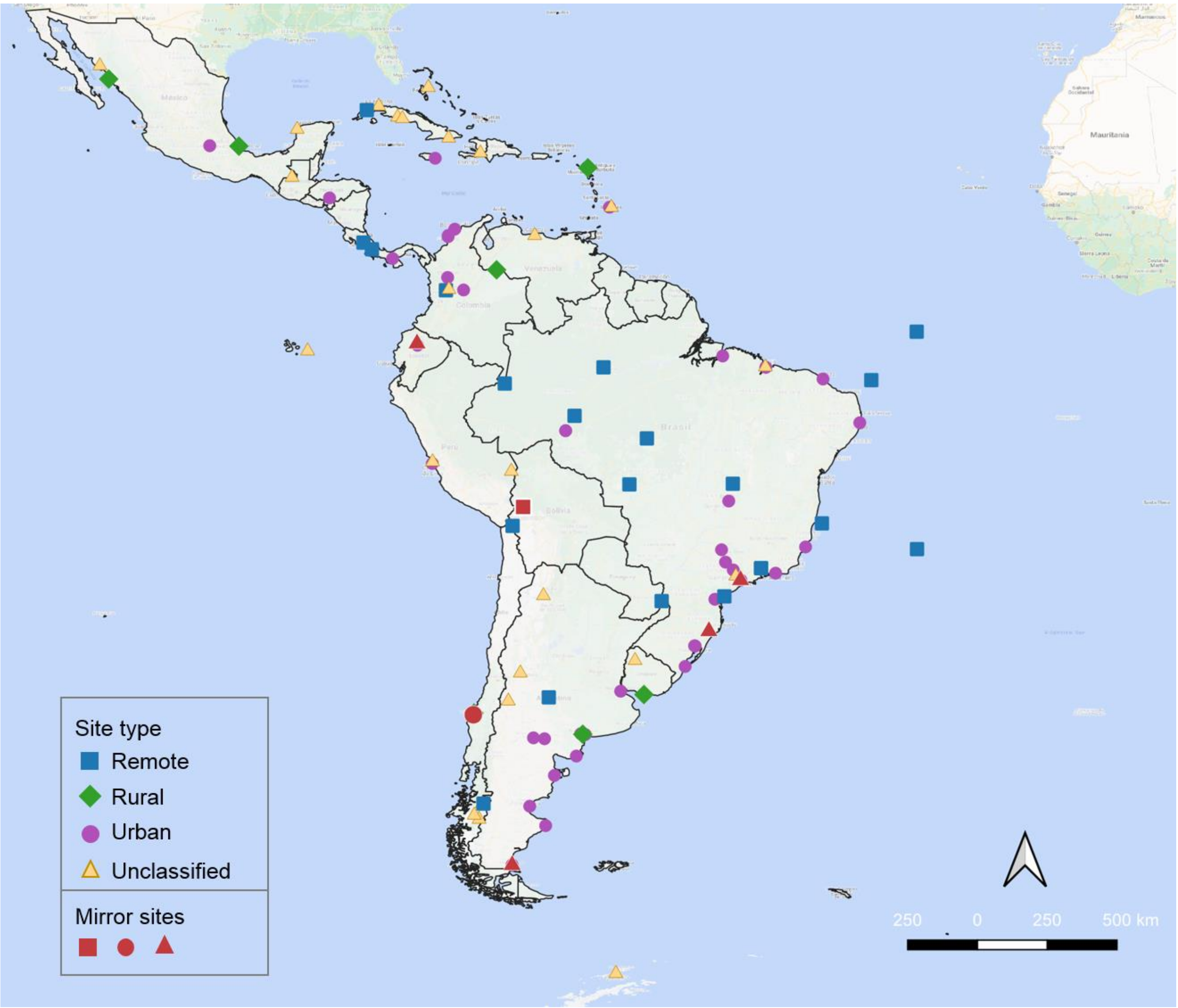


Table 8. Air sampling mirror sites

Site	Country	AIR - GEF	GAPS	LAPAN
Chacaltaya	Bolivia			
Concepción	Chile			
Quito	Ecuador			
Rio Gallegos	Argentina			
Sao Jose	Brazil			
Sao Paulo	Brazil			

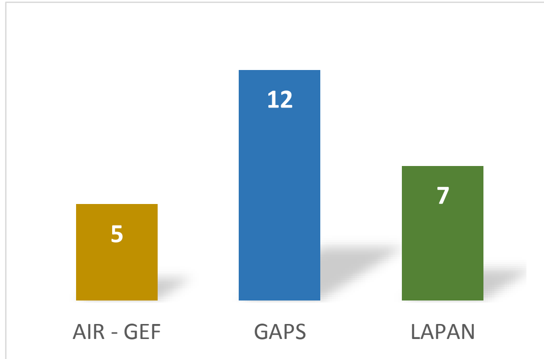
Years in which the programs were applied. Table 9 shows the years in which the Programs were applied. There, it can be seen that the UNEP/GEF GMP projects were implemented in two periods, the first from 2010 to 2011 and the second from 2016 to 2018. The GAPS Program has operated from 2004 to 2016 and the LAPAN Program from 2010 to 2016.

Number of years sampled by Program. The graph in Figure 16 shows the number of years in which the programs have been applied: UNEP/GEF GMP II (AIR-GEF) 5 years, GAPS 12 years and LAPAN 7 years.

Table 9. Years in which the Programs were applied

No.	YEAR	AIR - GEF	GAPS	LAPAN
1	2004			
2	2005			
3	2006			
4	2007			
5	2009			
6	2010			
7	2011			
8	2012			
9	2013			
10	2014			
11	2015			
12	2016			
13	2017			
14	2018			

Figure 16. Number of years sampled by Program



Number of sites sampled by Program. According to the data record in the GMP DWH, Figure 17 shows the number of sites sampled per program. With the UNEP/GEF GMP II projects (Air-GEF), 21 sites were sampled, with GAPS 29 sites and with LAPAN 56 sites.

Number of sites sampled per year and Program. When analyzing the data by year and program, the UNEP/GEF GMP II projects (Air-GEF) in their second period (2016-2018), were only applied in 10 sites (see Figure 18), in contrast to the first period (2010 - 2011) that was in 16 sites. The largest number of sites sampled in the LAPAN Program is concentrated between 2014 and 2015, while the GAPS Program shows greater consistency, since it has been applied in an average of 7 sites per year from 2004 to 2016.

Figure 17. Number of sites sampled per Program

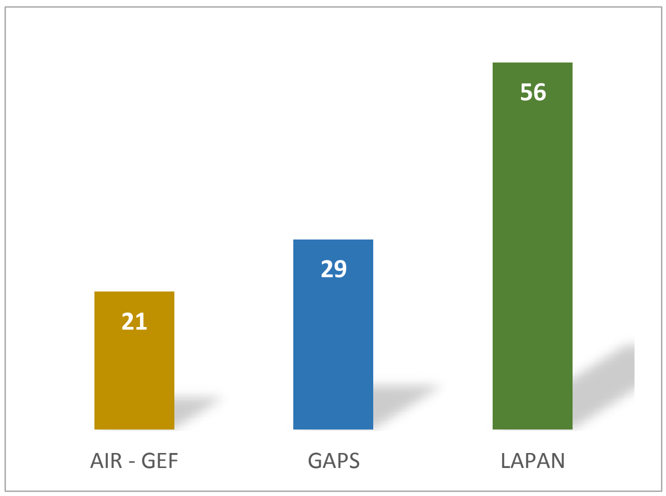


Figure 18. Number of sites sampled per year and program

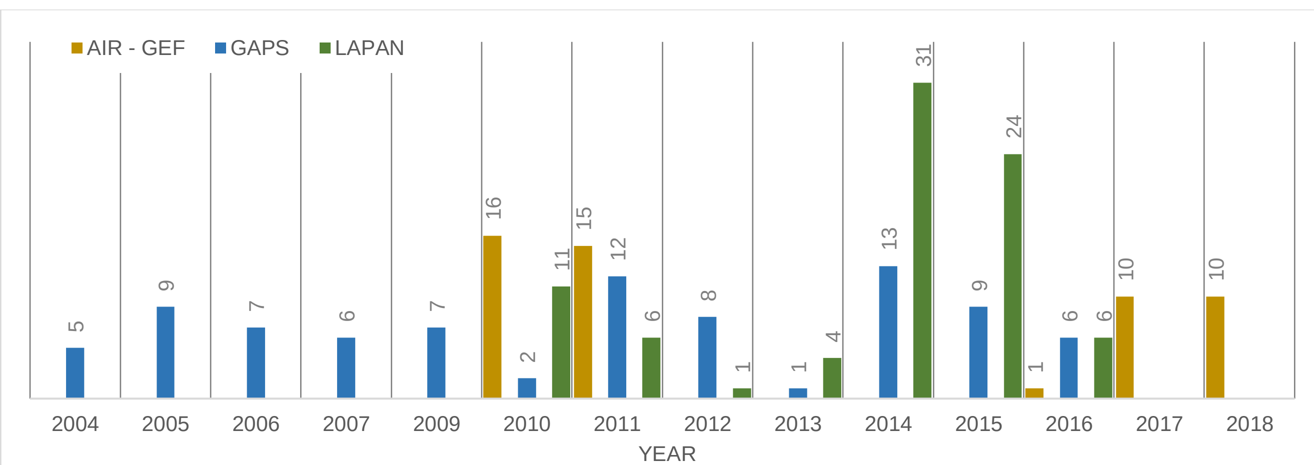
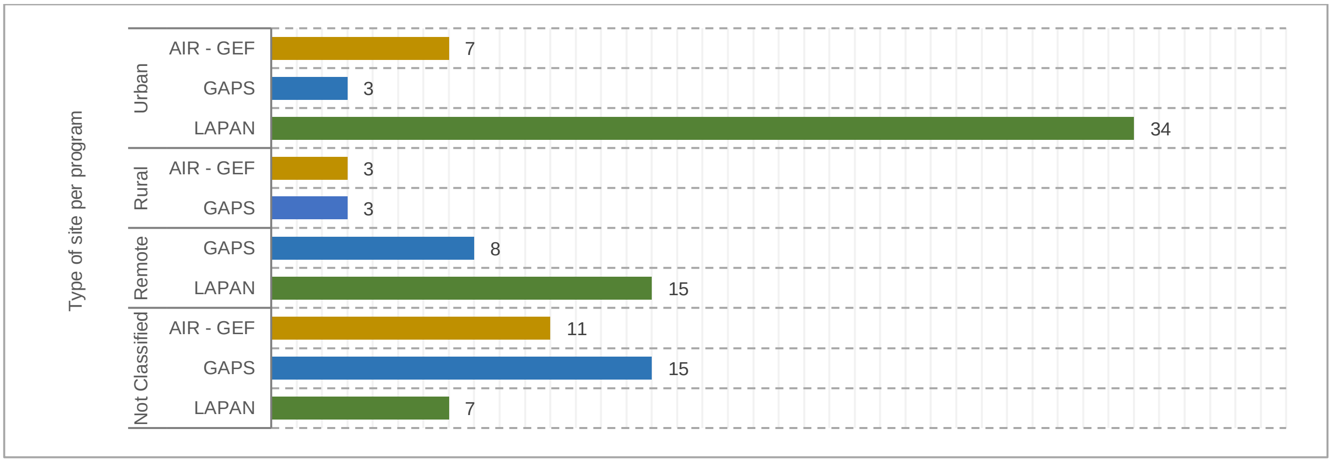


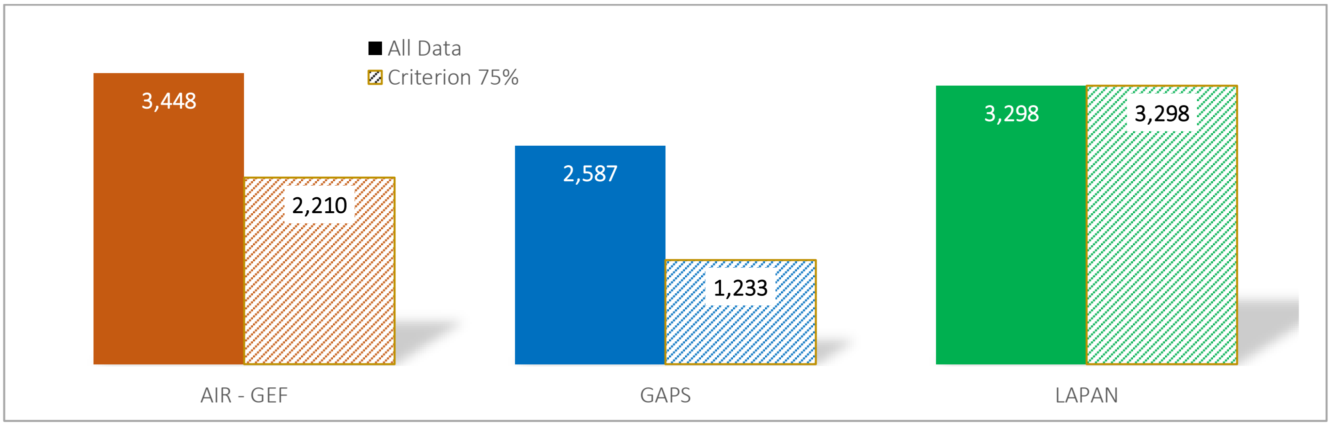
Figure 19 shows the distribution of sampling points by programs and type of sites. It is noteworthy that the sampling sites that participated in the LAPAN program are mostly classified as urban. In contrast, many sites that participated in the UNEP/GEF GMP II and GAPS programs were not classified.

Figure 19. Type and number of sites per program



Completeness of data. After analyzing the sampling sites by program, year and type of site, it is observed that data availability decreases when applying the completeness criterion of 75% data sufficiency per monitored year (Figure 20). In other words, the image shows that when applying the criteria in the AIR - GEF and GAPS databases almost 40% of the data is lost, while in LAPAN all the data is kept.

Figure 20. Amount of data available per Program and data available with the 75% criterion



Prevalence of sampling sites In Figure 21. It can be seen that more than half of the sites (57%) have only operated one year, 26% of the sites have operated two years, 14% three and only one site has operated for 4, 5 and 6 years. In Figure 22 the sites with completeness are listed, that is, those that measured for more than 75% of the calendar year and collected at least three samples in the year, and the number of years they have operated.

Figure 21. Percentage of sites that have operated for 1 year, 2 and more years

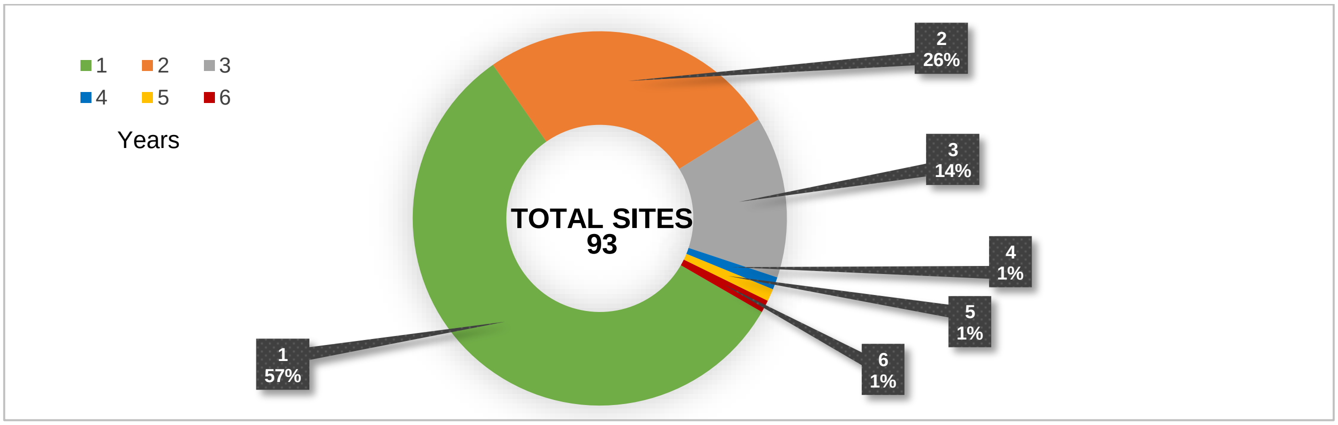
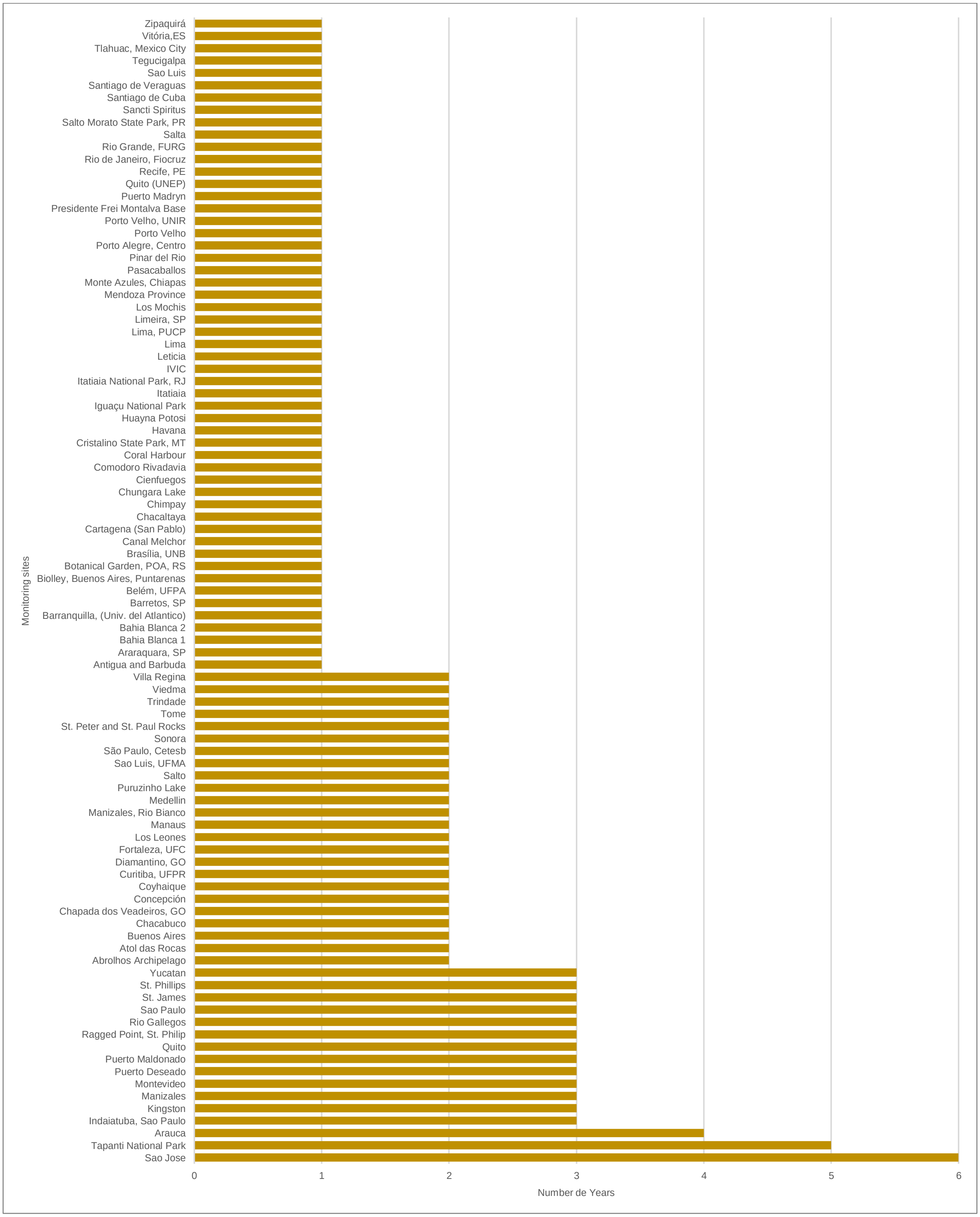


Figure 22. Sites with completeness and years of operation



The review of each of the indicated data sources is presented below and the description of the Colombian POPs Monitoring Network is included in section 4.1.1.4.

4.1.1.3. UNEP/GEF GMP II Project (AIR - GEF)

The UNEP/GEF GMP projects began in 2005 and are scheduled until 2020. Unlike the other monitoring programs, the GEF projects have supported the GMP from the beginning with various activities such as the development of the laboratory data bank; the elaboration of standard operating procedures; training of laboratory technicians for the development of capacities; and the training of the countries on the subject of monitoring and analysis of POPs. In total, 45 developing countries have participated in training activities, including 14 GRULAC countries, with an emphasis on sampling the basic GMP matrices and on-site training of laboratories in developing countries in the analysis of POPs. The air monitoring data is obtained from passive PUF air samplers exposed for three months, which are analyzed by the national and reference laboratories and data from the latter are incorporated into the GMP DWH with the support of UNEP Chemicals, the secretariat and RECETOX.

These projects use, as mentioned, the passive polyurethane foam disc (PUF) sampling method, so that, like the GAPS program, to guarantee the quality and representativeness of each year, it is required to have at least three out of four discs exposed at each monitoring site per year. Additionally, in the period 2016 - 2018, an active sampler was installed in Brazil in parallel with the passive one, however, there was no information on this sampler.

The UNEP / GEF GMP II project in the Latin American and Caribbean Region (GRULAC) was implemented from 2016 to 2018. It was coordinated by the Uruguay Regional Center (CCCB-CRCE) and provided assistance to the 11 implementing countries, namely, Antigua and Barbuda, Chile, Mexico, Argentina, Colombia, Peru, Barbados, Ecuador, Uruguay, Brazil and Jamaica. But due to the delay in Peru's monitoring the results of the analysis have not yet been incorporated into the DWH. This project was carried out in close collaboration with the Spanish Council for Scientific Research, CSIC-IDAEA, Barcelona (Spain); Swedish MTM Laboratory and also received support from the BRS Secretariat.

Location of UNEP/GEF GMP Projects sites. The UNEP/GEF GMP Projects covered the four subregions of Latin America and the Caribbean with 21 monitoring sites distributed in 14 countries as shown in Figure 23, of which 3 are rural, 7 urban and 11 unclassified.

Prevalence of sites per year. In Table 10 and 11, respectively, the sites and parameters monitored during the UNEP/GEF GMP I and II Projects are listed. As already mentioned, the two Projects were applied in 21 monitoring sites located in 14 countries in total.

Figure 23. Location of UNEP/GEF GMP I y II projects' monitoring sites

The first was applied from 2010 to 2011 in 16 monitoring sites and the second from 2016 to 2018 in 10 sites, of which only five sites prevailed and delivered results in the two Projects, these are: St. Phillips (Antigua and Barbuda), St. James (Barbados), Sao Paulo (Brazil), Kingston (Jamaica) and Montevideo (Uruguay).

Table 10. UNEP/GEF GMP sites prevalence. Years of sampling per site

No.	Country	Site	2010	2011	2016	2017	2018
1	Antigua & Barbuda	St. Phillips					
2	Argentina	Buenos Aires					
3	Bahamas	Coral Harbour					
4	Barbados	St. James					
5	Brazil	Sao Paulo					
6	Chile	Canal Melchor					
7		Tome					
8	Colombia	Medellin					
9	Cuba	Cienfuegos					
10		Havana					
11		Pinar del Rio					
12		Sancti Spiritus					
13		Santiago de Cuba					
14	Ecuador	Quito					
15		Quito (UNEP)					
16	Haiti	Port-au-Prince					
17	Jamaica	Kingston					
18	Mexico	Los Mochis					
19		Monte Azules, Chiapas					
20	Peru	Lima					
21	Uruguay	Montevideo					

Prevalence of parameters by year. Regarding the 95 parameters reported by the two UNEP/GEF GMP projects, Table 11 presents the parameters measured by year of monitoring. Note that in the period 2016-2018, of the 89 parameters measured in 2010-2011, 20 parameters were not measured; but Endosulfans, BDE 175/183, the Sum of 7 PCBs, Pentachlorobenzene and for the first time in the region Hexabromodiphenyl (PBB 153) were measured in this period 2016-2018.

Table 11. Prevalence of parameters in the Air-GEF Program. Parameters reported by year

No.	Parameter	2010	2011	2016	2017	2018
1	1,2,3,4,6,7,8-HpCDD (fg/m^3)					
2	1,2,3,4,6,7,8-HpCDF (fg/m^3)					
3	1,2,3,4,7,8,9-HpCDF (fg/m^3)					
4	1,2,3,4,7,8-HxCDD (fg/m^3)					
5	1,2,3,4,7,8-HxCDF (fg/m^3)					
6	1,2,3,6,7,8-HxCDD (fg/m^3)					
7	1,2,3,6,7,8-HxCDF (fg/m^3)					
8	1,2,3,7,8,9-HxCDD (fg/m^3)					
9	1,2,3,7,8,9-HxCDF (fg/m^3)					
10	1,2,3,7,8-PeCDD (fg/m^3)					
11	1,2,3,7,8-PeCDF (fg/m^3)					
12	2,3,4,6,7,8-HxCDF (fg/m^3)					
13	2,3,4,7,8-PeCDF (fg/m^3)					
14	2,3,7,8-TCDD (fg/m^3)					
15	2,3,7,8-TCDF (fg/m^3)					
16	Aldrin (pg/m^3)					
17	Alpha-HCH (pg/m^3)					
18	BDE 100 (pg/m^3)					
19	BDE 153 (pg/m^3)					
20	BDE 154 (pg/m^3)					
21	BDE 17 (pg/m^3)					
22	BDE 175/183 (pg/m^3)					
23	BDE 28 (pg/m^3)					
24	BDE 47 (pg/m^3)					
25	BDE 99 (pg/m^3)					
26	Beta-HCH (pg/m^3)					
27	cis-Chlordane (= alpha) (pg/m^3)					
28	cis-Heptachlorepoxide (= exo, B) (pg/m^3)					
29	cis-Nonachlor (pg/m^3)					
30	Dieldrin (pg/m^3)					
31	Endosulfan I (Alpha) (pg/m^3)					
32	Endosulfan II (beta) (pg/m^3)					
33	Endosulfan SO4 (pg/m^3)					

No.	Parameter	2010	2011	2016	2017	2018
34	Endrin (pg/m^3)					
35	Gamma-HCH (pg/m^3)					
36	HCB (pg/m^3)					
37	Heptachlor (pg/m^3)					
38	Mirex (pg/m^3)					
39	o,p-DDD (pg/m^3)					
40	o,p-DDE (pg/m^3)					
41	o,p-DDT (pg/m^3)					
42	OCDD (fg/m^3)					
43	OCDF (fg/m^3)					
44	Oxychlordane (pg/m^3)					
45	p,p-DDD (pg/m^3)					
46	p,p-DDE (pg/m^3)					
47	p,p-DDT (pg/m^3)					
48	PBB 153 (pg/m^3)					
49	PCB 101 (pg/m^3)					
50	PCB 105 (fg/m^3)					
51	PCB 114 (fg/m^3)					
52	PCB 118 (fg/m^3)					
53	PCB 123 (fg/m^3)					
54	PCB 126 (fg/m^3)					
55	PCB 138 (pg/m^3)					
56	PCB 153 (pg/m^3)					
57	PCB 156 (fg/m^3)					
58	PCB 157 (fg/m^3)					
59	PCB 167 (fg/m^3)					
60	PCB 169 (fg/m^3)					
61	PCB 180 (pg/m^3)					
62	PCB 189 (fg/m^3)					
63	PCB 28 (pg/m^3)					
64	PCB 52 (pg/m^3)					
65	PCB 77 (fg/m^3)					
66	PCB 81 (fg/m^3)					
67	PCBs WHO1998-TEQ LB (fg/m^3)					
68	PCBs WHO1998-TEQ UB (fg/m^3)					
69	PCBs WHO2005-TEQ LB (fg/m^3)					
70	PCBs WHO2005-TEQ UB (fg/m^3)					
71	PCDDs WHO1998-TEQ LB (fg/m^3)					
72	PCDDs WHO1998-TEQ UB (fg/m^3)					
73	PCDDs WHO2005-TEQ LB (fg/m^3)					
74	PCDDs WHO2005-TEQ UB (fg/m^3)					
75	PCDDs/Fs WHO1998-TEQ LB (fg/m^3)					
76	PCDDs/Fs WHO1998-TEQ UB (fg/m^3)					
77	PCDDs/Fs WHO2005-TEQ LB (fg/m^3)					
78	PCDDs/Fs WHO2005-TEQ UB (fg/m^3)					
79	PCDFs WHO1998-TEQ LB (fg/m^3)					
80	PCDFs WHO1998-TEQ UB (fg/m^3)					
81	PCDFs WHO2005-TEQ LB (fg/m^3)					
82	PCDFs WHO2005-TEQ UB (fg/m^3)					
83	PeCB (pg/m^3)					
84	Sum 10 PCDFs (fg/m3)					
85	Sum 12 PCBs (fg/m3)					
86	Sum 17 PCDDs/Fs (fg/m^3)					
87	Sum 2 heptachlorepoxides (cis + trans) (pg/m^3)					
88	Sum 3 p,p-DDTs (pg/m^3)					
89	Sum 6 DDTs (pg/m^3)					
90	Sum 6 PCBs (pg/m^3)					
91	Sum 7 PCBs (pg/m^3)					
92	Sum 7 PCDDs (fg/m^3)					
93	trans-Chlordane (= Gamma) (pg/m^3)					
94	trans-Heptachlorepoxide (= endo, A) (pg/m^3)					
95	trans-Nonachlor (pg/m^3)					

Completeness criterion. The completeness of the data during these years of monitoring is shown in Table 12, where it can be seen that this criterion is met only in three of the five years of sampling. Also, it can be observed that only five sites record more than three samples during these three years.

Table 12. Result of the application of the Completeness criterion in UNEP/GEF GMP projects' data

No.	Country	Site	2010	2017	2018
1	Antigua & Barbuda	St. Phillips			
2	Argentina	Buenos Aires			
3	Bahamas	Coral Harbour			
4	Barbados	St. James			
5	Brazil	Sao Paulo			
6	Chile	Canal Melchor			
7		Tome			
8	Colombia	Medellin			
9	Cuba	Cienfuegos			
10		Habana			
11		Pinar del Rio			
12		Sancti Spiritus			
13		Santiago de Cuba			
14	Ecuador	Quito			
15		Quito (UNEP)			
16	Jamaica	Kingston			
17	Mexico	Los Mochis			
18		Monte Azules, Chiapas			
19	Peru	Lima			
20	Uruguay	Montevideo			

4.1.1.1. Global Atmospheric Passive Sampling program (GAPS)

The Global Atmospheric Passive Sampling Network (GAPS) has been operating since 2002 as a pilot phase at 7 sites and since 2005 at more than 50 sites providing information to the GMP. It currently includes more than 60 sites located in Asia, Africa, North America, South America, Antarctica, Europe and Oceania, according to the GMP Guidance for POPs. At all sites, the GAPS Program uses the passive polyurethane foam disc (PUF) sampling method, which is exposed quarterly. Since 2009 and every two years PUF discs with specific absorbents have been exposed to detect POPs. As mentioned, to guarantee the representativeness of the site and its comparability, it is necessary to have at least three out of four discs exposed at each monitoring site per year.

Figure 24 Location of GAPS Program monitoring sites

Location of GAPS Program sites. As can be seen in the map of Figure 24, this program includes 29 monitoring sites that cover the four subregions of Latin America and the Caribbean, of which 8 are remote, 3 rural, 3 urbans, and 15 are unclassified.

Prevalence of sites per year. When analyzing the information from the GMP DWH repository (http://data.pops-gmp.org/2020/grulac/), data obtained by the GAPS Program from 2004 to 2016 were found, as mentioned, for the sites and parameters listed in Table 13 and 14, respectively.

In Table 13, it is observed that 29 monitoring sites have reported data during different periods of time, and none have obtained data during the 12 years of the Program. Only one site in Costa Rica has reported data for 10 years and the others for seven or less years.

Table 13. GAPS sites prevalence. Years of sampling per site

No.	Country	Site	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016
1		Bahia Blanca												
2		Malargue												
3		Mendoza Province												
4	Argentina	Pierre Auger Observatory in Patagonia Flats												
5		Rio Gallegos												
6		Salta												
7	Barbados	Ragged Point, St. Philip												
8	Bolivia	Chacaltaya												
9		Huayna Potosi												
10		Indaiatuba, Sao Paulo												
11		Itatiaia												
12		Porto Velho												
13	Brazil	Sao Jose												
14		Sao Luis												
15		Sao Paulo												
16		St. Peter and St. Paul Rocks												
17		Chungara Lake												
18	Chile	Concepción												
19		Coyhaique												
20	Colombia	Arauca												
21		Manizales												
22	Costa Rica	Tapanti National Park												
23	Cuba	La Palma												
24	Ecuador	Quito												
25		Santa Cruz Island												
26		Sonora												
27	Mexico	Tlahuac, Mexico City												
28		Veracruz												
29		Yucatan												

Prevalence of parameters by year. Regarding the 93 parameters reported by this Program (Table 14), Dioxins and Furans were only reported between the years 2010 to 2012, BDE mainly between 2013 and 2016, and Aldrin and DDT and their isomers were no longer registered in the recent years due to the low concentrations obtained, as was mentioned in Air monitoring of new and legacy POPs in the Group of Latin America and Caribbean (GRULAC) region, Environmental Pollution (Rauert et al., 2018). It is important to mention that among the parameters analyzed there are 19 parameters measured for the first time between 2013 and 2016 by this program, and 12 will provide baseline values. The PFHxS stands out, as a parameter under review by the Convention.

Table 14. Prevalence of parameters in the GAPS Program. Parameters reported by year

No.	Parameter	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016
1	1,2,3,4,6,7,8-HpCDD (fg/m^3)												
2	1,2,3,4,6,7,8-HpCDF (fg/m^3)												
3	1,2,3,4,7,8,9-HpCDF (fg/m^3)												
4	1,2,3,4,7,8-HxCDD (fg/m^3)												
5	1,2,3,4,7,8-HxCDF (fg/m^3)												
6	1,2,3,6,7,8-HxCDD (fg/m^3)												
7	1,2,3,6,7,8-HxCDF (fg/m^3)												
8	1,2,3,7,8,9-HxCDD (fg/m^3)												
9	1,2,3,7,8,9-HxCDF (fg/m^3)												
10	1,2,3,7,8-PeCDD (fg/m^3)												
11	1,2,3,7,8-PeCDF (fg/m^3)												
12	2,3,4,6,7,8-HxCDF (fg/m^3)												
13	2,3,4,7,8-PeCDF (fg/m^3)												
14	2,3,7,8-TCDD (fg/m^3)												
15	2,3,7,8-TCDF (fg/m^3)												
16	Aldrin (pg/m^3)												
17	Alpha-HBCD (pg/m^3)												
18	Alpha-HCH (pg/m^3)												
19	BDE 100 (pg/m^3)												
20	BDE 153 (pg/m^3)												
21	BDE 154 (pg/m^3)												
22	BDE 17 (pg/m^3)												
23	BDE 175/183 (pg/m^3)												
24	BDE 28 (pg/m^3)												
25	BDE 47 (pg/m^3)												
26	BDE 99 (pg/m^3)												
27	BDE209 (pg/m^3)												

No.	Parameter	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016
28	Beta-HBCD (pg/m^3)												
29	Beta-HCH (pg/m^3)												
30	cis-Chlordane (= alpha) (pg/m^3)												
31	cis-Heptachlorepoxide (= exo, B) (pg/m^3)												
32	Dieldrin (pg/m^3)												
33	Endosulfan I (Alpha) (pg/m^3)												
34	Endosulfan II (beta) (pg/m^3)												
35	Endosulfan SO_4 (pg/m^3)												
36	Gamma-HBCD (pg/m^3)												
37	Gamma-HCH (pg/m^3)												
38	HCB (pg/m^3)												
39	HCBD (pg/m^3)												
40	Heptachlor (pg/m^3)												
41	NEtFOSA (pg/m^3)												
42	NEtFOSE (pg/m^3)												
43	NMeFOSA (pg/m^3)												
44	NMeFOSE (pg/m^3)												
45	o,p-DDD (pg/m^3)												
46	o,p-DDE (pg/m^3)												
47	o,p-DDT (pg/m^3)												
48	OCDD (fg/m^3)												
49	OCDF (fg/m^3)												
50	p,p-DDD (pg/m^3)												
51	p,p-DDE (pg/m^3)												
52	p,p-DDT (pg/m^3)												
53	PCB 101 (pg/m^3)												
54	PCB 105 (fg/m^3)												
55	PCB 114 (fg/m^3)												
56	PCB 118 (fg/m^3)												
57	PCB 123 (fg/m^3)												
58	PCB 126 (fg/m^3)												
59	PCB 138 (pg/m^3)												
60	PCB 153 (pg/m^3)												
61	PCB 156 (fg/m^3)												
62	PCB 157 (fg/m^3)												
63	PCB 180 (pg/m^3)												
64	PCB 28 (pg/m^3)												
65	PCB 52 (pg/m^3)												
66	PCB 77 (fg/m^3)												
67	PCB 81 (fg/m^3)												
68	PCDDs WHO1998-TEQ LB (fg/m^3)												
69	PCDDs WHO1998-TEQ UB (fg/m^3)												
70	PCDDs WHO2005-TEQ LB (fg/m^3)												
71	PCDDs WHO2005-TEQ UB (fg/m^3)												
72	PCDDs/Fs WHO1998-TEQ LB (fg/m^3)												
73	PCDDs/Fs WHO1998-TEQ UB (fg/m^3)												
74	PCDDs/Fs WHO2005-TEQ LB (fg/m^3)												
75	PCDDs/Fs WHO2005-TEQ UB (fg/m^3)												
76	PCDFs WHO1998-TEQ LB (fg/m^3)												
77	PCDFs WHO1998-TEQ UB (fg/m^3)												
78	PCDFs WHO2005-TEQ LB (fg/m^3)												
79	PCDFs WHO2005-TEQ UB (fg/m^3)												
80	PeCB (pg/m^3)												
81	PFHxS (pg/m^3)												
82	PFOA (pg/m^3)												
83	PFOS (pg/m^3)												
84	Sum 10 PCDFs (fg/m^3)												
85	Sum 17 PCDDs/Fs (fg/m^3)												
86	Sum 2 heptachlorepoxides (cis + trans) (pg/m^3)												
87	Sum 3 p,p-DDTs (pg/m^3)												
88	Sum 6 DDTs (pg/m^3)												
89	Sum 6 PCBs (pg/m^3)												
90	Sum 7 PCBs (pg/m^3)												
91	Sum 7 PCDDs (fg/m^3)												
92	trans-Chlordane (= Gamma) (pg/m^3)												
93	trans-Nonachlor (pg/m^3)												

Completeness criterion. To guarantee the representativeness and comparability of the data, the criterion of 75% completeness of the data was applied to the monitoring years per site. The result is shown in Table 15, where a reduction in years, monitoring sites and countries can be seen, that is, of the 29 sites only 20 of them registered more than three samples per year distributed in 8 of the 10 participating countries in the GAPS Program.

Table 15. Result of the application of the Completeness criterion in GAPS program data

No.	Country	Site	2005	2006	2007	2009	2010	2011	2012	2014	2015
1	Argentina	Mendoza Province									
2		Pierre Auger Observatory in Patagonia Flats									
3	Barbados	Ragged Point, St. Philip									
4	Bolivia	Chacaltaya									
5		Huayna Potosi									
6	Brazil	Indaiatuba, Sao Paulo									
7		Itatiaia									
8		Porto Velho									
9		Sao Jose									
10		Sao Luis									
11		St. Peter and St. Paul Rocks									
12	Chile	Chungara Lake									
13		Concepción									
14		Coyhaique									
15	Colombia	Arauca									
16		Manizales									
17	Costa Rica	Tapanti National Park									
18	Mexico	Sonora									
19		Tlahuac, Mexico City									
20		Yucatan									

4.1.1.2. Latin American Passive Atmospheric Network (LAPAN)

The Latin American Passive Atmospheric Sampling Network (LAPAN) has been operating since 2010, initially as a pilot project in 6 countries, and has gradually increased the number of participating sites and countries. It now comprises 56 sites located in 12 countries in the GRULAC region (Figure 25). At all sites, samplers use the XAD technique with an annual exposure. Four passive sites with LAPAN XAD were exposed in parallel with PUF samplers from the GAPS network.

The sampling network uses a stainless steel mesh cylinder filled with XAD-2 (styrene / divinyl benzene copolymer resin), which is housed in a stainless steel chamber, so that to guarantee the quality and representativeness of the information it is required to have at least one exposure of 275 days to represent more than 75% of the year. From the analysis of the database, it is observed that the exposure of the resins ranges from 297 to 683 days, with 77% of the resins being exposed for more than one year.

Figure 25. Location of LAPAN Program monitoring sites

Location of LAPAN Program sites. The LAPAN Program presents data from 56 sites that covers the four subregions of Latin America and the Caribbean. These sites, as shown in Figure 25, are 15 remote, 34 urban and 7 unclassified.

Prevalence of sites per year. When analyzing the information obtained by the LAPAN Program from 2010 to 2016 for the sites listed in Table 16, it is observed that of the 56 monitoring sites that have reported data during different periods, none have done so during the 7 years of the Program. Only one site in Brazil has reported for 5 years and the others for three years or less.

Table 16. LAPAN sites prevalence. Years of sampling per site

No.	Country	Site	2010	2011	2012	2013	2014	2015	2016
1	Antigua & Barbuda	Antigua and Barbuda							
2	Argentina	Bahia Blanca 1							
3		Bahia Blanca 2							
4		Chimpay							
5		Comodoro Rivadavia							
6		Puerto Deseado							
7		Puerto Madryn							
8		Rio Gallegos							
9		Viedma							
10		Villa Regina							
11	Bolivia	Chacaltaya							
12	Brazil	Abrolhos Archipelago							
13		Araraquara, SP							
14		Atol das Rocas							
15		Barretos, SP							
16		Belém, UFPA							
17		Botanical Garden, POA, RS							
18		Brasília, UNB							
19		Chapada dos Veadeiros, GO							
20		Cristalino State Park, MT							
21		Curitiba, UFPR							
22		Diamantino, GO							
23		Fortaleza, UFC							
24		Iguaçu National Park							
25		Itatiaia National Park, RJ							
26		Limeira, SP							
27		Manaus							
28		Porto Alegre, Centro							
29		Porto Velho, UNIR							
30		Puruzinho Lake							
31		Recife, PE							
32		Rio de Janeiro, Fiocruz							
33		Rio Grande, FURG							
34		Salto Morato State Park, PR							
35		Sao Jose							
36		Sao Luis, UFMA							
37		São Paulo, Cetesb							
38		Trindade							
39		Vitória,ES							
40	Chile	Chacabuco							
41		Concepción							
42		Los Leones							
43		Presidente Frei Montalva Base							
44	Colombia	Barranquilla, (Univ. del Atlantico)							
45		Cartagena (San Pablo)							
46		Leticia							
47		Manizales, Rio Bianco							
48		Pasacaballos							
49		Zipaquirá							
50	Costa Rica	Biolley, Buenos Aires, Puntarenas							
51	Honduras	Tegucigalpa							
52	Panamá	Santiago de Veraguas							
53	Peru	Lima, PUCP							
54		Puerto Maldonado							
55	Uruguay	Salto							
56	Venezuela	IVIC							

Prevalence of parameters per year. In the review of the data from the LAPAN Program, it was found that there were 45 the parameters reported from 2010 to 2016 (Table 17) and only 40 from 2012 to 2016. It is important to mention that most of the parameters have been analyzed in the seven years, but not at all monitoring sites.

Table 17. Prevalence of parameters in the LAPAN Program. Parameters reported by year

No.	Parameter	2010	2011	2012	2013	2014	2015	2016
1	Aldrin (pg/m^3)							
2	Alpha-HCH (pg/m^3)							
3	BDE 100 (pg/m^3)							
4	BDE 153 (pg/m^3)							
5	BDE 154 (pg/m^3)							
6	BDE 28 (pg/m^3)							
7	BDE 47 (pg/m^3)							
8	BDE 99 (pg/m^3)							
9	BDE209 (pg/m^3)							
10	Beta-HCH (pg/m^3)							
11	cis-Chlordane (= alpha) (pg/m^3)							
12	cis-Heptachlorepoxide (= exo, B) (pg/m^3)							
13	Dieldrin (pg/m^3)							
14	Endosulfan I (Alpha) (pg/m^3)							
15	Endosulfan II (beta) (pg/m^3)							
16	Endosulfan SO4 (pg/m^3)							
17	Endrin (pg/m^3)							
18	Gamma-HCH (pg/m^3)							
19	HCB (pg/m^3)							
20	Heptachlor (pg/m^3)							
21	Mirex (pg/m^3)							
22	o,p-DDD (pg/m^3)							
23	o,p-DDE (pg/m^3)							
24	o,p-DDT (pg/m^3)							
25	Oxychlordane (pg/m^3)							
26	p,p-DDD (pg/m^3)							
27	p,p-DDE (pg/m^3)							
28	p,p-DDT (pg/m^3)							
29	PCB 101 (pg/m^3)							
30	PCB 105 (fg/m^3)							
31	PCB 118 (fg/m^3)							
32	PCB 138 (pg/m^3)							
33	PCB 153 (pg/m^3)							
34	PCB 156 (fg/m^3)							
35	PCB 169 (fg/m^3)							
36	PCB 180 (pg/m^3)							
37	PCB 28 (pg/m^3)							
38	PCB 52 (pg/m^3)							
39	PeCB (pg/m^3)							
40	Sum 3 p,p-DDTs (pg/m^3)							
41	Sum 6 DDTs (pg/m^3)							
42	Sum 6 PCBs (pg/m^3)							
43	Sum 7 PCBs (pg/m^3)							
44	trans-Chlordane (= Gamma) (pg/m^3)							
45	trans-Nonachlor (pg/m^3)							

Completeness criterion. Regarding the application of the completeness criterion, all the years of monitoring reported meet the criteria, so there is no reduction of the sites and their years of monitoring.

4.1.1.4. Colombia POPs Monitoring

Figure 26 shows the 5 sites of the Colombia - POPs monitoring study.

As can be seen in the map, four of the sites are located in Manizales within a radius of 4 km and the fifth site is located in Bogotá approximately 150 km away.

Passive samplers were used in the five sites and active samplers were used in three of them.

Prevalence of sites per year. In Table 18 and Table 19, the sites and parameters sampled by the Colombia - POPs monitoring program are listed.

Table 18 shows that the active sites only measured during the period 2009 to 2012. The passive sites have been measured from 2012, the year in which both types of sampling occur in the Liceo, Nubia and Palogrande sites, until 2014.

Figure 26. Colombia – POPs Monitoring sites

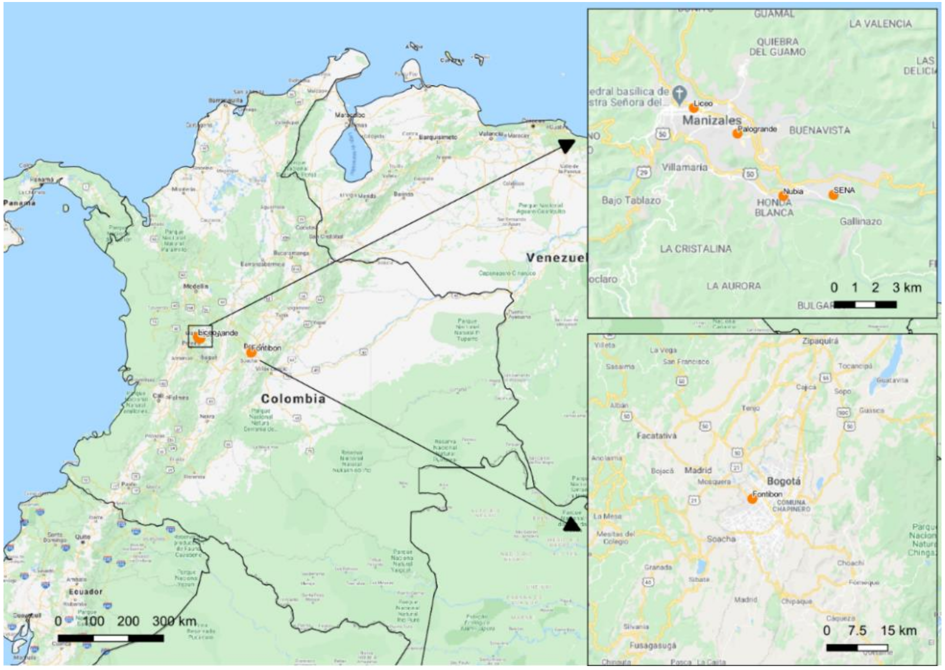


Table 18. Colombia – POPs Monitoring sites prevalence per year

Type of sampling	Site	2009	2010	2012	2013	2014
Active	Liceo					
	Nubia					
	Palogrande					
Passive	Fontibon					
	Liceo					
	Nubia					
	Palogrande					
	SENA					

Prevalence of parameters by year. From the review of the data from the Colombia - POPs monitoring program, it is observed that 44 parameters were analyzed by both samplers, passive and active, between the years 2009 and 2014 (Table 19); and with passive samplers 5 more parameters were analyzed in the years 2013 and 2014: the TEQs of the Dioxin-type PCBs and the sum of 12 PCBs.

Table 19. Prevalence of parameters of the Colombia - POPs monitoring program. Parameters reported by year

No.	Parameter	2009	2010	2012	2013	2014
1	1,2,3,4,6,7,8-HpCDD (fg/m^3)					
2	1,2,3,4,6,7,8-HpCDF (fg/m^3)					
3	1,2,3,4,7,8,9-HpCDF (fg/m^3)					
4	1,2,3,4,7,8-HxCDD (fg/m^3)					
5	1,2,3,4,7,8-HxCDF (fg/m^3)					
6	1,2,3,6,7,8-HxCDD (fg/m^3)					
7	1,2,3,6,7,8-HxCDF (fg/m^3)					
8	1,2,3,7,8,9-HxCDD (fg/m^3)					
9	1,2,3,7,8,9-HxCDF (fg/m^3)					
10	1,2,3,7,8-PeCDD (fg/m^3)					
11	1,2,3,7,8-PeCDF (fg/m^3)					
12	2,3,4,6,7,8-HxCDF (fg/m^3)					

No.	Parameter	2009	2010	2012	2013	2014
13	2,3,4,7,8-PeCDF (fg/m^3)					
14	2,3,7,8-TCDD (fg/m^3)					
15	2,3,7,8-TCDF (fg/m^3)					
16	OCDD (fg/m^3)					
17	OCDF (fg/m^3)					
18	PCB 105 (fg/m^3)					
19	PCB 114 (fg/m^3)					
20	PCB 118 (fg/m^3)					
21	PCB 123 (fg/m^3)					
22	PCB 126 (fg/m^3)					
23	PCB 156 (fg/m^3)					
24	PCB 157 (fg/m^3)					
25	PCB 167 (fg/m^3)					
26	PCB 169 (fg/m^3)					
27	PCB 189 (fg/m^3)					
28	PCB 77 (fg/m^3)					
29	PCB 81 (fg/m^3)					
30	PCBs WHO1998-TEQ LB (fg/m^3)					
31	PCBs WHO1998-TEQ UB (fg/m^3)					
32	PCBs WHO2005-TEQ LB (fg/m^3)					
33	PCBs WHO2005-TEQ UB (fg/m^3)					
34	PCDDs WHO1998-TEQ LB (fg/m^3)					
35	PCDDs WHO1998-TEQ UB (fg/m^3)					
36	PCDDs WHO2005-TEQ LB (fg/m^3)					
37	PCDDs WHO2005-TEQ UB (fg/m^3)					
38	PCDDs/Fs WHO1998-TEQ LB (fg/m^3)					
39	PCDDs/Fs WHO1998-TEQ UB (fg/m^3)					
40	PCDDs/Fs WHO2005-TEQ LB (fg/m^3)					
41	PCDDs/Fs WHO2005-TEQ UB (fg/m3)					
42	PCDFs WHO1998-TEQ LB (fg/m^3)					
43	PCDFs WHO1998-TEQ UB (fg/m^3)					
44	PCDFs WHO2005-TEQ LB (fg/m^3)					
45	PCDFs WHO2005-TEQ UB (fg/m^3)					
46	Sum 10 PCDFs (fg/m^3)					
47	Sum 12 PCBs (fg/m^3)					
48	Sum 17 PCDDs/Fs (fg/m^3)					
49	Sum 7 PCDDs (fg/m^3)					

Completeness Criterion. The completeness of the data during these years of monitoring is shown in Table 20, where it can be seen that, in relation to passive monitoring, this criterion is met only in 2013 for the Liceo, Nubia and Palogrande sites, where most of the highest medians was presented at the Liceo site, see table 21. Regarding the active monitoring of the three sites located in Manizales, Colombia, it provided a total of six data per parameter and site from 2009 to 2012.

Table 20. Completeness criterion. Sites with more than three samples per year. Colombia - POPs monitoring

Type of sampling	Site	2012	2013	2014
Passive	Fontibon			
	Liceo			
	Nubia			
	Palogrande			
	SENA			

Table 21. Maximum values of medians per monitoring site with completeness in 2013. Colombia - POPs monitoring

Parameter	Liceo	Nubia	Palogrande
1,2,3,4,6,7,8-HpCDD (fg/m^3)	17.9	13.1	9.8
1,2,3,4,6,7,8-HpCDF (fg/m^3)	9.8	8.6	4.4
1,2,3,4,7,8,9-HpCDF (fg/m^3)	1.6	1.2	0.7
1,2,3,4,7,8-HxCDD (fg/m^3)	1.3	1.0	0.3
1,2,3,4,7,8-HxCDF (fg/m^3)	3.0	2.5	1.3
1,2,3,6,7,8-HxCDD (fg/m^3)	3.2	2.0	1.4
1,2,3,6,7,8-HxCDF (fg/m^3)	2.2	2.5	1.0
1,2,3,7,8,9-HxCDD (fg/m^3)	2.7	2.4	0.8
1,2,3,7,8,9-HxCDF (fg/m^3)	0.4	0.4	0.2
1,2,3,7,8-PeCDD (fg/m^3)	1.8	2.1	0.9
1,2,3,7,8-PeCDF (fg/m^3)	5.8	3.6	2.0
2,3,4,6,7,8-HxCDF (fg/m^3)	4.8	4.3	1.9
2,3,4,7,8-PeCDF (fg/m^3)	6.9	5.1	2.5
2,3,7,8-TCDD (fg/m^3)	0.6	0.1	0.3
2,3,7,8-TCDF (fg/m^3)	5.6	5.4	2.7
OCDD (fg/m^3)	75.3	30.8	44.0
OCDF (fg/m^3)	5.9	3.3	2.8
PCB 105 (fg/m^3)	1,167.7	740.5	281.3
PCB 114 (fg/m^3)	49.0	49.4	19.0
PCB 118 (fg/m^3)	3,058.2	1,634.7	743.1
PCB 123 (fg/m^3)	286.9	184.7	77.8
PCB 126 (fg/m^3)	46.4	31.8	17.1
PCB 156 (fg/m^3)	244.5	162.7	63.3
PCB 157 (fg/m^3)	50.0	43.4	13.9
PCB 167 (fg/m^3)	113.4	73.7	30.2
PCB 169 (fg/m^3)	6.6	5.4	3.6
PCB 189 (fg/m^3)	12.2	17.9	6.0
PCB 77 (fg/m^3)	354.2	278.0	143.1
PCB 81 (fg/m^3)	26.9	23.1	10.3
PCBs WHO1998-TEQ LB (fg/m^3)	5.4	3.7	1.9
PCBs WHO1998-TEQ UB (fg/m^3)	5.4	3.7	1.9
PCBs WHO2005-TEQ LB (fg/m^3)	5.0	3.5	1.9
PCBs WHO2005-TEQ UB (fg/m^3)	5.0	3.5	1.9
PCDDs WHO1998-TEQ LB (fg/m^3)	3.2	2.9	1.5
PCDDs WHO1998-TEQ UB (fg/m^3)	3.2	2.9	1.5
PCDDs WHO2005-TEQ LB (fg/m^3)	3.2	2.9	1.5
PCDDs WHO2005-TEQ UB (fg/m^3)	3.2	2.9	1.5
PCDDs/Fs WHO1998-TEQ LB (fg/m^3)	8.2	7.3	3.6
PCDDs/Fs WHO1998-TEQ UB (fg/m^3)	8.2	7.3	3.6
PCDDs/Fs WHO2005-TEQ LB (fg/m^3)	6.7	6.2	3.1
PCDDs/Fs WHO2005-TEQ UB (fg/m^3)	6.7	6.2	3.1
PCDFs WHO1998-TEQ LB (fg/m^3)	5.4	4.4	2.1
PCDFs WHO1998-TEQ UB (fg/m^3)	5.4	4.4	2.1
PCDFs WHO2005-TEQ LB (fg/m^3)	3.9	3.3	1.6
PCDFs WHO2005-TEQ UB (fg/m^3)	3.9	3.3	1.6
Sum 10 PCDFs (fg/m^3)	48.2	36.8	19.3
Sum 12 PCBs (fg/m^3)	5,435.0	3,336.5	1,382.8
Sum 17 PCDDs/Fs (fg/m^3)	149.6	88.4	76.8
Sum 7 PCDDs (fg/m^3)	101.3	51.5	57.4

4.1.2. Human Tissue (maternal milk and/or blood)

Human milk and blood have been used as markers of human exposure to a number of POPs for several decades and are critical means of biomonitoring POPs under the Stockholm Convention. Both matrices reveal comparable temporal trends in a particular population because they integrate environmental exposure and dietary exposure related to different consumption habits. In addition, they provide pertinent information on the transfer of POPs to infants and possible health effects.

The objective set in the GMP Guidance in the analysis of these matrices is to identify temporal trends of levels of POPs in humans. The program also helps to build regional capacity in developing countries by supporting technical and analytical capacity to detect POPs exposure in humans. Furthermore, by comparing the levels of POPs found in a statistically reliable number of representative samples from a given country with the levels found in said samples from other regions, the priorities for possible follow-up, in a country, can be derived with respect to a determined POP.

To promote the reliability and comparability of results, participating countries collect samples following a harmonized comprehensive protocol developed by WHO and amended by UNEP. The protocol provides guidance on the number and type of samples, donor selection, collection, storage, and shipment of samples to the reference laboratory. For all studies, the following criteria are mainly applied for the selection of donor mothers: being first-time mothers; being healthy and exclusively breastfeeding a child (that is, without twins), among others.

According to the GMP Guidance, to obtain statistically reliable data, an appropriate number of individual donors must be recruited to provide samples for the survey. As a first approximation, a minimum of 50 individual samples is recommended for each country. Equal aliquots of these individual samples are pooled to form a representative composite sample ("pooled sample"). The power of the survey can be increased by including more than 50 individual samples. It is recommended to collect a representative individual sample per every million of citizens. In particular, countries with populations greater than 50 million must include at least one additional participant for every million inhabitants. Countries with populations greater than 50 million (or with sufficient resources) should prepare a second pooled sample (or more) if possible (UNEP, 2019).

4.1.2.1. Participating countries in Human milk studies

The GMP DWH data repository includes data from breast milk and blood studies from three different programs: GMP 1, MILK - WHO and WHO that have been applied in six rounds of studies. It is worth mentioning that the concept of sampling for breast milk exposure studies has changed between 2000 and 2012. While in 2000-2003, countries were encouraged to prepare two or more groups of samples to address the differences within each country, the guidance document for the Stockholm Convention Global Monitoring Plan currently calls for a representative sample of more than 50 million citizens.

In order to obtain comparable results, the average concentration of all national combinations shipped is the one commonly used. In Table 22, the countries where POPs have been analyzed in human milk by the GMP 1, WHO, and MILK - WHO programs are displayed. In total, 14 countries have participated since 1992 to date. However, only Brazil participated in GMP 1 and it is from 2008 when, with the support of the UNEP/GEF projects, more countries begin to participate.

Table 22. Years sampled by country and program

Program	Participating country	Years
GMP 1	Brazil	1992, 2002
MILK - WHO	Antigua & Barbuda	2008, 2018
	Argentina	2019
	Barbados	2010, 2018
	Brazil	2001, 2012
	Chile	2008, 2011
	Colombia	2019
	Cuba	2011
	Ecuador	2019
	Haiti	2004, 2011
	Jamaica	2011, 2018
	Mexico	2011, 2017
	Peru	2011, 2019
	Suriname	2012
	Uruguay	2009, 2019
WHO	Antigua & Barbuda	2007
	Brazil	2002
	Chile	2010
	Haiti	2007
	Uruguay	2010

The following map (Figure 27) shows the 14 participating countries in the three aforementioned programs. As can be seen, the four subregions of Latin America and the Caribbean have been covered, although it is worth noting that no Central American country has participated.

Figure 27. Participating countries in human milk surveys

Data availability. Table 23 shows the countries and the number of parameters reported to the GMP DWH repository in all the sampling rounds. Rounds 5 and 6 show the highest participation of GRULAC countries, thanks to the support of the UNEP/GEF GMP projects. In the last round of the 12 participating countries only nine sent samples to the laboratory.

Table 23. Availability of Breast Milk parameters, GMP DWH

Program	Country	Round 2	Round 3		Round 4		Round 5					Round 6				
		1992	2001	2002	2004	2007	2008	2009	2010	2011	2012	2015	2016	2017	2018	2019
GMP 1	Brazil	31		17												
MILK - WHO	Antigua & Barbuda						97								108	
	Argentina															108
	Barbados								97						108	
	Brazil		84								87					
	Chile						97			97						
	Colombia															108
	Cuba									66						
	Ecuador															108
	Haiti				84					97		97				
	Jamaica									97					108	
	Mexico									97				108		
	Peru									97						108
	Suriname										97					
	Uruguay							97								108
WHO	Antigua & Barbuda								26							
	Brazil		1													
	Chile								26							
	Haiti					1										
	Uruguay								26							

Prevalence of parameters by year. Regarding the 110 parameters reported in the Human Milk matrix (Table 24) 108 were analyzed in the sixth round and 13 for the first time including PFHxS compound under review and candidate to be included in the Convention. These thirteen compounds are: BDE 175/183, Chlordecone, Cis-Nonachlor, Dicofol, HCBD, PCA, PCP, PFOA, PFOS, PFHxS, Sum 7 PCBs, Sum SCCPs and Trans-Nonachlor.

Table 24. Prevalence of Human Milk Matrix parameters. Parameters analyzed per year

No	Parameter	1992	2001	2002	2004	2005	2007	2008	2009	2010	2011	2012	2017	2018	2019
1	1,2,3,4,6,7,8-HpCDD (pg/g fat)														
2	1,2,3,4,6,7,8-HpCDF (pg/g fat)														
3	1,2,3,4,7,8,9-HpCDF (pg/g fat)														
4	1,2,3,4,7,8-HxCDD (pg/g fat)														
5	1,2,3,4,7,8-HxCDF (pg/g fat)														
6	1,2,3,6,7,8-HxCDD (pg/g fat)														
7	1,2,3,6,7,8-HxCDF (pg/g fat)														
8	1,2,3,7,8,9-HxCDD (pg/g fat)														
9	1,2,3,7,8,9-HxCDF (pg/g fat)														
10	1,2,3,7,8-PeCDD (pg/g fat)														
11	1,2,3,7,8-PeCDF (pg/g fat)														
12	2,3,4,6,7,8-HxCDF (pg/g fat)														
13	2,3,4,7,8-PeCDF (pg/g fat)														
14	2,3,7,8-TCDD (pg/g fat)														
15	2,3,7,8-TCDF (pg/g fat)														
16	Aldrin (ng/g fat)														
17	Alpha-HBCD (ng/g fat)														
18	Alpha-HCH (ng/g fat)														
19	BDE 100 (ng/g fat)														
20	BDE 153 (ng/g fat)														
21	BDE 154 (ng/g fat)														
22	BDE 17 (ng/g fat)														
23	BDE 175/183 (ng/g fat)														
24	BDE 28 (ng/g fat)														
25	BDE 47 (ng/g fat)														
26	BDE 99 (ng/g fat)														
27	Beta-HBCD (ng/g fat)														
28	Beta-HCH (ng/g fat)														
29	Chlordecone (ng/g fat)														
30	cis-Chlordane (= alpha) (ng/g fat)														
31	cis-Heptachlorepoxide (= exo, B) (ng/g fat)														
32	cis-Nonachlor (ng/g fat)														
33	Dicofol (ng/g fat)														
34	Dieldrin (ng/g fat)														
35	Endosulfan I (Alpha) (ng/g fat)														
36	Endosulfan II (beta) (ng/g fat)														
37	Endosulfan SO4 (ng/g fat)														
38	Endrin (ng/g fat)														

No	Parameter	1992	2001	2002	2004	2005	2007	2008	2009	2010	2011	2012	2017	2018	2019
39	Gamma-HBCD (ng/g fat)														
40	Gamma-HCH (ng/g fat)														
41	HCB (ng/g fat)														
42	HCBD (ng/g fat)														
43	Heptachlor (ng/g fat)														
44	Mirex (ng/g fat)														
45	o,p-DDD (ng/g fat)														
46	o,p-DDE (ng/g fat)														
47	o,p-DDT (ng/g fat)														
48	OCDD (pg/g fat)														
49	OCDF (pg/g fat)														
50	Oxychlordane (ng/g fat)														
51	p,p-DDD (ng/g fat)														
52	p,p-DDE (ng/g fat)														
53	p,p-DDT (ng/g fat)														
54	Parlar 26 (ng/g fat)														
55	Parlar 50 (ng/g fat)														
56	Parlar 62 (ng/g fat)														
57	PBB 153 (ng/g fat)														
58	PCA (ng/g fat)														
59	PCB 101 (ng/g fat)														
60	PCB 105 (pg/g fat)														
61	PCB 114 (pg/g fat)														
62	PCB 118 (pg/g fat)														
63	PCB 123 (pg/g fat)														
64	PCB 126 (pg/g fat)														
65	PCB 138 (ng/g fat)														
66	PCB 153 (ng/g fat)														
67	PCB 156 (pg/g fat)														
68	PCB 157 (pg/g fat)														
69	PCB 167 (pg/g fat)														
70	PCB 169 (pg/g fat)														
71	PCB 180 (ng/g fat)														
72	PCB 189 (pg/g fat)														
73	PCB 28 (ng/g fat)														
74	PCB 52 (ng/g fat)														
75	PCB 77 (pg/g fat)														
76	PCB 81 (pg/g fat)														
77	PCBs WHO1998-TEQ LB (pg/g fat)														
78	PCBs WHO1998-TEQ UB (pg/g fat)														
79	PCBs WHO2005-TEQ LB (pg/g fat)														
80	PCBs WHO2005-TEQ UB (pg/g fat)														
81	PCDDs WHO1998-TEQ LB (pg/g fat)														
82	PCDDs WHO1998-TEQ UB (pg/g fat)														
83	PCDDs WHO2005-TEQ LB (pg/g fat)														
84	PCDDs WHO2005-TEQ UB (pg/g fat)														
85	PCDDs/Fs WHO1998-TEQ LB (pg/g fat)														
86	PCDDs/Fs WHO1998-TEQ UB (pg/g fat)														
87	PCDDs/Fs WHO2005-TEQ LB (pg/g fat)														
88	PCDDs/Fs WHO2005-TEQ UB (pg/g fat)														
89	PCDFs WHO1998-TEQ LB (pg/g fat)														
90	PCDFs WHO1998-TEQ UB (pg/g fat)														
91	PCDFs WHO2005-TEQ LB (pg/g fat)														
92	PCDFs WHO2005-TEQ UB (pg/g fat)														
93	PCP (ng/g fat)														
94	PeCB (ng/g fat)														
95	PFHxS (pg/l)														
96	PFOA (pg/l)														
97	PFOS (pg/l)														
98	Sum 10 PCDFs (pg/g fat)														
99	Sum 12 PCBs (pg/g fat)														
100	Sum 17 PCDDs/Fs (pg/g fat)														
101	Sum 2 heptachlorepoxides (cis + trans) (ng/g fat)														
102	Sum 3 p,p-DDTs (ng/g fat)														
103	Sum 6 DDTs (ng/g fat)														
104	Sum 6 PCBs (ng/g fat)														
105	Sum 7 PCBs (ng/g fat)														
106	Sum 7 PCDDs (pg/g fat)														
107	Suma de SCCPs (ng/g fat)														
108	trans-Chlordane (= Gamma) (ng/g fat)														
109	trans-Heptachlorepoxide (= endo, A) (ng/g fat)														
110	trans-Nonachlor (ng/g fat)														

4.1.3. WATER

The GMP DWH Repository has information on nine water sampling sites from three Projects: Monet-Aqua Project that was applied in Chile and Colombia (one passive sampling site in each country); GMP UNEP project in Uruguay with a single direct sampling to apply the active method; and UNEP/GEF GMP Project that was applied in 6 sites located in 5 countries: Argentina, Brazil, Ecuador, Jamaica and Mexico (Figure 28), following the sample collection protocol of the GMP Guidance.

Additionally, some countries of the region reported monitoring programs and studies of POPs in water, but no formal monitoring program was identified to determine the target pollutants, Fluorinated POPs, which will provide changes in concentration or trends.

Figure 28. Water monitoring sites

Data availability. Table 25 shows the countries, sites, and programs that reported data to the GMP DWH repository. Table 26 shows the reporting years. GMP UNEP was applied at one site in 2014, MONET-Aqua at two sites in 2016, and UNEP/GEF GMP at six sites in the years 2017 and 2018.

Table 25. Data availability in Water

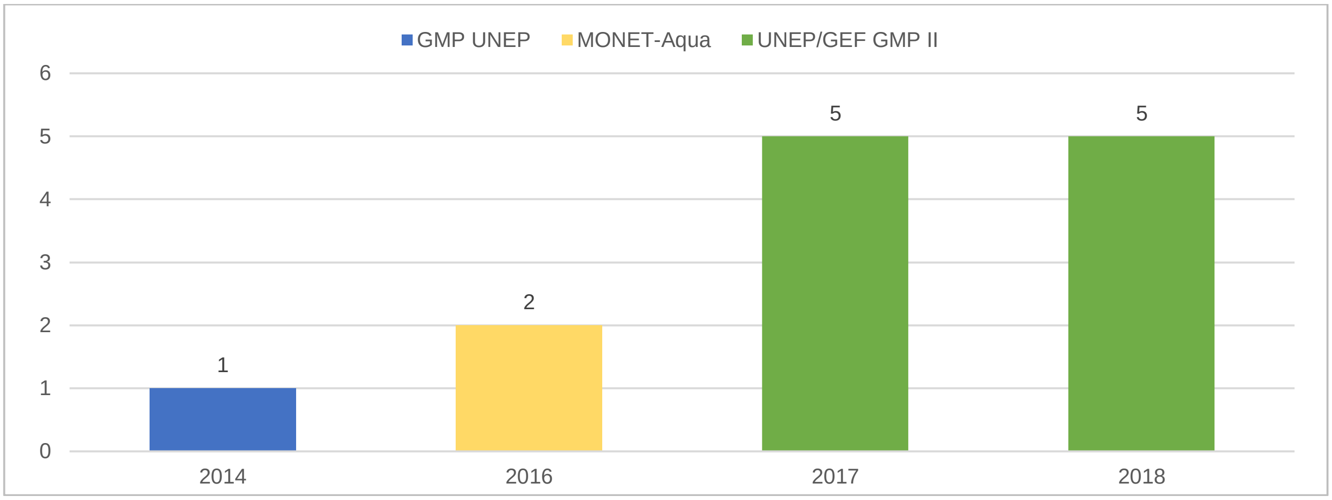
Site	Country	GMP UNEP	MONET-Aqua	UNEP/GEF GMP II
Argentina Rio de la Plata	Argentina			
Amazon River	Brazil			
São Paulo São Vicente channel	Brazil			
Daule and Babahoyo River Junction	Ecuador			
Hunts Bay River	Jamaica			
Llanquihue Lake, Los Lagos	Chile			
Ohuira Bay	Mexico			
Peñol-Guatapé Reservoir, Antioquia	Colombia			
Río de la Plata	Uruguay			

Table 26. Years in which the Programs were applied

	GMP UNEP	MONET-Aqua	UNEP/GEF GMP II
2014			
2016			
2017			
2018			

It is important to note that the years with most monitoring sites are 2017 and 2018, as can be seen in the graph in Figure 29.

Figure 29. Number of sampling sites per year and program



Parameters measured per year. In relation to the 50 parameters reported from the Water matrix (Table 27). It is observed that in 2016 47 of the 50 parameters were measured, but none of them correspond to the target compounds listed by the Convention at COP 6. In 2014 only the target compound PFOS was reported from a single sample in Rio de la Plata, Uruguay; and from 2017 to 2018 the three target compounds for water matrix were analyzed: PFOS (pg / l), PFHxS (pg / l) and PFOA (pg / l), by the UNEP/GEF GMP II Program.

Table 27. Parameters analyzed by year and program in the Water Matrix

No	Parameter	2014	2016	2017	2018
		GMP UNEP	MONET-Aqua	UNEP/GEF GMP II	
1	Aldrin (pg/l)				
2	Alpha-HBCD (pg/l)				
3	Alpha-HCH (pg/l)				
4	BDE 100 (pg/l)				
5	BDE 153 (pg/l)				
6	BDE 154 (pg/l)				
7	BDE 175/183 (pg/l)				
8	BDE 28 (pg/l)				
9	BDE 47 (pg/l)				
10	BDE 99 (pg/l)				
11	BDE209 (pg/l)				
12	Beta-HBCD (pg/l)				
13	Beta-HCH (pg/l)				
14	cis-Chlordane (= alpha) (pg/l)				
15	cis-Heptachlorepoxide (= exo, B) (pg/l)				
16	Dieldrin (pg/l)				
17	Endosulfan I (Alpha) (pg/l)				
18	Endosulfan II (beta) (pg/l)				
19	Endosulfan SO4 (pg/l)				
20	Endrin (pg/l)				
21	Gamma-HBCD (pg/l)				
22	Gamma-HCH (pg/l)				

No	Parameter	2014	2016	2017	2018
		GMP UNEP	MONET-Aqua	UNEP/GEF GMP II	
23	HCB (pg/l)				
24	Heptachlor (pg/l)				
25	Mirex (pg/l)				
26	o,p-DDD (pg/l)				
27	o,p-DDE (pg/l)				
28	o,p-DDT (pg/l)				
29	Oxychlordane (pg/l)				
30	p,p-DDD (pg/l)				
31	p,p-DDE (pg/l)				
32	p,p-DDT (pg/l)				
33	PCB 101 (pg/l)				
34	PCB 118 (fg/l)				
35	PCB 138 (pg/l)				
36	PCB 153 (pg/l)				
37	PCB 180 (pg/l)				
38	PCB 28 (pg/l)				
39	PCB 52 (pg/l)				
40	PeCB (pg/l)				
41	PFHxS (pg/l)				
42	PFOA (pg/l)				
43	PFOS (pg/l)				
44	Sum 2 heptachlorepoxides (cis + trans) (pg/l)				
45	Sum 3 p,p-DDTs (pg/l)				
46	Sum 6 DDTs (pg/l)				
47	Sum 6 PCBs (pg/l)				
48	Sum 7 PCBs (pg/l)				
49	trans-Chlordane (= Gamma) (pg/l)				
50	trans-Heptachlorepoxide (= endo, A) (pg/l)				

Additional information on other environmental matrices and scientific studies carried out in the region are included in chapter 6 of results.

4.2. Strategy concerning analytical procedures

The analytical procedures used to ensure the quality and comparability of the data includes from sampling, sample extraction and cleaning to the analysis of POPs.

The analytical procedures applied by the sampling programs in the GRULAC region, such as GAPS for air, Monet for water and the WHO studies, have their own procedures, which have been recognized and harmonized for the GMP. With regard to UNEP/GEF GMP projects, these follow the specifications given in the Global Monitoring Plan Guidance, specific standard operating procedures for ambient air sampling; Guides and tutorial videos for monitoring breast milk; the protocol for water sampling and guidelines for the analysis of POPs, developed by UN Environment from 2013 to 2018 to harmonize analytical procedures, all of which are available to the general public on the website: https://www.unenvironment.org/explore-topics/chemicals-waste/what-we-do/persistent-organic-pollutants/guidance-and-standard.

Available guides and procedures include, among others:

- Passive Sampling of Ambient Air. Methodology and Procedure (PAS)
- Procedure for air monitoring using active air samplers (HVS)
- Guidelines for Organization, Sampling and Analysis of human milk
- Protocol 1: Analysis of Perfluorooctane Sulfonic Acid (PFOS) in Water and Perfluorooctane Sulfonamide (FOSA) in Mothers' Milk, Human Serum and Air, and the Analysis of Some Perfluorooctane Sulfonamides (FOSAS) and Perfluorooctane Sulfonamido Ethanols (FOSES) in Air
- Protocol 2: Analysis of Polychlorinated Biphenyls (PCB) and Organochlorine Pesticides (OCP) in Human Milk, Air and Human Serum
- Protocol 3: Analysis of Polybrominated Diphenyl Ethers (PBDE) in Human Milk, Air and Human Serum
- Protocol 5: Analyse des polychlorodibenzo-paradioxines, des polychlorodibenzofurannes (PCDD/PCDF) et des polychlorobiphényles (PCB) de type dioxine (dl-PCB) dans l'air ambiant et les tissus humains

In the Latin America and the Caribbean region, two types of passive samplers have been used: passive polyurethane foam (PUF) and hydrophobic polyaromatic resin (XAD) samplers, which have different temporal resolution. From 2004 to 2009, PUF samplers were used more frequently in the region; however, XAD samplers were installed in conjunction with PUF samplers at some sites to allow comparison between the two sampling systems. In those years the PUF samplers were analyzed for polychlorinated biphenyls (PCBs) and some chlorinated pesticides, and the XAD samplers only for chlorinated pesticides. Starting in 2010, with LAPAN, the use of passive XAD samplers has been extended and also the parameters analyzed as described in section 4.1.

The active air sampler (HVS) procedure has been developed to support the implementation of the GMP for POPs under the Stockholm Convention. This procedure is applicable to HVS installation in urban, suburban, rural and remote locations. To date, there were only one active sampler located in Brazil under the UNEP/GEF GMP project, but no data was available; and three active samplers under the Colombia POPs program.

On the other hand, breast milk is considered one of the best sampling matrices for bio-monitoring due to its availability and the non-invasive approach in the collection of individual samples. Its high lipid content makes the extraction method easier and offers greater precision in POPs measurements. The first studies on human milk were conducted by WHO in Europe and North America from 1987 to 1989 and in 1992 and 1993, and focused exclusively on PCBs, PCDD and PCDF. In 2001-2003, a global survey was conducted that considered twelve POPs initially listed in the Stockholm Convention. Following the ratification of the Stockholm Convention, WHO and UNEP began their collaboration, and conducted two additional global surveys in 2005-2007 and 2008-2012. With these studies, the geographic scope was significantly expanded to obtain representative results from all regions of the world. The results of these surveys have been compiled in document UNEP/POPS/COP.6/INF/33. The fifth round of the human milk survey (2013-2014) aimed to detect changes in the levels of the initial POPs measured in human populations and to construct a consistent baseline for human exposure to newly included persistent organic pollutants. The sixth round 2016-2018 aims to obtain temporary trends in exposure to POPs.

In relation to the water matrix for this third evaluation, the UNEP/GEF GMP II projects applied the direct sampling method as recommended by the UN Environment 2017 Protocol for the sampling of water, “Protocol for the Sampling of Water as a Core Matrix in the UNEP/GEF GMP II Projects for the Analysis of PFOS”; with a sampling frequency of 4 times per year per monitoring site.

4.3. Strategy concerning participating laboratories

In the GRULAC region, each of the programs that have provided data has reference laboratories for the analysis of their samples, in order to guarantee the reliability of the data and improve the comparability of the analytical results. For the ambient air matrix, the samples from the LAPAN program are analyzed by the RECETOX center; the GAPS program samples are analyzed by the ECCC and the Air-GEF samples resulting from the UNEP/GEF GMP projects are analyzed by the CSIC-IDAEA of Spain and the MTM Research Center at the University of Örebro, Sweden, which performs the analyzes of perfluorinated chemicals in all matrices: air, water and breast milk.

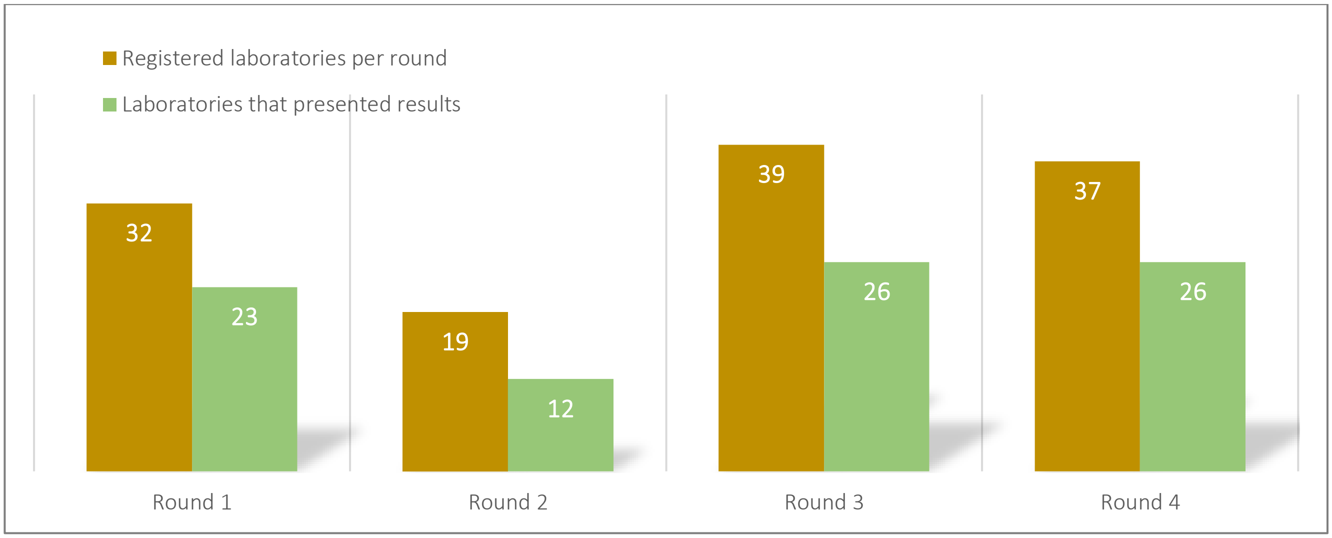
Likewise, WHO has coordinated a series of inter-laboratory quality assessment studies, with the Freiburg State Institute for Chemical and Veterinary Analysis of Foods meeting all predefined criteria for analysis of PCDD, PCDF, dioxin-like PCBs. and PCB markers in human milk fat, for which it was selected as the WHO Reference Laboratory to analyze POPs, with the exception of PFOS, from studies in human milk.

To date, the GRULAC region has not developed a methodology to classify national laboratories according to their level of instrumentation, nor have criteria been established for their classification. No laboratories in the region routinely analyze POPs samples in the target matrices and do not participate in the analysis of samples from regional programs. Only some countries in the region such as Brazil, Colombia and Mexico have implemented POPs monitoring and analysis programs for short periods of time. Such is the case of the data generated by Colombia included in the DWH.

To strengthen the analytical capacities of the laboratories of the countries of the region, guides and standard operating procedures have been developed to define analytical procedures; providing training courses; training in the laboratories of the countries and the participation of national laboratories in interlaboratory assessment rounds carried out every two years has been financed; all of the above through the UNEP/GEF GMP projects.

The United Nations Environment Program has been coordinating these biannual interlaboratory evaluations since 2010 and to date four rounds have been carried out in which evaluations of various matrices have been carried out such as sediments, fish, human milk and plasma, extracts of air and water samples among others. From the GRULAC region 64 laboratories participated in these evaluation rounds, however, only 5 participated in the four rounds, 14 in two rounds, 21 in one round, and 19 did not deliver results. The participation of the laboratories of the region and their delivery of results is observed in Figure 30. https://www.unenvironment.org/explore-topics/chemicals-waste/what-we-do/persistent-organic-pollutants/pops-interlaboratory.

Figure 30. Number of GRULAC laboratories that participated in interlaboratory assessments



Source: (Fiedler H, 2019)

The results of the performance of the laboratories in the region, which participated in these assessments, is presented below in Table 28 where S means a satisfactory result, Q questionable, U unsatisfactory, C consistent and I inconsistent.

Table 28. Distribution of z-scores in four rounds of interlaboratory assessments

Region	S	Q	U	C	I	Subtotal
GRULAC	2,054	431	1,692	87	304	4,568

Source: Fiedler H, 2019.

The results of the performance of these interlaboratory tests are also reflected in the POPs analysis laboratory data bank, which was developed from 2005 to 2007, thanks to the financing of the UNEP/GEF global project "Evaluation of the existing capacity and the needs of capacity building to analyze POPs in developing countries" established by mandate of COP1. (Biennial Global Interlaboratory Assessment on POPs 2010-2011, March 2012).

Since then, the Chemical Products Branch has kept this database updated through questionnaires filled out by laboratories and made available to the public on its website. http://chm.pops.int/Default.aspx?tabid=2420. There are currently 60 laboratories in the GRULAC region registered in the bank, corresponding to 22 countries. See Annex 2. List of Laboratories.

4.4. Data handling and preparation for the regional monitoring report

Data handling under the Global POPs Monitoring Plan is the responsibility of the members of the Regional Organization Groups (ROG). The objective of the GMP is to determine the changes in the concentrations of the listed POPs over time and to identify trends from the monitoring of POPs globally to support the effectiveness evaluation of the Stockholm Convention as specified in Article 16 of the Convention.

What the GMP requires, indicated in the GMP Guidance, is that the data generated and provided must be comparable, validated, harmonized and capable of revealing trends over time and space of pollutants of interest in the various regions. To this end, the Global Monitoring Plan data repository (GMP DWH) has been developed, as an electronic tool containing a multi-level data repository, analytical tools and a visualization platform.

For this report, the procedure that was implemented in handling the data obtained from the GMP DWH repository is described below:

A. **Configuration of the GRULAC Database.** A structured table was prepared in Excel (hereinafter referred to as the GRULAC database) of the data obtained, with which the data handling was carried out with dynamic tables and advanced Excel functions.

B. **Review of existing data by Sampling Program.** The amount of existing data by matrix and program was reviewed, verifying repeated, tripled and quadrupled lines and proceeded to clean it. Pivot tables by type of matrix were developed to review each matrix.

C. **In the case of Air matrix,** the following were reviewed:
   a) **Programs that supply data.** Description and review of the programs, participating countries, sites and parameters analyzed by each program.
   b) **Geographical location of the Sites.** The geographical location of the sampling sites was extracted from the GRULAC database and taken to an Open Source Geographic Information System (GIS) licensed under GPL (General Public License) called QGIS, this to facilitate the analysis of the location of the sites. With the QGIS, the location of the air sampling sites in each of the Programs was reviewed to validate the geographic location and the consistency of the coordinates in the records of each data line. In Annex 1, the list of stations with their corresponding coordinates is presented.
   c) **Prevalence of the sites.** It was evaluated if the air sampling sites used in the different stages of the programs were consistent, that is, that they maintained their geographic location from one monitoring year or period to another. For UNEP/GEF GMP projects, in general, the monitoring sites did not maintain their geographic location from one monitoring campaign to another (2010-2011 to 2016-2018), so those sites that were less than 10 kilometers away, located in the same country and with the same classification, were selected. Upon finding that there are sites with the same name but with different coordinates, or sites with different names and located within a radius of 10 kilometers around another, a query was made to the countries to verify their prevalence. From the result of the consultation, Chile and Ecuador expressed that the sites were different, the other countries indicated that they were the same sites, as is the case of Antigua and Barbuda and St Phillips; Barbados and St James; Brazil and Sao Paulo; Peru and Lima; Jamaica and Kingston; and Uruguay and Montevideo. Mexico stated that the Montes Azules site, Chiapas and the Los Mochis site have similar characteristics, although they are separated by almost two thousand kilometers apart, so they cannot be considered the same site. See Annex 3. Maps.
   d) **Harmonization of sites.** After having carried out the evaluation of the prevalence of the sites, the UNEP/GEF GMP database, known as Air-GEF in DWH, was harmonized, standardizing the coordinates of those sites that prevailed and adjusting them to the coordinates of the 2016-2018 campaign. It should be noted that the GAPS program also harmonized the location of its monitoring sites.
   e) **Review of site classification.** In the first reports, the air sampling sites according to the criteria established in the previous GMP Guidance were classified as remote, rural, suburban, urban and agricultural. The 2019 amendment to the Guidance recommends that sites be classified as: Remote, Rural and Urban. It should be noted that almost 30% of the sites in the GMP DWH database are reported as unclassified. For the classification of the sites, the population density is taken into account as follows: urban> = 200,000 inhabitants within a radius of 10 km; suburban = between 20,000 and 200,000 inhabitants within a radius of 10 km; rural = between 2,000 and 20,000 inhabitants in a radius of 10 km; remote = relatively uninhabited (<2,000 inhabitants within a 10 km radius). Site information and classification is important for comparing data within a region and between regions.
   f) **Completeness of data by monitoring site.** The criterion of 75% of sampling days per sampling year was applied to validate the sampling years of each monitoring site and program. In the case of passive PUF monitoring, it was verified that each year of sampling was represented by at least 3 samples exposed each for three months and in the case of XAD sampling, it was verified that the samplers were exposed for at least 275 days to represent each sampling year.
   g) **Parameters measured** in each site and year of monitoring.

D. **In the case of human milk matrix**, the following were reviewed:
   a) **Programs that supply data**. Description and review of the programs, participating countries and parameters analyzed by each program.
   b) **Location** of the participating countries.
   c) **Repeated participation of the countries** by round of breast milk studies.
   d) **Countries that submitted samples** to the reference laboratory and whose results are in the database.
   e) **Number of samples** per country.
   f) **Parameters measured** in each country and round.

E. **In the case of water matrix**, the following were reviewed:
   a) **Programs that supply data**. Description and review of the programs, participating countries, sites and parameters analyzed by each program.
   b) **Geographical location** of the sampling sites.
   c) **Prevalence** of sites.
   d) **Completeness**. Sites that met the criterion of sampling 3 out of 4 times in a year.
   e) **Sampling protocol** verification.
   f) **Parameters measured** in each site and year of sampling.

F. **Data deficiency.** During these activities, some deficiencies in the data were identified, as is the case:
   a) **Location of sites.** Not all countries maintain the location of monitoring sites in the programs.
   b) **Sufficiency of data.** There are sites that do not have enough data to represent one year of monitoring, that is, they do not reach the level of 75% completeness.
   c) **Not all countries repeatedly participate in monitoring programs**. In air, most sites only present one year of sample data. In breast milk, eight countries have participated in two rounds and one in three.
   d) **Unclassified sites**. Not classified sites (29 in total).
   e) **Missing data from the programs**. The programs or projects did not upload previously the data of all the samples to the GMP DWH repository when this report was integrated.

4.4.1. AGREED PROTOCOLS FOR DATA ACQUISITION, STORAGE, EVALUATION AND ACCESS

The GRULAC region does not have specific protocols agreed for the acquisition, storage, evaluation and access of data. For this third evaluation, as mentioned, the data incorporated into the GMP DWH data repository and the tools that this repository provides as formats and guidelines for data incorporation, storage, evaluation and data access are used. The data incorporated in the DWH comes from:

- The results obtained by the Global Passive Atmospheric Monitoring Program (GAPS) supported by the Environment and Climate Change Canada Federal Department.
- The results of the implementation of the UNEP/GEF projects, called "Support in the Implementation of the Global Monitoring Plan (GMP) of Persistent Organic Pollutants (POPs), in the countries of Latin America and the Caribbean"
- The results obtained from the Latin American Passive Atmospheric Monitoring Network (LAPAM)
- National programs or studies of the countries of the GRULAC Region, such as: POPs Monitoring Network of Colombia
- Human Milk WHO survey
- Monet Aqua program

4.4.2. STATISTICAL CONSIDERATIONS

According to the GMP Guidance, it is important to use various summary statistics for the annual aggregation, such as the minimum, maximum, arithmetic and geometric mean, and median, which can be used for further evaluation of trends.

Although the arithmetic mean was recommended by previous versions of the guidance document, the experiences of the first two monitoring campaigns show significant biases from a normal distribution of concentration data. Based on this knowledge, the median will be used in this third assessment as a robust and simple statistic for the annual aggregation. Therefore, most of the statistics reported in this report are based on the median values.

Regarding the availability of data to establish time series, it is necessary to have prevalence in the monitoring sites or repeated participation. For the ambient air matrix, after applying the completeness criterion, there were 93 sites of which 57% of them only monitored one year and 43 % more than two years, resulting in 40 available sites; and for the mother's milk matrix there are data from 9 countries that have participated in 2 rounds of the WHO study, but only seven participated in the six round.

Mann-Kendall was used and logarithmic trend lines, that generally had the best fit of r, were plotted for the calculation of trends. In general, non-significant results are obtained since the data show great variability. According to the experience of the first two sampling campaigns for the evaluation of POPs, the sample size to identify a trend (typically a decrease in the concentration of POPs) is observed between 7 and 10 years of monitoring (UNEP, 2019).

4.4.3. THE INFORMATION WAREHOUSE

As mentioned, the data used for this report has been obtained from the GMP DWH. It is important to note that this Global Monitoring Plan data storage supports data collection and assists regional groups and global coordinating groups in developing monitoring reports and on the effectiveness evaluation.

Said GMP DWH includes an interactive data capture system, management of data and a presentation module. The tool is also a valuable data repository of public access that can be used as a resource for policy makers and researchers around the world. The tool is available at http://data.pops-gmp.org/2020/.

4.4.4. DATA FROM EXISTING PROGRAMS

Data from existing programs have been incorporated into the Global Monitoring Plan DWH and made available to regional organization groups for validation and analysis (https://dmc.pops-gmp.org/auth/ dashboard). Likewise, access, in an efficient and friendly manner, is provided to regional organization groups to gather information on current monitoring programs and activities with harmonious data handling and presentation of all regions, for the development of the monitoring reports (http://data.pops-gmp.org/2020/grulac/#). Table 29 shows the number of data available in the GMP DWH for each year and the number of sites monitored per matrix.

Table 29. Summary of data availability in the DWH

Matrix	Program	Initial Year	Ending Year	Number of parameters	Number of sites	Data
Air	AIR - GEF	2010	2018	99	21	3552
	Colombia - POPs monitoring	2009	2014	49	5	901
	GAPS	2004	2016	93	29	2,587
	LAPAN	2010	2016	45	56	3,298
Human Milk	GMP 1	1992	2002	40	1	48
	MILK - WHO	2001	2019	110	14	2,360
	WHO	2002	2009	26	5	317
Human Blood	GMP 1	1997	2001	12	1	54
Water	MONET-Aqua	2016	2016	47	2	94
	GMP UNEP	2014	2014	1	1	1
	UNEP/GEF GMP II	2017	2019	3	6	33

Source: GMP DWH (http://data.pops-gmp.org/2020/grulac/#).

5. PREPARATION OF THE MONITORING REPORTS

The arrangements established by GRULAC's ROG for the preparation of the Third Regional Monitoring Report consisted of:

- Establishment of the writing team. The writing team would be composed of:
  - ROG members
  - One consultant
  - One translator
  - An editor
- Establishment of the report preparation schedule
- Development of the terms of reference for contracting
- Selection of consultants
- Hiring the consultant to process and analyze the data and produce a preliminary report
- Teleconferences to discuss the initial draft, with the participation of ROG members and the consultants
- Virtual meeting to discuss and finalize the draft of the report
- English / Spanish translation
- Distribution of the Report to the focal points of the countries of the region, for their review, comments and recommendations
- Conclusion of the report

The ROG prepared the terms of reference for the consulting work, which were distributed to the candidate consultants identified by the ROG. The main functions of the consultant were to review and update information on the region, such as characteristics of the region, National Implementation Plans and National Reports; management, analysis and interpretation of sampling data and data from studies of POPs incorporated in the DWH of the GMP; information processing for the delivery of results; formulate conclusions and recommendations in collaboration with ROG members; development of the third regional preliminary report draft during July 2020 to March 2021; incorporation of the observations of the ROG members and the countries and conclude the document.

It should be clarified that due to the COVID-19 pandemic, the face-to-face meeting that was scheduled to carry out the conclusion of the report, including development of conclusions, recommendations, and the final and complete review of it, could not be held. Therefore, work was performed via email and a series of virtual meetings were held in which the chapters of the report were reviewed one by one; clarifications were made, and observations from ROG members were addressed.

A semi-final version was circulated in English and Spanish among the focal points of the 33 GRULAC region countries and the secretariat during April 2021. Of these countries, 32 confirmed receipt of the document by electronic message. One did not receive it because of the lack of internet capacity. Comments were received from 4, and others required additional time to review the document, giving an extension for it during a second call.

The ROG members and the consultants met in a virtual workshop to review and include the comments and observations sent by the countries and finalize the regional report.

The final report was sent to the secretariat in April 2021 and is going to be presented to the coordination group in the following months. The final edition in Spanish and English will be published in the Web site of the Stockholm Convention (http://www.pops.int/) in 2021.

6. RESULTS

The formal monitoring of POPs in ambient air in the GRULAC region began in 2004 with the participation of five countries in the GAPS Program. In 2005, three more countries were incorporated, giving a total of eight countries that, under said program, provided the data for the First Monitoring Report of the region. For the Second Monitoring Report, data was available from 17 countries from: GAPS, UNEP/GEF/SAICM I and LAPAN projects. This Third Monitoring Report includes information from 19 countries from the same programs that provided data for the Second Report.

Countries and sites with full years and recurring monitoring were added to the Third Report for air media, which allow evaluating concentration changes in nine countries. Also, 83 parameters were measured, of which 13 were measured for the first time in the Region; these include new, emerging compounds and Perfluorohexane Sulfonic Acid (PFHxS), a candidate compound to be incorporated into the Convention.

However, the variability of the data in the region and its low recurrence didn't allow significant trends to be obtained. Figure 31 summarizes the availability of data by matrix and compound of the DWH as of January 4, 2021, note that in the region the air and human milk matrices present non-significant trends for some compounds and the water and blood matrices do not have sufficient data to evaluate them.

Figure 31. Summary of data availability and trends in the GRULAC region

	Air	Water	Breast milk	Human blood
Aldrin	85 (Inc.: 0, Dec.: 0, Insig.: 45, N/A: 40)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	17 (Inc.: 0, Dec.: 0, Insig.: 8, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Chlordane	362 (Inc.: 1, Dec.: 0, Insig.: 210, N/A: 151)	6 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 6)	75 (Inc.: 0, Dec.: 0, Insig.: 27, N/A: 48)	
Dichlorodiphenyltrichloroethane	691 (Inc.: 0, Dec.: 0, Insig.: 365, N/A: 326)	16 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 16)	136 (Inc.: 0, Dec.: 0, Insig.: 72, N/A: 64)	4 (Inc.: 0, Dec.: 0, Insig.: 1, N/A: 3)
Dieldrin	103 (Inc.: 0, Dec.: 0, Insig.: 55, N/A: 48)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	18 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Endrin	77 (Inc.: 0, Dec.: 0, Insig.: 41, N/A: 36)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	17 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 8)	
Hexachlorobenzene	86 (Inc.: 0, Dec.: 0, Insig.: 50, N/A: 36)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	18 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Heptachlor	207 (Inc.: 0, Dec.: 1, Insig.: 132, N/A: 74)	8 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 8)	70 (Inc.: 0, Dec.: 0, Insig.: 33, N/A: 37)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Mirex	77 (Inc.: 0, Dec.: 0, Insig.: 40, N/A: 37)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	17 (Inc.: 0, Dec.: 0, Insig.: 8, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Polychlorinated biphenyls	812 (Inc.: 1, Dec.: 1, Insig.: 425, N/A: 385)	16 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 16)	116 (Inc.: 0, Dec.: 0, Insig.: 64, N/A: 52)	
Polychlorinated biphenyls coplanar	597 (Inc.: 0, Dec.: 0, Insig.: 285, N/A: 312)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	223 (Inc.: 0, Dec.: 0, Insig.: 153, N/A: 70)	
Polychlorinated dibenzodioxins	456 (Inc.: 0, Dec.: 2, Insig.: 233, N/A: 221)		175 (Inc.: 0, Dec.: 0, Insig.: 108, N/A: 67)	
Polychlorinated dibenzofurans	507 (Inc.: 0, Dec.: 4, Insig.: 236, N/A: 267)		204 (Inc.: 0, Dec.: 0, Insig.: 126, N/A: 78)	
Polychlorinated dibenzodioxins/dibenzofurans	198 (Inc.: 0, Dec.: 2, Insig.: 70, N/A: 126)		84 (Inc.: 0, Dec.: 0, Insig.: 54, N/A: 30)	
Toxaphene			51 (Inc.: 0, Dec.: 0, Insig.: 27, N/A: 24)	
Chlordecone			9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Alphahexachlorocyclohexane	103 (Inc.: 0, Dec.: 0, Insig.: 55, N/A: 48)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	18 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Beta-hexachlorocyclohexane	85 (Inc.: 0, Dec.: 0, Insig.: 45, N/A: 40)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	18 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Gamma-hexachlorocyclohexane	103 (Inc.: 0, Dec.: 0, Insig.: 55, N/A: 48)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	18 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 9)	1 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 1)
Hexabromobiphenyl	10 (Inc.: 0, Dec.: 0, Insig.: 10, N/A: 0)		4 (Inc.: 0, Dec.: 0, Insig.: 8, N/A: 6)	
Pentachlorobenzene	71 (Inc.: 0, Dec.: 0, Insig.: 31, N/A: 40)	2 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 2)	14 (Inc.: 0, Dec.: 0, Insig.: 8, N/A: 6)	
Polybromodiphenyl ethers	654 (Inc.: 0, Dec.: 0, Insig.: 267, N/A: 387)	16 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 16)	95 (Inc.: 0, Dec.: 0, Insig.: 44, N/A: 51)	
Perfluorooctane sulfonic acid	31 (Inc.: 0, Dec.: 0, Insig.: 10, N/A: 21)	11 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 11)	9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Endosulfan	276 (Inc.: 0, Dec.: 2, Insig.: 131, N/A: 143)	6 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 6)	42 (Inc.: 0, Dec.: 0, Insig.: 24, N/A: 18)	
Hexabromocyclododecane	65 (Inc.: 0, Dec.: 0, Insig.: 41, N/A: 24)	6 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 6)	6 (Inc.: 0, Dec.: 0, Insig.: 24, N/A: 12)	
Hexachlorobutadiene	9 (Inc.: 0, Dec.: 0, Insig.: 9, N/A: 0)		9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Pentachlorophenol			9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Pentachloroanisole			9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Dicofol			9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Perfluorohexanesulfonate	7 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 7)	10 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 10)	9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Perfluorooctanoic acid	15 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 15)	10 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 10)	9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	
Short-Chain Chlorinated Paraffins (SCCP)			9 (Inc.: 0, Dec.: 0, Insig.: 0, N/A: 9)	

Ttrends type

Increasing Decreasing Insignificant No avalaible Not enough data

Source: GMP DWH.

Formal monitoring of biotic matrices in the region focuses mainly on the mother's milk matrix under the WHO/UNEP program. This Third Report includes the analysis of changes in concentration in nine countries that participated in two or more rounds and comparisons of 108 parameters of the MILK-WHO program, among which 13 were also measured for the first time.

Water monitoring in the region began in 2014 with a sample collection and was formalized for the target compounds PFOS, PFOA and PFHxS in 2017 and 2018, when six monitoring sites in five countries were implemented. These substances' concentrations, from these sites and years, will represent baseline information for future evaluations.

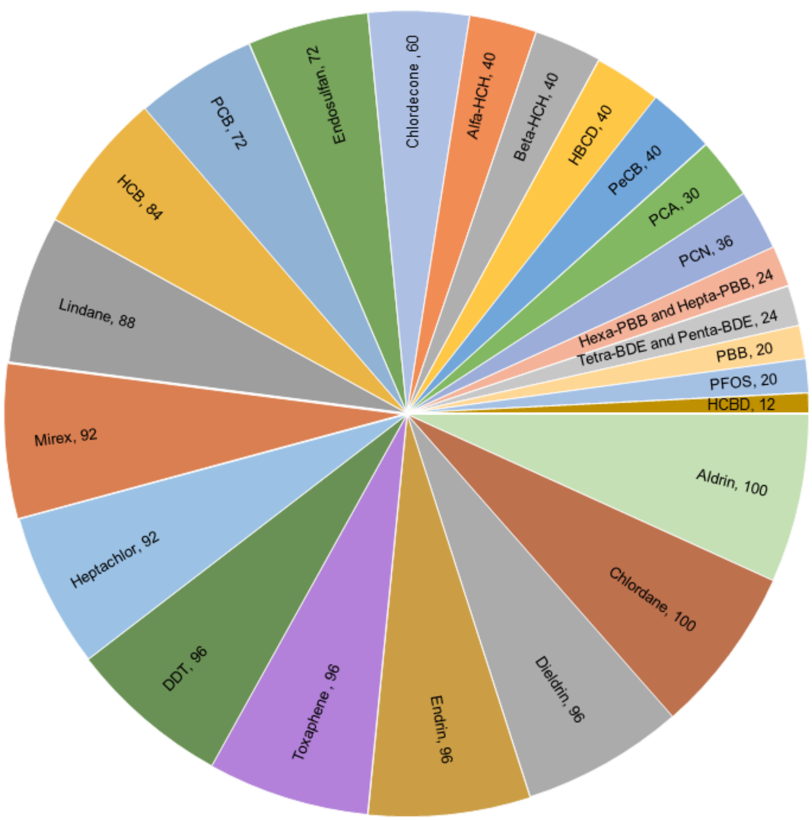
The results by matrix and program are detailed in section 6.2. Review of levels and trends in the region.

6.1. Regional Considerations

The sources of persistent organic pollutants in the Latin American and Caribbean Region are production, stocks and imports. These have been decreasing due to the effect of the prohibitions applied by the countries of the region. The prohibitions include their production, use, import and export.

Of the 31 GRULAC countries that are signatories to the Convention, 25 have reported some prohibition in the National Reports that have to be submitted every four years in compliance with the provisions of Article 15 of the Convention (http://www.pops.int /Countries/Reporting/NationalReports/tabid/3668/Default.aspx). There are POPs to which all these prohibitions apply including all uses. The POPs regulated by more countries in the region are Aldrin, Chlordane, Dieldrin, Endrin, Toxaphene and DDT; Figure 32 shows the percentages of regulation of each POP, where 100% is assigned to those substances that have some regulation in all 25 countries that have issued reports.

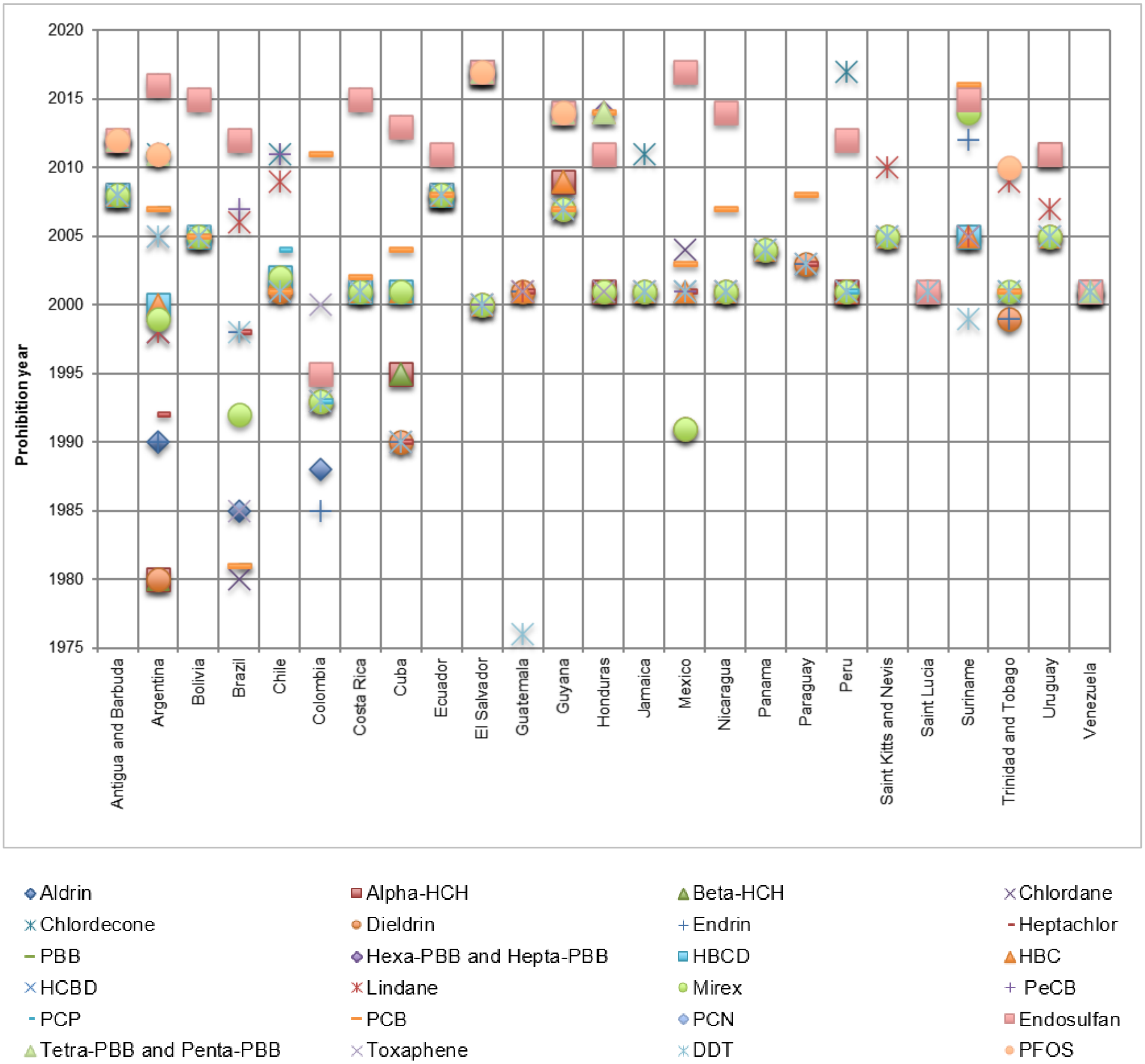
Figure 32. Compounds regulated by 25 countries in the GRULAC region



Source: Created by the authors with data from:
http://www.pops.int/Countries/Reporting/NationalReports/tabid/3668/Default.aspx

The oldest prohibition record was issued by Guatemala in 1976 on DDT; in the 1980s, Argentina and Brazil issued bans on Endosulfan, Dieldrin, and Chlordane; and after the year 2000 most of GRULAC parties established prohibitions for various POPs. Figure 33 summarizes this information presenting the regulated POPs, year and countries that issued a ban.

Figure 33. Regulated compounds, countries and year of regulation in GRULAC



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/NationalReports/tabid/3668/Default.aspx.

Regarding production, 18 countries have reported production bans since 1980, despite the fact that many of them have never produced the compounds, see figure 34. However, in the 2018 National Reports two countries in the region still communicated POPs production: Brazil, DDT, Endosulfan and Lindane from 2004 to 2008; and Mexico DDT until 2004 and Pentachlorophenol from 2004 to 2008. Figure 35 summarizes the kilograms produced by these countries.

Figure 34. Compounds with production bans, countries and year of regulation in GRULAC

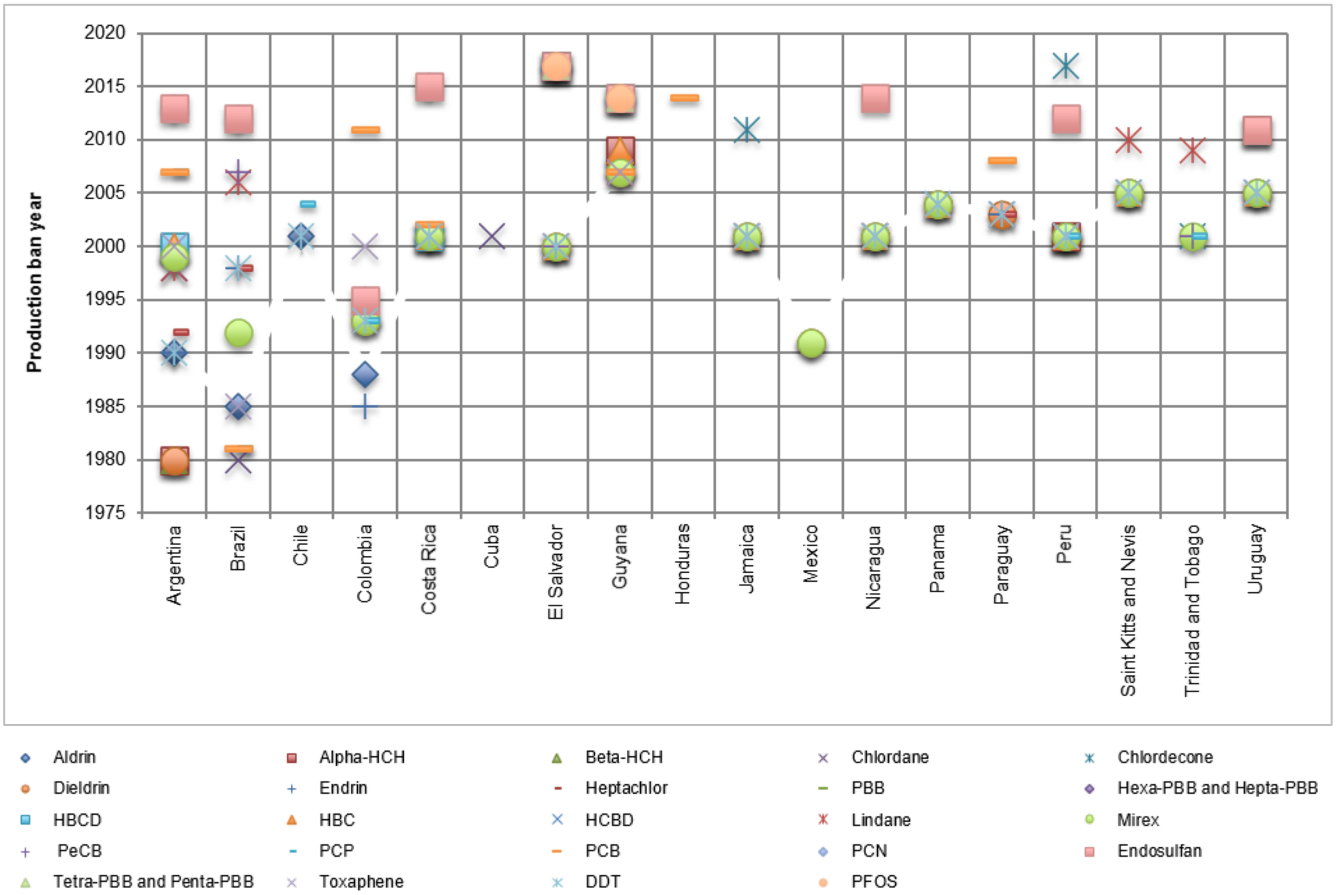
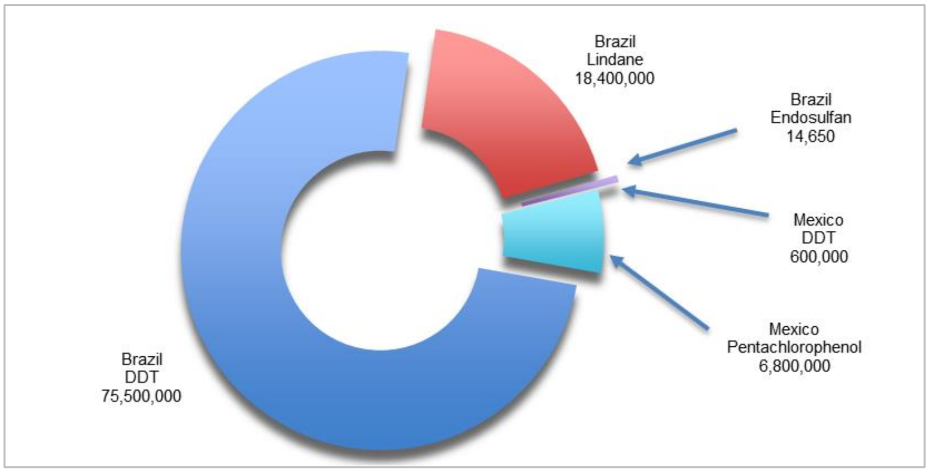


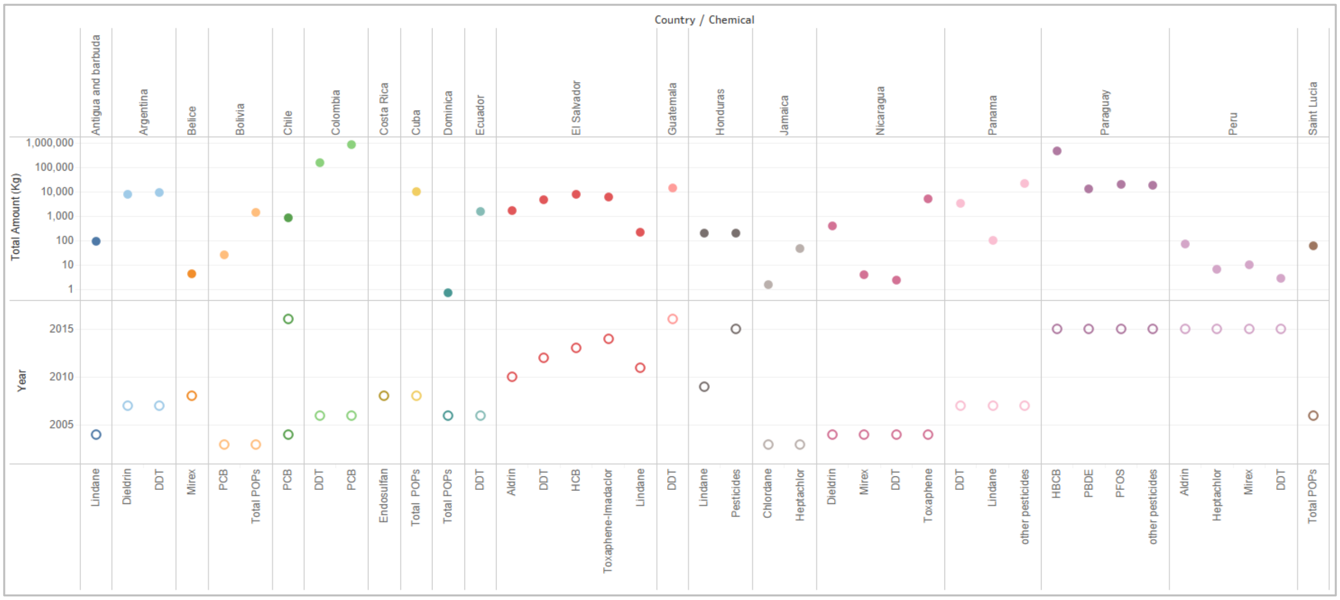
Figure 35. POPs production in GRULAC Region (Total Kg)



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/NationalReports/tabid/3668/Default.aspx.

In the region, stocks were reported mainly of Aldrin, Chlordane, Dieldrin, Endosulfan, Heptachlor, Mirex, DDT, HBCB, HCB, PBCDE, PCB, Toxaphene, Lindane and PFOS. However, Honduras, Paraguay and Panama reported their stocks as pesticides. While Bolivia, Cuba, Dominica, and Saint Lucia reported it as total POPs. Most of these stocks are expired and only have them stored, Figure 36 shows the quantities of compounds stored, report year and country.

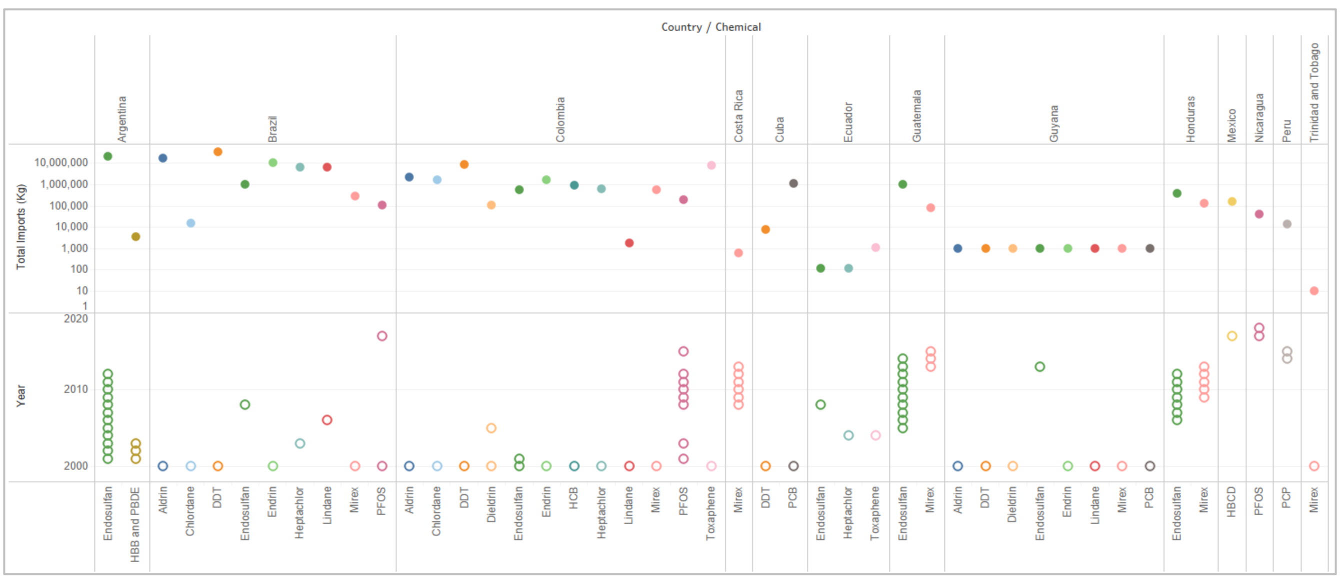
Figure 36. Quantity of compounds stored in the GRULAC countries



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/NationalReports/tabid/3668/Default.aspx.

The imports of the GRULAC region are shown in figure 37. which shows the total imports of POPs by country and by year. The countries that have made periodic imports are Argentina, Colombia, Costa Rica, Guatemala and Honduras; and the compounds mainly imported after 2010 are Endosulfan, Mirex and PFOS.

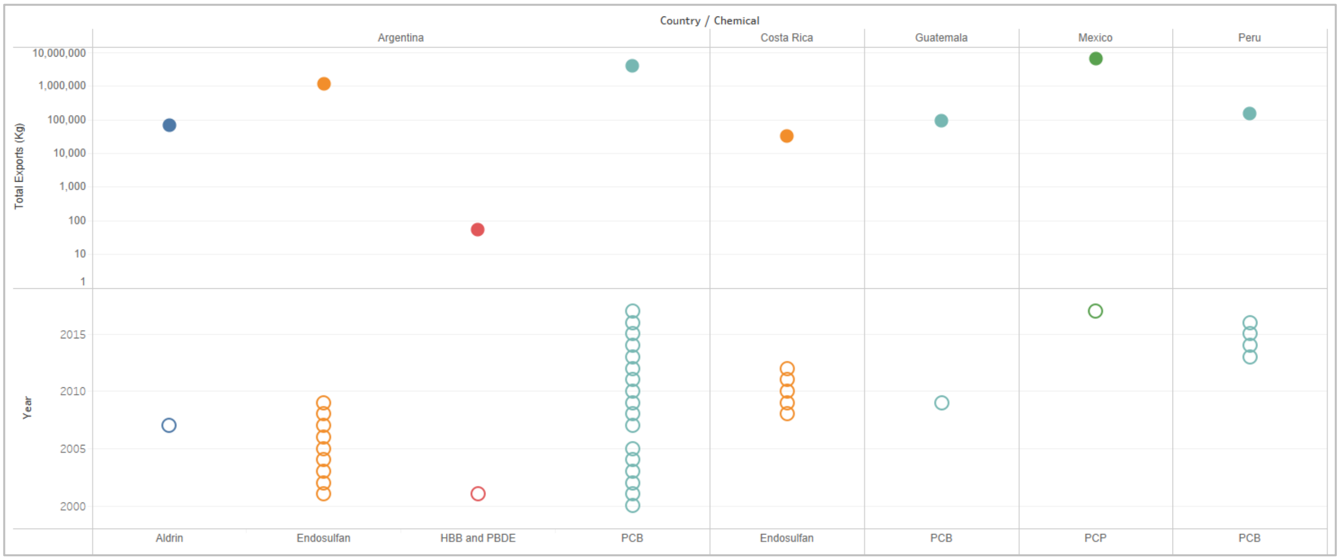
Figure 37. Imports of POPs in the GRULAC Region from 2001 to 2018



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/ReportingDatabase/tabid/7477/Default.aspx.

Regarding exports, the compounds that are exported in the Region are: Aldrin, Polychlorinated Biphenyls (PCBs), Endosulfan, Hexabromodiphenyl ether and Pentachlorophenol; mainly by Argentina, Mexico, Costa Rica, Guatemala and Peru. Figure 38 presents the total exports, by year and by country, communicated in the National Reports. Some countries export their waste for disposal. Colombia allows the export of POPs only for treatment. These exports were added to the disposal totals and are presented with the disposal data.

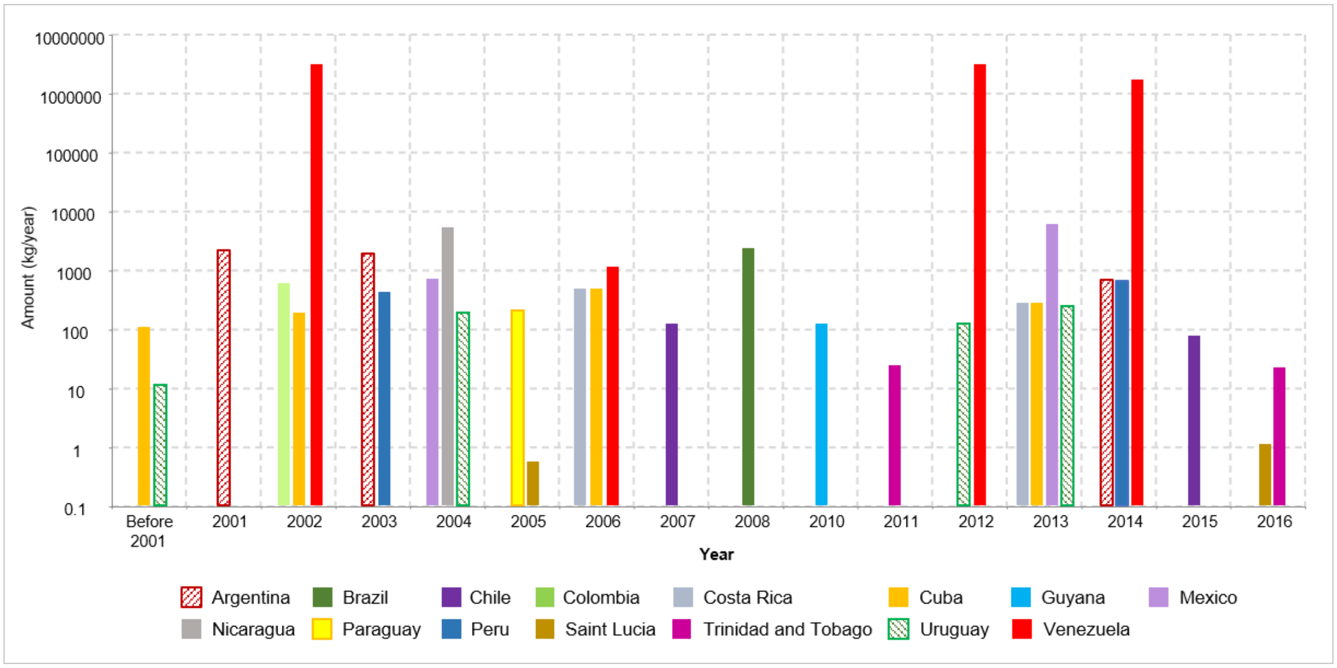
Figure 38. Export of POPs in GRULAC Region



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/ReportingDatabase/tabid/7477/Default.aspx.

Likewise, the countries of the GRULAC Region that submitted reports on the inventory of releases of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) from the established evaluation sources: waste incineration, production of ferrous and non-ferrous metals, generation of electrical energy and heating, production of mineral products, transportation, uncontrolled combustion processes, production and use of chemical substances and consumer goods, in five matrices, air, water, soil, waste and production, were: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Guyana, Mexico, Nicaragua, Paraguay, Peru, Saint Lucia, Trinidad and Tobago, Uruguay and Venezuela. The inventory was reported in 2018 and covers the period 2001 to 2016. Figure 39 shows the total amounts of PCDD/PCDF released by year and country. The highest releases were reported by Venezuela (Bolivarian Rep. of) in 2002, 2012 and 2014, followed by Mexico and Nicaragua. The highest releases of PCDD/PCDF per year were presented in the matrices of air, soil and residues.

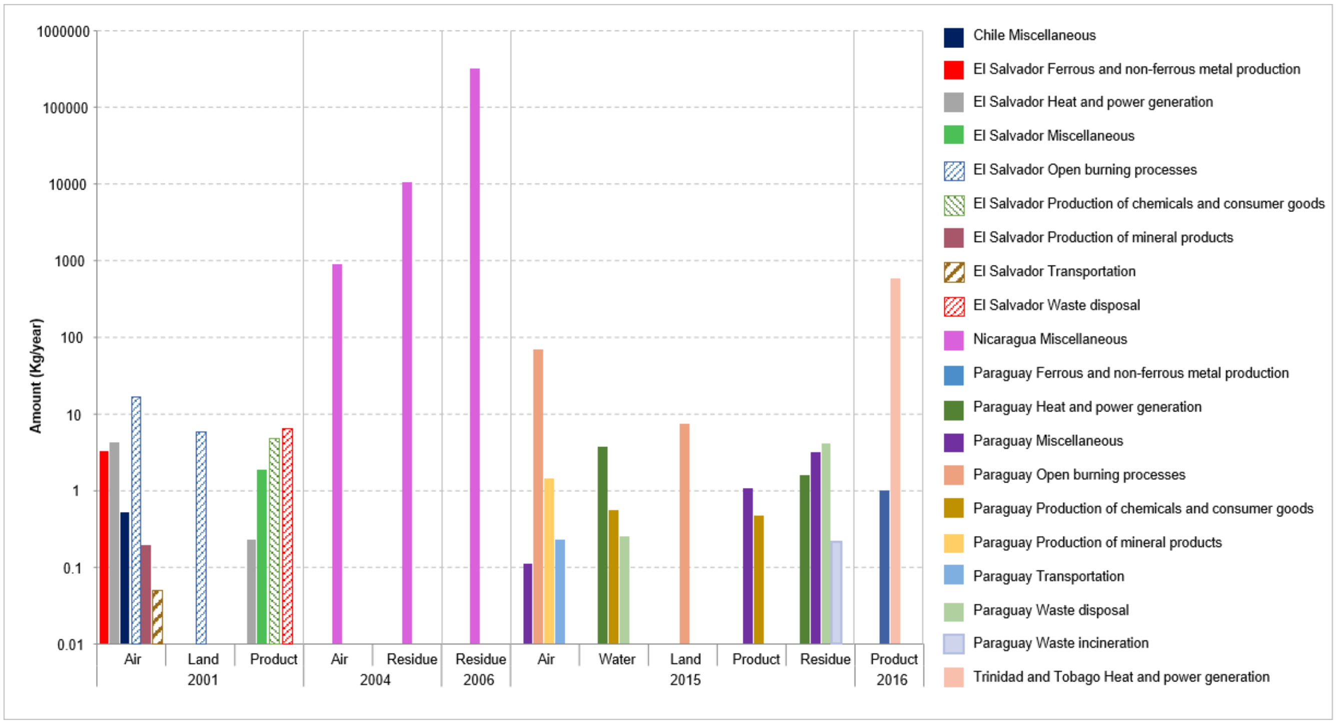
Figure 39. Total inventory of PCDD/PCDF releases



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/ReportingDatabase/tabid/7477/Default.aspx.

The parties that reported PCB releases, Figure 40 Inventory of PCB releases, were: Chile, El Salvador, Nicaragua, Paraguay and Trinidad and Tobago; being Nicaragua the one with the highest releases of PCBs per year into the air in 2004 and residues in 2006. For 2016 only Chile and Trinidad and Tobago reported inventory.

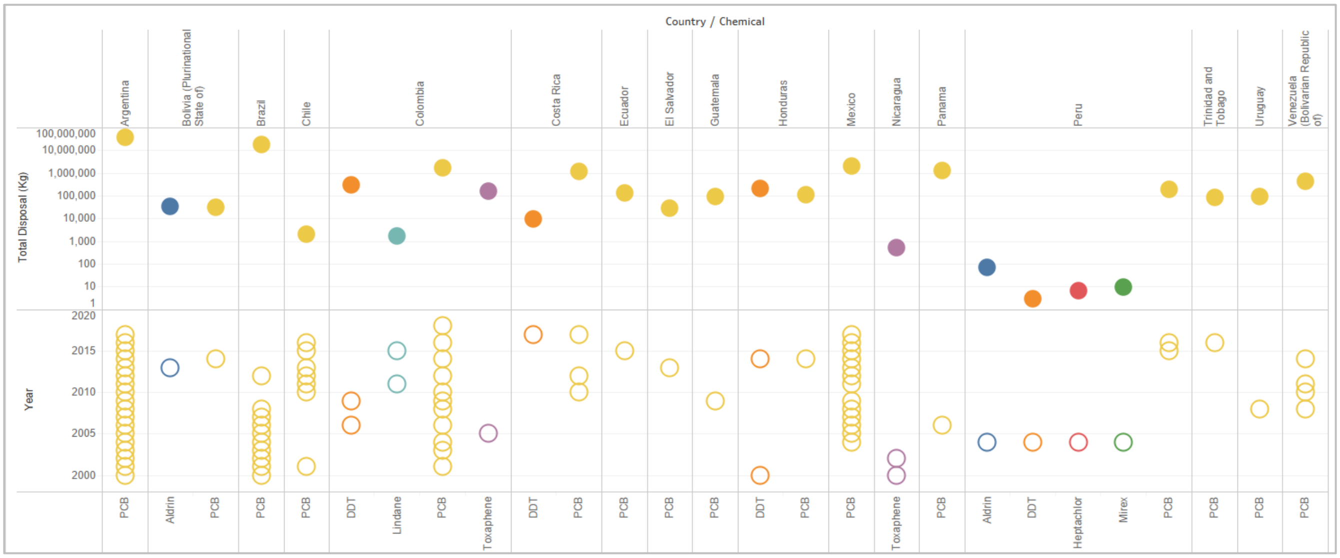
Figure 40. Inventory of PCB releases



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/ReportingDatabase/tabid/7477/Default.aspx.

Regarding the elimination of all chemicals listed by the Convention in Annexes A, B and C, figure 41 summarizes the historical disposition of POPs, countries and year in which these compounds were eliminated. The elimination of a large amount of PCBs has been reported mainly by Argentina, Colombia, Brazil and Mexico and to a lesser extent by Chile, Peru, Uruguay, El Salvador and Guatemala.

Figure 41. Final disposition of POPs in the GRULAC Region from 2001-2018



Source: Created by the authors with data from: http://www.pops.int/Countries/Reporting/ReportingDatabase/tabid/7477/Default.aspx.

Additional Information

Additional information was obtained from scientific articles in indexed journals. These articles were collected from a search on trends in levels of POPs reported in the region, the search words were “persistent organic pollutants, POPs, in GRULAC Region, Polychlorinated Dibenzo-p -Dioxins and Polychlorinated Dibenzofurans” the search was limited from 2010 to date.

The main findings are presented below.

Regarding the initial POPs that include a variety of organochlorine pesticides (OC) and polychlorinated biphenyls (PCB), the study by Rauert et al., 2018a, reports that there were no significant changes in concentration except for Gamma-hexachlorocyclohexane (HCH) and endosulphanes that decreased significantly from 2005 to 2015, suggesting that regional levels are declining.

Three authors confirm decreasing trends of Dioxins and Furans in the GRULAC region and establish that the concentration differences between the measured sites depend on meteorological conditions, season of the year and characteristics of the sites: urban, industrial, rural (background). The concentration being higher in urban sites (Francisco et al., 2017; Hu et al., 2019; and Schuster et al., 2015). However, de Lacerda, 2019, found that from 2012 to 2016 there was an increase in the analysis of Dioxins and Furans in food in Brazil.

Rauter's publications also highlight the importance of the GAPS monitoring network for analyzing various POPs for the first time. Regional atmospheric concentrations of the new and emerging POPs HCBD, PCA and Dicofol (degradation products) were reported. HCBD had similar concentrations regardless of location. PCA had high concentrations at the Concepción urban site in Chile and Dicofol was detected at the Sonora Mexico agricultural site (Rauert et al., 2018a).

Another initiative of this network was the regional monitoring of flame retardants that was reported for the first time in 2016 and in the second report included polybrominated diphenyl ethers (PBDE), organo-phosphate esters (OPE) and a range of FR alternatives, resulting that phosphate esters were present in all places with values at least one order of magnitude higher than most of other flame retardants and PBDEs. This same study detected concentrations of perfluoroalkyl sulphonates (PFAS) throughout the GRULAC region regardless of the type of location, and concentrations of volatile methylsiloxanes (VMS) increased with the population density of the sampling sites (Rauert et al., 2016 and 2018b and 2018c).

Also, Saini et al., 2020, reported that atmospheric concentrations of OPE significantly dominated the profile of flame retardants at all sites. A correlation was observed between the total levels of OPE and the index of the Gross Domestic Product of the cities.

Two studies found that airborne PBDE concentrations were similar to those reported in many other urban areas globally and that they are similar to those detected in samples collected in 2005 at GAPS sites. It is suggested that global atmospheric concentrations of PBDE have not decreased since regulatory measures were implemented (Pozo et al., 2017; and Rauert et al., 2018c).

Regarding the water matrix, Lohmann et al., 2017 reported water monitoring since 1916 by Aqua -GAPS to detect initial and emerging POPs around the world with two sites in GRULAC and a study by Baabish et al., 2021, reported variation within and between regions, and statistically significant differences were found in the average concentration of PFOA in Asia Pacific compared to Africa and GRULAC. Also, MONET-AQUA network carried out passive monitoring of POPs in water at two sites in the GRULAC region. The results are presented in section 6.2.3.

6.2. Review of levels and trends in GRULAC region

The review of levels and trends in the region considered the data from the abiotic and biotic matrices incorporated into the GMP DWH data repository as of January 4, 2021. These data were grouped by core matrix and groups of compounds and as described in Chapter 4 Completeness and site prevalence criteria were applied to the databases.

For air matrix, the concentration changes and trends of the data generated by the UNEP/GEF GMP (AIR - GEF) projects, GAPS and LAPAN programs are presented. The associated periods were 2004-2012 and 2013-2018. In total, data from 106 sites were reviewed that provided information of 107 parameters from 2004 to 2018 with participation from 19 countries in total. In section 6.2.1 the results obtained from the analysis of this matrix are presented.

Regarding the biotic matrices, the data on human milk from the GEF-1, MILK-WHO and WHO studies from the period 1992 to 2019 were reviewed. For this third evaluation, data from 110 parameters of 14 countries samples was obtained by the MILK-WHO program which was used because it is the only program that provided data in the 2015-2019 period. In section 6.2.2 the concentration changes obtained from this matrix are presented.

In relation to the Water matrix, the data obtained by the GMP UNEP, UNEP/GEF GMP II Projects, and the Monet-Aqua Project were verified. The analysis comprised 50 parameters from 9 sampling sites located in 8 countries. In section 6.2.3 the results obtained from this matrix are presented.

6.2.1. AIR RESULTS

In GRULAC region, as described in Chapter 4, three monitoring programs measured 107 parameters in 106 sites from 2004 to 2018 to evaluate concentrations of Persistent Organic Pollutants (POPs) in ambient air with participation of 19 countries: UNEP/GEF GMP program called AIR - GEF after the acronym used in the DWH, and that was applied in 14 countries; GAPS program in 10 countries and LAPAN in 12 countries. However, from 2013 to 2018 there were only 75 monitoring sites and 83 parameters data, of which 13 were measured for the first time in the region.

The analysis of data of each of these programs includes the integration and organization of data, its review by sites, countries and groups of compounds, and their statistical analysis.

The integration was carried out starting with the organization of the data by program and by compound in a common sequence, grouping them to present the groups of compounds that were measured by each of the monitoring programs, following the strategy recommended in the Guidance document UNEP/POPS/COP.9/INF/36, Chapter Seven.

Data review for each parameter was performed by classifying those data that meet the 75% completeness criterion, separating these data from those that do not meet the criterion, and creating two databases: one complete and the other with all data.

With these two databases, medians comparisons were made at regional level by groups of compounds and monitoring program.

Databases were separated by monitoring program for analysis; sites were selected from each program that measured two or more full years and that included measurements during the 2013-2018 period; its behavior was evaluated by type of site and year of monitoring; statistical parameters were evaluated for different arrangements; and changes in concentration and possible trends of the parameters were graphed and calculated at the sites where it applied.

Likewise, distribution and variability of all the data was reviewed using box and whisker graphs and a statistical analysis was performed to compare, by parameter analyzed, the medians of the types of monitoring sites.

The national analysis, that is, by country and by monitoring site, was obtained from the analysis by monitoring program and groups of compounds and the results are presented in the technical sheets structured by group of compounds for each program. Relevant results are presented below.

Relevant results

Regional Analysis

To analyze the behavior of the parameters at regional level, medians of the data for the period 2004-2012 were compared with those of 2013-2018 by means of box diagrams and the statistical parameters were calculated by program for both databases: data with Completeness and Totals. Result of the comparison of the medians and the value of the median of medians for the period 2013-2018 by parameter and program is presented in mosaic table 30, where it is seen in red if the concentration increased, in green if it decreased and in blue if it was measured only in the period 2013-2018.

In general, an increase in concentration is observed in the period 2013-2018 for the groups: Cyclodienes, DDT, PCBs with TEF, HCH, and BDE; and a decrease for PCB, PCDD and PCDF, and PeCB. In addition, the highest median values are presented by the Air-GEF program. It is important to mention that among the 13 parameters that were measured for the first time in the region, the PFHxS stands out, a candidate compound to be included in the Stockholm Convention.

Mosaic Table 30. Comparison of medians for the periods 2004-2012 and 2013-2018 by monitoring program

No	GROUP	Parameter	DATA WITH COMPLETENESS AIR - GEF 2016 - 2018	DATA WITH COMPLETENESS GAPS 2013 - 2016	DATA WITH COMPLETENESS LAPAN 2013 - 2018	TOTAL DATA AIR - GEF 2016 - 2018	TOTAL DATA GAPS 2013 - 2016	TOTAL DATA LAPAN 2013 - 2018
1	Organochlorine Insecticides	Aldrin (pg/m^3)	1.221	NM	0.172	1.445	NM	0.172
2		cis-Chlordane (= alpha) (pg/m^3)	3.145	1.037	0.498	3.295	1.029	0.498
3		trans-Chlordane (= gamma) (pg/m^3)	7.492	0.108	0.649	8.733	0.114	0.649
4		cis-Nonachlor (pg/m^3)	0.770	NM	NM	0.771	NM	NM
5		trans-Nonachlor (pg/m^3)	4.970	0.007	NM	6.782	0.006	NM
6		Oxychlordane (pg/m^3)	0.867	NM	0.077	0.868	NM	0.077
7		Dieldrin (pg/m^3)	16.537	0.305	1.697	18.999	0.157	1.697
8		Endosulfan I (alpha) (pg/m^3)	3.889	9.025	2.136	2.168	8.609	2.136
9		Endosulfan II (beta) (pg/m^3)	1.948	1.738	2.439	1.977	1.492	2.439
10		Endosulfan SO4 (pg/m^3)	0.383	0.864	0.087	0.383	0.943	0.087
11		Endrin (pg/m^3)	1.514	NM	0.389	2.038	NM	0.389
12		Heptachlor (pg/m^3)	2.625	0.124	0.564	3.007	0.170	0.564
13		Sum 2 heptachlorepoxides (cis + trans) (pg/m^3)	1.341	0.277	NM	1.793	0.224	NM
14		Mirex (pg/m^3)	0.153	NM	0.043	0.153	NM	0.043
15	Dichlorodiphenyltrichloroethane (DDT)	o,p-DDD (pg/m^3)	1.015	NM	0.263	0.993	NM	0.263
16		o,p-DDE (pg/m^3)	2.931	NM	0.409	2.491	NM	0.409
17		o,p-DDT (pg/m^3)	7.323	NM	0.630	7.291	NM	0.630
18		p,p-DDD (pg/m^3)	1.562	NM	0.488	1.502	NM	0.488
19		p,p-DDE (pg/m^3)	32.106	NM	3.028	31.844	NM	3.028
20		p,p-DDT (pg/m^3)	17.941	NM	1.500	17.908	NM	1.500
21		Sum 3 p,p-DDTs (pg/m^3)	54.419	NM	5.875	51.829	NM	5.875
22		Sum 6 DDTs (pg/m^3)	66.827	NM	7.253	63.692	NM	7.253
23	Hexachlorobenzene (HCB)	HCB (pg/m^3)	26.139	27.000	14.360	26.078	27.000	14.360
24	Polychlorinated biphenyls (PCB)	PCB 28 (pg/m^3)	6.608	0.700	2.068	7.128	0.717	2.068
25		PCB 52 (pg/m^3)	8.680	0.274	0.625	5.589	0.364	0.625
26		PCB 101 (pg/m^3)	4.882	0.429	0.365	2.613	0.420	0.365
27		PCB138 (pg/m^3)	2.719	0.010	0.357	1.117	0.010	0.357
28		PCB 153 (pg/m^3)	2.967	0.257	0.374	1.342	0.260	0.374
29		PCB 180 (pg/m^3)	1.131	0.011	0.125	0.381	0.010	0.125
30		Sum 6 PCBs (pg/m^3)	30.044	1.720	4.076	15.124	1.806	4.076
31		Sum 7 PCBs (pg/m^3)	4,949.599	2.082	4.283	1,307.739	2.151	4.283
32	Polychlorinated biphenyls (PCB with TEF)	PCB 105 (fg/m^3)	1,196,914.0	NM	NM	570,255.1	NM	NM
33		PCB 114 (fg/m^3)	91,154.9	NM	NM	49,017.1	NM	NM
34		PCB 118 (fg/m^3)	3,019,307.3	241.582	308.500	1,244,453.0	252.848	308.500
35		PCB 156 (fg/m^3)	225,947.3	NM	NM	97,437.3	NM	NM
36		PCB157 (fg/m^3)	56,416.1	NM	NM	23,717.5	NM	NM
37		PCB 189 (fg/m^3)	27,711.6	NM	NM	9,634.0	NM	NM
38	Polychlorinated Dibenzodioxins and Dibenzofurans (PCDD and PCDF)	1,2,3,4,6,7,8-HpCDD (fg/m^3)	13.302	NM	NM	17.650	NM	NM
39		1,2,3,4,6,7,8-HpCDF (fg/m^3)	7.109	NM	NM	14.358	NM	NM
40		1,2,3,4,7,8,9-HpCDF (fg/m^3)	0.862	NM	NM	0.931	NM	NM
41		1,2,3,4,7,8-HxCDD (fg/m^3)	0.757	NM	NM	1.294	NM	NM
42		1,2,3,4,7,8-HxCDF (fg/m^3)	2.595	NM	NM	4.626	NM	NM
43		1,2,3,6,7,8-HxCDD (fg/m^3)	3.480	NM	NM	3.480	NM	NM
44		1,2,3,6,7,8-HxCDF (fg/m^3)	2.778	NM	NM	4.976	NM	NM
45		1,2,3,7,8,9-HxCDD (fg/m^3)	2.057	NM	NM	2.374	NM	NM
46		1,2,3,7,8,9-HxCDF (fg/m^3)	0.471	NM	NM	0.471	NM	NM
47		1,2,3,7,8-PeCDD (fg/m^3)	2.119	NM	NM	3.107	NM	NM
48		2,3,4,6,7,8-HxCDF (fg/m^3)	2.510	NM	NM	4.289	NM	NM
49		2,3,4,7,8-PeCDF (fg/m^3)	3.868	NM	NM	7.826	NM	NM
50		2,3,7,8-TCDD (fg/m^3)	0.780	NM	NM	0.949	NM	NM
51		2,3,7,8-TCDF (fg/m^3)	5.786	NM	NM	7.462	NM	NM
52		OCDD (fg/m^3)	96.766	NM	NM	96.766	NM	NM
53		OCDF (fg/m^3)	5.773	NM	NM	5.853	NM	NM
54		Sum 7 PCDDs (fg/m^3)	67.458	NM	NM	160.677	NM	NM
55	PCDD/PCDF and Dioxin-like PCBs' TEQ	PCDDs WHO1998-TEQ LB (fg/m^3)	2.185	NM	NM	4.214	NM	NM
56		PCDDs WHO2005-TEQ LB (fg/m^3)	2.187	NM	NM	4.227	NM	NM
57		PCDDs WHO1998-TEQ UB (fg/m^3)	2.523	NM	NM	7.104	NM	NM
58		PCDDs WHO2005-TEQ UB (fg/m^3)	2.525	NM	NM	7.122	NM	NM
59	Hexachlorocyclohexane (HCH)	Alpha-HCH (pg/m^3)	2.281	0.333	0.920	2.442	0.258	0.920
60		Beta-HCH (pg/m^3)	0.418	NM	0.708	0.419	NM	0.708
61		Gamma-HCH (pg/m^3)	10.753	0.477	0.633	10.773	0.605	0.633
62	Pentachlorobenzene (PeCB)	PeCB (pg/m^3)	142.350	11.500	6.590	138.474	11.000	6.590
63	Bromine Diphenyl Ethers (PBDE)	BDE 47 (pg/m^3)	2.273	1.008	0.258	2.133	1.008	0.258
64		BDE 99 (pg/m^3)	0.932	1.210	0.099	0.932	1.210	0.099
65		BDE 153 (pg/m^3)	0.946	0.130	0.015	0.946	0.130	0.015
66		BDE 154 (pg/m^3)	0.303	0.109	0.015	0.303	0.109	0.015
67		BDE 175/183 (pg/m^3)	1.891	0.150	NM	1.891	0.150	NM
68		BDE 17 (pg/m^3)	0.192	0.020	NM	0.186	0.020	NM
69		BDE 28 (pg/m^3)	0.430	0.090	0.063	0.405	0.090	0.063
70		BDE 100 (pg/m^3)	0.259	0.278	0.021	0.256	0.278	0.021
71	Decabromodiphenyl ether (Deca BDE)	Deca-BDE209 (pg/m^3)	NM	0.500	0.604	NM	0.500	0.604
72	Hexabromocyclododecane (HBDC)	Alpha-HBCD (pg/m^3)	NM	0.044	NM	NM	0.044	NM
73		Beta-HBCD (pg/m^3)	NM	0.031	NM	NM	0.031	NM
74		Gamma-HBCD (pg/m^3)	NM	0.031	NM	NM	0.300	NM
75	Hexabromobiphenyl (PBB)	PBB 153 (pg/m^3)	0.00005672	NM	NM	0.00005672	NM	NM
76	Perfluorooctane sulfonic acid (PFOS)	PFOS (pg/m^3)	NM	2.500	NM	NM	6.700	NM
77		NMeFOSA (pg/m^3)	NM	0.050	NM	NM	0.480	NM
78		NMeFOSE (pg/m^3)	NM	0.190	NM	NM	0.150	NM
79		NEtFOSA (pg/m^3)	NM	0.110	NM	NM	0.160	NM
80		NEtFOSE (pg/m^3)	NM	0.035	NM	NM	0.150	NM
81	Hexachlorobutadiene (HCBD)	HCBD (pg/m^3)	NM	26.500	NM	NM	27.000	NM
82	Pentadecafluorooctanoic acid (PFOA)	PFOA (pg/m^3)	NM	7.900	NM	NM	7.900	NM
83	Perfluorohexane sulfonic acid (PFHxS)	PFHxS (pg/m^3)	NM	0.015	NM	NM	1.500	NM

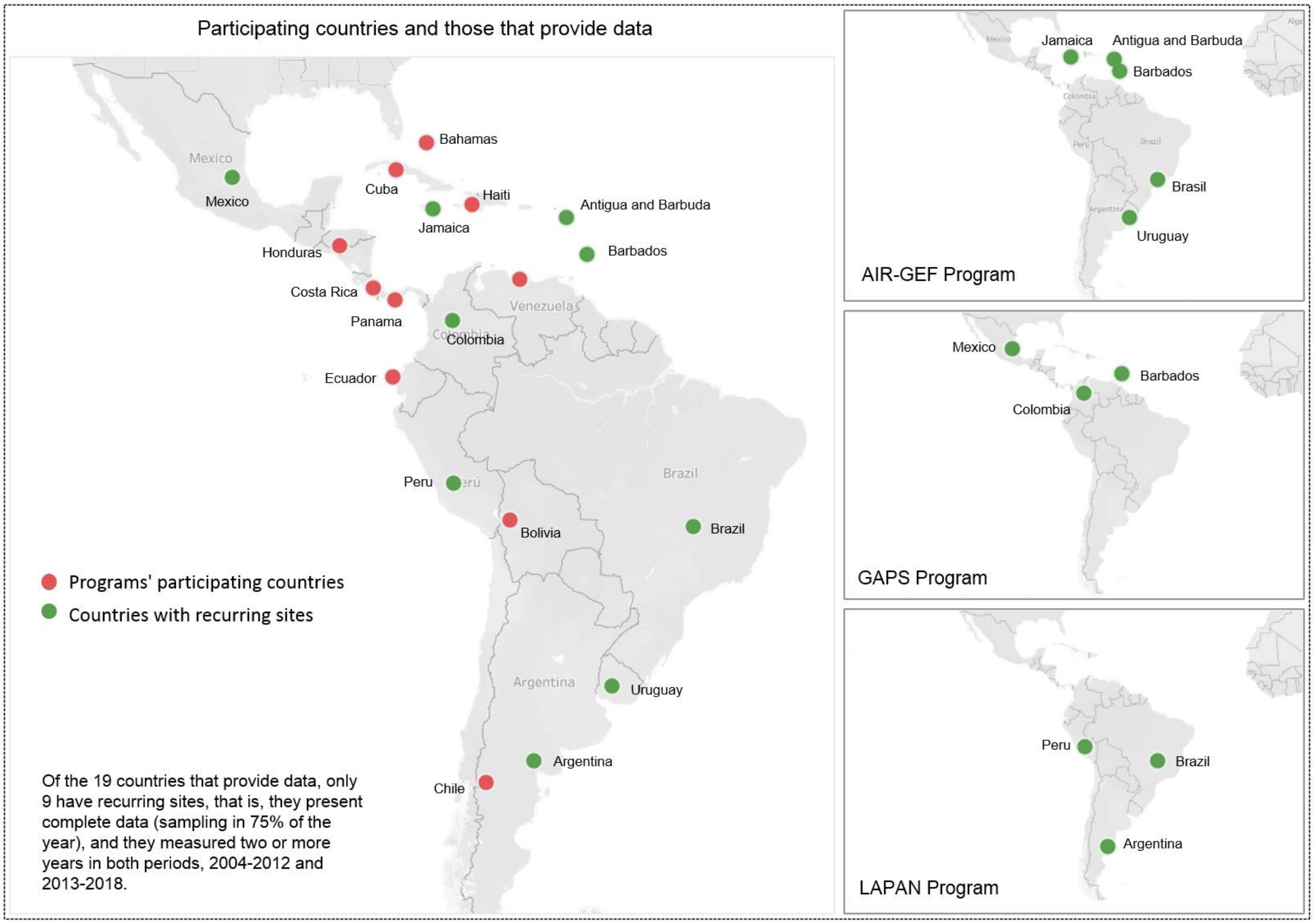
	Parameter with increased concentration
	Parameter with decreased concentration
	Parameter measured only in 2013-2018
NM	Parameter Not Measured by the Program.

National Analysis (country/site)

Results of the analysis of concentration's changes in the monitoring sites of each country are presented by program and group of compounds in the technical sheets, as mentioned. From the review of the data by program those recurring sites were selected which present data with completeness, that measured two or more years and that also include measurements in both periods 2004-2012 and 2013-2018. Changes in these sites represent changes in countries.

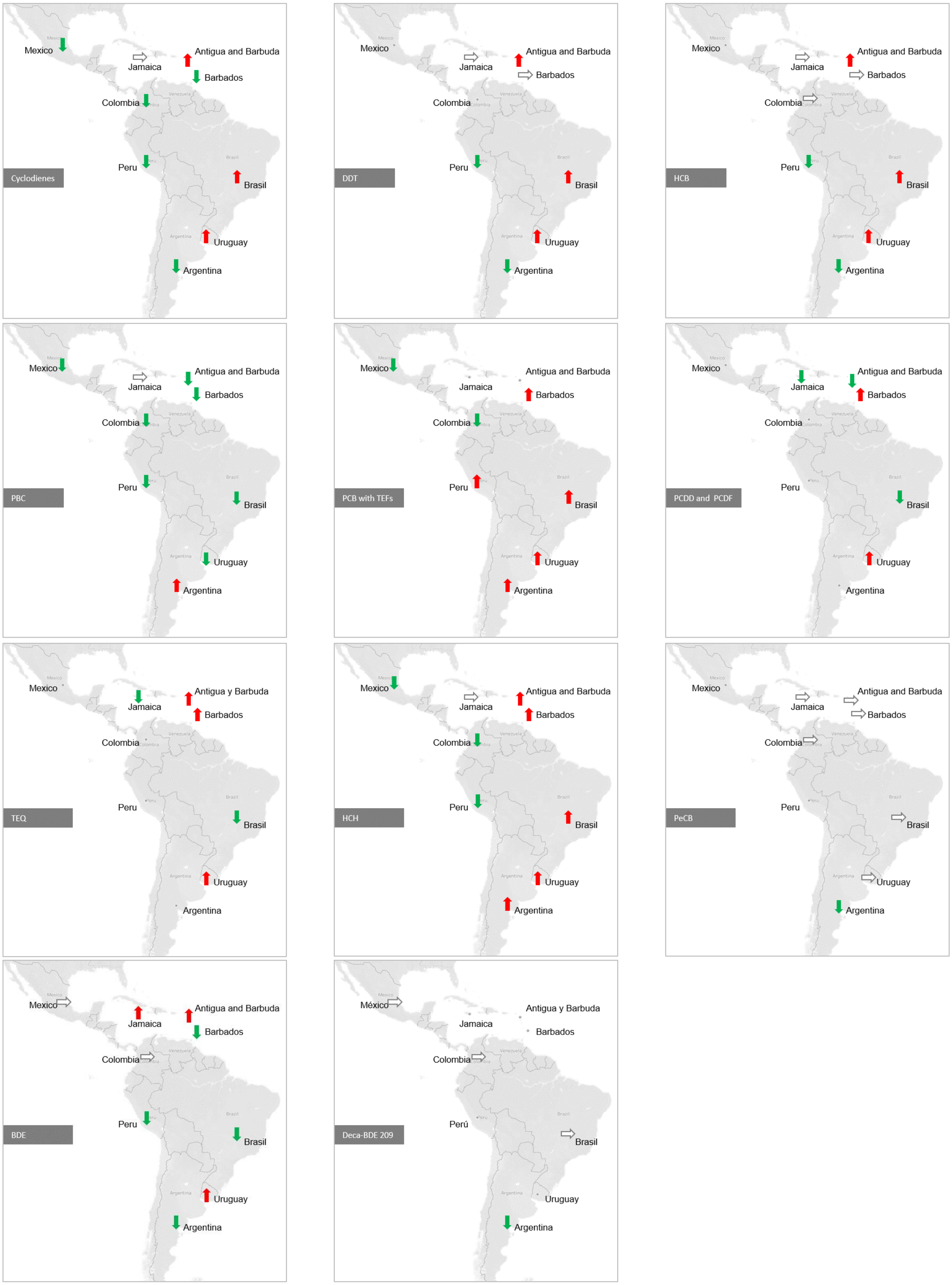
The countries by monitoring program, with sites that provide data to evaluate changes in concentration level, are presented in Figure 42, where the 9 countries with recurring sites are highlighted in green, that is, they meet the aforementioned characteristics.

Figure 42. Participating countries and those that provide data to assess concentration's changes in GRULAC countries



Results of the comparisons between the periods 2004-2012 and 2013-2018 by country with recurring sites, are presented in figure 2 and mosaic table 32 where the number of parameters per group of compound that showed an increase in concentration in the 2013-2018 period is appreciated. In this table, color red is assigned when the number of parameters increasing in relation to the number of parameters analyzed per group of compounds is 50% or greater; and green when it is less. The figure 43 and table 31 show a similar situation to the regional analysis for some groups of compounds: increase in PCBs with TEF, TEQ and HCH; and decrease for: PCB, PCDD and PCDF and PeCB. The decrease in the Cyclodiene and BDE groups contrasts, where only in the countries of the Air-GEF program have increases in most of the parameters.

Figure 43. Parameters with change in concentration by country



The countries that showed an increase in the largest number of groups of compounds were Uruguay, followed by Antigua and Barbuda and Brazil; all under Air-GEF program. In contrast, Brazil under LAPAN program, and Colombia and Mexico under GAPS program, show a decrease in most of the parameters of all groups.

Table 31. Number of parameters with change in concentration by country and program

Parameter	COUNTRIES WITH RECURRING SITES										
	ANTIGUA and BARBUDA	ARGENTINA	BARBADOS		BRAZIL		COLOMBIA	JAMAICA	MEXICO	PERU	URUGUAY
	AIR-GEF	LAPAN	AIR-GEF	GAPS	AIR-GEF	LAPAN	GAPS	AIR-GEF	GAPS	LAPAN	AIR-GEF
	Rural	Urban	Urban	NC	Urban	Remote/NC	NC	Urban	NC	NC	Urban
Cyclodiene	11 de 12	2 de 22	0 de 12	4 de 9	11 de 14	16 de 55	3 de 9	2 de 12	9 de 18	2 de 11	10 de 12
DDT	8 de 8	5 de 16	0 de 8		8 de 8	14 de 40		5 de 8		1 de 8	8 de 8
HCB	1 de 1	0 de 2	0 de 1		1 de 1	0 de 5	1 de 1	0 de 1		0 de 1	1 de 1
PCB	0 de 7	12 de 16	4 de 7	0 de 8	0 de 7	18 de 40	1 de 8	5 de 7	3 de 14	1 de 8	1 de 8
PCB with TEFs		2 de 2	6 de 6	0 de 1	6 de 6	2 de 5	0 de 1		0 de 2	1 de 1	6 de 6
PCDD and PCDF	4 de 17		13 de 17		1 de 17			2 de 17			16 de 17
TEQ	4 de 4		4 de 4		0 de 4			0 de 4			4 de 4
HCH	2 de 3	3 de 6	0 de 3	2 de 2	3 de 3	3 de 15	0 de 2	2 de 3	1 de 4	0 de 3	3 de 3
PeCB	1 de 1	0 de 1	0 de 1		1 de 1	0 de 1	1 de 1	1 de 1			1 de 1
BDE	5 de 7	3 de 8	2 de 8		2 de 8	4 de 14	1 de 7	6 de 8	6 de 7	0 de 2	7 de 8
Deca-BDE 209		0 de 1				**0 de 1**	0 de 1		0 de 1		
HBCD							0 de 1		0 de 1		
HCBD							1 de 1				
PBB	0 de 1		0 de 1		0 de 1			0 de 1			0 de 1

	Increased concentration
	Decreased concentration
# of #	2013-2018 data only
	No data with completeness

Programs' Analysis

Utmost to note that 13 new parameters were measured for the first time in the region, providing baseline data for future evaluations and include Perfluorohexane Sulfonic Acid (PFHxS), candidate compound to be listed in the Convention. However, the analysis of the POPs monitoring programs in air matrix showed great variability of data and low recurrence in sites' monitoring, which prevents obtaining significant trends in the region. The highest median values are generally present in urban sites of the three programs and the maximum values in Air-GEF program.

In summary, the Air-GEF program shows an increase in concentration for most of the parameters of the groups: Cyclodienes, except for Endosulphanes; DDT and isomers, HCB, HCH and PCBs with TEF, BDE and congeners and TEQ of Dioxins; and decrease for: PCB and D and F. With respect to parameters measured within the same period 2016 to 2018: PeCB presents an increase and PBB generally presents data with values below the LDC. The maximum values are presented mainly in St. James, Barbados, followed by Montevideo, Uruguay and in third place Los Mochis, Mexico.

GAPS program presents significant reductions in most of the parameters of the groups: Cyclodienes, PCB, HCH and BDE; measured at urban and NC sites. The remote sites present an increase in most of the parameters of: Cyclodienes, PCB and HCH. In general, urban sites present the highest median values, however the NC site Sonora, Mexico 2014 stands out for its extreme values in most of the parameters.

Regarding LAPAN Program, urban sites presented the highest concentration values compared to NC and Remote sites and increases in concentration values in the period 2013 to 2016, compared to 2010-2012 mainly in non-recurring sites, that is, sites that only measured in the period 2013-2016. Only Aldrin, HCB and BDE 153 showed a decrease in concentration in the three groups of sites. The maximum and extreme values of all the parameters are presented mainly in Brazil, followed by Argentina and Colombia in third place.

6.2.1.1. Global Monitoring Plan for Persistent Organic Pollutants in GRULAC (Air-GEF)

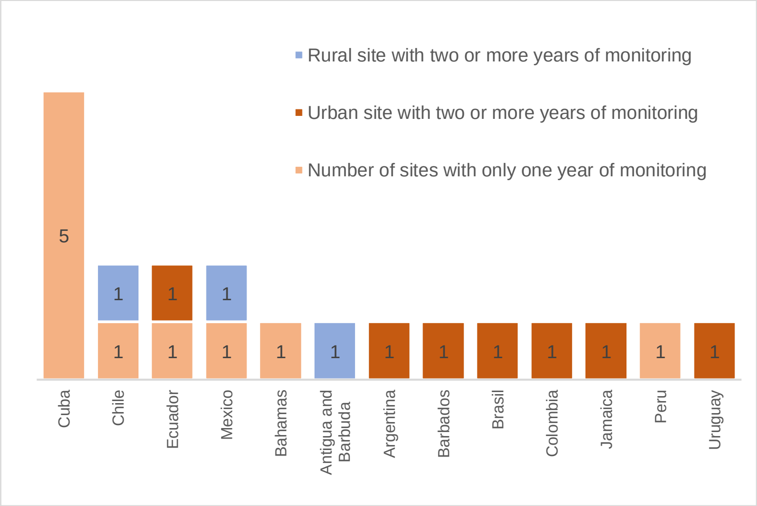
Air-GEF has data from 21 passive sampling sites distributed in 14 countries, which have monitored 95 POP's parameters in the periods of 2010-2011 and 2016-2018. However, not all the parameters have been monitored in every year. In the 2010-2011 period, 88 parameters were monitored and 71 in 2016-2018, of which 7 were analyzed for the first time by this program and one, PBB 153 for the first time in the air matrix in the region.

Likewise, not all the sites have measured every year and as can be seen in Figure 44, despite the fact that 20 of these sites present data for 2 years or more, when applying the completeness criterion (75%) only 10 of them comply with measurements of two or more years and only 5 of them present measurements in both periods: 2010-2011 and 2013-2016, allowing to evaluate changes in concentrations from one period to another.

The distribution of the 20 sites by type of site and location is shown in Figure 45 where it can be seen that: 5 sites are located in Cuba, 2 in Chile, Ecuador and Mexico and the other countries only have one monitoring site. The 5 sites that measured POPs in both periods and that meet the completeness criterion are called recurrent and are 4 urban sites located in: Barbados, Brazil, Jamaica and Uruguay; and a rural one located in Antigua and Barbuda.

Figure 44. Number of AIR-GEF Program's sites and years monitored

Figure 45. Distribution of sites that meet the 75% criterion by country and Site type



Results of the comparisons of both periods for these five recurring sites are presented in Table Mosaic 32, where comparisons of concentrations of non-recurring sites are also presented, that is, sites that measured two or more years in the period 2016-2018. It is worth mentioning that in two of the recurring sites, only some parameters meet the compliance criteria, mainly in the 2010-2011 period. Therefore, the parameters and boxes are marked with an asterisk in the recurring sites that do not have completeness in some period.

It is observed, in the period 2016-2018, that St. James Barbados site presents most of the maximum values, but only 43% of its parameters measured have an increase in concentration; followed by Montevideo Uruguay, which despite having second place in highs, is the site with the highest percentage of parameters with increased concentration, 83%; and in third place of the highest Los Mochis México with 53% of parameters with increase.

Note that St. Phillips, Antigua and Barbuda presents an increase of 59% of its parameters, but only presents one maximum value. In contrast, Tome, Chile site presents the highest number of parameters 47%, with values under the LOQ.

Mosaic Table 32. Concentration levels' comparison

GROUP	PARAMETER	RECURRING: SITES WITH DATA IN BOTH PERIODS 2010-2011 and 2016-2018					NON-RECURRING: SITES WITH DATA FROM 2017-2018					Maximum (2016 - 2018)	Site where the maximum was recorded (YEAR)
		Urban				Rural	Urban			Rural			
		Kingston, Jamaica (2010, 2011, 2017, 2018)	Montevideo, Uruguay (2010, 2011, 2017, 2018)	Sao Paulo, Brazil (2010, 2011, 2017, 2018)	St. James, Barbados (2010, 2011, 2016, 2017, 2018)	St. Phillips, Antigua and Barbuda (2010, 2011, 2017, 2018)	Buenos Aires, Argentina (2017, 2018)	Medellin, Colombia (2017, 2018)	Quito, Ecuador (2017, 2018)	Los Mochis, Mexico (2017, 2018)	Tome, Chile (2017, 2018)		
Cyclodiene	Aldrin (pg/m^3)	*		U	M*		ULOQ				ULOQ	11.41	St. James, Barbados (2016)
	cis-Chlordane (pg/m^3)	*			M*				ULOQ		ULOQ	42.29	St. James, Barbados (2016)
	trans-Chlordane (pg/m^3)	M*			*						ULOQ	62.08	Kingston, Jamaica (2017)
	cis-Nonachlor (pg/m^3)	*	U	U	M*		ULOQ		ULOQ	ULOQ	ULOQ	7.67	St. James, Barbados (2016)
	trans-Nonachlor (pg/m^3)	M*			*						ULOQ	42.49	Kingston, Jamaica (2018)
	Oxy Chlordane (pg/m^3)	U*		U	M*	U	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	2.68	St. James, Barbados (2017)
	Dieldrin (pg/m^3)	*			M*						ULOQ	345.26	St. James, Barbados (2017)
	Endosulfan I (alpha) (pg/m^3)*	U*	*	*	ULOQ	*	*	*	*	M*	ULOQ	48.43	Los Mochis, Mexico (2018)
	Endosulfan II (beta) (pg/m^3)*	U*	*	*	U*	U*	*	U*		M*	ULOQ	26.13	Los Mochis, Mexico (2017)
	Endosulfan SO4 (pg/m^3)*	U*	*	*	U*	U*	*	U*		M*	ULOQ	2.70	Los Mochis, Mexico (2017)
	Endrin (pg/m^3)	ULOQ*			M*		ULOQ	ULOQ	ULOQ		ULOQ	7.46	St. James, Barbados (2017)
	Heptachlor (pg/m^3)	*		M	*	U			ULOQ	ULOQ	ULOQ	16.84	Sao Paulo, Brazil (2017)
	Sum 2 heptachlorepoxides (cis + trans) (pg/m^3)	*			*	U	M	ULOQ	ULOQ		ULOQ	7.13	Buenos Aires, Argentina (2017)
	Mirex (pg/m^3)	ULOQ*	M		U*			U	ULOQ	ULOQ	ULOQ	3.02	Montevideo, Uruguay (2017)
DDT	o,p-DDD (pg/m^3)	*			*				M		ULOQ	1.58	Los Mochis, Mexico (2018)
	o,p-DDE (pg/m^3)	*			U*				M		ULOQ	12.94	Los Mochis, Mexico (2018)
	o,p-DDT (pg/m^3)	*			*			M			U	18.58	Medellin, Colombia (2017)
	p,p-DDD (pg/m^3)	*			*						ULOQ	2.99	Montevideo, Uruguay (2017)
	p,p-DDE (pg/m^3)	*			*					M		32,000.00	Los Mochis, Mexico (2018)
	p,p-DDT (pg/m^3)	*			*			M				28.91	Medellin, Colombia (2017)
	Sum 3 p,p-DDTs (pg/m^3)	*			*					M		32,020.24	Los Mochis, Mexico (2018)
	Sum 6 DDTs (pg/m^3)	*			*					M		32,043.19	Los Mochis, Mexico (2018)
HCB	HCB (pg/m^3)	*			*		M					96.28	Buenos Aires, Argentina (2017)
PCB	PCB 28 (pg/m^3)	*			*	U		M				18.08	Medellin, Colombia (2017)
	PCB 52 (pg/m^3)	*			*	U	M					40.35	Buenos Aires, Argentina (2018)
	PCB 101 (pg/m^3)	*			*	U	M					32.63	Buenos Aires, Argentina (2017)
	PCB138 (pg/m^3)	*			ULOQ*	U	M					12.76	Buenos Aires, Argentina (2018)
	PCB 153 (pg/m^3)*	*			U*	U	M					12.68	Buenos Aires, Argentina (2018)
	PCB 180 (pg/m^3)	*			ULOQ*	U	M			ULOQ	ULOQ	2.50	Buenos Aires, Argentina (2017)
	Sum 6 PCBs (pg/m^3)	*			*	U	M					117.70	Buenos Aires, Argentina (2018)
	Sum 7 PCBs (pg/m^3)*		M*	*	*	*	*	*	*	*	*	9,688.25	Montevideo, Uruguay (2018)
PCB with TEFs	PCB 105 (fg/m^3)		M									3,981,476.1	Montevideo, Uruguay (2018)
	PCB 114 (fg/m^3)		M									273,341.7	Montevideo, Uruguay (2018)
	PCB 118 (fg/m^3)		M									9,619,995.0	Montevideo, Uruguay (2018)
	PCB 156 (fg/m^3)		M									701,814.6	Montevideo, Uruguay (2018)
	PCB157 (fg/m^3)		M									172,477.1	Montevideo, Uruguay (2018)
	PCB 189 (fg/m^3)		M									69,216.1	Montevideo, Uruguay (2017)
PCDD and PCDF	1,2,3,4,6,7,8-HpCDD (fg/m^3)	M								*		187.92	Kingston, Jamaica (2018)
	1,2,3,4,6,7,8-HpCDF (fg/m^3)	M								*		102.52	Kingston, Jamaica (2018)
	1,2,3,4,7,8,9-HpCDF (fg/m^3)				M	ULOQ		U		*		5.61	St. James, Barbados (2018)
	1,2,3,4,7,8-HxCDD (fg/m^3)				M	ULOQ				*		15.16	St. James, Barbados (2016)
	1,2,3,4,7,8-HxCDF (fg/m^3)		M							*	ULOQ	21.08	Montevideo, Uruguay (2017)
	1,2,3,6,7,8-HxCDD (fg/m^3)				M					*		28.16	St. James, Barbados (2017)
	1,2,3,6,7,8-HxCDF (fg/m^3)		M			U				*		23.30	Montevideo, Uruguay (2018)
	1,2,3,7,8,9-HxCDD (fg/m^3)				M					*		25.20	St. James, Barbados (2018)
	1,2,3,7,8,9-HxCDF (fg/m^3)	U			M	ULOQ			ULOQ	*	ULOQ	3.85	St. James, Barbados (2018)
	1,2,3,7,8-PeCDD (fg/m^3)				M	ULOQ				*		25.84	St. James, Barbados (2017)
	2,3,4,6,7,8-HxCDF (fg/m^3)		M			U				*		27.02	Montevideo, Uruguay (2017)
	2,3,4,7,8-PeCDF (fg/m^3)		M							*		45.59	Montevideo, Uruguay (2018)
	2,3,7,8-TCDD (fg/m^3)		M			ULOQ				*		6.93	Montevideo, Uruguay (2018)
	2,3,7,8-TCDF (fg/m^3)		M							*		54.59	Montevideo, Uruguay (2018)
	OCDD (fg/m^3)	M								*		988.24	Kingston, Jamaica (2018)
	OCDF (fg/m^3)	M								*		73.98	Kingston, Jamaica (2018)
	Sum 7 PCDDs (fg/m^3)	M								*		1,239.14	Kingston, Jamaica (2018)
TEQ	PCDDs WHO1998-TEQ LB (fg/m^3)				M							39.88	St. James, Barbados (2017)
	PCDDs WHO2005-TEQ LB (fg/m^3)				M							39.97	St. James, Barbados (2017)
	PCDDs WHO1998-TEQ UB (fg/m^3)				M							39.88	St. James, Barbados (2017)
	PCDDs WHO2005-TEQ UB (fg/m^3)				M							39.97	St. James, Barbados (2017)
HCH	Alpha-HCH (pg/m^3)	*		M	*						ULOQ	17.23	Sao Paulo, Brazil (2017)
	Beta-HCH (pg/m^3)	ULOQ*		M	*	ULOQ		ULOQ			ULOQ	5.10	Sao Paulo, Brazil (2017)
	Gamma-HCH (pg/m^3)	*			*				M			57.12	Quito, Ecuador (2018)
PeCB	PeCB (pg/m^3)*	*	*	*	*	M*	*	*	*	*	*	1,223.63	St. Phillips, Antigua and Barbuda (2018)
BDE	BDE 47 (pg/m^3)	M									ULOQ	16.83	Kingston, Jamaica (2018)
	BDE 99 (pg/m^3)	M									ULOQ	8.13	Kingston, Jamaica (2018)
	BDE 153 (pg/m^3)	UM		U		U			ULOQ		ULOQ	0.96	Kingston, Jamaica (2017)
	BDE 154 (pg/m^3)			U		U			ULOQ	M	ULOQ	1.23	Los Mochis, Mexico (2018)
	BDE 175/183 (pg/m^3)*	*	*	U*	M*	*	*	*	*	*	*	5.70	St. James, Barbados (2016)
	BDE 17 (pg/m^3)					U			U	M	ULOQ	1.34	Los Mochis, Mexico (2018)
	BDE 28 (pg/m^3)									M	ULOQ	3.74	Los Mochis, Mexico (2018)
	BDE 100 (pg/m^3)									M	ULOQ	2.04	Los Mochis, Mexico (2018)
PBB	PBB 153 (pg/m^3)*	M*	ULOQ*	ULOQ*	ULOQ*	ULOQ*	ULOQ	ULOQ	ULOQ	*	ULOQ	0.000057	Kingston, Jamaica (2017)

(red)	Increased concentration
(green)	Decreased concentration
(yellow)	Without changes
ULOQ	All data below the limit of quantification
(brown)	Value out of range

M	Maximum value for the period 2016-2018
	Without or with a single data
*	Only data from 2016-2018
U	Most recent value under LOQ

The concentration of the parameters of the Cyclodiene group increased in most of the parameters, 82%, in the recurrent sites with the exception of Endosulfan and isomers that are only analyzed in the period 2016-2018. In the non-recurring sites, there is a decrease or values under the LDC in most parameters, 86%; again, highlighting Tome Chile, 2017-2018, which presents values under the LOQ in all its data.

In general, a similar situation is observed for DDT and isomers, HCB and HCH, where the recurrent sites show an increase in all parameters and the non-recurrent parameters decrease 55% in the case of DDT and 86% and 76% for the HCB and HCH respectively.

PCBs show a 95% decrease in their parameters in recurrent sites and an increase of 61% in non-recurrent sites. In contrast, PCBs with TEF show a 100% increase in their congeners in the recurrent sites and a decrease in the non-recurrent Los Mochis México site.

Dioxins and Furans show a decrease or values under the LOQ of 52% of the parameters in the recurrent sites and an increase of 76% in the non-recurrent ones. Dioxin TEQs show a 60% and 75% increase in parameters at recurrent and non-recurrent sites respectively.

BDEs show an increase of 56% of their parameters in the recurrent sites and a decrease, values under LOQ and without change in 63% of the non-recurrent ones. And finally, the parameters measured only in the 2016-2018 period present an increase of 60% in all sites for PeCB and 80% of the data under the LOQ for PBB 153.

Likewise, the analysis carried out shows that 20% of all data present values under LOQ and all the trends of the recurring sites with more than three years of measurement were not significant.

To analyze the variability of all data of the Air -GEF program, the same procedure was followed in the ambient air monitoring programs: first, year by year of monitoring of each parameter was compared, then the data were separated by groups of years and then by type of sites: Not Classified (NC), Rural and Urban; for the case of Air-GEF program's comparisons. The dispersion of data was analyzed by means of box plots and the statistical parameters were calculated to estimate the concentration changes in the region. Comparisons between the data, for the period 2010-2011 with those for 2016-2018, are presented for 64 parameters, since 7 were analyzed for the first time.

However, not all parameters are measured on all sites, nor do all sites have completeness for all parameters. Furthermore, despite the fact that 15 sites met the 75% completeness criterion, in the 2010-2011 period, 10 of them are not classified (NC) and have no comparable sites in the 2016-2018 period. These sites are only considered in the regional comparison of Air Monitoring Programs Mosaic Table 32 The statistical analysis of the data considers the 71 parameters measured in the 2013-2016 period.

These analyses are presented below by compound group:

Organochlorine Insecticides, Cyclodiene Subgroup

The Organochlorine Insecticides group, Cyclodiene Subgroup presents data from both periods. However, most of the data from 2010-2011 present values below the LOQ or do not meet the completeness criterion; only 3 sites, one rural and two urbans, meet the criteria. For the 2016-2018 period, there are data from 3 rural and 7 urban sites and only the cis-Nonachlor and Oxy Chlordane parameters show values under the LOQ.

The statistical analysis shows that there is an increase in concentration for almost all the parameters in both groups of sites, rural and urban, with the exception of Mirex in urban sites in the period 2016-2018. In general, most of the medians with higher values are found in urban sites. Extreme values of Dieldrin are presented in St. James Barbados, 2017 and 2018. See figure 46 and table 33.

Figure 46. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in GRULAC (75% criterion)

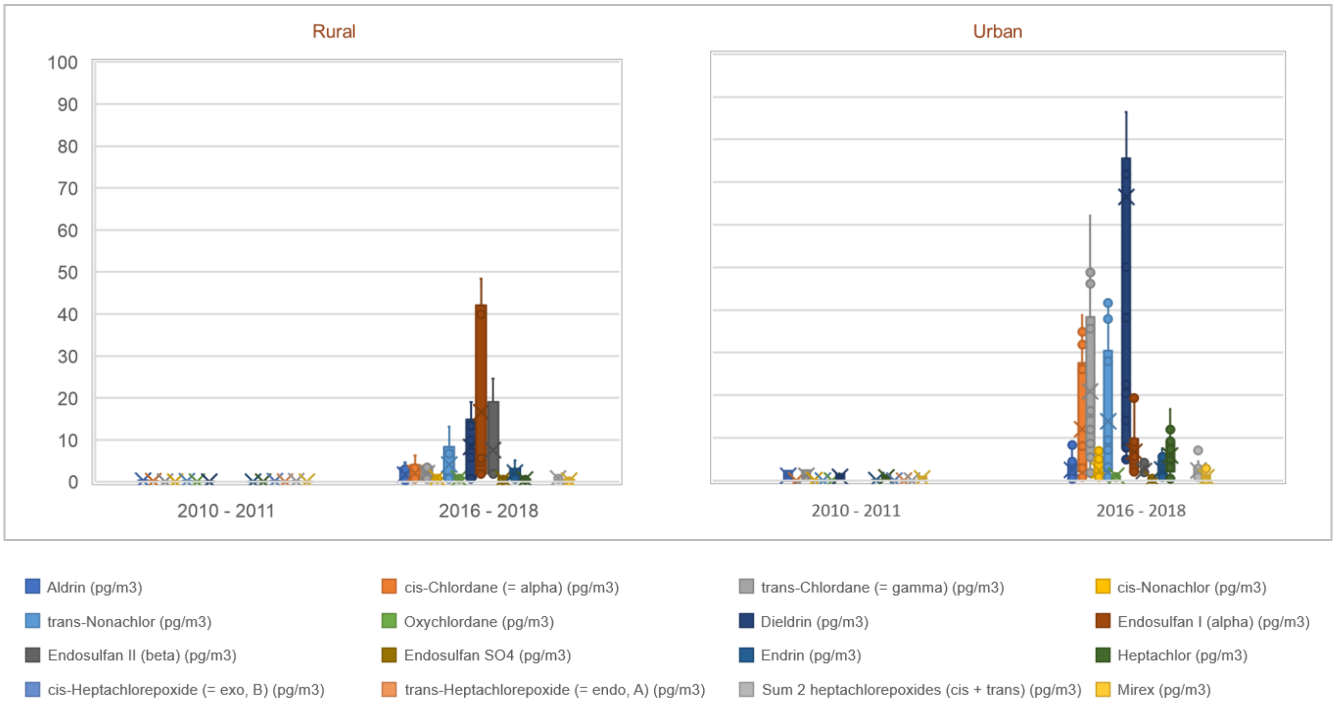


Table 33. Statistical analysis of the Organochlorine Insecticides, Cyclodiene Subgroup in GRULAC (75% criterion)

CYCLODIENES (pg/m^3)						
Parameter	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
Aldrin	0.265	4.675	0.265	1.662	0.265	0.741
cis-Chlordane	0.127	6.286	0.127	2.126	0.127	0.831
trans-Chlordane	0.040	3.519	0.040	2.116	0.040	2.102
cis-Nonachlor	0.002	1.583	0.002	0.903	0.002	0.781
trans-Nonachlor	0.125	13.104	0.125	4.187	0.125	1.870
Oxy Chlordane	0.002	0.911	0.002	0.858	0.002	0.878
Dieldrin	0.002	18.999	0.002	8.284	0.002	7.890
Endosulfan I (alpha)*		48.426		16.643		3.849
Endosulfan II (beta)*		24.614		7.619		1.973
Endosulfan SO4*		1.401		0.640		0.390
Endrin	0.035	5.134	0.035	2.268	0.035	2.202
Heptachlor	0.002	0.623	0.002	0.555	0.002	0.589
Sum 2 heptachlorepoxides (cis + trans)	0.220	0.889	0.220	0.841	0.220	0.855
Mirex	0.002	0.578	0.002	0.284	0.002	0.151
URBAN						
Aldrin	2.206	8.531	1.104	2.503	1.104	1.476
cis-Chlordane	0.002	38.855	0.002	11.964	0.002	3.722
trans-Chlordane	2.328	62.079	1.165	20.867	1.165	14.935
cis-Nonachlor	0.180	7.209	0.091	2.352	0.091	0.767
trans-Nonachlor	0.002	42.491	0.002	13.956	0.002	7.598
Oxy Chlordane	0.002	2.682	0.002	1.074	0.002	0.865
Dieldrin	1.537	345.256	0.812	66.489	0.812	22.466
Endosulfan I (alpha)*		19.400		6.706		3.915
Endosulfan II (beta)*		4.230		2.281		1.948
Endosulfan SO4*		0.393		0.385		0.383
Endrin	0.119	7.464	0.100	2.661	0.100	0.989
Heptachlor	1.272	16.840	0.688	5.852	0.688	4.810
Sum 2 heptachlorepoxides (cis + trans)	0.002	7.129	0.002	2.404	0.002	2.022
Mirex	0.832	3.021	0.513	0.785	0.513	0.153

Dichlorodiphenyltrichloroethane and its isomers

Dichloro Diphenyl Trichloroethane (DDT) and its isomers also present data for both periods. However, only 3 sites: one rural and two urban meet the criteria of 75% completeness during 2010-2011. For the 2016-2018 period, there are data from 3 rural and 7 urban sites. The behavior of the data is shown in figure 47 where it is observed that during 2016-2018 extreme values are presented in Sum of 3 p, p-DDTs and Sum of 6 DDTs in rural sites due to the atypical out-of-range value of p, p-DDE in Los Mochis México, 2018. The statistical parameters are summarized in table 34, where all the medians of the isomers in both groups of sites show increased concentration and the highest values in urban sites. Most of the data analyzed is above the LOQ.

Figure 47. Behavior of DDT and its isomers in GRULAC (75% criterion)

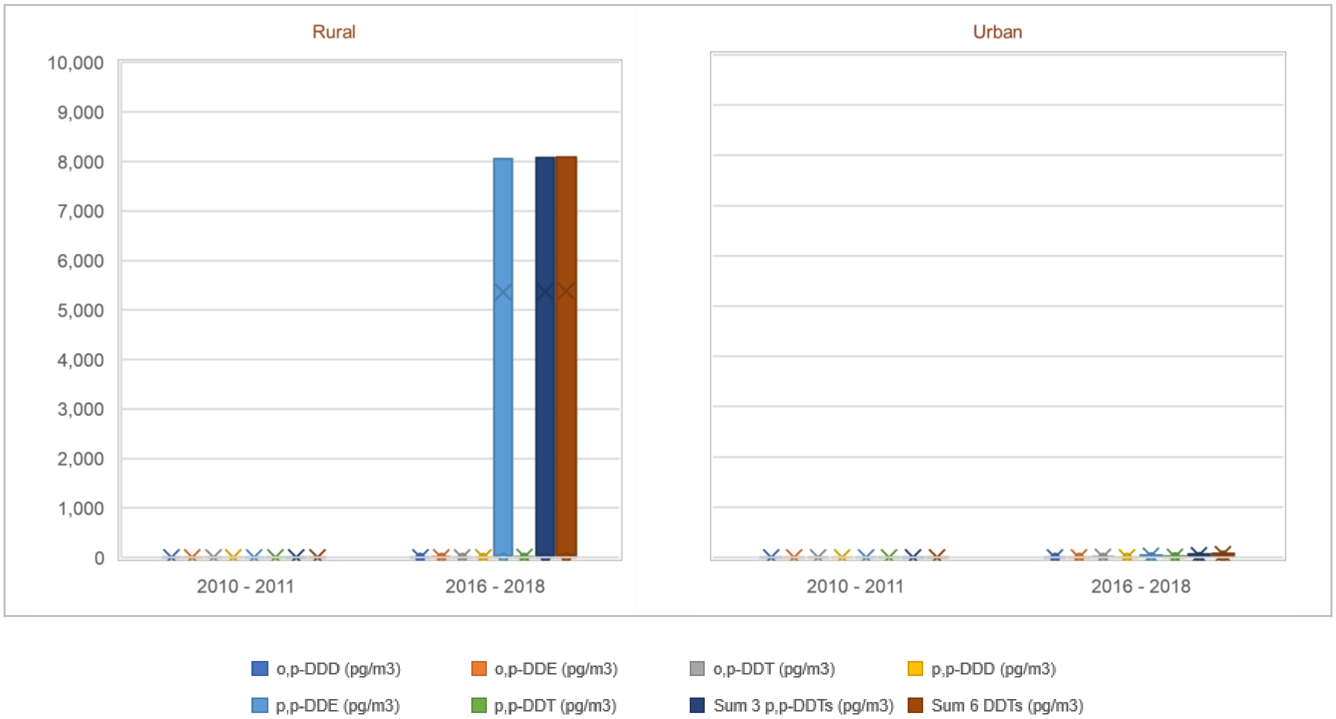


Table 34. Statistical analysis of DDT and its isomers in GRULAC (75% criterion)

Parameter	DDT (pg/m³)					
	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
o,p-DDD	0.002	1.578	0.002	0.636	0.002	0.449
o,p-DDE	0.002	12.938	0.002	3.469	0.002	0.681
o,p-DDT	0.002	7.291	0.002	2.980	0.002	2.260
p,p-DDD	0.002	2.337	0.002	1.055	0.002	0.923
p,p-DDE	0.016	32,000.000	0.016	28.716	0.016	31.582
p,p-DDT	0.002	17.974	0.002	9.311	0.002	9.511
Sum 3 p,p-DDTs	0.016	32,020.245	0.016	5,367.551	0.016	45.281
Sum 6 DDTs	0.047	32,043.185	0.047	5,375.638	0.047	50.793
URBAN						
o,p-DDD	0.134	1.577	0.068	0.932	0.068	1.064
o,p-DDE	0.158	8.145	0.080	3.455	0.080	3.476
o,p-DDT	0.008	18.584	0.005	9.506	0.005	9.392
p,p-DDD	0.297	2.988	0.149	1.539	0.149	1.638
p,p-DDE	0.519	60.724	0.410	30.674	0.410	34.048
p,p-DDT	0.452	28.906	0.280	16.950	0.280	19.856
Sum 3 p,p-DDTs	0.915	91.369	0.889	49.418	0.889	57.862
Sum 6 DDTs	1.376	119.387	1.266	63.396	1.266	73.342

Hexachlorobenzene

Hexachlorobenzene (HCB) also present data from both periods and only 3 sites: one rural and two urbans met the 75% completeness criterion during 2010-2011. For the period 2016-2018 it is same, with data from 3 rural and 7 urban sites. All data are above the LOQ. The behavior of the data and the statistical values are shown in figure 48 and table 35, where it is observed that during 2016-2018 there is an increase in the median's concentration, with higher values in urban sites and an extreme value in the urban site Buenos Aires Argentina, 2017.

Figure 48. Behavior of HCB in GRULAC (75% criterion)

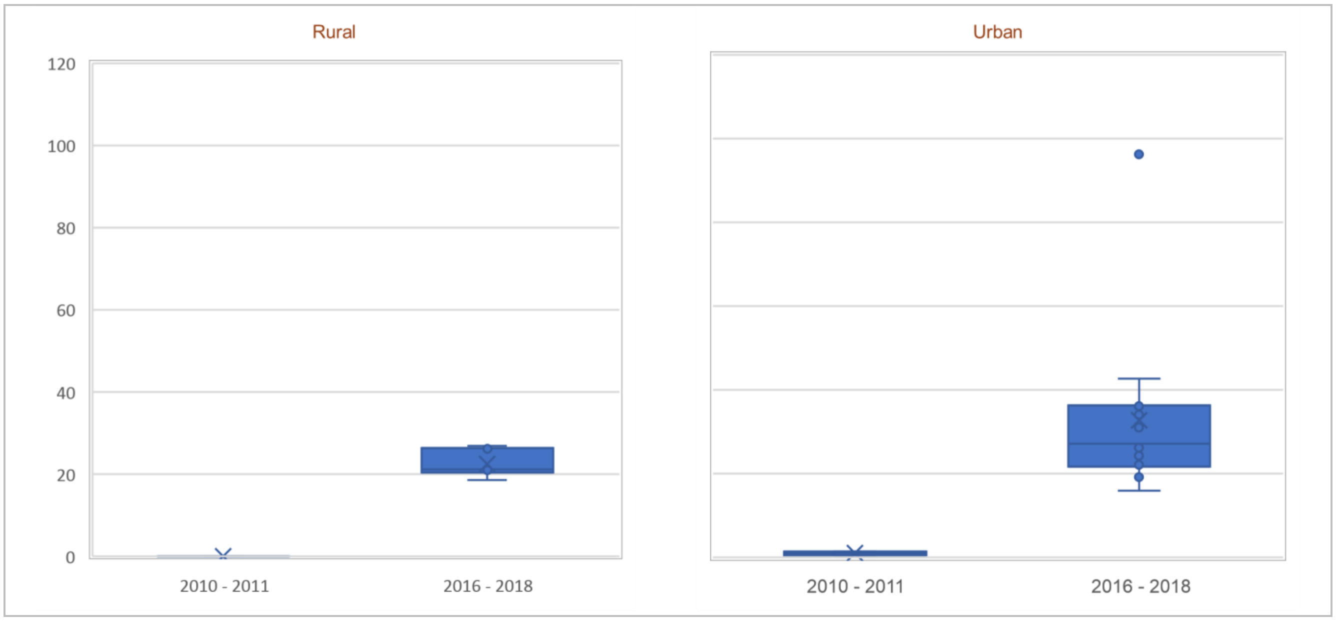


Table 35. Statistical analysis of HCB in GRULAC (75% criterion)

HBC (pg/m³)						
Site type	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL	0.002	26.864	0.002	22.474	0.002	21.187
URBAN	1.394	96.283	0.994	32.784	0.994	27.180

Polychlorinated biphenyls and congeners

In the 2016-2018 period, 6 Polychlorinated Biphenyls' congeners (PCB) were analyzed and the sums of 6 and 7 PCBs, the latter includes PCB with TEF 118 and is plotted with PCBs with TEF, from 10 sampling sites, 3 rural and 7 urbans, which meet the criterion of 75 %. From the 2010-2011 period, in the 3 mentioned sites: one rural and two urban that meet the 75% criterion, the same congeners were analyzed except for the sum of 7 PCBs, measured only in 2016-2018. Most of the data present values above the LOQ, except for PCB 180 with 48% of its data under the LOQ in both periods. As can be seen in figure 49 and table 36, in 2016-2018, there is a decrease in concentration in the medians of both groups of sites, rural and urban with higher values in urban sites. No extreme values are presented.

Figure 49. Behavior of PCBs in GRULAC (75% criterion)

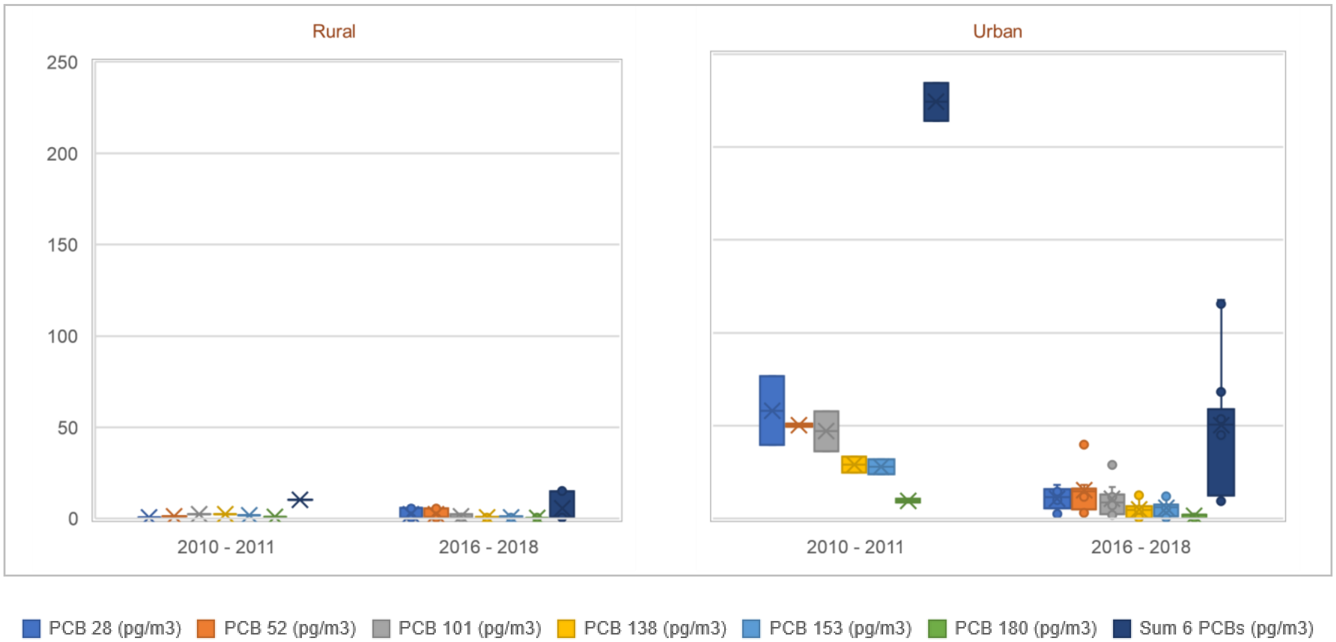


Table 36. Statistical analysis of PCB in GRULAC (75% criterion)

PCB (pg/m^3)						
Parameter	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
PCB 28	0.51	7.13	0.51	2.39	0.51	0.499
PCB 52	1.09	5.59	1.09	2.25	1.09	0.798
PCB 101	2.52	2.61	2.52	1.15	2.52	0.528
PCB138	2.49	1.12	2.49	0.67	2.49	0.477
PCB 153	1.92	1.20	1.92	0.70	1.92	0.479
PCB 180	0.91	0.38	0.91	0.38	0.91	0.380
Sum 6 PCBs	10.32	15.12	10.32	5.46	10.32	0.823
URBAN						
PCB 28	76.74	18.08	58.14	10.78	58.14	11.527
PCB 52	51.03	40.35	50.27	15.26	50.27	14.556
PCB 101	57.85	32.63	47.03	10.77	47.03	8.792
PCB138	33.22	12.76	29.04	4.91	29.04	4.562
PCB 153	31.78	12.68	27.84	5.68	27.84	6.095
PCB 180	10.57	2.50	9.56	1.63	9.56	2.037
Sum 6 PCBs	234.46	117.70	224.28	50.16	224.28	50.421

Polychlorinated biphenyls with TEFs

With respect to Polychlorinated Biphenyls with TEF, 6 congeners were also analyzed, but only 4 monitoring sites, 1 rural and 3 urbans, meet the 75% criterion in the 2016-2018 period; unlike 15 sites from 2010-2011: 10 NC, 1 rural and 4 urbans, meet the criteria. Figure 50 and table 37 show the significant increase in the values of the medians from 2016-2018, with higher values in urban sites, mainly for PCB 118 and the Sum of 7 PCBs. No extreme values are observed. The data are above the LOQ.

Figure 50. Behavior of PCB with TEFs in GRULAC (75% criterion)

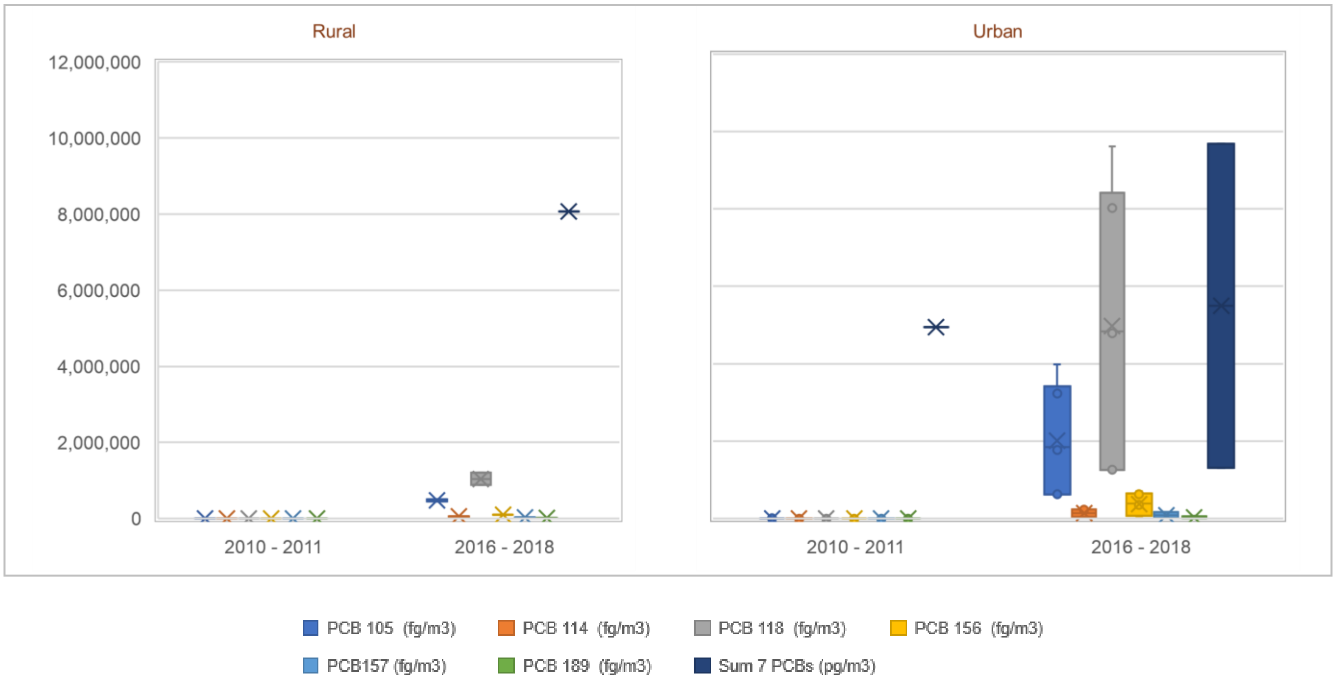


Table 37. Statistical analysis of PCB with TEFs in GRULAC (75% criterion)

PCB with TEFs (fg/m³)						
Parameter	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
PCB 105	165.04	503,513.25	165.04	475,797.67	165.04	475,797.67
PCB 114	12.60	54,749.32	12.60	52,340.06	12.60	52,340.06
PCB 118	86.67	1,200,512.05	86.67	1,040,203.62	86.67	1,040,203.62
PCB 156	65.93	102,713.63	65.93	100,956.55	65.93	100,956.55
PCB157	13.53	34,146.07	13.53	32,453.32	13.53	32,453.32
PCB 189	21.33	19,379.07	21.33	15,749.76	21.33	15,749.76
Sum 7 PCBs		895,019.60		895,019.60		895,019.60
URBAN						
PCB 105	6,060.00	3,981,476.01	3,624.62	2,018,654.55	4,097.83	1,841,533.39
PCB 114	453.56	273,341.67	265.34	144,545.61	294.01	135,253.19
PCB 118	2,976.03	9,619,995.04	1,547.83	4,968,577.53	1,563.49	4,839,865.37
PCB 156	1,269.95	701,814.57	706.77	372,670.50	752.70	388,949.94
PCB157	297.52	172,477.14	170.85	90,948.78	188.01	91,107.37
PCB 189	154.36	69,216.07	73.27	35,790.74	65.34	42,704.97
Sum 7 PCBs		9,688,254.08		6,003,867.40		6,509,738.40

Polychlorinated Dibenzodioxins and Dibenzofurans and congeners

In the 2016-2018 period, 17 parameters of Dioxins and Furans (PCDD y PCDF) and their congeners were analyzed from 10 sampling sites that meet the completeness criterion, 7 urban and three rural, that present data mostly above the LOQ. From the 2010-2011 period, 5 sites are analyzed to carry out the comparison, one rural and 4 urbans. Figure 51 and Table 38 show an increase in concentration in 2016-2018 for 13 of the 17 parameters measured in rural sites, and 2 in urban sites. The highest values of medians are presented in urban sites where OCDD presents extreme values in Kingston Jamaica, 2017 and 2018.

Figure 51. Behavior of PCDD and PCDF and congeners in GRULAC (75% criterion)

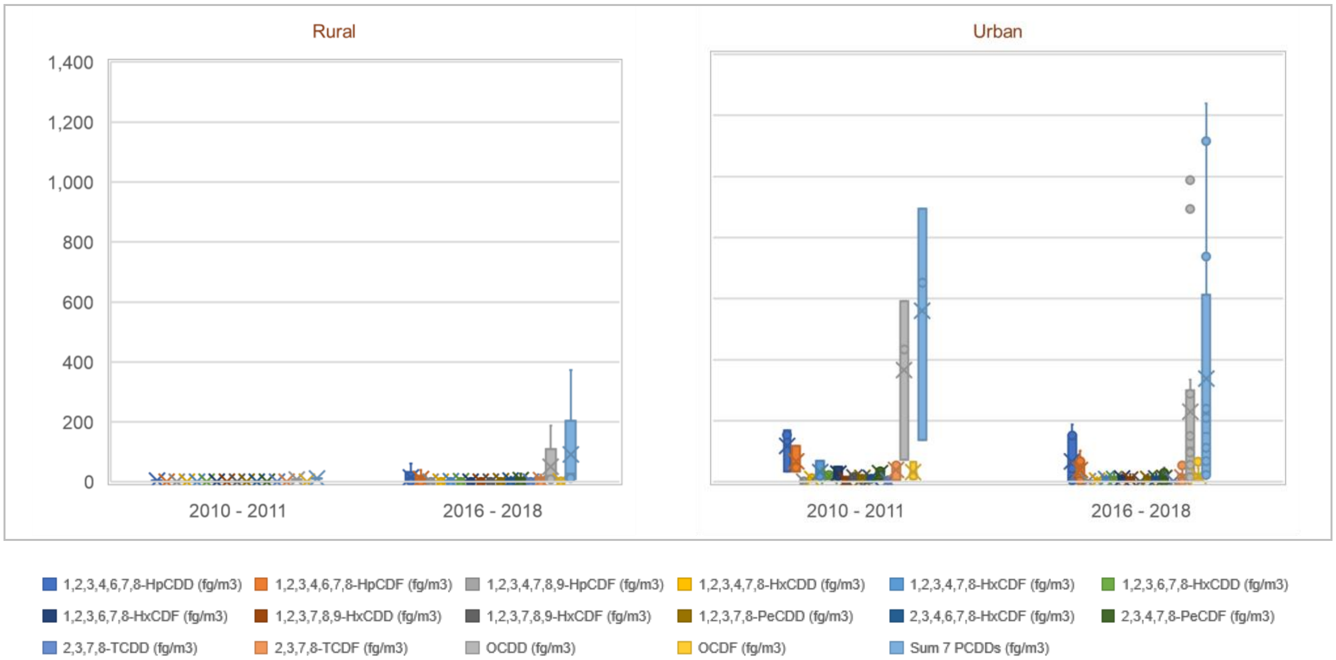


Table 38. Statistical analysis of PCDD and PCDF and congeners in GRULAC (75% criterion)

PCDD and PCDF (fg/m3)						
Parameter	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
1,2,3,4,6,7,8-HpCDD	3.58	62.02	3.58	15.05	3.58	3.804
1,2,3,4,6,7,8-HpCDF	1.44	39.91	1.44	8.94	1.44	1.215
1,2,3,4,7,8,9-HpCDF	0.06	3.98	0.06	1.08	0.06	0.224
1,2,3,4,7,8-HxCDD	0.09	3.36	0.09	0.86	0.09	0.263
1,2,3,4,7,8-HxCDF	0.77	7.81	0.77	1.78	0.77	0.230
1,2,3,6,7,8-HxCDD	0.09	8.75	0.09	2.04	0.09	0.421
1,2,3,6,7,8-HxCDF	0.65	6.86	0.65	1.57	0.65	0.218
1,2,3,7,8,9-HxCDD	0.08	6.29	0.08	1.58	0.08	0.347
1,2,3,7,8,9-HxCDF	0.08	3.81	0.08	1.04	0.08	0.418
1,2,3,7,8-PeCDD	0.23	8.56	0.23	1.98	0.23	0.393
2,3,4,6,7,8-HxCDF	0.71	17.66	0.71	3.81	0.71	0.344
2,3,4,7,8-PeCDF	0.37	27.14	0.37	5.89	0.37	0.647
2,3,7,8-TCDD	0.05	2.19	0.05	0.60	0.05	0.153
2,3,7,8-TCDF	0.79	24.45	0.79	6.51	0.79	3.038
OCDD	8.62	188.46	8.62	50.84	8.62	20.897
OCDF	0.12	11.16	0.12	3.34	0.12	1.467
Sum 7 PCDDs	12.21	373.17	12.21	91.11	12.21	26.675
URBAN						
1,2,3,4,6,7,8-HpCDD	953.6	187.9	327.5	67.1	161.2	47.021
1,2,3,4,6,7,8-HpCDF	510.0	102.5	177.5	39.4	82.5	41.042
1,2,3,4,7,8,9-HpCDF	2.7	5.6	1.1	2.2	0.9	1.387
1,2,3,4,7,8-HxCDD	57.4	14.4	21.6	4.5	12.8	2.851
1,2,3,4,7,8-HxCDF	89.9	21.1	47.3	9.8	43.9	12.567
1,2,3,6,7,8-HxCDD	122.9	28.2	45.5	9.7	24.8	4.944
1,2,3,6,7,8-HxCDF	108.2	23.3	47.9	11.1	34.1	13.224
1,2,3,7,8,9-HxCDD	100.0	25.2	29.3	8.3	8.6	3.497
1,2,3,7,8,9-HxCDF	107.7	3.9	38.2	1.2	19.5	0.733
1,2,3,7,8-PeCDD	105.7	25.8	36.1	8.7	15.7	5.034
2,3,4,6,7,8-HxCDF	16.6	27.0	10.4	10.4	10.0	13.586
2,3,4,7,8-PeCDF	133.5	45.6	55.1	13.2	39.1	10.884
2,3,7,8-TCDD	28.2	6.9	10.4	1.9	5.5	1.633
2,3,7,8-TCDF	122.7	54.6	59.8	14.5	55.4	7.712
OCDD	4,249.7	988.2	1,336.9	229.6	512.6	113.489
OCDF	405.3	74.0	125.5	19.9	43.2	10.626
Sum 7 PCDDs	5,617.6	1,239.1	1,825.2	338.5	773.5	160.677

Toxic Equivalence Factors (TEQs). Dioxins and Furans and PCBs similar to Dioxins

The toxic equivalence factors present data in both periods only for the 4 Dioxin parameters. The 2016-2018 period has 10 sampling sites that meet the completeness criterion: 7 urban and three rural; and despite the fact that in the 2010-2011 period 15 sites meet the criteria, 10 NC, 1 rural and 4 urbans, the 10 NCs are not considered in the analysis because there is no comparison with similar sites. As can be seen in Figure 52 and Table 39, in the 2016-2018 period, rural sites show an increase in concentration in all parameters and urban sites a decrease. There are no extreme values, and the highest values of medians are observed in urban sites. All the data for these parameters are above the LOQ.

Figure 52. Behavior of Toxic Equivalence Factors (TEQs) in GRULAC (75% criterion).

Table 39. Statistical analysis of TEQs in GRULAC (75% criterion)

TEQ (fg/m³)						
Parameter	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
PCDDs WHO1998-TEQ LB	0.04	10.71	0.04	2.40	0.04	0.106
PCDDs WHO2005-TEQ LB	0.04	10.77	0.04	2.41	0.04	0.108
PCDDs WHO1998-TEQ UB	0.66	14.85	0.66	3.78	0.66	1.135
PCDDs WHO2005-TEQ UB	0.66	14.88	0.66	3.79	0.66	1.141
URBAN						
PCDDs WHO1998-TEQ LB	171.9	31.4	57.8	11.8	23.7	4.214
PCDDs WHO2005-TEQ LB	172.8	31.5	58.0	11.8	23.7	4.227
PCDDs WHO1998-TEQ UB	171.9	33.7	61.4	12.5	27.6	7.352
PCDDs WHO2005-TEQ UB	172.8	33.8	61.7	12.6	27.7	7.367

Hexachlorocyclohexane and its isomers

Hexachlorocyclohexane (HCH) and its 3 isomers also present data from both periods. However, only 3 sites, one rural and two urbans, meet the criteria of 75% completeness during 2010-2011. For the 2016-2018 period, there are data from 10 sites: 3 rural sites and 7 urban sites. Most of the data are above the LOQ with the exception of Beta-HCH, which presents 50% of the values under the LOQ. The behavior of the data and the statistics are presented in figure 53 and in table 40 where it is observed that during 2016-2018 there is an increase in medians for the three isomers in rural and urban sites, without extreme values.

Figure 53. Behavior of HCH and its isomers in GRULAC (75% criterion)

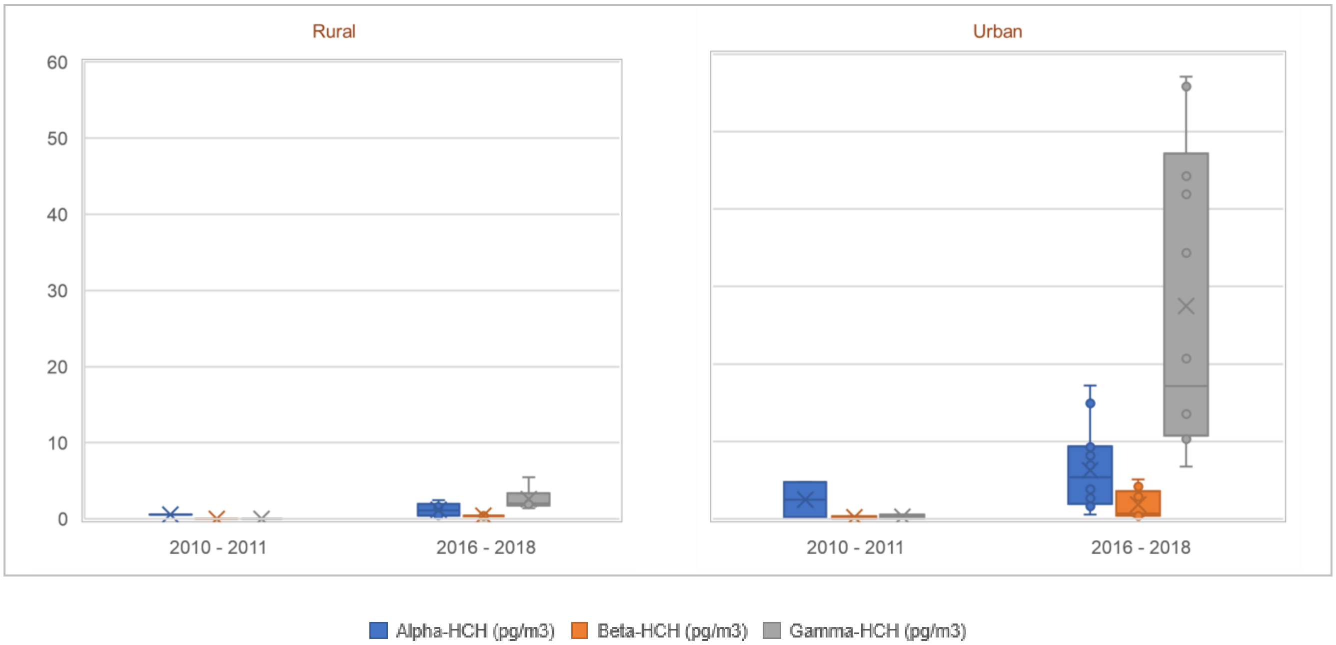


Table 40. Statistical analysis of HCH and its isomers in GRULAC (75% criterion)

HCH (pg/m^3)						
Parameter	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
Alpha-HCH	0.58	2.44	0.58	1.24	0.58	1.135
Beta-HCH	0.00	0.42	0.00	0.40	0.00	0.404
Gamma-HCH	0.02	5.51	0.02	2.61	0.02	2.053
URBAN						
Alpha-HCH	4.78	17.23	2.50	6.27	2.50	5.363
Beta-HCH	0.35	5.10	0.19	1.89	0.19	0.721
Gamma-HCH	0.59	57.12	0.30	27.49	0.30	17.140

Bromine Diphenyl Ethers and their isomers

In the 2016-2018 period, 8 isomers of Polybrominated Diphenyl Ethers (BDE) from 10 sampling sites that meet the completeness criteria were analyzed, 7 urban and three rural, and present data mostly above the LOQ. It is worth mentioning that the BDE 175/183 was measured for the first time by this program in this period. From the 2010-2011 period, 5 sites are analyzed to carry out the comparison, one rural and 4 urbans. In figure 54 and table 41 it is observed that in 2016-2018, rural sites show an increase in concentration of all medians and urban sites a decrease in the majority, except for BDE 153 and 154 that show increases. Extreme values are presented in urban sites: Kingston Jamaica, 2017 and 2018, for BDEs 47, 99, 154, 28 and 100. The highest values of medians are generally presented in urban sites.

Figure 54. Behavior of BDE and its isomers in GRULAC (75% criterion)

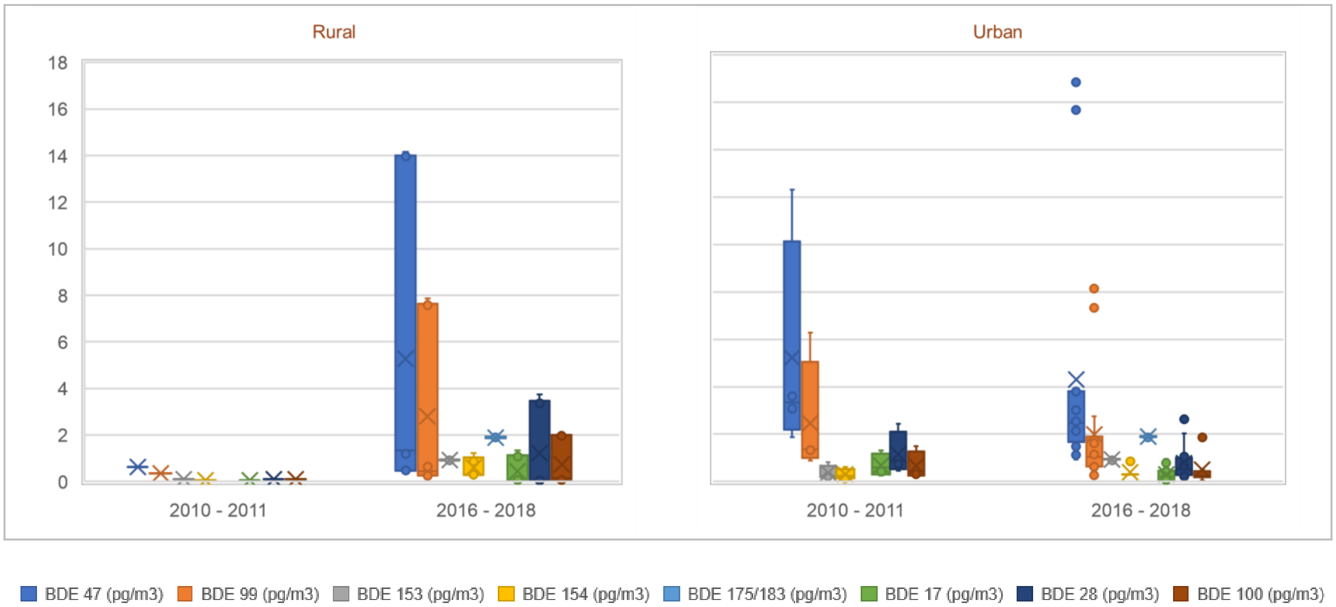


Table 41. Statistical analysis of BDE and its isomers in GRULAC (75% criterion)

BDE (pg/m^3)						
	Maximum		Average		Median	
	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018	2010 - 2011	2016 - 2018
RURAL						
BDE 47	0.620	14.160	0.620	5.286	0.620	1.335
BDE 99	0.358	7.856	0.358	2.808	0.358	0.455
BDE 153	0.108	0.946	0.108	0.932	0.108	0.945
BDE 154	0.045	1.234	0.045	0.597	0.045	0.302
BDE 175/183		1.978		1.897		1.892
BDE 17	0.051	1.341	0.051	0.441	0.051	0.059
BDE 28	0.107	3.737	0.107	1.221	0.107	0.069
BDE 100	0.099	2.040	0.099	0.735	0.099	0.143
URBAN						
BDE 47	12.301	16.828	5.215	4.305	3.337	2.477
BDE 99	6.275	8.127	2.468	2.000	1.353	1.038
BDE 153	0.808	0.957	0.363	0.941	0.226	0.946
BDE 154	0.609	1.037	0.303	0.393	0.234	0.303
BDE 175/183		2.048		1.901		1.891
BDE 17	1.322	0.944	0.690	0.310	0.588	0.218
BDE 28	2.444	2.622	1.167	0.774	0.886	0.496
BDE 100	1.490	1.964	0.653	0.496	0.441	0.264

Compounds measured for the first time

Pentachlorobenzene

Pentachlorobenzene (PeCB) was measured for the first time by this monitoring program in 2016-2018 at the 10 monitoring sites, 3 rural and 7 urbans. All the data present values above the LOQ. Figure 55 and Table 42 show that the highest median occurs in urban sites despite the extreme maximum value occurring in rural St. Phillips, Antigua and Barbuda, 2018.

Figure 55. Statistical analysis of PeCB in GRULAC (75% criterion)

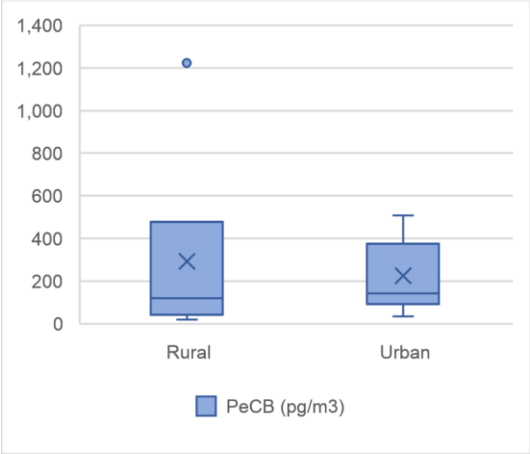


Table 42. Statistical analysis of Pentachlorobenzene (75% criterion)

PeCB (pg/m³)			
Site type	Maximum	Average	Median
	2016 - 2018	2016 - 2018	2016 - 2018
RURAL	1,224	293	121
URBAN	508	225	142

Hexabromobiphenyl and its isomers

From the group of Hexabromobiphenyl (PBB) and its isomers, only PBB153 was measured for the first time in the region in 10 sites during the period 2016-2018. All data presented values under the LOQ, except for one urban site Kingston Jamaica, and one rural Los Mochis Mexico, both in 2018. Greater variability is observed in rural sites and a minimum outlier outside the interquartile range in Quito Peru, 2018. See figure 56 and table 43.

Figure 56. Behavior of Hexabromobiphenyl and its isomers in GRULAC (75% criterion)

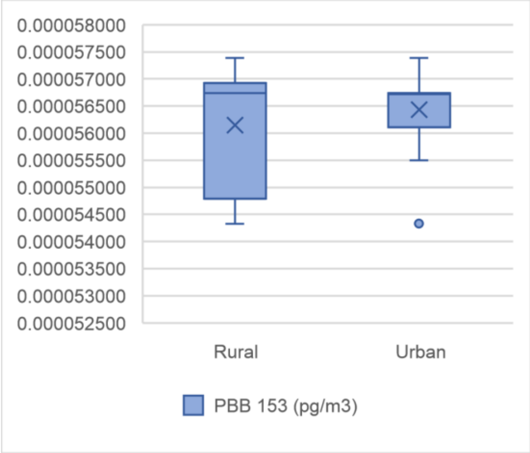


Table 43. Statistical analysis of Hexabromobiphenyl and its isomers in GRULAC (75% criterion)

PBB 153 (pg/m³)			
Site type	Maximum	Average	Median
	2016 - 2018	2016 - 2018	2016 - 2018
RURAL	0.0000574	0.0000561	0.0000567
URBAN	0.0000574	0.0000564	0.0000567

6.2.1.2. Global Atmospheric Passive Sampling Program (GAPS)

The GAPS network, which is made up of 29 monitoring sites spread over ten countries in Latin America and the Caribbean, as described in Chapter 4, has provided POPs data from 2004 to 2016 evaluating 93 parameters.

It should be noted that 19 of these parameters were analyzed for the first time by this program during the 2013-2016 period. However, not all sites measured all years, nor did all parameters, and many sites do not measure full years.

See Figure 57 where the number of sites and the years of monitoring can be observed. To guarantee the comparability of the data, those sites that monitored during 75% of each year were selected, reducing the number of sites to 20.

Of these 20 sites, only 10 monitored two or more full years and they are distributed in: Brazil 2, Colombia 2, Chile 2, Mexico 2, Barbados and Costa Rica (see Figure 58), where its classification is also observed: Remote 3, Rural 1, Urban 1 and 6 Not Classified (NC).

Likewise, despite the fact that there are data from 13 monitoring sites from the 2013-2016 period, of which 12 meet the criterion of 75% completeness, only 4 NC sites present monitoring in previous periods allowing comparisons between 32 parameters which include: HBCD, HCB, HCBD and PeCB, measured for the first time in 2014

Figure 57. Number of GAPS Program sites and years monitored

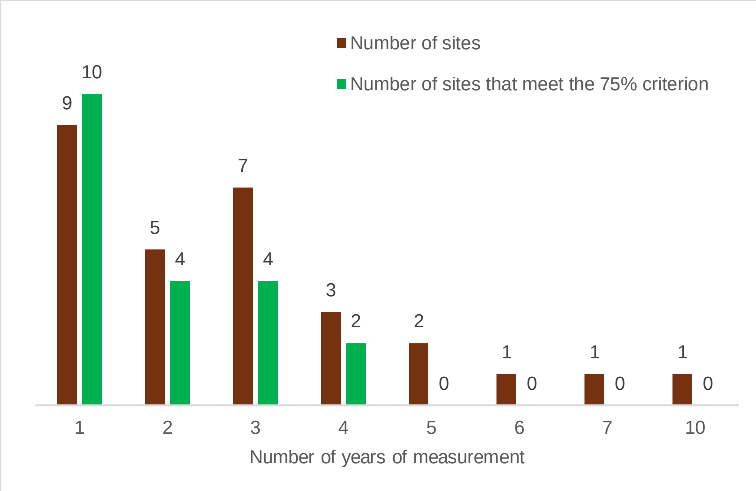
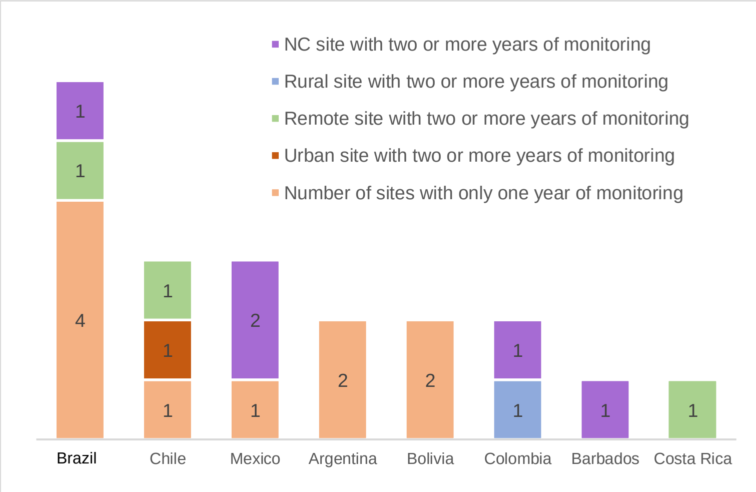


Figure 58. Distribution of sites that meet the 75% criterion by country and type of site



Said comparisons are presented in Mosaic Table 44, where it is observed that of the four sites only Yucatán, Mexico shows an increase in concentration in most of the parameters analyzed, 59%, while the other sites show a decrease in most of the parameters analyzed. Likewise, the Sonora, Mexico site presents most of the maximum values. All trends for sites with more than three years of measurement were not significant.

The parameters of the cyclodiene group generally show significant reductions in the concentration of Endosulfan and isomers and Dieldrin in most of the 4 monitoring sites. Significant increase in Chlordane Isomers mainly in Sonora and slight increase in Heptachlor in the 4 sites. PCBs, including PCBs with TEF 118, generally show a decrease in concentration at all sites; as well as the HCHs that also show a decrease in most of the sites with the exception of Ragged Point, St. Philip, Barbados that shows slight increases.

BDEs show a decrease in concentration in Manizales, Colombia and an increase in Yucatán, Mexico. Parameters Gamma-HBCD, HCB, HCBD and PeCB that were measured from 2013-2016 show increased concentration in Manizales, Colombia, with the exception of Gamma-HBCD, which presents values under the LOQ.

Mosaic Table 44. Concentration levels' comparison

Group	Parameter	Unclassified sites: Manizales, Colombia (2011, 2014 y 2015)	Unclassified sites: Ragged Point, St. Philip, Barbados (2009, 2011 y 2014)	Unclassified sites: Sonora, Mexico (2011 y 2014)	Unclassified sites: Yucatan, Mexico (2011, 2014 y 2015)	Maximum (2013-2016)	Site where the Maximum was given (YEAR)
Cyclodiene	cis-Chlordane (pg/m^3)		U	M		4.089	Sonora, Mexico (2014)
	trans-Chlordane (pg/m^3)	M				1.812	Manizales, Colombia (2013)
	trans-Nonachlor (pg/m^3)			M		3.414	Sonora, Mexico (2014)
	Dieldrin (pg/m^3)		M			44.022	Ragged Point, St. Philip, Barbados (2014)
	Endosulfan I (alpha) (pg/m^3)			M		188.269	Sonora, Mexico (2014)
	Endosulfan II (beta) (pg/m^3)		ULOQ	M		82.171	Sonora, Mexico (2014)
	Endosulfan SO4 (pg/m^3)	M		M		18.171	Manizales, Colombia (2013)
	Heptachlor (pg/m^3)	M				0.570	Manizales, Colombia (2013)
	Sum 2 heptachlorepoxides (pg/m^3)	ULOQ		M		1.439	Sonora, Mexico (2014)
PCB	PCB 28 (pg/m^3)		ULOQ	M		3.140	Sonora, Mexico (2014)
	PCB 52 (pg/m^3)					1.744	Chacaltaya, Bolivia (2014)
	PCB 101 (pg/m^3)					1.552	Chacaltaya, Bolivia (2014)
	PCB138 (pg/m^3)			U		0.016	Sao Luis, Brazil (2014)
	PCB 153 (pg/m^3)				M	0.798	Yucatan, Mexico (2014)
	PCB 180 (pg/m^3)	M		U	ULOQ	0.331	Manizales, Colombia (2013)
	Sum 6 PCBs (pg/m^3)					5.421	Concepción, Chile (2014)
	PCB with TEF 118 (fg/m^3)					613.931	Rio Gallegos, Argentina (2014)
	Sum 7 PCBs (pg/m^3)					5.946	Concepción, Chile (2014)
HCH	Alpha-HCH (pg/m^3)			M		1.180	Sonora, Mexico (2014)
	Gamma-HCH (pg/m^3)	M				7.045	Manizales, Colombia (2013)
BDE	BDE 47 (pg/m^3)	*		M	*	37.000	Sonora, Mexico (2014)
	BDE 99 (pg/m^3)	*		M	*	32.000	Sonora, Mexico (2014)
	BDE 153 (pg/m^3)	*		M	*	1.557	Sonora, Mexico (2014)
	BDE 154 (pg/m^3)	*		M	*	1.794	Sonora, Mexico (2014)
	BDE 175/183 (pg/m^3)	ULOQ*		M	*	0.165	Sonora, Mexico (2014)
	BDE 28 (pg/m^3)	U*		M	*	6.216	Sonora, Mexico (2014)
	BDE 100 (pg/m^3)	*		M	*	6.292	Sonora, Mexico (2014)
Deca-BDE	Deca-BDE 209 (pg/m^3)	ULOQ*		M	ULOQ*	2.151	Sonora, Mexico (2014)
HBCD	Gamma-HBCD (pg/m^3)	ULOQ*			ULOQ*	0.930	Concepción, Chile (2015)
HCB	HCB (pg/m^3)	*				76.000	Chacaltaya, Bolivia (2015)
HCBD	HCBD (pg/m^3)	*				71.000	Concepción, Chile (2015)
PeCB	PeCB (pg/m^3)	*		M		119.000	Sonora, Mexico (2016)

	Increased concentration	M	Maximum value in the period 2013-2015
	Decreased concentration		Without or with a single data
ULOQ	All data below the limit of quantification	*	Only data from 2014 and 2015
	Data that did not meet the 75% criterion	U	Most recent value under LOQ

To analyze the variability of all the data from the GAPS monitoring program, the same procedure was followed in the ambient air monitoring programs, where year by year of monitoring of each parameter was compared, then the data were separated by groups of years and then by site type: Not Classified (NC), Remote, Rural and Urban. The dispersion of the data was analyzed by means of box plots and the statistical parameters were calculated to estimate the concentration changes in the region. Comparisons are presented between the data, from the period 2004-2012 with those from 2013-2016, of 20 parameters that met the criterion of 75% completeness; the analysis of the dispersion of the data considers the 42 parameters measured in the period 2013-2016. The analysis by group of compounds is presented below:

Organochlorine Insecticides, Cyclodiene Subgroup

In the case of Cyclodienes, the data for the period 2013-2016 that were used to make the comparisons of concentrations in the region come from 11 of the 13 monitoring sites and less than 10% of these data presented values below the LOQ. It is worth mentioning that in that period no samplings were carried out in rural sites, that 7 of the 11 sites are NC, 3 are remote and 1 is urban.

The statistical analysis of the cyclodienes for the unclassified sites (NC) shows, as in the comparative analysis of the sites, significant decreases of Endosulfan and isomers and of Dieldrin; and increases of cis-Chlordane, trans chlordane and heptachlor. However, extreme values are observed in 2014 for: Dieldrin at Ragged Point, St. Philip, Barbados; and Endosulfan alpha and beta in Sonora, Mexico. Likewise, in the NC sites most of the highest values of medians are present. The remote sites show an increase in cis-Chlordane and Heptachlor, but also show an increase in Endosulfan beta and sulfate, and the sum of 2 Heptachlor epoxides. Urban sites show a decrease in all parameters and the lowest median values for almost all parameters in the 2013-2016 period. See Figure 59 where the behavior of the data that met the 75% completeness criterion and the statistical summary table 45 are presented.

Figure 59. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in GRULAC (75% criterion)

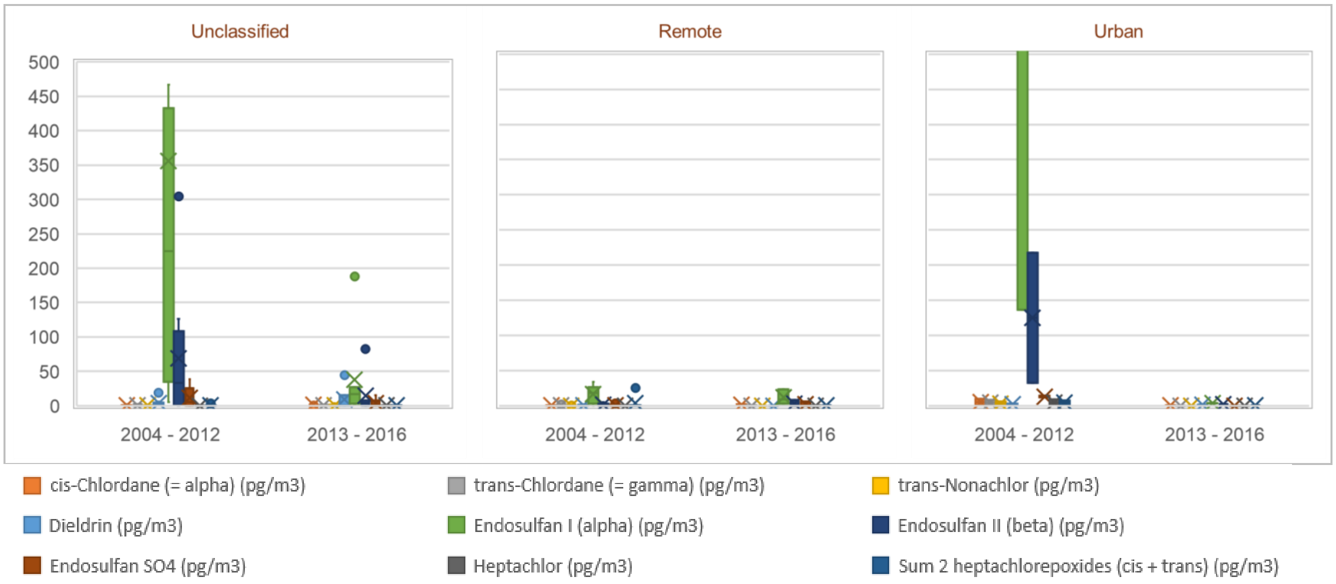


Table 45 Statistical analysis of the Organochlorine Insecticides, Cyclodiene Subgroup in GRULAC (75% criterion)

CYCLODIENES (pg/m^3)						
Parameter	Maximum		Average		Median	
	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016
UNCLASSIFIED						
cis-Chlordane	1.768	4.089	0.528	1.481	0.335	1.209
trans-Chlordane	2.333	1.333	0.799	0.558	0.159	0.578
trans-Nonachlor	1.100	3.414	0.321	0.724	0.060	0.007
Dieldrin	18.907	44.022	3.878	8.882	2.185	0.841
Endosulfan I (Alpha)	1,449.261	188.269	356.264	37.826	225.074	16.468
Endosulfan II (beta)	304.673	82.171	68.847	14.209	33.287	3.759
Endosulfan SO4	38.245	15.012	11.212	3.782	5.532	1.076
Heptachlor	0.211	0.353	0.098	0.160	0.086	0.162
Sum 2 heptachlorepoxides (cis + trans)	3.138	1.439	0.613	0.352	0.234	0.130
REMOTE						
cis-Chlordane	0.306	1.684	0.153	1.007	0.178	0.777
trans-Chlordane	1.775	0.183	0.283	0.067	0.075	0.013
trans-Nonachlor	0.294	0.011	0.092	0.007	0.068	0.007
Dieldrin	2.119	0.009	0.588	0.005	0.269	0.003
Endosulfan I (Alpha)	34.017	23.666	16.329	11.818	17.666	9.025
Endosulfan II (beta)	5.017	7.978	1.266	3.076	0.139	1.245
Endosulfan SO4	3.533	6.080	0.707	2.340	0.086	0.864
Heptachlor	0.218	0.240	0.119	0.141	0.102	0.116
Sum 2 heptachlorepoxides (cis + trans)	25.301	0.394	3.295	0.289	0.183	0.302
URBAN						
cis-Chlordane	9.998	0.801	5.198	0.801	5.198	0.801
trans-Chlordane	8.053	0.006	4.146	0.006	4.146	0.006
trans-Nonachlor	6.206	0.005	3.155	0.005	3.155	0.005
Dieldrin	2.712	1.095	1.697	1.095	1.697	1.095
Endosulfan I (Alpha)	1,269.871	3.373	702.959	3.373	702.959	3.373
Endosulfan II (beta)	217.441	1.738	124.981	1.738	124.981	1.738
Endosulfan SO4	14.002	0.075	12.850	0.075	12.850	0.075
Heptachlor	8.728	0.124	4.579	0.124	4.579	0.124
Sum 2 heptachlorepoxides (cis + trans)	7.452	0.466	3.968	0.466	3.968	0.466

Polychlorinated biphenyls and congeners

In the 2013-2016 period, a total of 7 Polychlorinated Biphenyls (PCB) from 11 sampling sites were analyzed, of which PCB 138 and 180 presented more than 70% of their data below the LOQ. The only PCB with TEF analyzed in this period was 118, which presented all values above the LOQ and a significant decrease in concentration in the medians of the NC and urban monitoring sites. Again, it is worth mentioning that, in that period, no samples were carried out in rural sites, that 7 of the sites are NC, 3 are remote and 1 is urban.

The behavior of these compounds is presented in Figure 60 and Table 46, where the NC sites show significant decreases in their medians in almost all the parameters except for PCB 101, which shows a slight increase. Similarly, the urban site presents a decrease in all its parameters. However, the Remote sites show an increase in almost all their parameters except for PCB 138 and 180. Note that extreme values were only presented in the NC site Sonora México, 2014; and that the highest values of medians occur mainly in urban sites.

Figure 60. Behavior of PCBs in GRULAC (75% criterion)

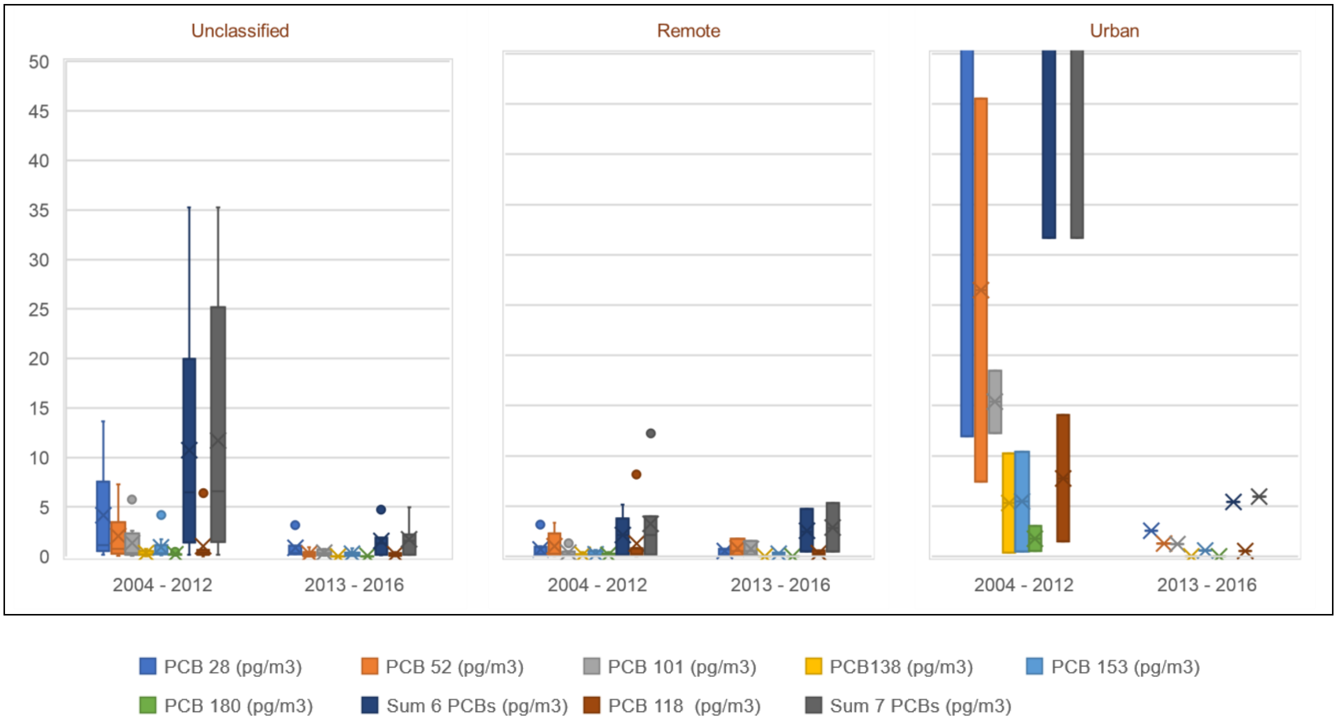


Table 46. Statistical analysis of PCB in GRULAC (75% criterion)

PCB (pg/m3)						
Parameter	Maximum		Average		Median	
	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016
UNCLASSIFIED						
PCB 28	13.646	3.140	4.175	0.857	0.824	0.345
PCB 52	7.277	0.913	2.040	0.303	0.758	0.241
PCB 101	5.736	0.741	1.356	0.364	0.333	0.360
PCB138	0.740	0.016	0.330	0.012	0.233	0.011
PCB 153	4.203	0.798	0.922	0.265	0.356	0.198
PCB 180	0.456	0.208	0.214	0.040	0.200	0.011
Sum 6 PCBs	35.236	4.738	9.528	1.559	2.540	1.315
PCB 118 with TEF	6.415	0.463	1.027	0.207	0.237	0.187
Sum 7 PCBs	35.236	4.962	10.417	1.752	2.673	1.556
REMOTE						
PCB 28	3.141	0.748	0.710	0.547	0.223	0.700
PCB 52	3.349	1.744	0.995	0.810	0.289	0.558
PCB 101	1.333	1.552	0.362	0.753	0.189	0.533
PCB138	0.417	0.024	0.164	0.015	0.154	0.010
PCB 153	0.621	0.404	0.240	0.256	0.148	0.257

PCB (pg/m3)						
Parameter	Maximum		Average		Median	
	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016
PCB 180	0.425	0.025	0.196	0.015	0.184	0.011
Sum 6 PCBs	5.155	4.712	1.864	2.563	1.190	2.472
PCB 118 with TEF	8.171	0.612	1.270	0.336	0.198	0.264
Sum 7 PCBs	12.262	5.324	2.834	2.877	1.190	2.803
URBAN						
PCB 28	128.963	2.541	70.458	2.541	11.953	2.541
PCB 52	45.512	1.298	26.474	1.298	26.474	1.298
PCB 101	18.493	1.236	15.383	1.236	15.383	1.236
PCB138	10.258	0.010	5.325	0.010	5.325	0.010
PCB 153	10.432	0.569	5.471	0.569	5.471	0.569
PCB 180	3.038	0.010	1.788	0.010	1.788	0.010
Sum 6 PCBs	220.294	5.421	125.979	5.421	125.979	5.421
PCB 118 with TEF	14.053	0.524	7.767	0.524	7.767	0.524
Sum 7 PCBs	231.188	5.946	131.425	5.946	131.425	5.946

Hexachlorocyclohexane and its isomers

Hexachlorocyclohexane (HCH) isomers analyzed in the 2013-2016 period were Alpha-HCH and Gamma-HCH, which presented values under the LOQ in less than 10% of the data in the 11 sampling sites. Figure 61 and table 47 show a reduction in concentration in the NC and urban sites, and a slight increase in the remote sites. However, highest values are presented in the NC sites and median maximum value of Gama HCH in urban site Concepción, Chile 2015. No extreme values are presented.

Figure 61. Behavior of HCH and its isomers in GRULAC (75% criterion)

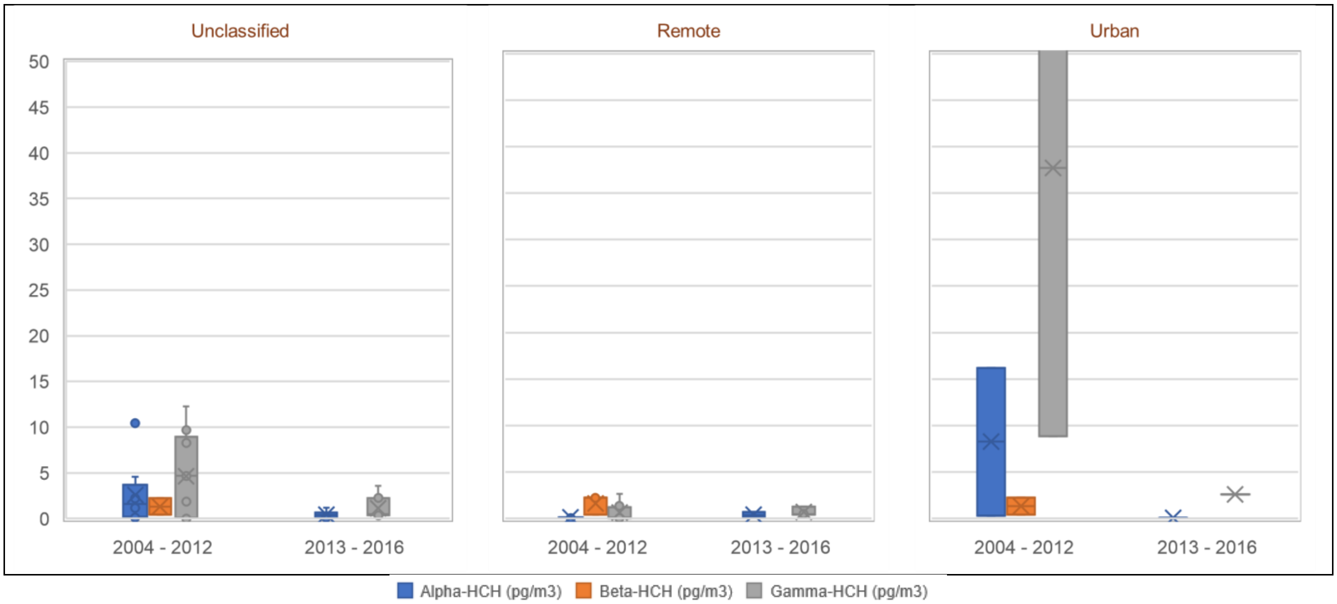


Table 47. Statistical analysis of HCH and its isomers in GRULAC (75% criterion)

HCH (pg/m^3)						
Parameter	Maximum		Average		Median	
	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016
UNCLASSIFIED						
Alpha-HCH	10.457	1.180	2.562	0.437	0.609	0.333
Gamma-HCH	12.239	3.599	4.614	1.146	4.667	0.471
REMOTE						
Alpha-HCH	0.284	0.674	0.103	0.385	0.098	0.383
Gamma-HCH	2.658	1.276	0.635	0.716	0.128	0.477
URBAN						
Alpha-HCH	16.209	0.070	8.264	0.070	0.319	0.070
Gamma-HCH	66.539	2.594	37.707	2.594	37.707	2.594

Polybromodiphenyl Ethers (Bromine Diphenyl Ethers, their isomers and Decabromodiphenyl ether)

Three isomers of Polybrominated Diphenyl Ethers (BDE), BDE 47, 99, and 100, were measured in the region at 5 sites that met the completeness criterion in 2004 and 2005: 2 NC, 2 remote, and 1 rural. In the 2013-2016 period, 9 isomers were measured at 8 sites: 6 NC sites and 2 remote sites; and 8 in the urban site Concepción, Chile where the BDE 17 was not measured. Data presented 53% of the values below the LOQ. The behavior of all the parameters is showed in figure 62 and the statistical summary in table 48, where it is observed that there is an increase in concentration of the BDE 47, 99 and 100, in the NC sites due to the extreme values presented by the Sonora Mexico site, in 2014 and in remote sites from the 2013-2016 period. Decabromodiphenyl ether (Deca-BDE 209) also presented extreme value at the NC Sonora México site, 2014.

Figure 62. Behavior of BDE and its isomers in GRULAC (75% criterion)

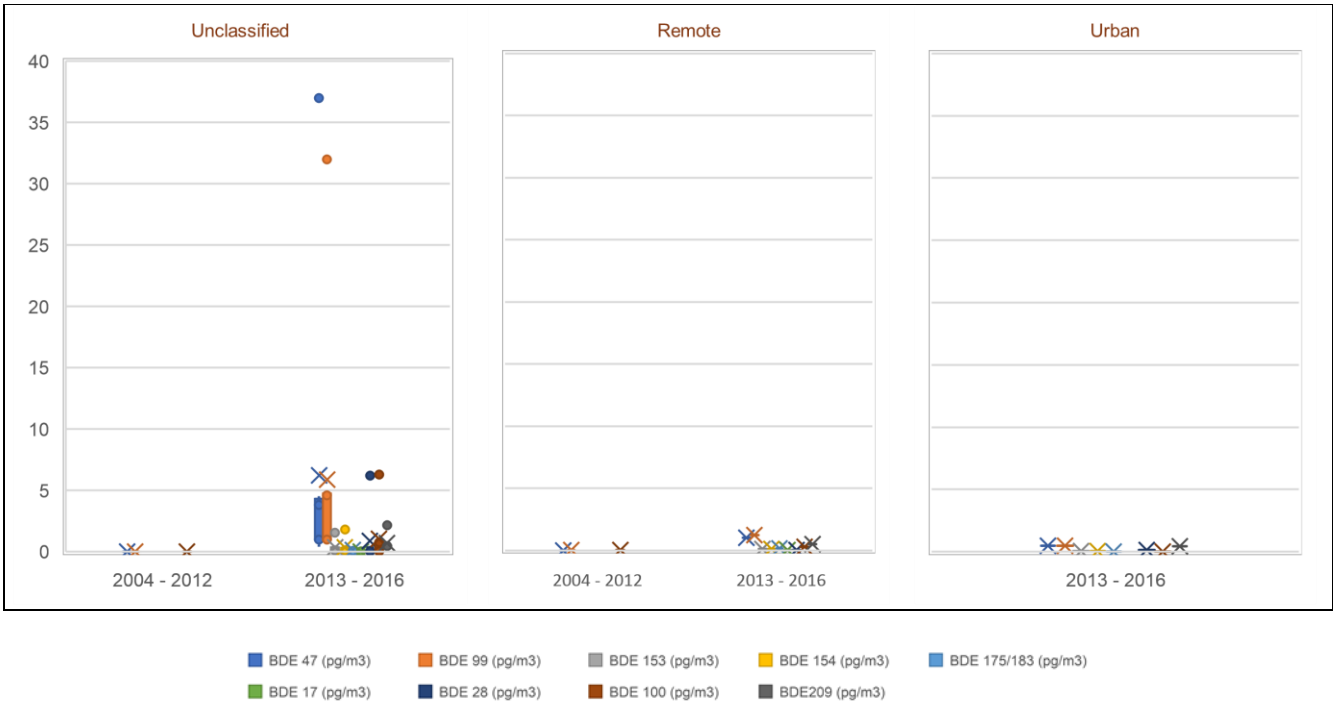


Table 48. Statistical analysis of BDE and its isomers in GRULAC (75% criterion)

BDE (pg/m³)						
Parameter	Maximum		Average		Median	
	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016
UNCLASSIFIED						
BDE 47	0.005	37.000	0.005	6.223	1.004	1.008
BDE 99	0.021	32.000	0.021	5.864	0.021	1.210
BDE 153		1.557		0.352		0.140
BDE 154		1.794		0.354		0.109
BDE 175/183		0.165		0.130		0.150
BDE 17		0.020		0.015		0.020
BDE 28		6.216		0.898		0.105
BDE 100	0.019	6.292	0.019	1.073	0.019	0.278
Deca-BDE 209		2.151		0.694		0.500
REMOTE						
BDE 47	0.005	1.008	0.005	1.008	0.507	1.008
BDE 99	0.021	1.210	0.021	1.210	0.021	1.210
BDE 153		0.130		0.130		0.130
BDE 154		0.109		0.109		0.109
BDE 175/183		0.165		0.165		0.165
BDE 17		0.020		0.020		0.020
BDE 28		0.032		0.032		0.032
BDE 100	0.019	0.278	0.019	0.278	0.019	0.278
Deca-BDE 209		0.500		0.500		0.500

BDE (pg/m³)						
Parameter	Maximum		Average		Median	
	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016	2004 - 2012	2013 - 2016
URBAN						
BDE 47		0.500		0.500		0.500
BDE 99		0.500		0.500		0.500
BDE 153		0.050		0.050		0.050
BDE 154		0.050		0.050		0.050
BDE 175/183		0.030		0.030		0.030
BDE 28		0.140		0.140		0.140
BDE 100		0.015		0.015		0.015
Deca-BDE 209		0.450		0.450		0.450

Compounds measured for the first time

Hexachlorocyclohexane and its isomers

Hexachlorocyclohexane (HCH) isomers analyzed in the 2013-2016 period were Alpha-HCH and Gamma-HCH, which presented values under the LOQ in less than 10% of the data in the 11 sampling sites. Figure 61 and table 49 show a reduction in concentration in the NC and urban sites, and a slight increase in the remote sites. However, highest values are presented in the NC sites and median maximum value of Gama HCH in urban site Concepción, Chile 2015. No extreme values are presented.

Figure 63. Behavior of HCH and its isomers in GRULAC (75% criterion)

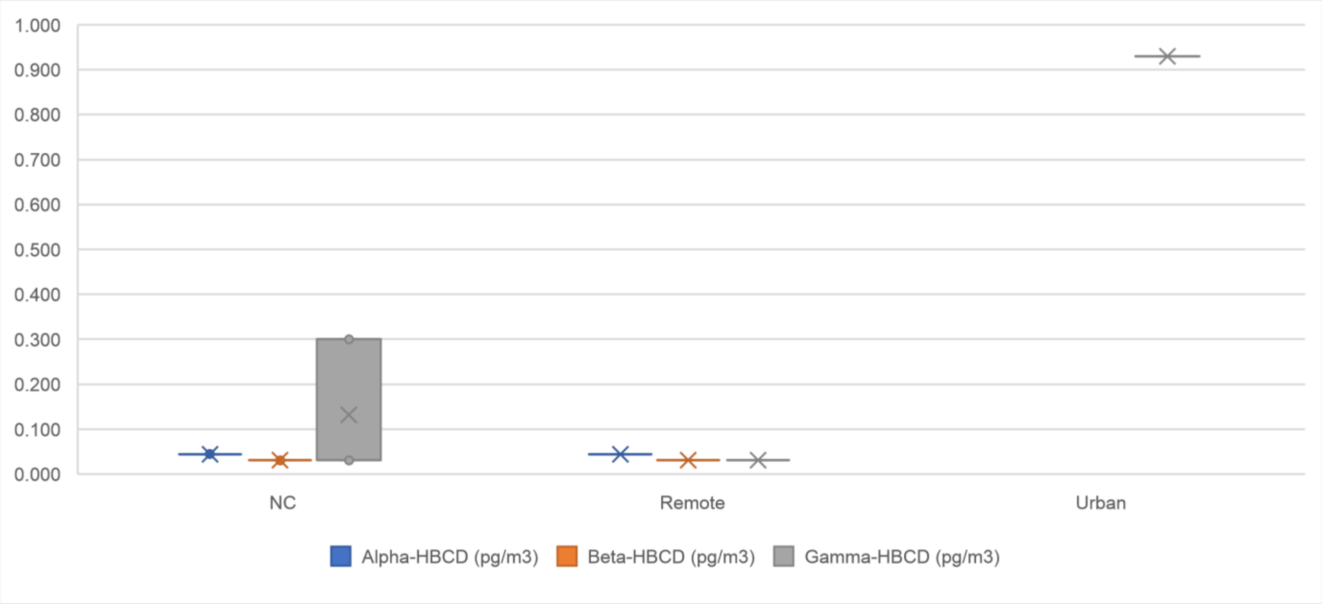


Table 49. Statistical analysis of BDE and its isomers in GRULAC (75% criterion)

HBCD (pg/m³)			
Parameter	Maximum	Average	Median
	2013 - 2016	2013 - 2016	2013 - 2016
UNCLASSIFIED			
Alpha-HBCD	0.044	0.033	0.044
Beta-HBCD	0.031	0.023	0.031
Gamma-HBCD	0.300	0.132	0.031
REMOTE			
Alpha-HBCD	0.044	0.044	0.044
Beta-HBCD	0.031	0.031	0.031
Gamma-HBCD	0.031	0.031	0.031
URBAN			
Gamma-HBCD	0.930	0.930	0.930

Hexachlorobenzene

Hexachlorobenzene (HCB) was only analyzed in the period 2013-2016 and for the first time in samples from 2014. It was measured in 9 sites (6 NC, 2 remote and 1 urban) but only 3 (2 NC and 1 urban) meet the criterion of 75% completeness. All data presented values above the limit of quantification. The behavior of the HCB is presented in figure 64 and its statistics in table 50, where data meeting the 75% criterion is compared with all data. It is observed that when using all the data, the value of the median of the urban sites increases. The maximum value is presented at the remote site Chacaltaya Bolivia, 2015, which does not meet the 75% criterion. It is unknown if this is due to a seasonal bias.

Figure 64. Behavior of HCB in GRULAC

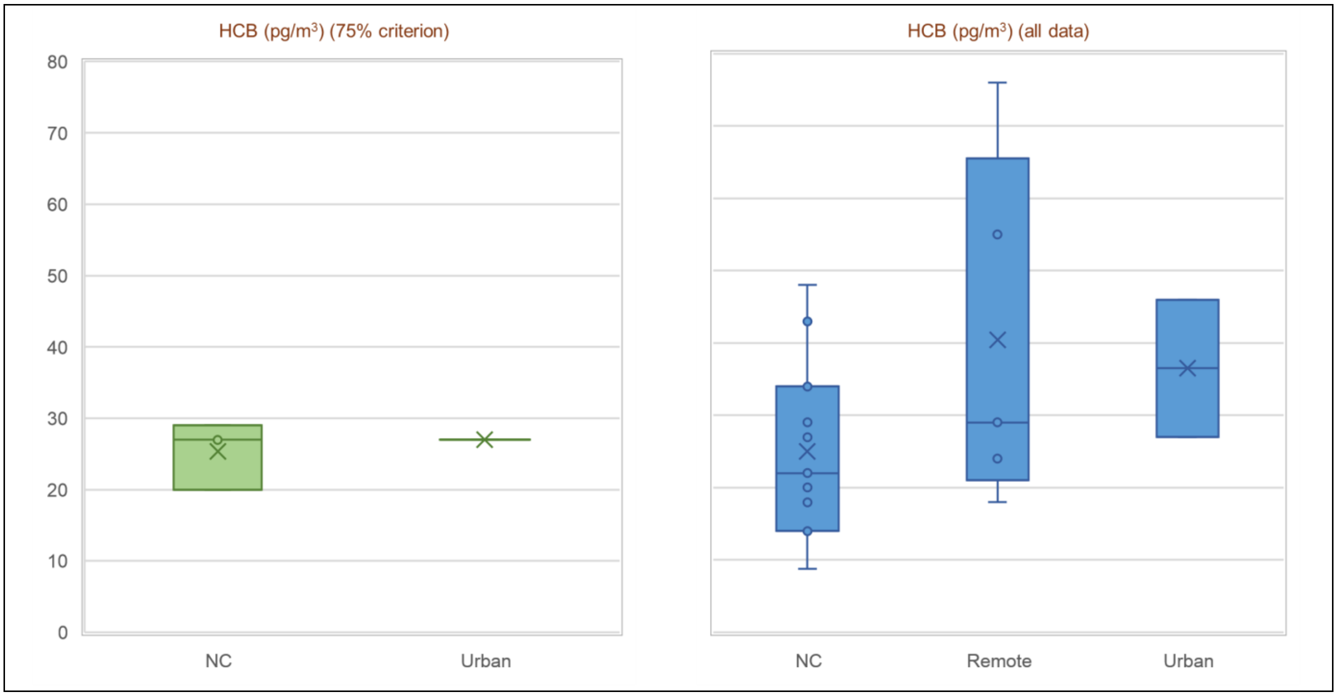


Table 50. Statistical analysis of HCB in GRULAC (75% criterion)

HCB (pg/m³)			
Site type and criterion	Maximum	Average	Median
	2013 - 2016	2013 - 2016	2013 - 2016
Unclassified (75% criterion)	29.0	25.3	27.0
Unclassified (all data)	48.0	25.0	22.0
Remote (all data)	76.0	40.4	29.0
Urban (75% criterion)	27.0	27.0	27.0
Urban (all data)	46.0	36.5	36.5

Hexachlorobutadiene

Hexachlorobutadiene (HCBD) was measured in 2014, 2015 and 2016 at 7 (5 NC, 1 remote and 1 urban), 9 (6 NC, 2 remote and 1 urban) and 6 (4 NC and 2 remote) sites respectively. However, only 3 sites met the completeness criterion: 2 NC and the urban Concepción Chile, 2015. All the data present values above the LOQ. Figure 65 shows the behavior of the data comparing those that meet the completeness criterion against all the data. Maximum value is observed in the urban site Concepción Chile, 2015 in both cases. Table 51 presents the statistical parameters.

Figure 65. Behavior of HCBD in GRULAC

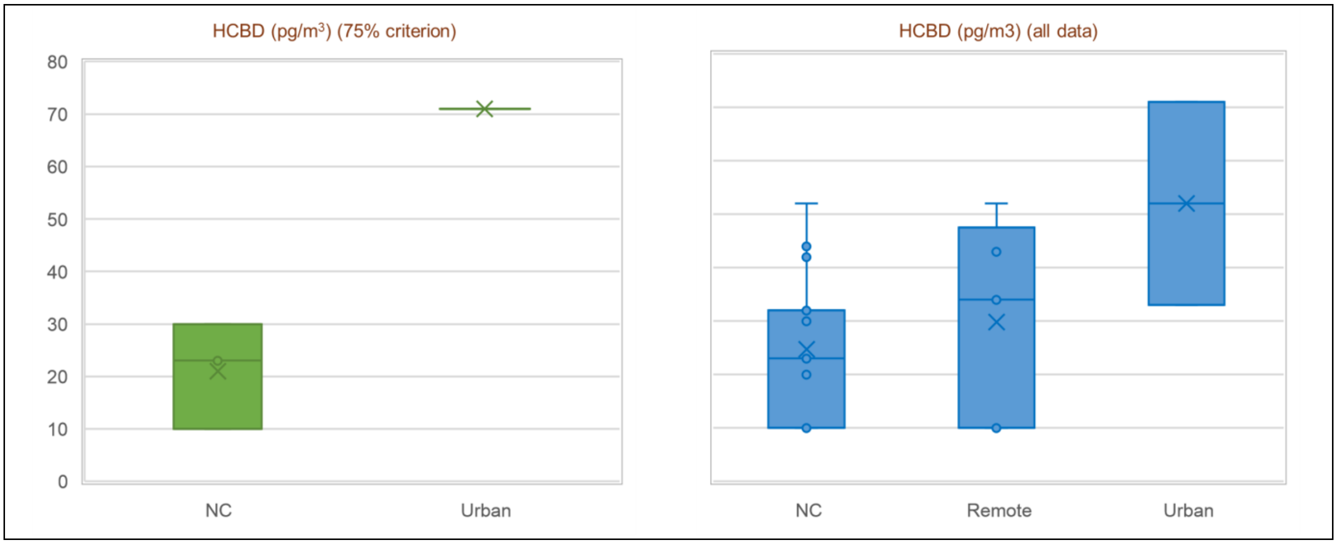


Table 51. Statistical analysis of HCBD in GRULAC

HCBD (pg/m³)			
Site type and criteria	Maximum	Average	Median
	2013 - 2016	2013 - 2016	2013 - 2016
Unclassified (75% criterion)	30.0	21.0	23.0
Unclassified (all data)	52.0	24.7	23.0
Remote (all data)	52.0	29.8	34.0
Urban (75% criterion)	71.0	71.0	71.0
Urban (all data)	71.0	52.0	52.0

Pentachlorobenzene

Pentachlorobenzene (PeCB) was also analyzed in 2014, 2015 and 2016 from samples of 7 (5 NC, 1 remote and 1 urban), 9 (6 NC, 2 remote and 1 urban) and 6 (4 NC and 2 remote) sites respectively. However, only 3 sites met the completeness criterion: 2 NC and the urban Concepción Chile, 2015. Most of the data present values above the LOQ. Figure 66 compares the behavior of the data that meet the 75% criterion with all the data. Extreme values are observed in the NC Sonora México site, 2014, 2015 and 2016 for all the data and a maximum in Concepción Chile, 2015 for the data that meet the completeness criterion. Table 52 presents the statistical parameters.

Figure 66. Behavior of PeCB in GRULAC

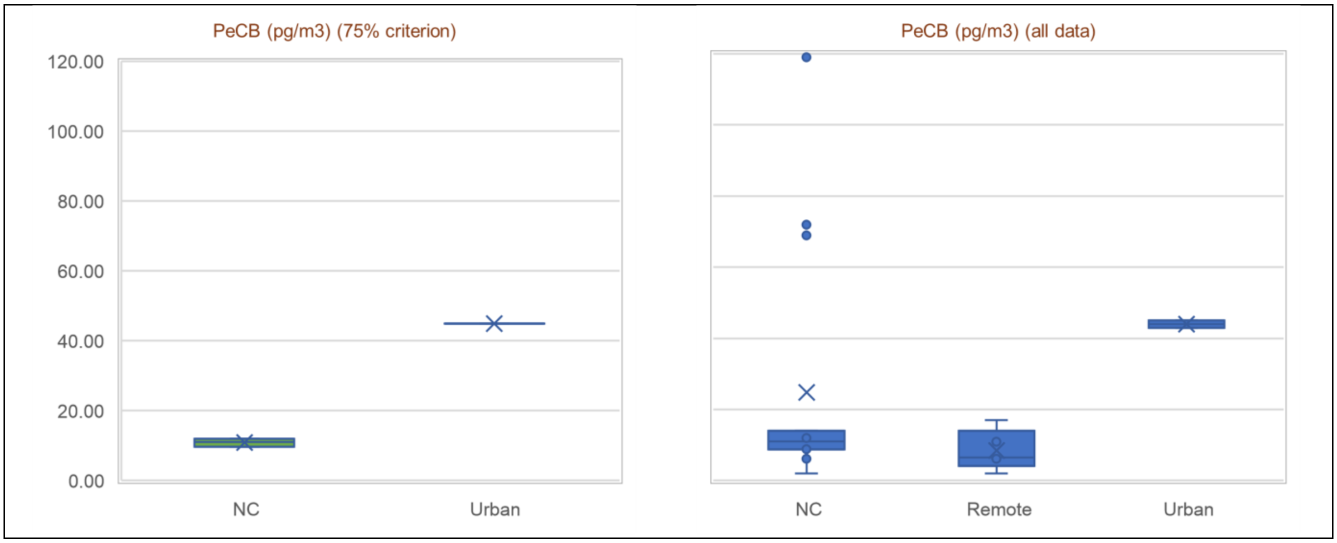


Table 52. Statistical analysis of PeCB in GRULAC

PeCB (pg/m³)			
Site type and criterion	Maximum	Average	Median
	2013 - 2018	2013 - 2018	2013 - 2018
Unclassified (75% criterion)	120	10.9	11.0
Unclassified (all data)	1190.	24.9	11.0
Remote (all data)	17.0.	8.5	6.5
Urban (75% criterion)	45.0	45.0	45.0
Urban (all data)	45.0	44.0	44.0

Perfluorooctane sulphonate and its isomers

Perfluorooctane sulphonate (PFOS) and its isomers (NEtFOSA, NEtFOSE, NMeFOSA, NMeFOSE) were measured in 2015 at 6 sites (5 NC and one remote) and in 2016 at a different remote site. They mostly present data above the LOQ except for the NMeFOSE and NEtFOSE isomers that present 57% and 85% of data below the LOQ. However, only the Tapanti National Park Costa Rica, 2015 site met the completeness criterion; presenting annual values above the LOQ for: PFOS, NEtFOSA and NMeFOSE. The behavior of all the data is presented in Figure 67 where it is observed that the highest values are generally present in the NC sites, but NMeFOSE presents a higher median in the remote ones. See table 53 with the statistical parameters. The maximum values are presented in Sonora and Yucatán, Mexico; and Sao Jose, Brazil in 2015; and Chacaltaya, Bolivia in 2016.

Figure 67. Behavior of PFOS and its isomers in GRULAC

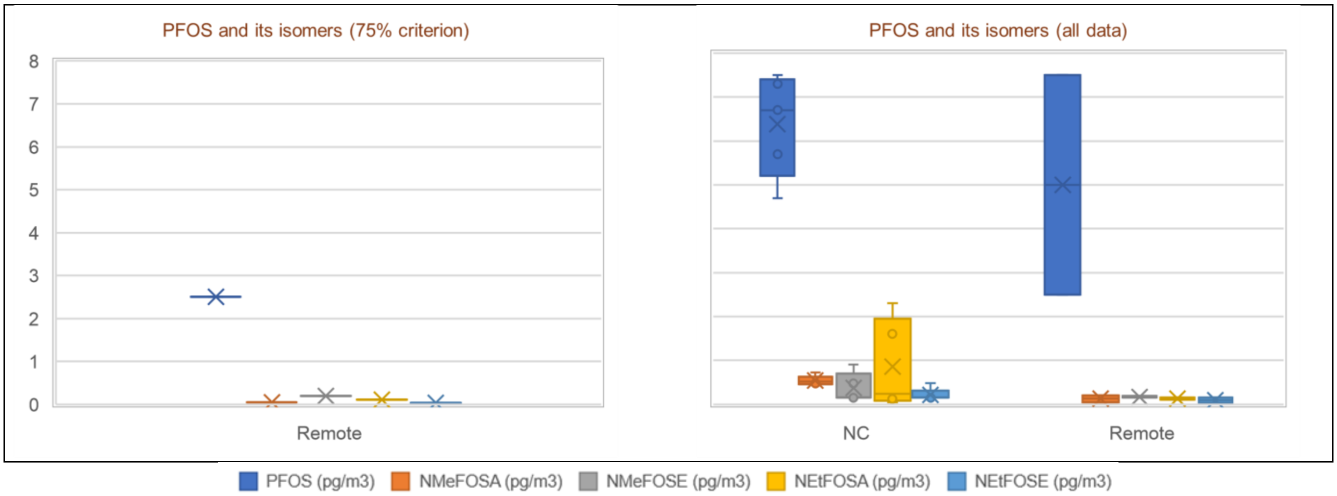


Table 53. Statistical analysis of PFOS and its isomers in GRULAC

PFOS and its isomers (pg/m³)			
Parameter	Maximum	Average	Median
	2013 - 2016	2013 - 2016	2013 - 2016
UNCLASSIFIED (ALL DATA)			
PFOS	7.500	6.380	6.700
NMeFOSA	0.720	0.540	0.520
NMeFOSE	0.910	0.368	0.150
NEtFOSA	2.300	0.862	0.240
NEtFOSE	0.480	0.216	0.150
REMOTE (ALL DATA)			
PFOS	7.500	5.000	5.000
NMeFOSA	0.200	0.125	0.125
NMeFOSE	0.190	0.170	0.170
NEtFOSA	0.160	0.135	0.135
NEtFOSE	0.150	0.093	0.093
REMOTE (75% CRITERION)			
PFOS	2.500	2.500	2.500
NMeFOSA	0.05	0.05	0.05
NMeFOSE	0.19	0.19	0.19
NEtFOSA	0.11	0.11	0.11
NEtFOSE	0.035	0.035	0.035

Perfluorooctanoic acid

Perfluorooctanoic acid (PFOA) was ratified in 2019 to be part of the POPs listed in the Stockholm Convention. Measured for the first time in the air matrix in 2015 at the Tapanti National Park Remote site, Costa Rica, the value of PFOA 7.9 pg / m^3 represents the baseline and is the only value available in the GRULAC region for Air matrix. This value meets the completeness criterion.

Perfluorohexane sulphonic acid, its salts and related compounds

Perfluorohexane Sulfonic Acid (PFHxS) is a candidate compound to be included in the Stockholm Convention. It was measured for the first time at 5 NC sites and one remote site in 2015, and in 2016 at another remote site. Only the data from the remote site Tapanti National Park Costa Rica, 2015 meets the completeness criterion and its value is under the LOQ. The behavior of all the data is observed in figure 68 where it can be seen that the maximum value is presented in the NC site Yucatán México, 2015. The statistical parameters are presented in table 54.

Figure 68. Behavior of PFHxS in GRULAC

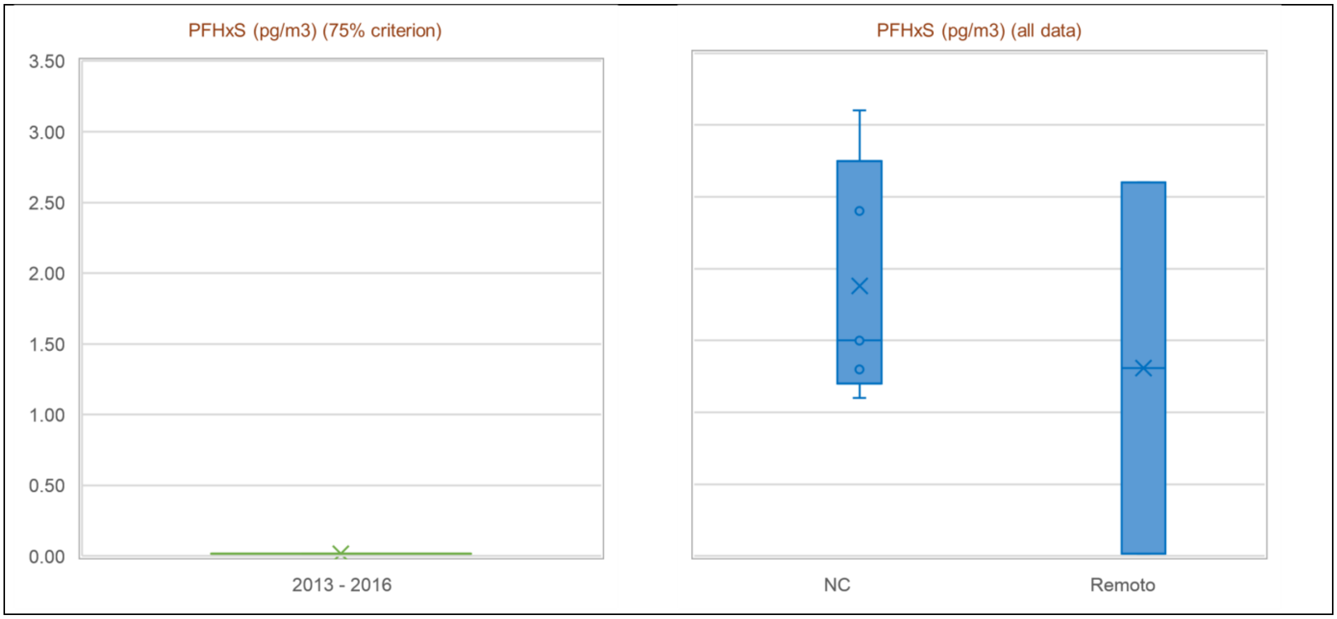


Table 54. Statistical analysis of PFHxS in GRULAC

	PFHxS (pg/m^3)		
Site type and criterion	Maximum	Average	Median
	2013 - 2016	2013 - 2016	2013 - 2016
Unclassified (all data)	3.100	1.880	1.500
Remote (75% criterion)	0.015	0.015	0.015
Remote (all data)	2.600	1.308	1.308

6.2.1.3. Red Latinoamericana de Muestreo Atmosférico Pasivo (LAPAN)

LAPAN has data from 56 passive sampling sites distributed in 12 countries, which have monitored 45 POPs parameters from 2010 to 2016 and all meet the completeness criterion.

However, as seen in Figure 69, 35 of these sites have only measured for one year and 21 have measured 2 or more years, 18 of them have measurements during the period 2013-2016 and only 8 present measurements in both periods 2010-2012 and 2013-2016, allowing the evaluation of changes in concentrations from one period to another.

The 18 sites are distributed: 12 in Brazil, 4 in Argentina, 1 in Colombia and 1 in Peru; Its classification is shown in Figure 70, where it is observed: 8 urban sites, 8 remote and 5 unclassified, of which only 2 located in Brazil and Peru, measured in the period 2013-2016.

Likewise, in said Figure 70 we can see that half of the sites are located in Brazil, and the remaining 28 mainly in Argentina, Colombia and Chile. Due to this distribution, the results of concentration changes that will be described in the following sections have a bias that should be considered to represent the region.

The parameters analyzed under this program were 45 from 2010 to 2012, but only 40 of them from 2013 to 2016. Therefore, comparisons of concentration levels are limited to these last 40 parameters.

Figure 69. Number of LAPAN Program sites and years monitored

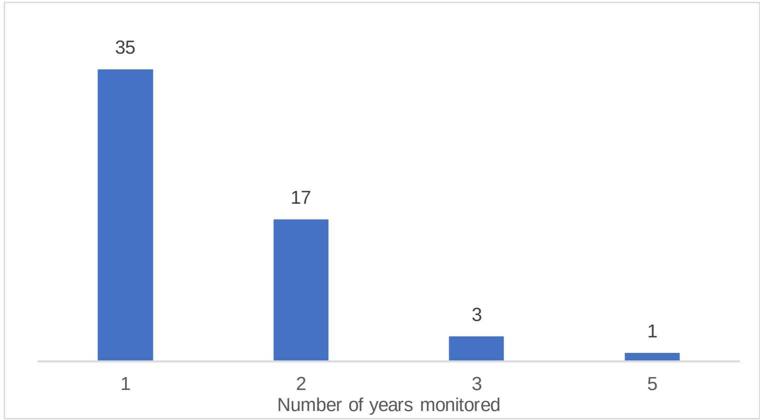
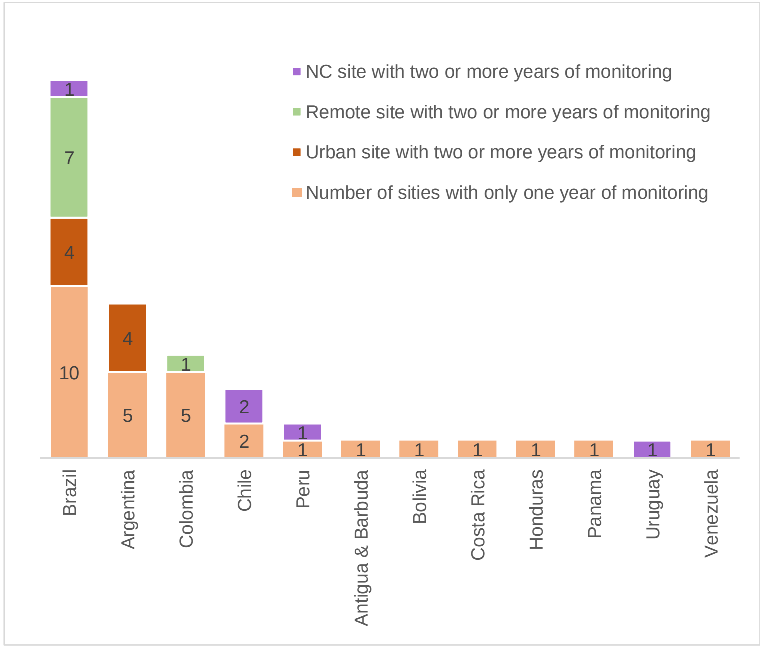


Figure 70. Distribution of sites that meet the 75% criterion by country and site type



The behavior of each of these parameters by monitoring site is presented in mosaic Table 55, where the changes in concentration of each parameter analyzed by recurrent site and non-recurrent sites are observed. In general, the parameters of the cyclodiene group and HCH show concentration reductions in most of the monitoring sites, with the exception of cis-Chlordane, trans-Chlordane and Endosulfan II (beta) in the recurrent sites. In 40% of the non-recurrent sites there is also an increase in Oxy Chlordane, Endosulfan Sulfate and Endrin. Most of the Aldrin and Dieldrin data show values under the LOQ.

DDT and isomers show increases in some urban sites, while in the NC and remote sites in general there is a decrease with the exception of the recurrent site Puruzinho Lake, Brazil. Likewise, PCBs show increases in concentration in most of their parameters and mainly in urban sites. The HCHs generally present a decrease in most of the recurrent sites, highlighting the Beta isomer, which presents in its majority values under the LOQ. With regard to BDE, in general, urban sites show an increase and remote and NC sites show a decrease.

Mosaic Table 55. Concentration levels' comparisons

Parameter (pg/m³)	RECURRING: SITES WITH DATA IN BOTH PERIODS 2010-2011 AND 2013-2016								NON-RECURRENT: SITES WITH DATA FROM 2013-2016										Maximum	
	Urban		Remote				NC		Urban						Remote					
	Puerto Deseado, Argentina (2010, 2011 y 2014)	Rio Gallegos, Argentina (2012, 2014 y 2015)	Atol das Rocas, Brazil (2010 y 2015)	Manaus, Brazil (2010 y 2014)	Puruzinho Lake, Brazil (2010 y 2014)	Trindade, Brazil (2010 y 2014)	Puerto Maldonado, Peru (2010, 2011 y 2015)	Sao Jose, Brazil (2010, 2011, 2014, 2015 y 2016)	*Viedma, Argentina (2014 y 2015)	*Villa Regina, Argentina (2014 y 2015)	*Curitiba, UFPR, Brazil (2014 y 2015)	*Fortaleza, UFC, Brazil (2013 y 2015)	*Sao Luis, UFMA, Brazil (2014 y 2015)	*São Paulo, Cetesb, Brazil (2014 y 2015)	*Abrolhos Archipelago, Brazil (2014 y 2015)	*Chapada dos Veadeiros, GO, Brazil (2014 y 2015)	*Diamantino, GO, Brazil (2014 y 2016)	*Manizales, Rio Bianco, Colombia (2014 y 2015)	Maximum (2013-2016)	Site where the maximum was recorded (Year)
Aldrin	ULOQ	ULOQ	ULOQ		ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	5.67	Araraquara, SP (2014)
cis-Chlordane		ULOQ		ULOQ			ULOQ	U	U								U	ULOQ	6.44	Porto Alegre, Centro (2014)
trans-Chlordane	ULOQ	ULOQ		ULOQ			ULOQ	U	U						U		U	ULOQ	44.45	Porto Alegre, Centro (2014)
Oxychlordane				ULOQ	ULOQ		ULOQ	ULOQ							ULOQ		ULOQ		1.11	Araraquara, SP (2014)
Dieldrin	ULOQ		ULOQ	ULOQ	ULOQ		ULOQ	ULOQ	ULOQ	ULOQ			ULOQ		ULOQ	ULOQ	ULOQ	ULOQ	88.85	Porto Alegre, Centro (2014)
Endosulfan I (Alpha)					U		U	U	U	M			ULOQ		ULOQ		U	U	94.25	Villa Regina (2015)
Endosulfan II (beta)	ULOQ	U			ULOQ	U	U	U	ULOQ	M	ULOQ	ULOQ	ULOQ		ULOQ	ULOQ	ULOQ	ULOQ	16.72	Villa Regina (2015)
Endosulfan SO4	ULOQ		ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	U							ULOQ		U	U	5.68	Araraquara, SP (2014)
Endrin	ULOQ			ULOQ	ULOQ		ULOQ	ULOQ	ULOQ	M	ULOQ				ULOQ		ULOQ	ULOQ	53.95	Villa Regina (2015)
Heptachlor		ULOQ		U		U		U	U						U		U	ULOQ	38.51	Porto Alegre, Centro (2014)
Mirex)				ULOQ			ULOQ	U	ULOQ	ULOQ							U	ULOQ	3.99	Araraquara, SP (2014)
o,p-DDD	U	U					ULOQ	U		M							ULOQ	ULOQ	5.21	Villa Regina (2015)
o,p-DDE)		U		ULOQ			ULOQ	U		M							U	ULOQ	23.27	Villa Regina (2015)
o,p-DDT	ULOQ	U	U			ULOQ		U	ULOQ			M					U		18.35	Fortaleza, UFC (2013)
p,p-DDD	ULOQ	U	ULOQ			ULOQ		ULOQ	ULOQ								ULOQ	ULOQ	14.01	Pasacaballos (2015)
p,p-DDE	ULOQ	U	U	U		ULOQ				M							ULOQ		299.33	Villa Regina (2015)
p,p-DDT			U			U		U	ULOQ								ULOQ		43.48	Porto Alegre, Centro (2014)
Sum 3 p,p-DDTs			U			U				M									316.10	Villa Regina (2015)
Sum 6 DDTs										M									356.19	Villa Regina (2015)
HCB																			14.36	Same value 2013-2016
PCB 28	U						U	U	U								U		56.28	Porto Alegre, Centro (2014)
PCB 52									U								ULOQ		32.30	Recife, PE (2014)
PCB 101					ULOQ		ULOQ	U									U	ULOQ	25.51	Recife, PE (2014)
PCB138					ULOQ		ULOQ	U									ULOQ	ULOQ	6.27	Recife, PE (2014)
PCB 153							U	U				M			U		U	ULOQ	11.36	Fortaleza, UFC (2013)
PCB 180		M					ULOQ	U									U	ULOQ	20.17	Rio Gallegos (2015)
Sum 6 PCBs																	U		99.81	Porto Alegre, Centro (2014)
PCB 118							U	U									U	ULOQ	11.00	Recife, PE (2014)
Sum 7 PCBs																	U		105.69	Porto Alegre, Centro (2014)
Alpha-HCH			U		ULOQ		U	U					ULOQ	M	ULOQ				7.91	São Paulo, Cetesb (2014)
Beta-HCH	ULOQ	ULOQ		ULOQ	ULOQ	ULOQ	ULOQ	ULOQ	U		U	ULOQ	ULOQ	ULOQ		M/U	ULOQ	ULOQ	17.98	Chapada dos V., GO (2014)
Gamma-HCH		ULOQ	U	U	ULOQ	U	U	U	ULOQ	ULOQ						ULOQ	ULOQ	U	27.37	Recife, PE (2014)
BDE 47		U	U		U	U		*	ULOQ						ULOQ		ULOQ		11.15	Rio Grande, FURG (2014)
BDE 99		ULOQ			U		U		ULOQ					M	U		ULOQ	U	4.98	São Paulo, Cetesb (2014)
BDE 153		ULOQ		ULOQ	ULOQ		ULOQ		U	U	U		U	U	U	ULOQ	U	ULOQ	1.71	Barretos, SP (2015)
BDE 154		U			U			*	ULOQ					M	U		ULOQ	U	0.42	São Paulo, Cetesb (2014)
BDE 28		U			U			U*	ULOQ						ULOQ		ULOQ		0.83	Pasacaballos (2015)
BDE 100		ULOQ			U	U	U	*	ULOQ					M	U		ULOQ	ULOQ	1.02	São Paulo, Cetesb (2014)
Deca-BDE 209		U			U	U		*	ULOQ	U	ULOQ	ULOQ	ULOQ	U	U	U	U	ULOQ	9.17	Manaus (2014)
PeCB								*											28.65	Rio de Janeiro, Fiocruz (2014)

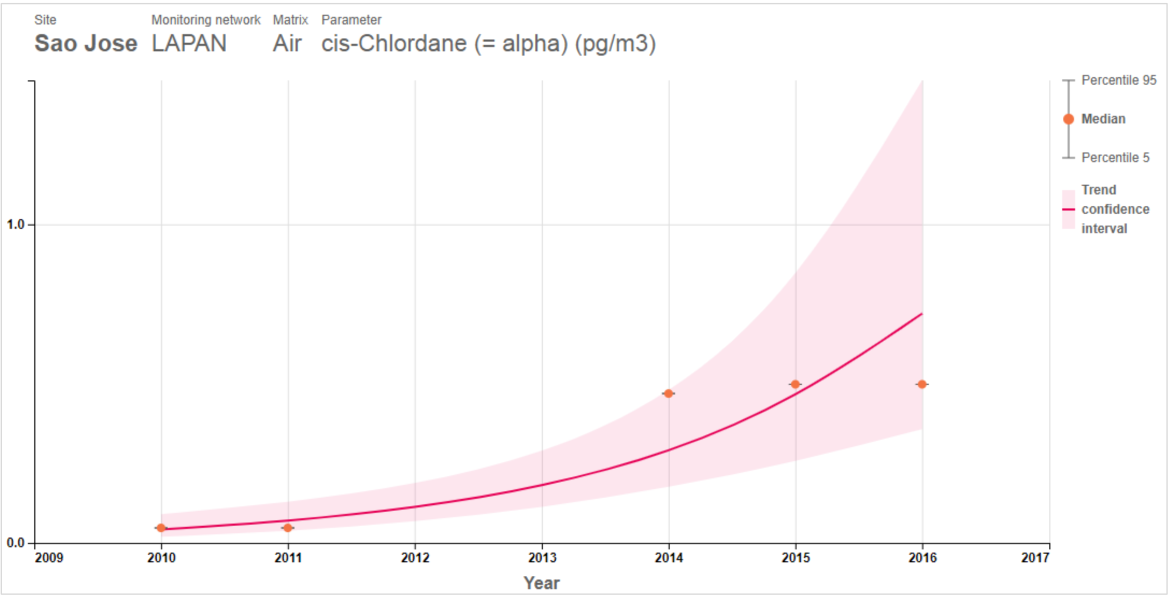
- Increased concentration
- Decreased concentration
- Without changes
- ULOQ: All data below the limit of quantification

- M: Maximum value in the period 2013-2016
- Without or with a single data
- *: Only data from 2013-2016
- U: Most recent value under LOQ

Note that most of the values of the recurring sites show a decrease or values below the LOQ, unlike the non-recurrent sites which show the majority of the maximum values and the urban sites Curitiba, UFPR, Brazil and Villa Regina, Argentina stand out with concentration increases of 75 and 85% of the parameters analyzed, respectively. In contrast with the Fortaleza UFC urban site, and with the remote sites Abrolhos Archipelago and Atol das Rocas, all in Brazil that presented a decrease in 75, 58 and 58% of the parameters analyzed respectively.

Of all the sites analyzed, only four sites show trends, three sites that measured 3 years, two in Argentina, Puerto Deseado and Rio Gallegos and Puerto Maldonado in Peru and a site that measured 5 years, Sao Jose in Brazil, which presented increased concentration of cis-Chlordane, however, 4 of its 5 data presented values below the LOQ, see figure 71. The other parameters presented non-significant trends in all the places.

Figure 71. Cis-Chlordane trend at the Sao Jose site in Brazil



Source: DWH

To analyze the variability of all the data from the LAPAN monitoring program, the same procedure was followed in the ambient air monitoring programs: first, year by year of monitoring of each parameter was compared, then the data were separated by groups of years and then by type of site, Not Classified (NC), Remote and Urban for this program's comparisons. The dispersion of the data was analyzed by means of box plots and the statistical parameters were calculated to estimate the concentration's changes in the region.

It is worth mentioning that because there is no monitoring at the same sites every year and the distribution of monitoring sites is not homogeneous, the graphs year by year do not provide relevant information. But if we compare the period from 2010-2012 with the period 2013 to 2016 and we separate the data by type of monitoring site, it is observed that for all parameters the urban sites present greater variability and higher values than the other monitoring sites. It should be noted that only 12 of the 56 sites measured in the 2010-2012 period and that most of the data from that period present values under the LOQ:

Organochlorine Insecticides, Cyclodiene Subgroup

Cyclodiene group presents data from 2010 to 2016 from the 56 LAPAN program sites. All the data from Aldrín present values below the LDC in most of the sites except for the sites Araraquara, SP and Manaus, Brazil both 2014; the graphs show increases in the period 2013 to 2016 of cis-Chlordane and Endosulfan II (beta) in all groups; also increases in Endosulfan and isomers in remote sites and increases in all the parameters analyzed except for Aldrin in Urban sites. In remote sites extreme values are observed mainly of Endosulfan I (alpha) and in urban sites of trans - Chlordane, Dieldrin, Endosulfan I, Endrin and Heptachlor, in Porto Alegre Centro, Brazil 2014 and Villa Regina, Argentina 2015. See in Figure 72 the behavior of the data and in Table 56, the statistical summary.

Figure 72. Statistical analysis of the Organochlorine Insecticides, Cyclodiene Subgroup in GRULAC

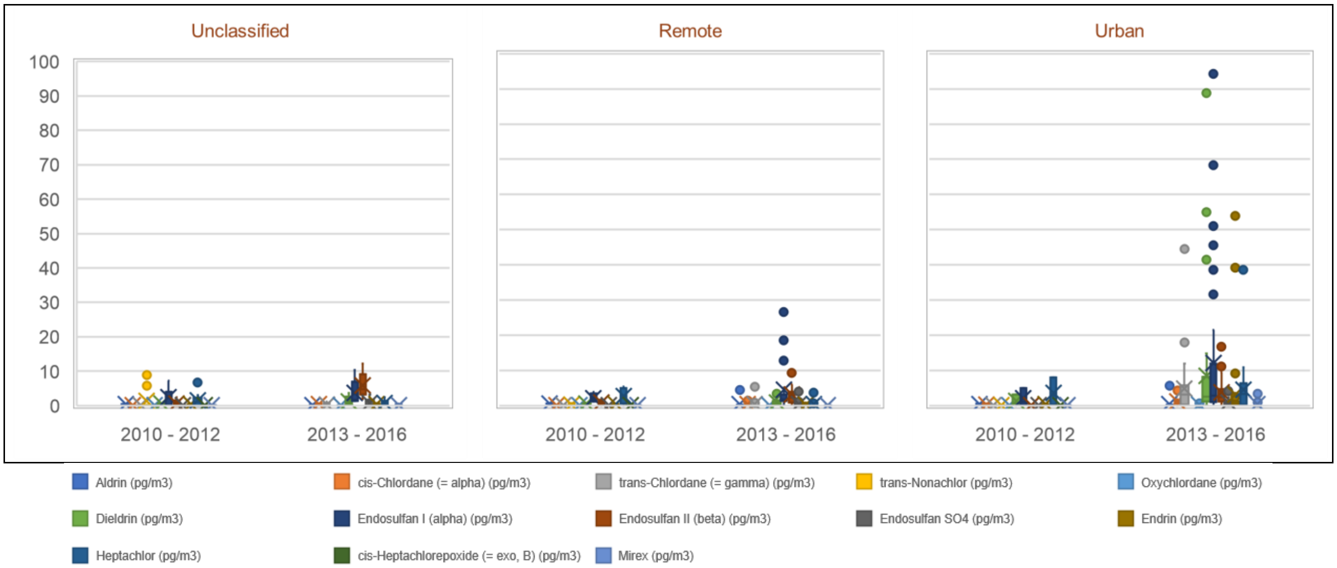


Table 56. Statistical analysis of the Organochlorine Insecticides, Cyclodiene Subgroup in GRULAC

CYCLODIENES (pg/m^3)						
Parameter	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
UNCLASSIFIED						
Aldrin	0.489	0.376	0.489	0.141	0.489	0.109
cis-Chlordane	0.047	0.498	0.047	0.431	0.047	0.498
trans-Chlordane	0.050	1.211	0.050	0.332	0.050	0.022
trans-Nonachlor	8.937		1.377		0.052	
Oxychlordane	0.034	0.101	0.034	0.043	0.034	0.016
Dieldrin	0.516	3.615	0.516	1.271	0.516	0.455
Endosulfan I (Alpha)	7.274	10.328	2.502	3.678	2.778	1.734
Endosulfan II (beta)	2.505	12.276	0.591	5.833	0.012	4.717
Endosulfan SO4	0.040	3.168	0.040	0.677	0.040	0.029
Endrin	0.460	0.658	0.460	0.369	0.460	0.271
Heptachlor	6.731	2.416	1.558	0.690	1.113	0.202
cis-Heptachlorepoxide (= exo, B)	0.071		0.071		0.071	
Mirex	0.048	0.561	0.048	0.152	0.048	0.045
REMOTE						
Aldrin	0.489	4.434	0.489	0.351	0.489	0.118
cis-Chlordane	0.047	1.343	0.047	0.403	0.047	0.498
trans-Chlordane	0.050	5.281	0.050	0.417	0.050	0.022
trans-Nonachlor	0.696		0.213		0.052	
Oxychlordane	0.034	0.128	0.034	0.046	0.034	0.034
Dieldrin	0.516	3.411	0.516	0.903	0.516	0.597
Endosulfan I (Alpha)	3.910	26.624	2.145	4.558	1.717	1.751
Endosulfan II (beta)	1.824	10.830	0.813	3.076	0.708	2.174
Endosulfan SO4	0.040	3.953	0.040	0.477	0.040	0.010
Endrin	0.460	0.795	0.460	0.303	0.460	0.175
Heptachlor	5.378	3.677	2.756	0.460	2.816	0.202
cis-Heptachlorepoxide (= exo, B)	0.071		0.071		0.071	
Mirex	0.048	0.325	0.048	0.079	0.048	0.025
URBAN						
Aldrin	0.489	5.665	0.359	0.360	0.489	0.209
cis-Chlordane	0.498	6.435	0.197	1.216	0.047	0.741
trans-Chlordane	0.050	44.453	0.041	4.764	0.050	3.127
trans-Nonachlor	0.052		0.052		0.052	
Oxychlordane	0.159	1.107	0.076	0.227	0.034	0.162
Dieldrin	3.075	88.848	1.369	8.391	0.516	2.501
Endosulfan I (Alpha)	5.001	94.255	2.019	12.151	1.021	2.783
Endosulfan II (beta)	0.283	16.725	0.102	3.680	0.012	2.410
Endosulfan SO4	0.040	5.683	0.039	0.881	0.040	0.267
Endrin	0.460	53.946	0.411	3.152	0.460	0.517
Heptachlor	7.997	38.509	3.669	4.569	2.807	3.339
cis-Heptachlorepoxide (= exo, B)	0.071		0.071		0.071	
Mirex	0.048	3.987	0.040	0.416	0.048	0.103

Dichlorodiphenyltrichloroethane and its isomers

Dichlorodiphenyltrichloroethane (DDT) and its isomers were measured in the region from 2010 to 2016. In the 2010-2012 period, most of the data presented values below the LOQ. In the 2013-2016 period, the NC sites, as shown in figure 73 and table 57, present slight increases in all o,p isomers of DDT and in p,p DDD; the remote ones show increases of o,p of DDD and DDE and p,p DDD with extreme values in: Iguaçu National Park, and Puruzinho Lake, both in Brazil 2014; and urban sites showed increases in all parameters, with extreme values in Fortaleza, UFC and Porto Alegre, Centro, both also in Brazil 2014; Pasacaballos Colombia and Villa Regina Argentina, both 2015.

Figure 73. Behavior of DDT and its isomers in GRULAC

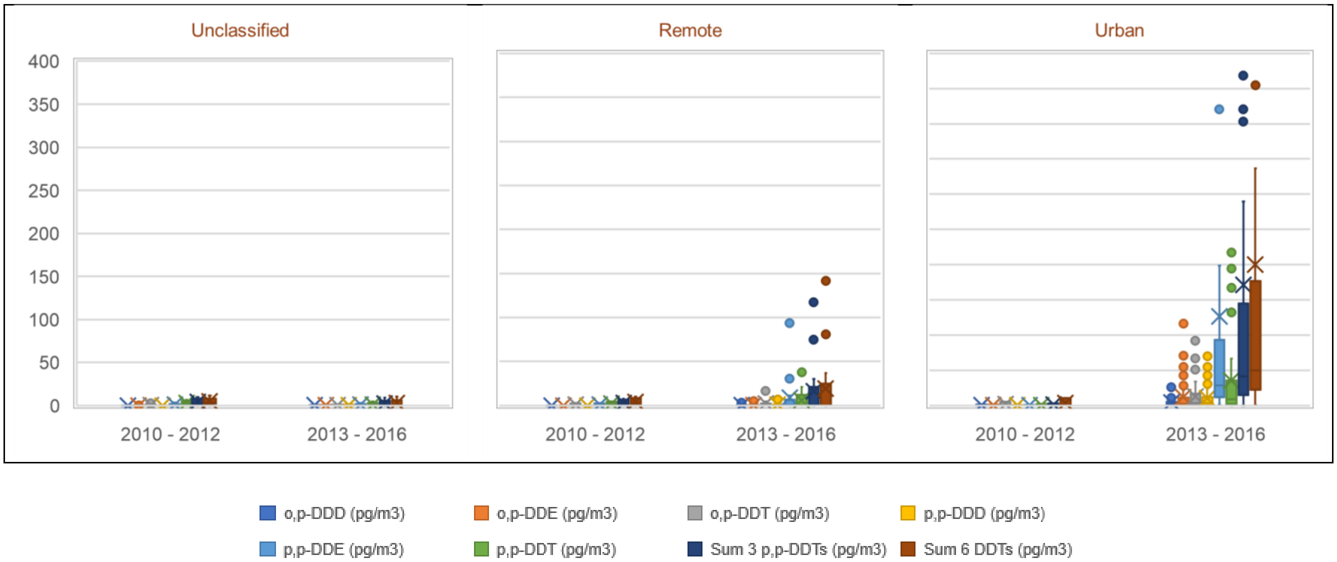


Table 57. Statistical analysis of DDT and its isomers in GRULAC

DDT (pg/m³)						
Parameter	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
UNCLASSIFIED						
o,p-DDD	0.011	0.497	0.011	0.252	0.011	0.192
o,p-DDE	0.162	0.355	0.055	0.215	0.039	0.175
o,p-DDT	2.668	1.003	0.599	0.472	0.054	0.288
p,p-DDD	0.036	1.641	0.036	0.446	0.036	0.204
p,p-DDE	3.568	2.892	0.934	0.821	0.586	0.240
p,p-DDT	6.340	4.715	3.192	1.207	2.754	0.234
Sum 3 p,p-DDTs	9.907	9.248	4.107	2.232	3.038	0.243
Sum 6 DDTs	11.674	10.250	4.700	2.743	3.369	0.878
REMOTE						
o,p-DDD	0.011	3.019	0.011	0.442	0.011	0.197
o,p-DDE	0.039	4.969	0.039	0.615	0.039	0.197
o,p-DDT	2.565	16.219	0.822	1.998	0.335	0.243
p,p-DDD	0.036	6.667	0.036	0.890	0.036	0.164
p,p-DDE	2.701	93.845	0.962	8.806	0.549	0.240
p,p-DDT	4.890	37.856	2.113	5.984	1.753	0.192
Sum 3 p,p-DDTs	7.591	117.237	3.049	16.349	2.276	0.344
Sum 6 DDTs	10.156	141.444	3.845	19.278	2.584	0.559
URBAN						
o,p-DDD	0.234	5.207	0.141	0.816	0.178	0.310
o,p-DDE	0.221	23.275	0.100	2.429	0.039	0.546
o,p-DDT	1.069	18.346	0.393	2.594	0.054	0.693
p,p-DDD	0.091	14.005	0.054	2.021	0.036	0.724
p,p-DDE	0.078	299.331	0.060	25.324	0.052	5.700
p,p-DDT	0.387	43.477	0.166	7.026	0.055	1.716
Sum 3 p,p-DDTs	0.555	316.099	0.222	34.310	0.055	8.282
Sum 6 DDTs	2.080	356.190	0.771	40.038	0.178	9.970

Hexachlorobenzene

Hexachlorobenzene (HCB) was measured from 2010 to 2016 at the 56 monitoring sites. It does not present values below the LOQ extremes, or maximums, as shown in figure 74 and table 58; since all the data present the same value for the period 2013-2016 and this value is lower than the one presented in the period 2010 -2012, this implies that there is a decrease in concentrations of all groups of sites, NC, remote and urban.

Figure 74. Behavior of HCB in GRULAC

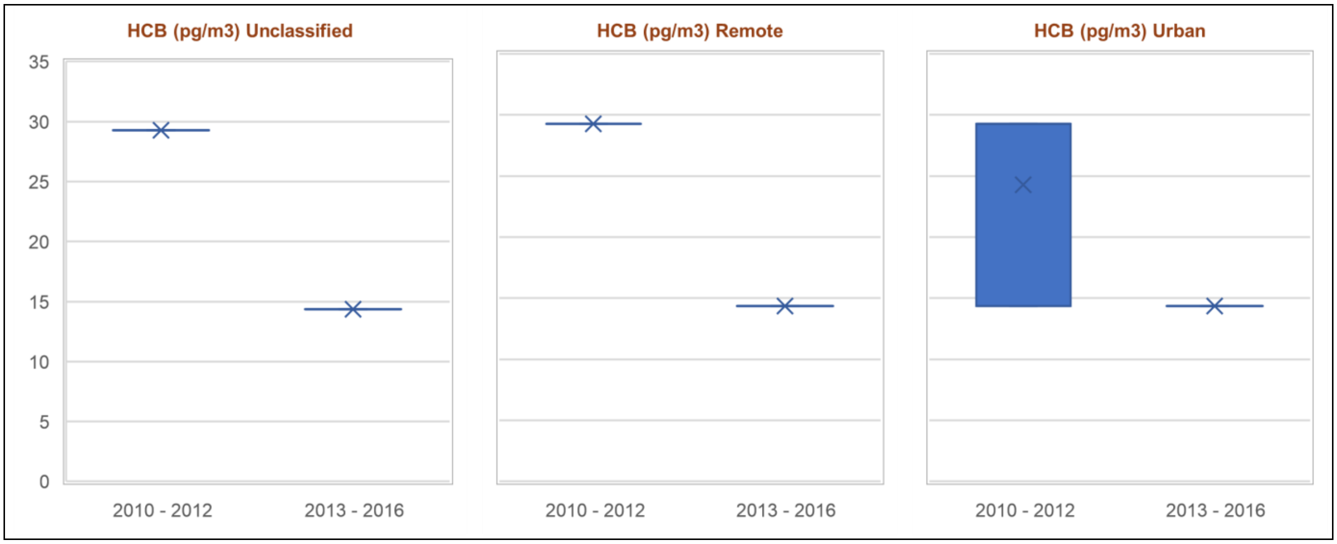


Table 58. Statistical analysis of HCB in GRULAC

HCB (pg/m3)						
Tipo de sitio	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
Unclassified	29.265	14.360	29.265	14.360	29.265	14.360
Remote	29.265	14.360	29.265	14.360	29.265	14.360
Urban	29.265	14.360	24.297	14.360	29.265	14.360

Polychlorinated biphenyls and congeners

Polychlorinated biphenyls (PCBs) were measured in the 56 monitoring sites in both periods 2010-2012 and 2013-2016: 6 PCB congeners, PCB with TEF 118, and the sums of 6 and 7 PCBs. In the period 2013 to 2016, NC sites show increases of 5 out of 6 parameters and remote sites of 4 out of 6. However, the sums of 6 and 7 PCBs decrease in both cases, as shown in figure 75 and table 59. In both groups there are no extreme values. In urban sites, all the parameters show increased concentration and extreme values in Fortaleza, UFC 2013; Porto Alegre, Centro and Recife, PE, both 2014, all in Brazil; and Rio Gallegos, Argentina 2015. Of the PCBs with TEF, only the congener PCB 118 was measured in the period 2013 to 2016, which presented increased concentration in remote and urban sites, with extreme values in the remote site Leticia, Colombia 2015 and Recife, PE, Brazil 2014. In reference to the data values, it should be mentioned that most of the data for the 2010-2012 period present values under the LOQ.

Figure 75. Behavior of PCBs in GRULAC

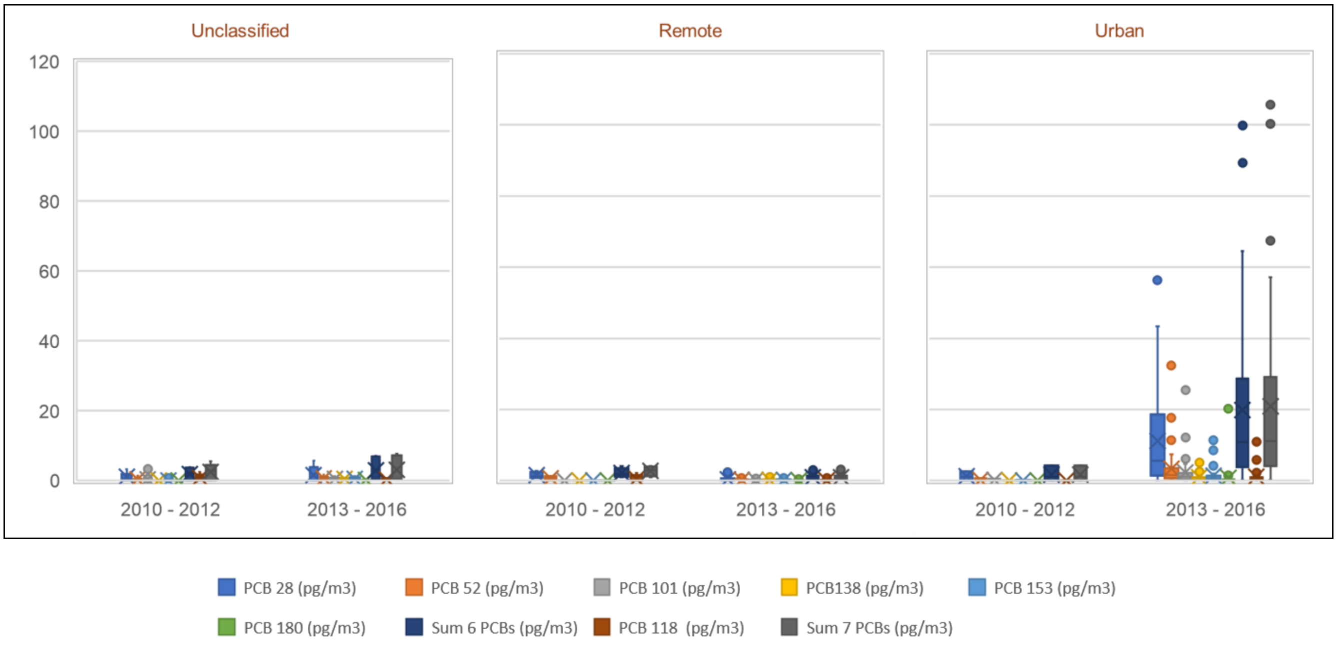


Table 59. Statistical analysis of PCB and congeners in GRULAC

PCB and congeners (pg/m³)						
Parameter	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
UNCLASSIFIED						
PCB 28	3.301	5.694	1.126	1.627	0.623	0.125
PCB 52	1.404	1.693	0.305	0.693	0.044	0.552
PCB 101	3.333	1.293	0.370	0.499	0.011	0.295
PCB138	0.012	0.866	0.012	0.465	0.012	0.498
PCB 153	0.824	1.260	0.085	0.564	0.012	0.374
PCB 180	0.044	0.333	0.044	0.188	0.044	0.191
Sum 6 PCBs	3.941	7.093	1.837	2.990	2.027	0.552
PCB 118	2.443	0.683	0.856	0.413	0.667	0.393
Sum 7 PCBs	5.526	7.652	2.674	3.123	3.750	0.552
REMOTE						
PCB 28	2.805	2.340	1.538	0.417	1.283	0.125
PCB 52	1.277	0.681	0.658	0.244	0.655	0.226
PCB 101	0.011	0.592	0.011	0.150	0.011	0.148
PCB138	0.012	0.999	0.012	0.203	0.012	0.061
PCB 153	0.012	0.751	0.012	0.226	0.012	0.188
PCB 180	0.044	0.582	0.044	0.114	0.044	0.063
Sum 6 PCBs	4.082	3.014	2.174	0.905	1.849	0.593
PCB 118	2.142	0.788	0.568	0.141	0.044	0.070
Sum 7 PCBs	4.082	3.166	2.709	0.948	2.920	0.638
URBAN						
PCB 28	2.570	56.284	1.238	11.178	1.111	5.618
PCB 52	0.655	32.297	0.248	3.435	0.044	1.527
PCB 101	0.464	25.511	0.162	2.248	0.011	1.049
PCB138	0.135	6.266	0.053	0.908	0.012	0.404
PCB 153	0.291	11.364	0.105	1.396	0.012	0.680
PCB 180	0.084	20.169	0.058	0.818	0.044	0.149
Sum 6 PCBs	4.198	99.815	1.784	19.893	1.111	10.898
PCB 118	0.044	10.973	0.038	1.079	0.044	0.499
Sum 7 PCBs	4.198	105.689	1.784	20.948	1.111	11.119

Hexachlorocyclohexane and its isomers

Hexachlorocyclohexane (HCH) and its isomers was measured from 2010 to 2016 in the 56 monitoring sites, and it presents values below the LOQ in most of the data of the Beta and Gamma HCH isomers. However, in the period 2013 to 2016 it showed an increase in the concentration value of said Beta and Gamma isomers in all groups of sites and of the Alpha isomer only in urban sites. See figure 76 and table 60. The extreme values are presented at the remote site Chapada dos Veadeiros, GO, 2014 in Brazil and in the urban sites Recife, PE and São Paulo, Cetesb, both Brazil, 2014.

Figure 76. Behavior of HCH and its isomers in GRULAC

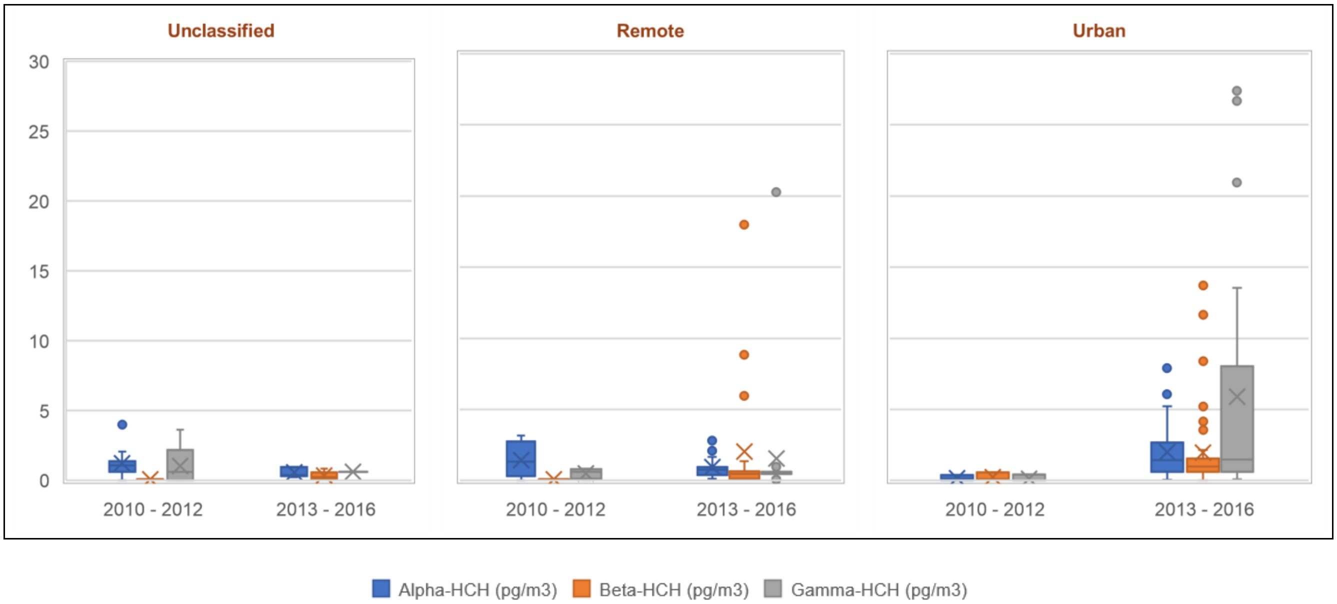


Table 60. Statistical analysis of HCH and its isomers in GRULAC (75% criterion)

HCH and its isomers (pg/m^3)						
Parameter	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
UNCLASSIFIED						
Alpha-HCH	4.001	0.978	1.233	0.588	1.102	0.395
Beta-HCH	0.084	0.854	0.084	0.351	0.084	0.265
Gamma-HCH	3.656	0.633	1.032	0.633	0.609	0.633
REMOTE						
Alpha-HCH	3.178	2.849	1.457	0.946	1.317	0.758
Beta-HCH	0.084	17.981	0.084	2.055	0.084	0.467
Gamma-HCH	0.831	20.257	0.512	1.562	0.605	0.633
URBAN						
Alpha-HCH	0.402	7.910	0.179	2.014	0.119	1.443
Beta-HCH	0.597	13.701	0.255	1.962	0.084	0.973
Gamma-HCH	0.420	27.370	0.145	5.897	0.008	1.485

Polybromodiphenyl Ethers (Bromine Diphenyl Ethers, their isomers and Decabromodiphenyl ether)

Seven parameters of Bromo Diphenyl Ethers and its isomers (BDE) were measured in the 44 sites that monitored during the 2013-2016 period, and only in one urban site, Rio Gallegos, in the 2010-2012 period. In the other remaining sites of the 2010-2012 period, two parameters were analyzed, BDE 99 and 153, which allow us to make comparisons of changes in level between both periods for the NC and remote sites. In the period 2013 to 2016, in Figure 77 and table 61, it is observed that the medians of BDE 153 show decreases in concentration in all sites:

and 99 at NC and remote sites. It is worth mentioning that most of the BDE 153 data presented values under the LOQ. The NC sites do not present extreme values, but they present the highest values of medians for the BDE 47, 99 and 100; remote sites present extreme values in Salto Morato State Park, PR, 2013, Manaus, 2014, and Chapada dos Veadeiros, GO, 2015 all in Brazil; and urban ones mainly in Rio Grande, FURG and São Paulo, Cetesb, both Brazil, 2014; and in Barretos, SP, Brazil and Pasacaballos, Colombia, both 2015. This analysis includes Decabromodiphenyl ether (Deca-BDE 209), which was only measured in the 2013-2016 period and presented increased concentrations for the period 2013 to 2016, and extreme values in remote site Manaus, and urban Rio Grande, FURG, both Brazil, 2014; being the highest that of Manaus; however, most of its values are under the LOQ. See again figure 77 and table 61.

Figure 77. Behavior of BDE and its isomers in GRULAC

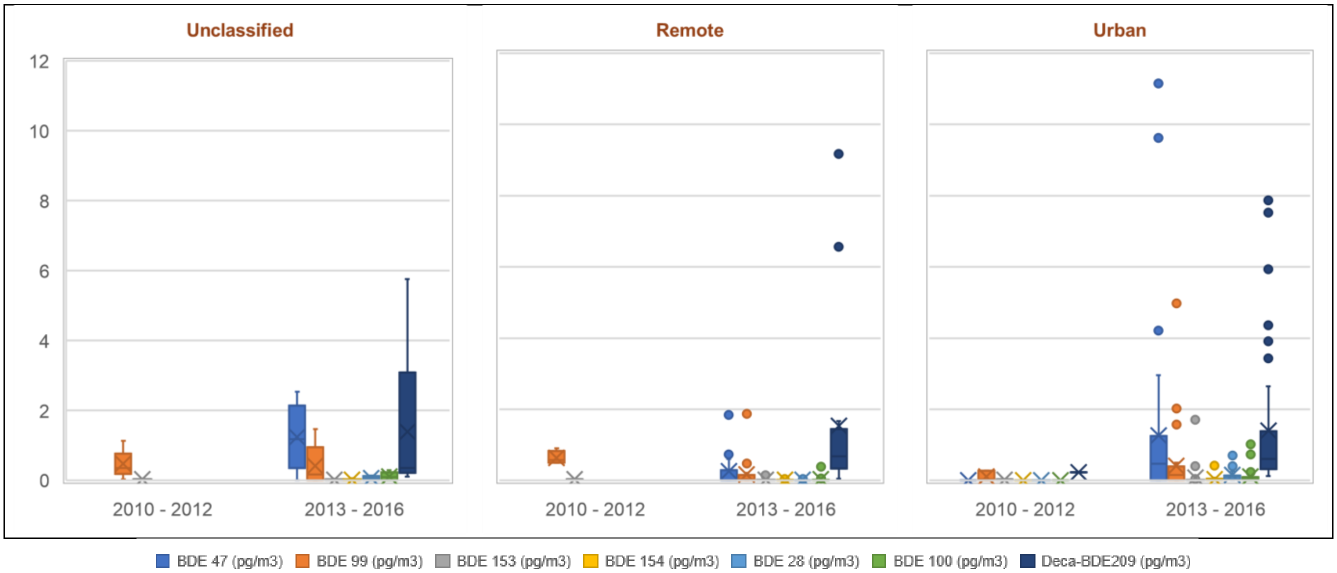


Table 61. Statistical analysis of BDE and its isomers in GRULAC

BDE and its isomers (pg/m³)						
Parameter	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
UNCLASSIFIED						
BDE 47		2.544		1.240		1.180
BDE 99	1.140	1.476	0.484	0.418	0.350	0.180
BDE 153	0.035	0.049	0.035	0.025	0.035	0.017
BDE 154		0.062		0.024		0.014
BDE 28		0.150		0.068		0.075
BDE 100		0.304		0.119		0.093
Deca-BDE209		5.769		1.399		0.357
REMOTE						
BDE 47		1.842		0.261		0.004
BDE 99	0.902	1.868	0.638	0.177	0.576	0.032
BDE 153	0.035	0.149	0.035	0.022	0.035	0.017
BDE 154		0.140		0.021		0.011
BDE 28		0.216		0.028		0.006
BDE 100		0.393		0.041		0.013
Deca-BDE209		9.172		1.529		0.675
URBAN						
BDE 47	0.004	11.155	0.004	1.267	0.004	0.473
BDE 99	0.283	4.982	0.106	0.414	0.035	0.161
BDE 153	0.035	1.708	0.028	0.081	0.035	0.014
BDE 154	0.007	0.417	0.007	0.036	0.007	0.021
BDE 28	0.005	0.830	0.005	0.156	0.005	0.108
BDE 100	0.012	1.021	0.012	0.106	0.012	0.030
Deca-BDE209	0.231	7.875	0.231	1.398	0.231	0.611

Pentachlorobenzene

Pentachlorobenzene (PeCB) was measured mainly in the period 2013 to 2016, only in an urban site, Rio Gallegos Argentina (2012) in the period 2010-2012, and all its data present values above the LOQ. In the period 2013 to 2016, it is observed in figure 78 and table 62, that the NC sites do not present extreme values and the remote ones present it in Abrolhos Archipelago, Brazil 2014; the highest median and the highest values are found in urban sites, with a maximum extreme value in Rio de Janeiro, Fiocruz, Brazil 2014. The comparison of medians in urban sites shows a slight decrease during the period 2013 to 2016.

Figure 78. Behavior of PeCB in GRULAC

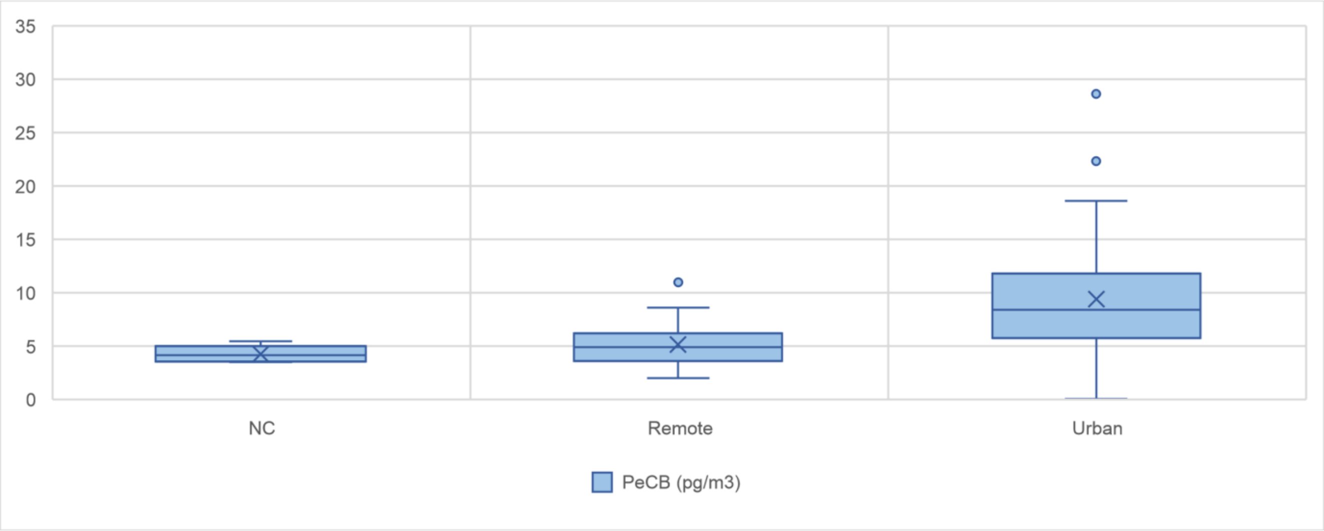


Table 62. Statistical analysis of PeCB in GRULAC

PeCB (pg/m^3)						
Site type	Maximum		Average		Median	
	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016	2010 - 2012	2013 - 2016
UNCLASSIFIED		5.489		4.279		4.178
REMOTE		10.998		5.160		4.942
URBAN	8.520	28.646	8.520	9.439	8.520	8.423

6.2.2. HUMAN MILK RESULTS

Human milk data is distributed in 3 programs, as described in Chapter 4. The GEF 1 program contains only data from Brazil from 1992 and 2002, the MILK-WHO program contains data from 14 countries from 2001 to 2019 and the WHO program contains data from 5 countries from 2001 to 2010. GEF 1 analyzed 31 parameters in 1992 and 17 in 2002; while WHO analyzed a parameter from Brazil in 2001-2002, a parameter of Haiti in 2007 and 26 parameters of Antigua and Barbuda, Chile and Uruguay in 2010. It is worth mentioning that the values of these 26 parameters of the three countries are exactly the same as those of the MILK-WHO program, because they were the same samples, analyzed by the same laboratory and incorporated into the UNEP/GEF I projects.

The analysis of data from both programs, GEF 1 and WHO, has already been reported in previous GRULAC evaluations, as well as data from the MILK-WHO program until 2011. However, Brazil's and Suriname's 2012 data and Haiti's 2015 have not been included.

For this third evaluation, the review of data levels and trends focuses on the MILK-WHO program that, as mentioned, contains data from 14 countries from 2001 to 2019 and has analyzed 110 parameters. However, of the 14 countries only 9 have participated in more than one round and the remaining 5 have only participated in one round so its values can only be considered as a baseline for future evaluations.

The analysis of the data of this program includes the integration and organization of the database in dynamic tables, its review by values, rounds, countries and groups of substances and the statistical analysis of them.

The integration was carried out starting with the organization of the parameters in a common sequence, grouping them to present changes in levels by country and by groups of substances, following the strategy recommended in the draft Guidance document UNEP/POPS/COP.9/INF/36 Seventh Chapter.

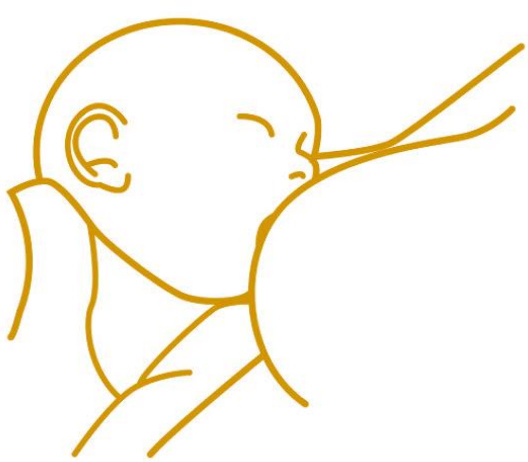
The review of the values of each parameter was carried out by comparing, using bar graphs, median concentrations' values from countries in each year in which they participated.

Those countries that presented values in more than one round and that also had participated in the sixth round were selected; establishing, for this analysis, the period 2015-2019 as the sixth round, to include Haiti 2015 in the analysis. Of this selection, seven countries remained. It is worth mentioning that even though Brazil and Chile have also participated in two rounds, the most recent values are from 2012.

Likewise, the behavior of the groups of substances in the countries that show increased concentrations in some parameter was analyzed, graphing the changes in levels of each parameter by country. These graphs were called Country Graphs and they were included in the analysis by group of substances.

Parameters of interest were selected from each group of substances, that is, those parameters that showed changes in levels in more than three countries, and to support the results of these comparisons, the statistical summaries of the GMP DWH were reviewed by parameter.

The statistical analysis of the region was carried out by comparing, per parameter, the medians of the concentrations from 2001 to 2012 of 11 countries from the third to the fifth round, against the medians from 2015 to 2019 of ten countries, that include the nine which participated in the sixth round and Haiti 2015; of which seven countries presented values in both groups. The summary of the results of this comparisons is presented in Table 63. Mosaic Results. Box plot diagrams and tables with the statistical analysis of each group of substances also show this aforementioned comparisons.



A summary of relevant findings is offered below, and the full analysis is presented by group of substances.

Relevant findings of human milk

Parameters analyzed and regarding the countries

The parameters analyzed, at regional and country level, in the 2015-2019 period were 108.

Regional Analysis:

- Most of the parameters showed concentration reductions, see table 63.
- Thirteen parameters were analyzed for the first time and constitute the baseline for future evaluations. These include candidate POP PFHxS under review, to be listed by the Convention.
- Twenty parameters presented values ULOQ or zero and some had never presented values above the LOQ in any country in the region.
- Six parameters from four groups showed increased concentrations in three or more countries, but at regional level only three parameters presented slight increases. See figure 79 and statistical summary, table 64.
    - o *Insecticides Cyclodiene group: Cis-Heptachlor epoxide and Sum 2 Heptachlor Epoxides*
    - *Polychlorinated Biphenyls with TEFs*: PCB 77
    - *PCDD and PCDF*: 1,2,3,4,7,8-HxCDF and 1,2,3,7,8-PeCDF
    - *Hexabromociclododecano*: Alpha-HBCD
- The Caribbean Countries presented most of the parameters with maximum medians values.

Analysis per country:

- 14 countries participated in human milk studies from 2001 to 2019. Nine participated more than once: 8 twice and Haiti three times.
- Seven participated in more than one round and in the sixth round (2015 to 2019) and are the foundation for concentration level comparisons.
- Seven showed an increase in two or more parameters from 2015 to 2019. Barbados and Jamaica presented the highest number of significant increases. See table 65.

Figure 79. Parameters with concentration increases in three or more countries in GRULAC

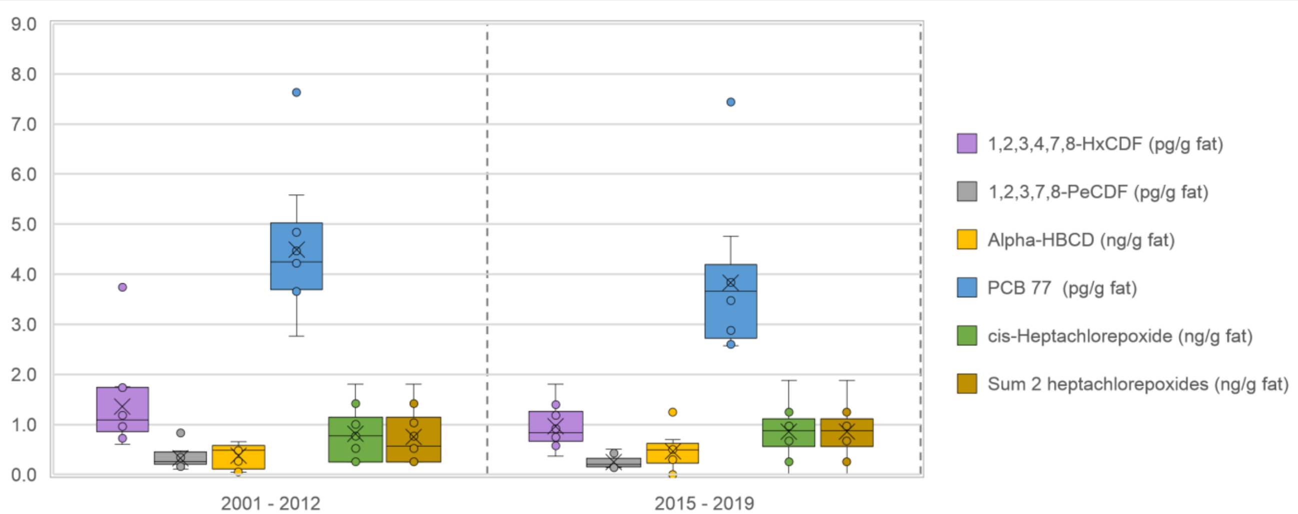


Table 63. Mosaic Results of the statistical analysis of the region. Comparison of medians of 2001-2012 and 2015-2019

Group	Parameter	Regional medians MILK-WHO (2015-2019)	Country and year (with maximum median)
Cyclodiene Subgroup (ng/g fat)	Aldrin	LDC	LDC
	cis-Chlordane	LDC	LDC
	trans-Chlordane	LDC	LDC
	cis-Nonachlor	0.00	Barbados (2018)
	trans-Nonachlor	1.683	Barbados (2018)
	Oxy chlordane	1.647	Barbados (2018)
	Chlordecone	0	All data are zero
	Dieldrin	1.916	Barbados (2018)
	Endosulfan I (Alpha)	LDC	LDC
	Endosulfan II (beta)	LDC	LDC
	Endosulfan sulfate	LDC	LDC
	Endrin	LDC	LDC
	Heptachlor	LDC	LDC
	cis-Heptachlor-epoxide	0.88	Uruguay (2019)
	trans-Heptachlor-epoxide	LDC	LDC
	Sum 2 heptachlorepoxides (cis + trans)	0.88	Uruguay (2019)
	Mirex	0.00	Uruguay (2019)
DDT (ng/g fat)	o,p-DDD	LDC	LDC
	o,p-DDE	LDC	LDC
	o,p-DDT	0.00	Jamaica (2018)
	p,p-DDD	0.00	Ecuador (2019)
	p,p-DDE	0.85	Mexico (2017)
	p,p-DDT	0.33	Mexico (2017)
	Sum 3 p,p-DDTs	0.91	Mexico (2017)
	Sum 6 DDTs	0.91	Mexico (2017)
Toxaphene (ng/g fat)	Parlar 26	0	All data are zero
	Parlar 50	0.00	Antigua & Barbuda (2018)
	Parlar 62	LDC	LDC
HCB	HCB (ng/g fat)	4.25	Uruguay (2019)
PCB (ng/g fat)	PCB 28	0.46	Argentina (2019)
	PCB 52	0.11	Jamaica (2018)
	PCB 101	0.13	Jamaica (2018)
	PCB138	0.3	Jamaica (2018)
	PCB 153	0.48	Barbados (2018)
	PCB 180	0.25	Barbados (2018)
	Sum 6 PCBs	1.1	Barbados (2018)
	Sum 7 PCBs	12.37	Barbados (2018)
PCB con TEFs (pg/g fat)	PCB 77	3.66	Jamaica (2018)
	PCB 81	0.97	Argentina (2019)
	PCB 105	0.37	Argentina (2019)
	PCB 114	0.54	Jamaica (2018)
	PCB 118	1.4	Argentina (2019)
	PCB 123	1.09	Argentina (2019)
	PCB 126	0.57	Peru (2019)
	PCB 156	0.53	Jamaica (2018)
	PCB157	1.14	Jamaica (2018)
	PCB 167	1.66	Jamaica (2018)
	PCB 169	3.62	Uruguay (2019)
	PCB 189	4.15	Barbados (2018)
	Sum 12 PCBs	2.74	Argentina (2019)
HCH (ng/g fat)	Alpha-HCH	0.00	Barbados (2018)
	Beta-HCH	0.22	Uruguay (2019)
	Gamma-HCH	0.00	Antigua & Barbuda (2018)

Group	Parameter	Regional medians MILK-WHO (2015-2019)	Country and year (with maximum median)
PCDD and PCDF (pg/g fat)	1,2,3,4,6,7,8-HpCDD	3.67	Jamaica (2018)
	1,2,3,4,6,7,8-HpCDF	1.03	Jamaica (2018)
	1,2,3,4,7,8-HxCDD	0.05	Jamaica (2018)
	1,2,3,4,7,8-HxCDF	0.48	Mexico (2017)
	1,2,3,4,7,8,9-HpCDF	0.83	Mexico (2017)
	1,2,3,6,7,8-HxCDD	2.74	Jamaica (2018)
	1,2,3,6,7,8-HxCDF	0.84	Mexico (2017)
	1,2,3,7,8-PeCDD	0.67	Jamaica (2018)
	1,2,3,7,8-PeCDF	0.04	Mexico (2017)
	1,2,3,7,8,9-HxCDD	1.11	Jamaica (2018)
	1,2,3,7,8,9-HxCDF	0.21	Uruguay (2019)
	2,3,4,6,7,8-HxCDF	0.36	Uruguay (2019)
	2,3,4,7,8-PeCDF	1.56	Uruguay (2019)
	2,3,7,8-TCDD	0.29	Uruguay (2019)
	2,3,7,8-TCDF	0.35	Uruguay (2019)
	OCDD	2.11	Jamaica (2018)
	OCDF	0.11	Ecuador (2019)
	Sum 7 PCDDs	2.81	Jamaica (2018)
	Sum 10 PCDFs	5.64	Uruguay (2019)
	Sum 17 PCDDs/Fs	3.39	Jamaica (2018)
TEQ (pg/g fat)	PCDDs WHO1998-TEQ LB	1.91	Jamaica (2018)
	PCDDs WHO2005-TEQ LB	1.91	Jamaica (2018)
	PCDDs WHO1998-TEQ UB	1.91	Jamaica (2018)
	PCDDs WHO2005-TEQ UB	1.91	Jamaica (2018)
	PCDDs/Fs WHO1998-TEQ LB	2.99	Uruguay (2019)
	PCDDs/Fs WHO1998-TEQ UB	2.99	Uruguay (2019)
	PCDDs/Fs WHO2005-TEQ LB	2.73	Uruguay (2019)
	PCDDs/Fs WHO2005-TEQ UB	2.73	Uruguay (2019)
	PCDFs WHO1998-TEQ LB	1.07	Uruguay (2019)
	PCDFs WHO1998-TEQ UB	1.07	Uruguay (2019)
	PCDFs WHO2005-TEQ LB	0.76	Uruguay (2019)
	PCDFs WHO2005-TEQ UB	0.76	Uruguay (2019)
	PCBs WHO1998-TEQ LB	1.07	Argentina (2019)
	PCBs WHO1998-TEQ UB	1.07	Argentina (2019)
	PCBs WHO 2005-TEQ LB	0.74	Peru (2019)
	PCBs WHO 2005-TEQ UB	0.74	Peru (2019)
HBB	PBB 153 (ng/g fat)	LDC	LDC
PeCB	PeCB (ng/g fat)	0.00	Mexico (2017)
BDE (ng/g fat)	BDE 47	0.19	Mexico (2017)
	BDE 99	0.05	Antigua & Barbuda (2018)
	BDE 153	0.5	Antigua & Barbuda (2018)
	BDE 154	0.04	Haiti (2015)
	BDE 175/183	0.04	Haiti (2015)
	BDE 100	0.35	Antigua & Barbuda (2018)
HBCD (ng/g fat)	Alpha-HBCD	0.50	Ecuador (2019)
	Beta-HBCD	LDC	LDC
	Gamma-HBCD	0.00	Haiti (2015)
HCBD	HCBD (ng/g fat)	0	All data are zero
Pentachlorophenol (ng/g fat)	PCA	0	All data are zero
	PCP	0	All data are zero
Short-chain chlorinated paraffins	Suma de SCCPs (ng/g fat)	33.4	Peru (2019)
Fluorinated POPs (pg/l)	PFOS	118.4	Uruguay (2019)
	PFOA	159.3	Barbados (2018)
	PFHxS	27.5	Unique Value
Dicofol	Dicofol (ng/g fat)	0	All data are zero

(green)	Parameter with concentration reduction
(red)	Parameter with concentration increase
(light blue)	Parameter measured for the first time in the region in 2015-2019
LDC	All data below the limit of quantification
0	All data are zero

NUMBER OF MAXIMUM MEDIANS PER SUBREGION	
ANDINA	7
CARIBBEAN	41
SOUTHERN CONE	29
MESOAMERICA	10

Table 64. Statistical analysis of parameters with concentration increases in three or more countries in GRULAC

Parameter (pg/g fat)	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
1,2,3,4,7,8-HxCDF	3.74	1.80	1.29	0.96	1.07	0.83
1,2,3,7,8-PeCDF	0.83	0.50	0.30	0.25	0.23	0.21
Alpha-HBCD	0.65	1.25	0.35	0.47	0.38	0.50
PCB 77	7.63	7.43	4.26	3.83	4.22	3.66
cis-Chlordane	1.81	1.88	0.77	0.86	0.67	0.88
Sum 2 heptachlorepoxides (cis + trans)	1.81	1.88	0.80	0.86	0.67	0.88

The increases and reductions that the groups of parameters presented in the different countries in the sixth round are summarized in table 65, where the increases are shown in red and orange, and the reductions in green. The cells without color correspond to values that were presented at zero or for which there are no comparisons because they are parameters that are measured for the first time in the country or in the whole region. Information is also included on the number of maximum and extreme values that occurred in each country.

Table 65. Behavior of the parameters' groups in the countries of GRULAC

Countries		Cyclodiene Insecticides	DDT	Toxaphene (Parlar)	HCB	PCB	PCB with TEFs	PCDD and PCDF	HCH	PBB 153	PeCB	BDE	HBCD	TEQ	First Time Measured Substances
Participating Countries in two or more rounds	Antigua & Barbuda			M/1					SV			EV/1 M/2			
	Barbados	EV/4				M/4	M/1		SV						M/1
	Haiti											M/2	EV/1		
	Jamaica		EV/1			EV/1 M/2	EV/1 M/4	EV/4 M/5						M/4	
	Mexico		EV/4					M/4			SV	M/1			
	Peru													M/2	M/1
	Uruguay	EV/1 M/3			M/1		EV/1	M/6						M/6	M/1
Participating Countries in one round	Argentina					EV/1	M/5							M/2	
	Colombia														
	Ecuador		EV/1					EV/1					EV/1		

Parameters' groups with concentration increases in the region
Decreases in all the parameters of the group.
Significant increases in one or more parameters of the group
Slight increases in one or more parameters of the group

EV/#	Extreme value/number of parameters with extreme values
M/#	Maximum value/number of parameters with maximum values
SV	Single value.

Analysis by group of substances

Organochlorine Insecticides, Cyclodiene Subgroup

Most of the substances, nine in total, presented concentrations with values below the LOQ; three showed a decrease in their concentration level in most of the countries; other three were measured for the first time in the period 2016-2019, one presented value at zero and another only presented values in Barbados and Jamaica; and two parameters showed increased values in four countries: Cis-Heptachlorepoxide and the sum of 2 heptachlorepoxides (cis + trans). Table 66 summarizes these results.

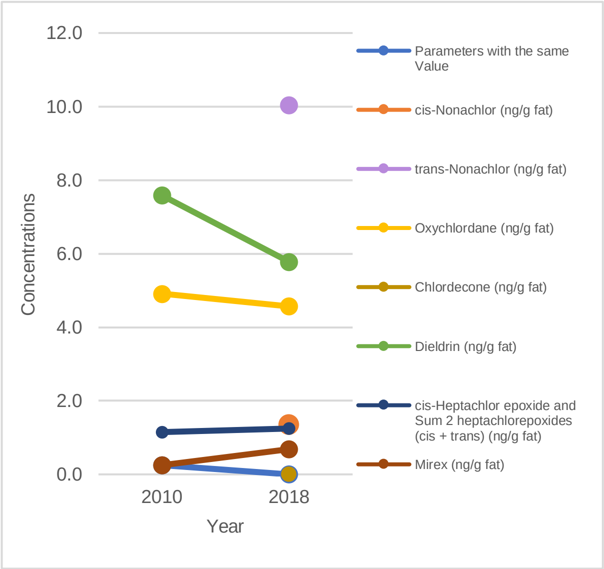
Table 66. Analysis' summary of Organochlorine insecticides cyclodiene subgroup

Cyclodiene insecticides (ng/g fat)	Concentration values						
	From more than one round	Only sixth round	All under LOQ	All equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
Aldrin	✓		✓				
cis-Chlordane	✓		✓				
trans-Chlordane	✓		✓				
cis-Nonachlor		✓					Barbados (2018)
trans-Nonachlor		✓					Barbados (2018)
Oxy chlordane	✓				Mexico	All the rest	Barbados (2010-2018)
Chlordecone		✓		✓			
Dieldrin	✓					All	Barbados (2010-2018)
Endosulfan I (Alpha)	✓		✓				
Endosulfan II (beta)	✓		✓				
Endosulfan SO4	✓		✓				
Endrin	✓		✓				
Heptachlor	✓		✓				
cis-Heptachlor-epoxide	✓				Barbados, Jamaica, Mexico and Uruguay.	Antigua y Barbuda y Peru	Uruguay (2019) Chile (2011)
trans-Heptachlor epoxide	✓		✓				
Sum 2 Heptachlor Epoxides	✓				Barbados, Jamaica, Mexico and Uruguay.	Antigua y Barbuda y Peru	Uruguay (2019) Chile (2011)
Mirex	✓				Barbados	All the rest	Uruguay (2009-2019)

Parameters with concentrations increases in the region.
Parameters measured for the first time in human milk in the region.

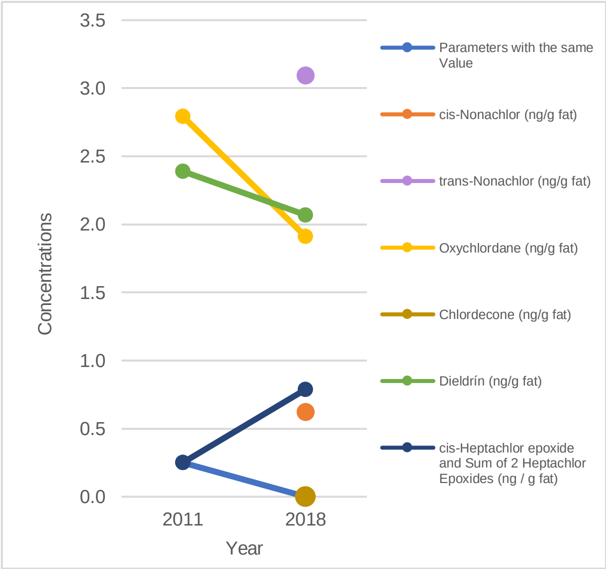
In relation to the countries that show increased values of some parameters of the cyclodiene group, in the sixth round, figures 80 to 83 display increases in the concentrations of cis-Heptachlorepoxide and the sum of 2 heptachlorepoxides in Jamaica, Mexico and Uruguay and are almost imperceptible in Barbados. The maximum values of both substances are presented in Uruguay. Likewise, in the sixth round, Mirex in Barbados and a significant increase of Oxychlordane in Mexico were confirmed. It is worth mentioning that Mirex only presented values above the LOQ in Argentina, Barbados and Uruguay. Figure 84.

Figure 80. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in Barbados



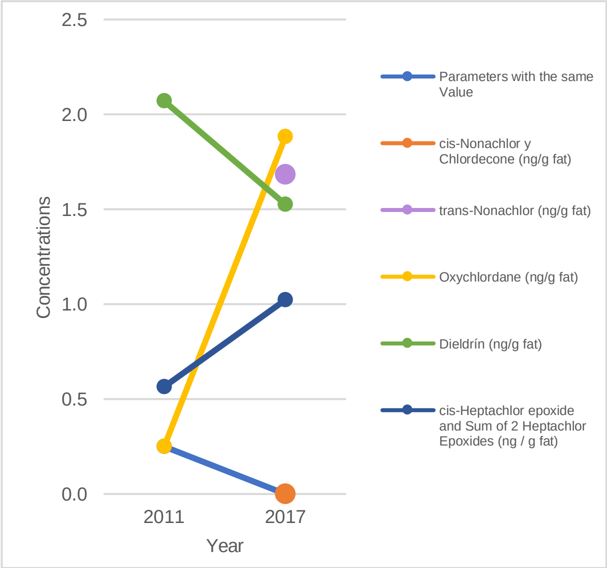
Parameters with the same value (ng/g fat): Aldrin, cis-Chlordane, trans-Chlordane, Endosulfan I (alpha y beta), Endosulfan SO4, Endrin, Heptachlor, trans-Heptachlorepoxide.

Figure 81. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in Jamaica



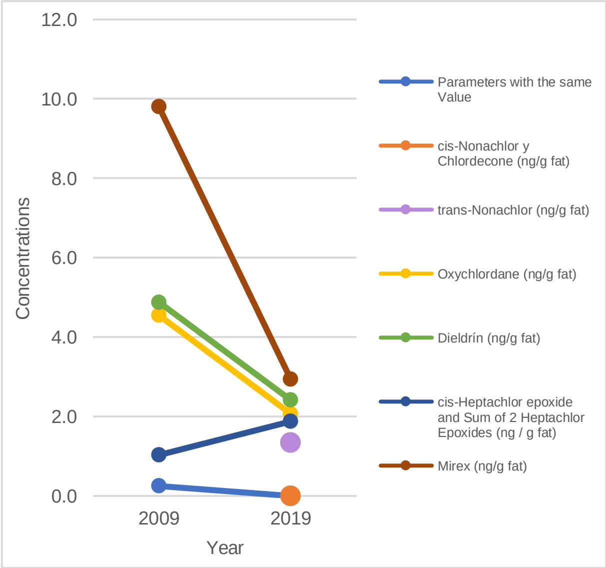
Parameters with the same value (ng/g fat): Aldrin, cis-Chlordane, trans-Chlordane, Endosulfan I (alpha y beta), Endosulfan SO4, Endrin, Heptachlor, trans-Heptachlorepoxide, Mirex.

Figure 82. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in Mexico



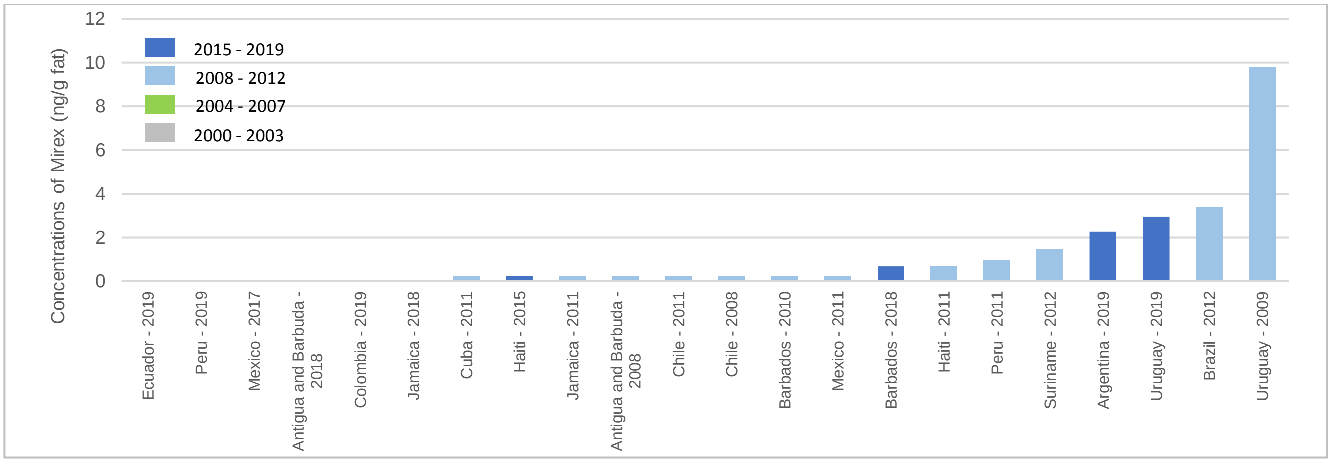
Parameters with the same value (ng/g fat): Aldrin, cis-Chlordane, trans-Chlordane, Endosulfan I (alpha y beta), Endosulfan SO4, Endrin, Heptachlor, trans-Heptachlorepoxide, Mirex.

Figure 83. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in Uruguay



Parameters with the same value (ng/g fat): Aldrin, cis-Chlordane, trans-Chlordane, Endosulfan I (alpha y beta), Endosulfan SO4, Endrin, Heptachlor, trans-Heptachlorepoxide.

Figure 84. Mirex's Concentrations by country and year



The comparison of the medians, average and maximum values of all participating countries in the region are presented in Figure 85 and Table 67, where it is observed that only the substances cis-Heptachlorepoxide and the sum of the 2 Heptachlorepoxides show an increase in 2015-2019 concentrations. Likewise, there are 9 substances that have not presented concentrations above the LOQ in more than 15 years of monitoring in any country. Barbados and Uruguay presented the extreme values of the region in the sixth round, 4 of them correspond to Barbados and Mirex's extreme value corresponds to Uruguay.

Figure 85. Behavior of Organochlorine Insecticides: Cyclodiene Subgroup in GRULAC

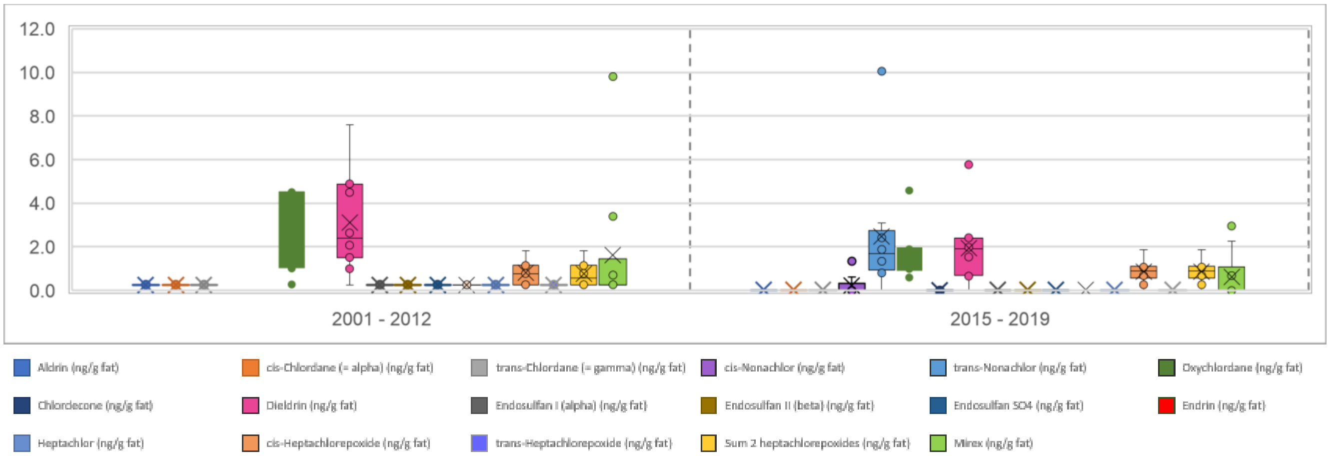


Table 67. Statistical analysis of the Organochlorine Insecticides, Cyclodiene Subgroup in GRULAC

CYCLODIENE (ng/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
Aldrin	0.250	0.250	0.250	0.025	0.250	0.000
cis-Chlordane (= alpha)	0.250	0.250	0.250	0.025	0.250	0.000
trans-Chlordane	0.250	0.250	0.250	0.025	0.250	0.000
cis-Nonachlor		1.349		0.219		0.000
trans-Nonachlor		10.040		2.478		1.683
Oxychlordane	4.914	4.567	2.651	1.671	2.683	1.647
Chlordecone		0.000		0.000		0.000
Dieldrin	7.583	5.780	3.115	1.939	2.415	1.916
Endosulfan I (Alpha)	0.250	0.250	0.250	0.025	0.250	0.000
Endosulfan II (beta)	0.250	0.250	0.250	0.025	0.250	0.000
Endosulfan SO4	0.250	0.250	0.250	0.025	0.250	0.000
Endrin	0.250	0.250	0.250	0.025	0.250	0.000
Heptachlor	0.250	0.250	0.250	0.025	0.250	0.000
cis-Chlordane (= alpha)	1.807	1.877	0.820	0.862	0.770	0.880
trans-Heptachlor epoxide	0.250	0.250	0.250	0.025	0.250	0.000
Sum 2 heptachlorepoxides (cis + trans)	1.807	1.877	0.752	0.862	0.565	0.880
Mirex	9.800	2.944	1.619	0.614	0.250	0.000

Dichlorodiphenyltrichloroethane (DDT) and its isomers

The group presented values below the limit of quantification for the isomers o, p-DDD and DDE; and decrease in the concentration of all the compounds except for p, p-DDT in Jamaica and Mexico where slight increases are presented in both countries. See Table 68. Likewise, the o, p-DDT in the sixth round only presented values above the LOQ in Jamaica and Mexico (Figure 86, 87 and 88); and p, p-DDD only in Ecuador.

Table 68. Analysis' summary of DDT and its Isomers

DDT and Isomers (ng/g fat)	Concentration values				
	From more than one round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
o,p-DDD	✓	✓			
o,p-DDE	✓	✓			
o,p-DDT	✓			All	Suriname (2012), Jamaica (2018)
p,p-DDD	✓			All	Cuba (2011), Ecuador (2019)
p,p-DDE	✓			All	Haiti (2004), Mexico (2017)
p,p-DDT	✓		Jamaica and Mexico	All the rest	Suriname (2012), Mexico (2017)
Sum 3 p,p-DDTs	✓			All	Haiti (2004), Mexico (2017)
Sum 6 DDTs	✓			All	Haiti (2004), Mexico (2017)

The behavior of DDT and its isomers in the countries of Jamaica and Mexico is presented below in figures 86 and 87 where the imperceptible increase in p, p-DDT in Jamaica and calculated 25% in Mexico is observed.

Figure 86. Behavior of DDT and its isomers in Jamaica

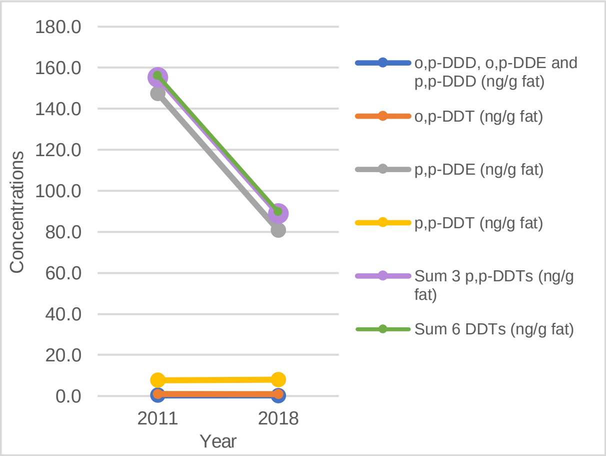


Figure 87. Behavior of DDT and its isomers in Mexico

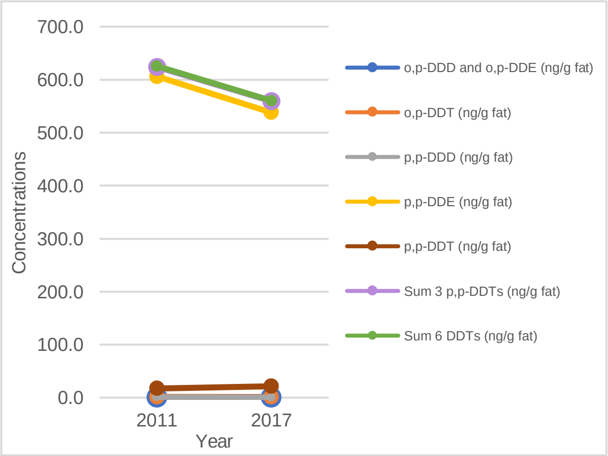
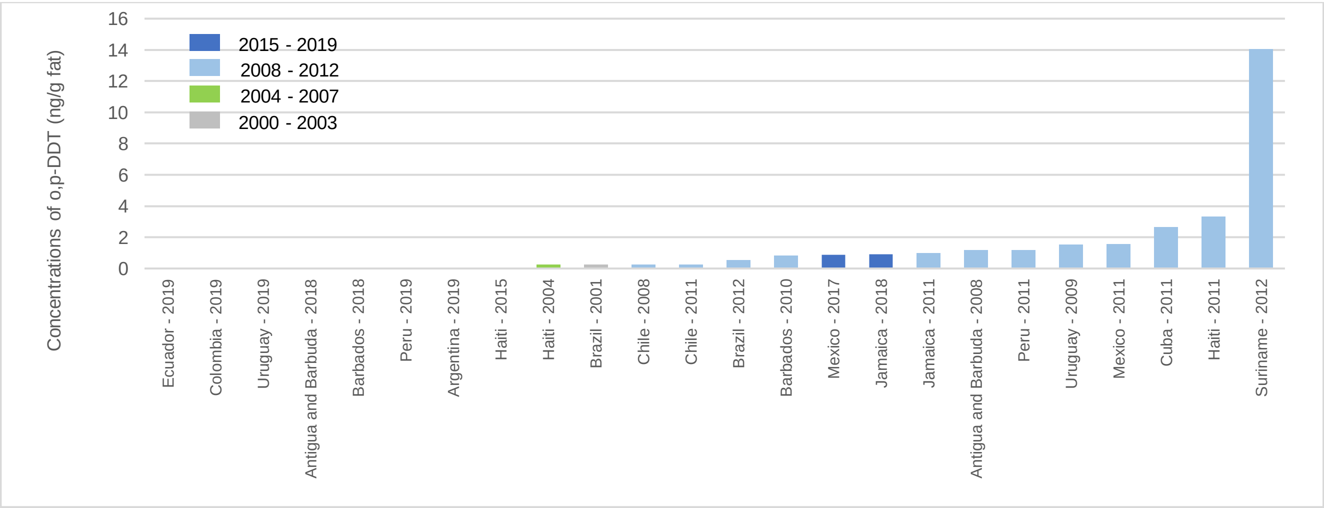
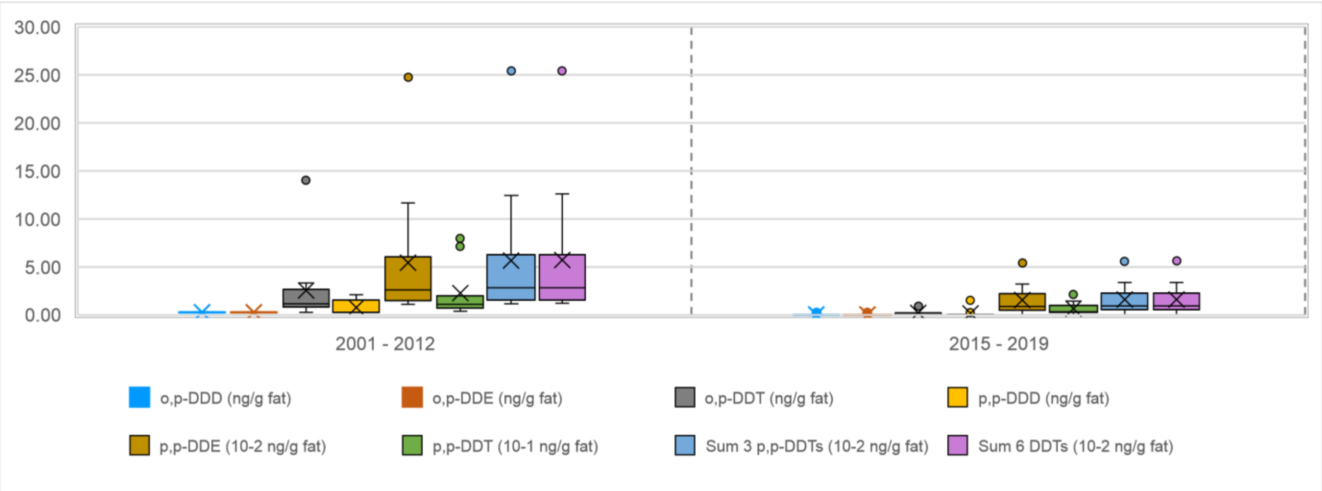


Figure 88. o,p-DDT's Concentrations by country and year



The comparison of the statistics of the medians of all the participating countries of the region is presented in figure 89 and table 69, where it is observed that all the compounds present a decrease in the concentrations of the sixth round. p,p-DDT has decreased its concentration in almost all countries except Jamaica and Mexico, but it is still present in the region. Extreme values of p, p-DDD in Ecuador, o, p-DDT in Jamaica and other parameters, 4 in total, in Mexico.

Figure 89. Behavior of DDT and its isomers in GRULAC



Note. The values in the figure were adjusted as follows:
10-1 ng/g fat means 10^{-1} ng/g fat, that is, the data were divided by 10.
10-2 ng/g fat means 10^{-2} ng/g fat, that is, the data were divided by 100.

Table 69. Statistical analysis of DDT and its isomers in GRULAC

DDT and its isomers (ng/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
o,p-DDD	0.25	0.25	0.25	0.03	0.25	0.00
o,p-DDE	0.25	0.25	0.25	0.03	0.25	0.00
o,p-DDT	14.04	0.92	2.54	0.18	1.16	0.00
p,p-DDD	2.08	1.52	0.76	0.18	0.25	0.00
p,p-DDE (10^{-2})	24.72	5.38	5.44	1.51	2.60	0.85
p,p-DDT (10^{-1})	7.96	2.15	2.25	0.63	1.09	0.33
Sum 3 p,p-DDTs (10^{-2})	25.43	5.59	5.67	1.58	2.82	0.91
Sum 6 DDTs (10^{-2})	25.43	5.60	5.69	1.58	2.84	0.91

Toxaphene and congeners

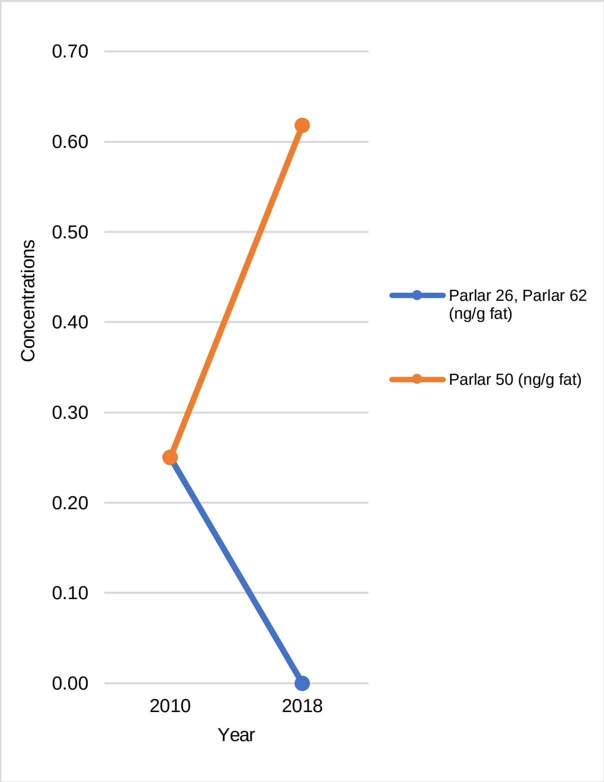
In the sixth round, all congeners presented a decrease of concentrations in all countries except for Barbados where Parlar 50 presented a significant increase in the concentration level. The summary of the analysis is presented in table 70.

Table 70. Analysis' summary of Toxaphene and its congeners

Toxaphene and congeners (ng/g fat)	Concentration values					
	From more than one round	All under LOQ	All equal to cero.	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
Parlar 26	✓		✓		All	Haiti (2011)
Parlar 50	✓			Barbados	All the rest	Jamaica (2011) Antigua & Barbuda (2018)
Parlar 62	✓	✓	✓			

The behavior of Toxaphene and congeners in Barbados is shown below in figure 90 where the increase in the level of Parlar 50 is observed.

Figure 90. Behavior of toxaphene congeners in Barbados



The comparison of the statistics of the medians of all the participating countries in the region is presented in figure 91 and table 71, where it is observed that all congeners present a decrease in concentrations and specifically in the sixth round all the values of the Parlar 26 and 62 are under the LOQ. Notice that Parlar 62 has not presented concentrations above the LOQ in any country, in more than 15 years of monitoring and that Parlar 50 was only detected in the Caribbean Subregion (Antigua and Barbuda, Barbados and Jamaica).

Figure 91. Behavior of toxaphene and its congeners in GRULAC

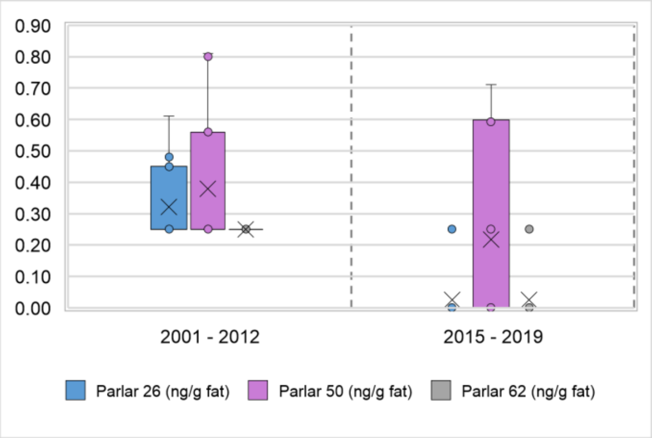


Table 71. Statistical analysis of toxaphene and its congeners in GRULAC

TOXAPHENE (ng/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
Parlar 26	0.610	0.250	0.322	0.025	0.250	0.000
Parlar 50	0.810	0.711	0.379	0.217	0.250	0.000
Parlar 62	0.250	0.250	0.250	0.025	0.250	0.000

Hexachlorobenzene

In the sixth round, the comparisons of values and countries showed a decrease in concentration levels in all the countries, and Uruguay continued presenting the highest value in the region (Table 72 and Figure 92). However, the statistics of the region, figure 93 and table 73, showed a slight increase in the median of the sixth round, due to the values above the mean of countries that participated for the first time in the sixth round, Argentina and Ecuador. When comparing only the medians of the 7 countries that had participated in two rounds, including the sixth round, the decrease in concentrations is clearly seen Fig. 94 and table 74.

Table 72. Analysis' summary of Hexachlorobenzene

HCB (ng/g fat)	Concentration values			
	From more than one round	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
HCB	✓		All	Uruguay (2009-2019)

Figure 92. Concentrations of HCB by country and year

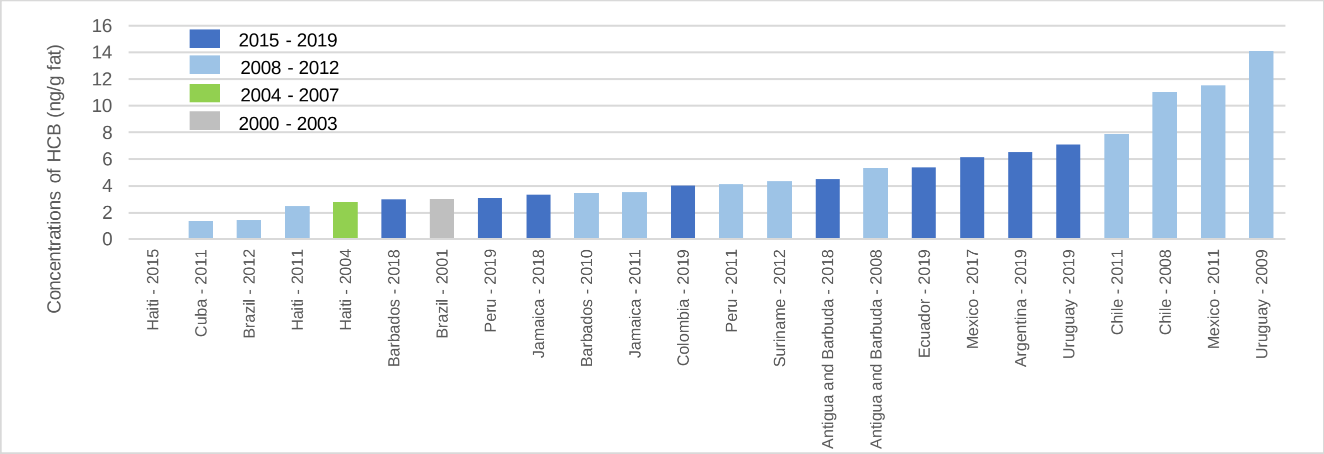


Figure 93. Behavior of HCB in GRULAC with all participating countries

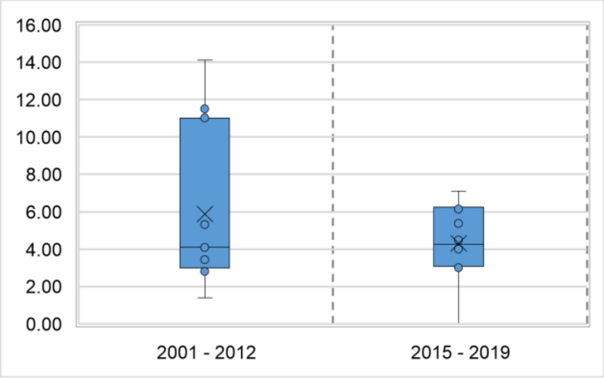


Figure 94. Behavior of HCB in GRULAC with countries which participated in two rounds

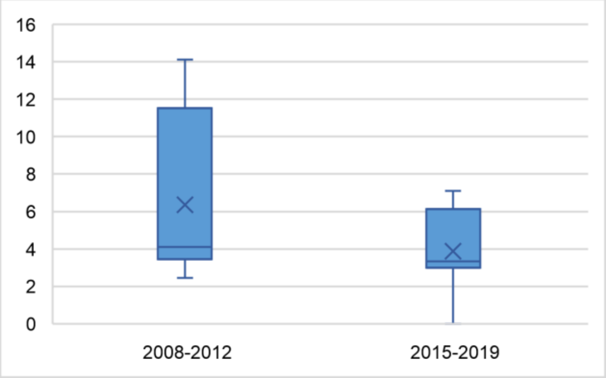


Table 73. Statistical analysis of HCB considering all participating countries

HCB (ng/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 – 2012	2015 - 2019
HCB	14.11	7.11	5.86	4.31	4.09	4.25

Table 74. Statistical analysis of HCB considering countries which participated in two rounds

HCB (ng/g fat)						
Parameter	Maximum		Average		Median	
	2008 - 2012	2015 - 2019	2008 - 2012	2015 - 2019	2008 – 2012	2015 - 2019
HCB	14.11	7.11	6.34	3.88	4.09	3.33

Polychlorinated biphenyls and congeners

For the analysis, these compounds were separated in two groups: those with toxic equivalence factors (TEFs) and those without it. PCBs that do not have TEFs showed, in the sixth round, a decrease in their concentrations in all countries except for PCB 52 in Barbados and several PCBs in Mexico, which despite their low values, in the sixth round displayed slight increases. The maximum values of PCBs 52, 101 and 138 are presented in Jamaica and of PCBs 153, 180 and the sums of 6 and 7 PCBs in Barbados. The summary of this analysis is presented in Table 75 and the analysis of Barbados and Mexico in figures 95 and 96. Note that for the first time the sum of 7 PCBs, which includes PCB with TEF 118, is analyzed. The statistics of the medians of the region showed the same results. Please see Figure 97 and Table 76.

Table 75. Analysis' summary of Polychlorinated biphenyls and congeners

PCB (ng/g fat)	Concentration values					
	From more than one round	Only sixth round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
PCB 28	✓				All	Haiti (2004), Argentina (2019)
PCB 52	✓			Barbados	All the rest	Haiti (2004), Jamaica (2018)
PCB 101	✓				All	Haiti (2004), Jamaica (2018)
PCB 138	✓			Mexico	All the rest	Cuba (2011), Jamaica (2018)
PCB 153	✓			Mexico	All the rest	Cuba (2011), Barbados (2018)
PCB 180	✓			Mexico	All the rest	Haiti (2004), Barbados (2018)
Sum 6 PCBs	✓			Mexico	All the rest	Antigua y Barbuda (2008) Barbados (2018)
Sum 7 PCBs		✓				Barbados (2018)

Parameter measured for the first time in human milk in the region.

Figure 95. Behavior of PCBs in Barbados

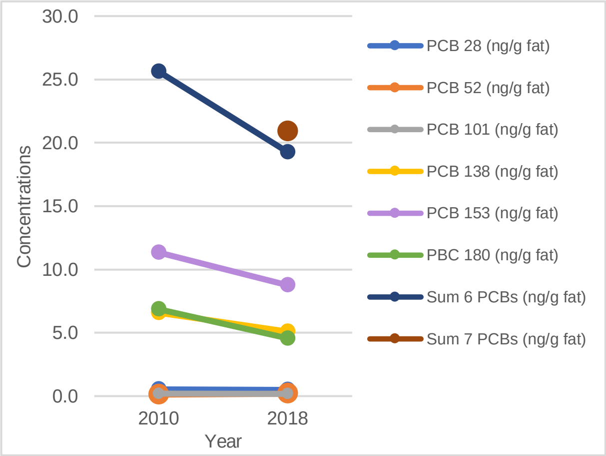
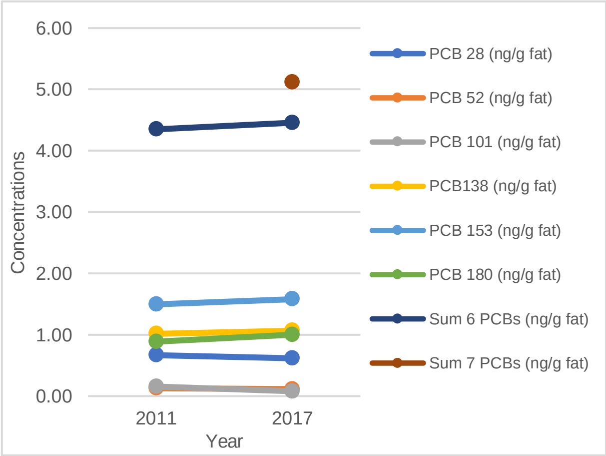
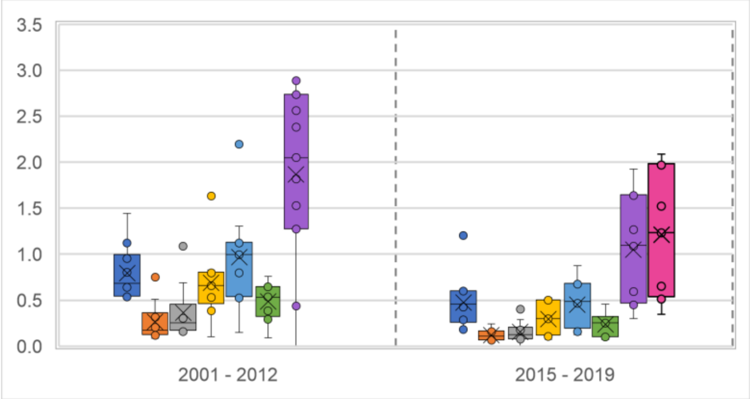


Figure 96. Behavior of PCBs in México



In figure 97, the box plot diagrams of the sixth round present extreme values of PCB 28 in Argentina and PCB 101 in Jamaica. Decreasing median values are seen in table 76.

Figure 97. Behavior of PCBs in GRULAC



Note. The values in the figure were adjusted as follows: 10-1 ng/g fat means 10^{-1} ng/g fat, that is, the data were divided by 10.

Table 76. Statistical analysis of PCB in GRULAC

Parameter	PCB (ng/g fat)					
	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
PCB 28	1.44	1.20	0.79	0.48	0.67	0.46
PCB 52	0.75	0.24	0.26	0.12	0.13	0.11
PCB 101	1.09	0.40	0.37	0.16	0.20	0.13
PCB138 (10^{-1})	1.64	0.53	0.69	0.29	0.66	0.30
PCB 153 (10^{-1})	2.20	0.88	0.97	0.45	1.00	0.48
PCB 180 (10^{-1})	0.76	0.46	0.49	0.23	0.53	0.25
Sum 6 PCBs (10^{-1})	2.89	1.93	1.87	1.05	2.05	1.10
Sum 7 PCBs (10^{-1})		20.88		12.12		12.37

Regarding PCBs with TEFs

The summary of the analysis is presented in Table 77, where it is observed that in the sixth round there was a decrease in levels in almost all compounds except for PCB 77, which increased in Barbados, Haiti, Jamaica and Peru. Mexico shows very slight increases in other congeners and Barbados and Peru significant increases. The analysis of congeners in these countries is presented in figures 98 to 102 and the statistics of the medians of the region are shown in figure 103 and table 78 where a decrease in the concentrations of all compounds is also observed. It is worth mentioning that maximum values of most of the parameters are found in Argentina and Jamaica.

Table 77. Analysis' summary of Polychlorinated biphenyls with TEFs

PCB with TEFs (pg/g fat)	Concentration values			
	From more than one round	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
PCB 77	✓	Barbados, Haiti 2015, Jamaica and Peru	All	Haiti (2004), Jamaica (2018)
PCB 81	✓	Barbados	All the rest	Uruguay (2009), Argentina (2019)
PCB 105	✓		All	Jamaica (2011), Argentina (2019)
PCB 114	✓	Mexico and Peru	All the rest	Jamaica (2011-2018)
PCB 118	✓		All	Jamaica (2011), Argentina (2019)
PCB 123	✓		All	Jamaica (2011), Argentina (2019)
PCB 126	✓		All	Peru (2011-2019)
PCB 156	✓	Mexico	All the rest	Uruguay (2009), Jamaica (2018)
PCB 157	✓	Mexico	All the rest	Jamaica (2011-2018)
PCB 167	✓		All	Haiti (2004), Jamaica (2018)
PCB 169	✓		All	Uruguay (2009-2019)
PCB 189	✓	Mexico	All the rest	Barbados (2010-2018)
Sum 12 PCBs	✓		All	Jamaica (2011), Argentina (2019)

Parameter with concentrations increases in four countries.

Figure 98. Behavior of PCBs with TEFs in Barbados

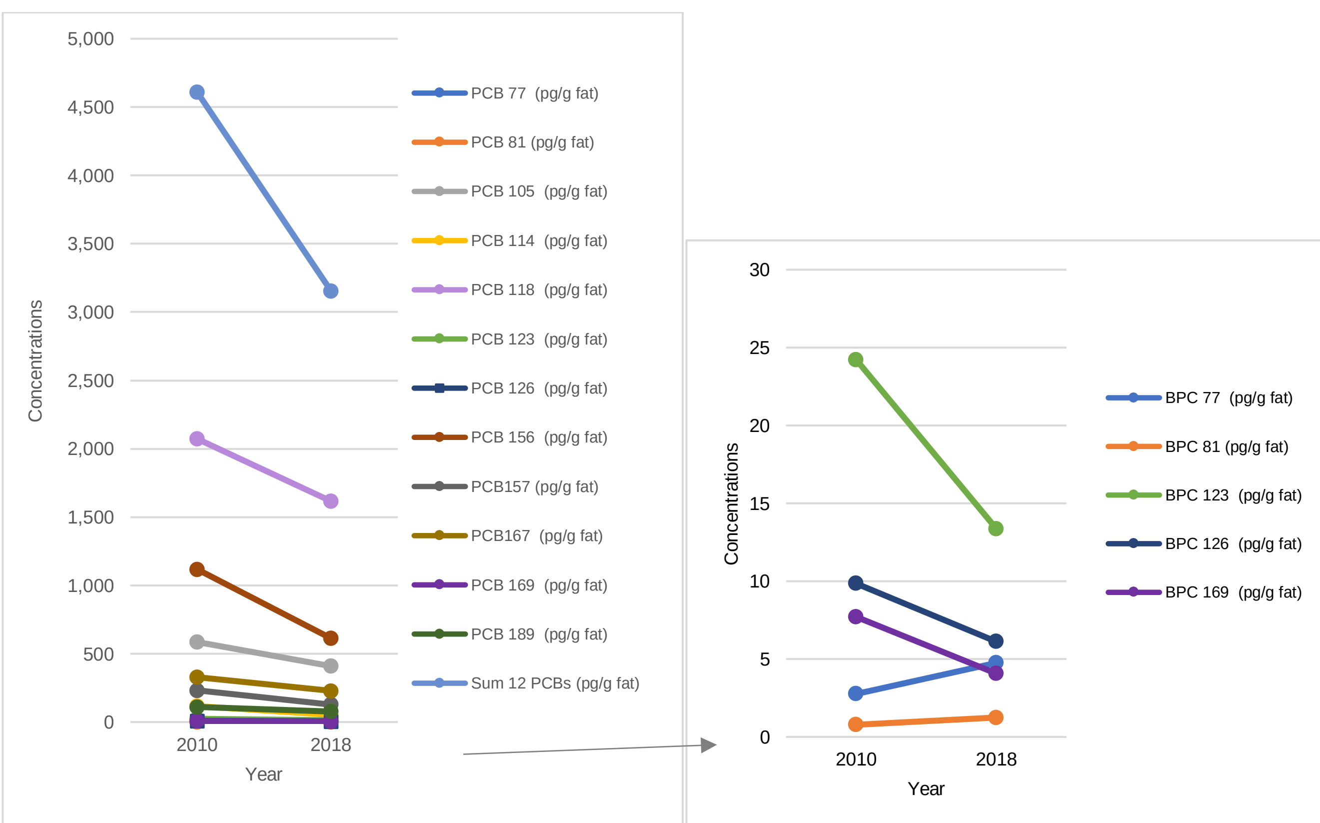


Figure 99. Behavior of PCBs with TEFs in Haiti

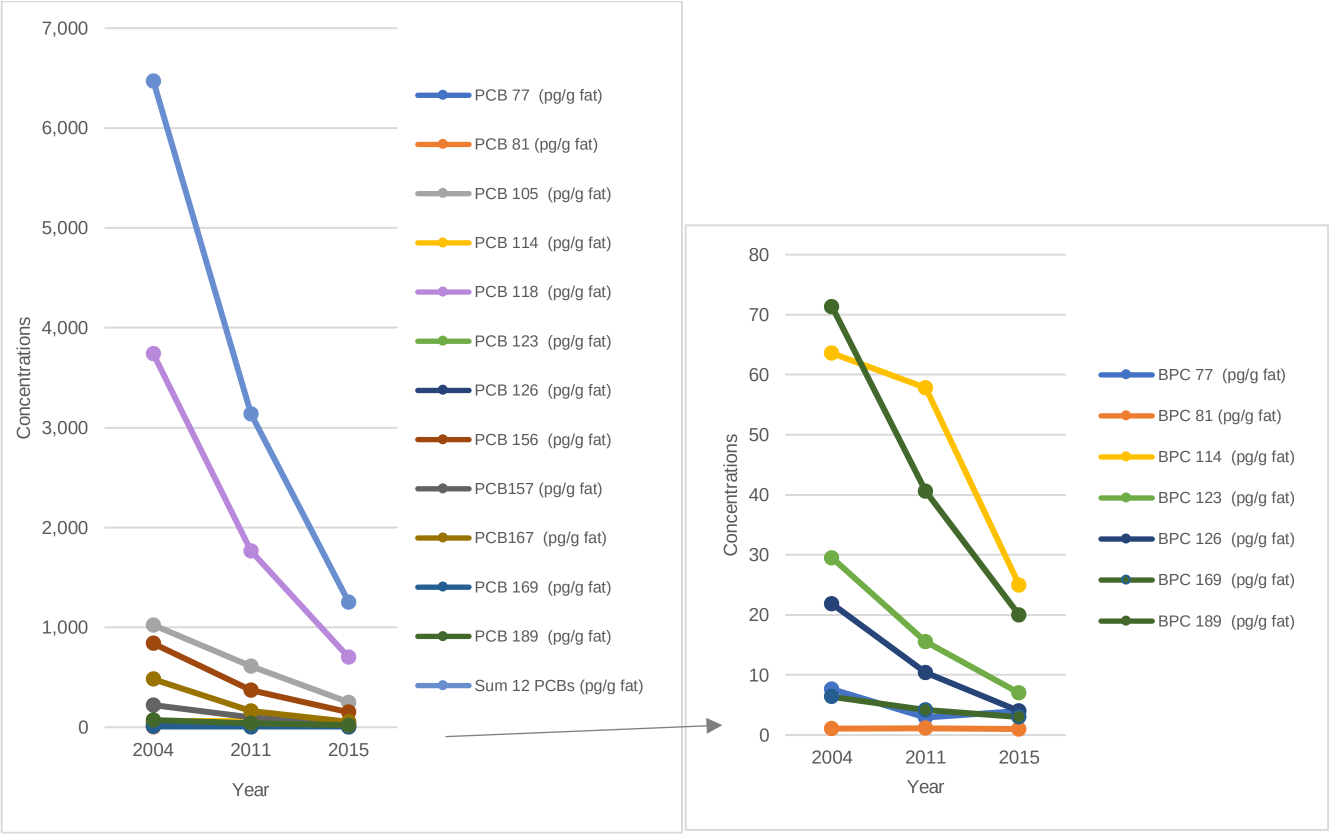


Figure 100. Behavior of PCBs with TEFs in Jamaica

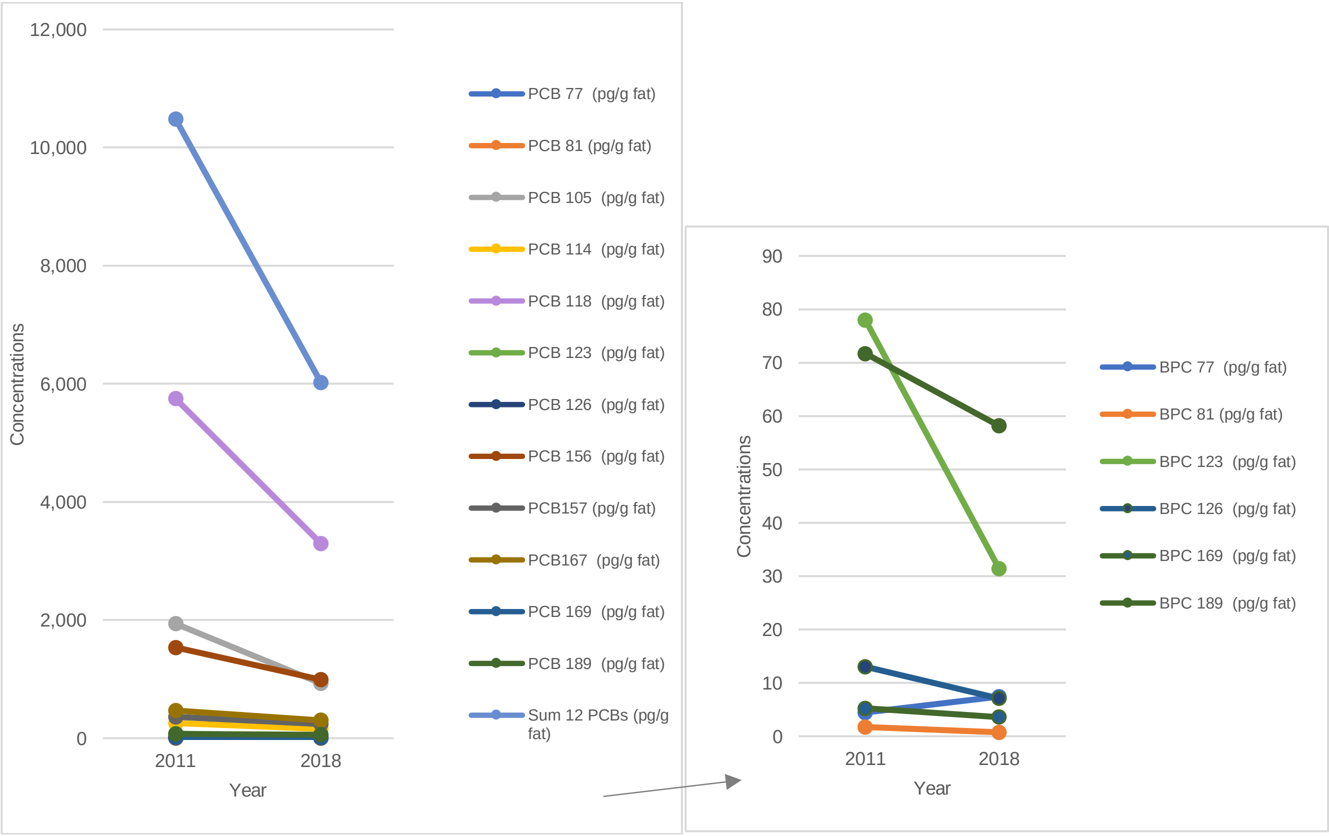


Figure 101. Behavior of PCBs with TEFs in México

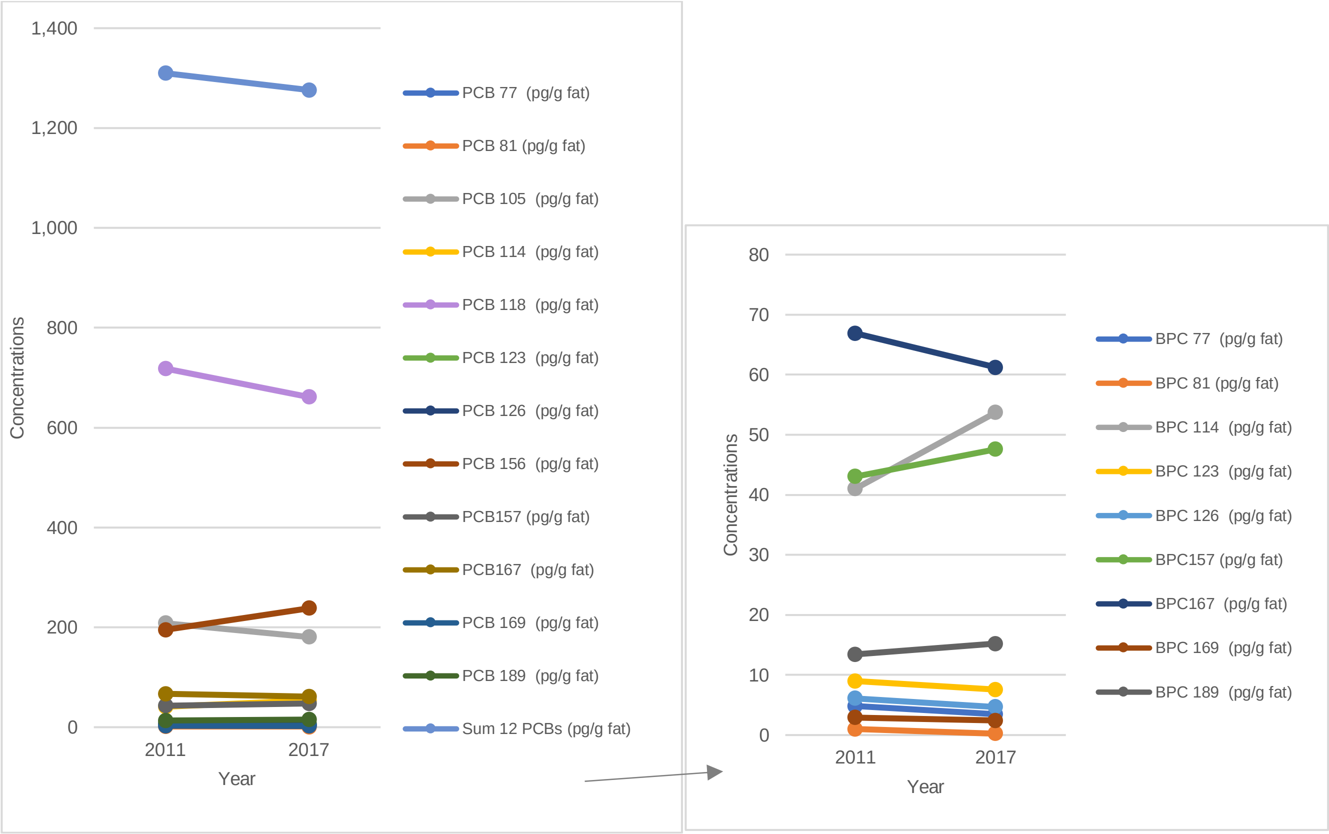
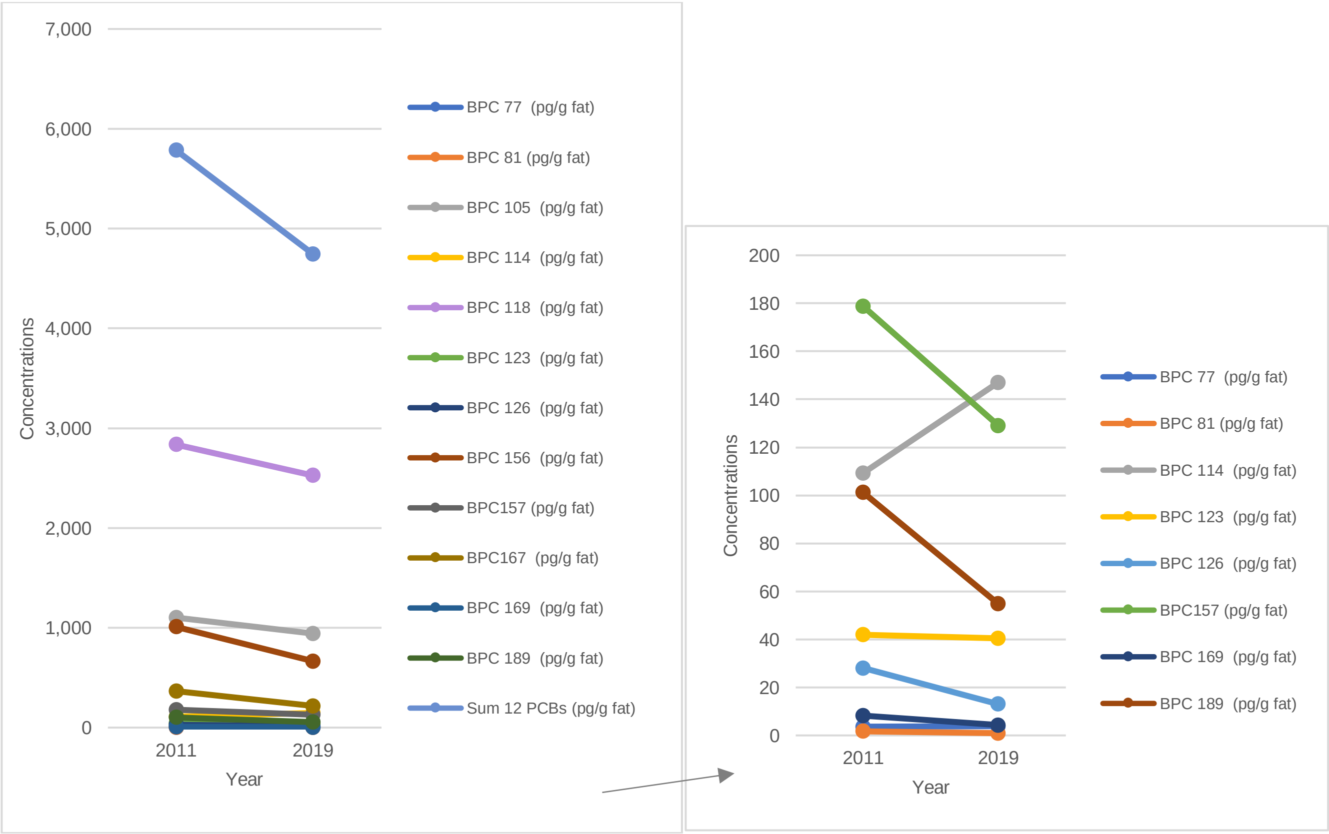
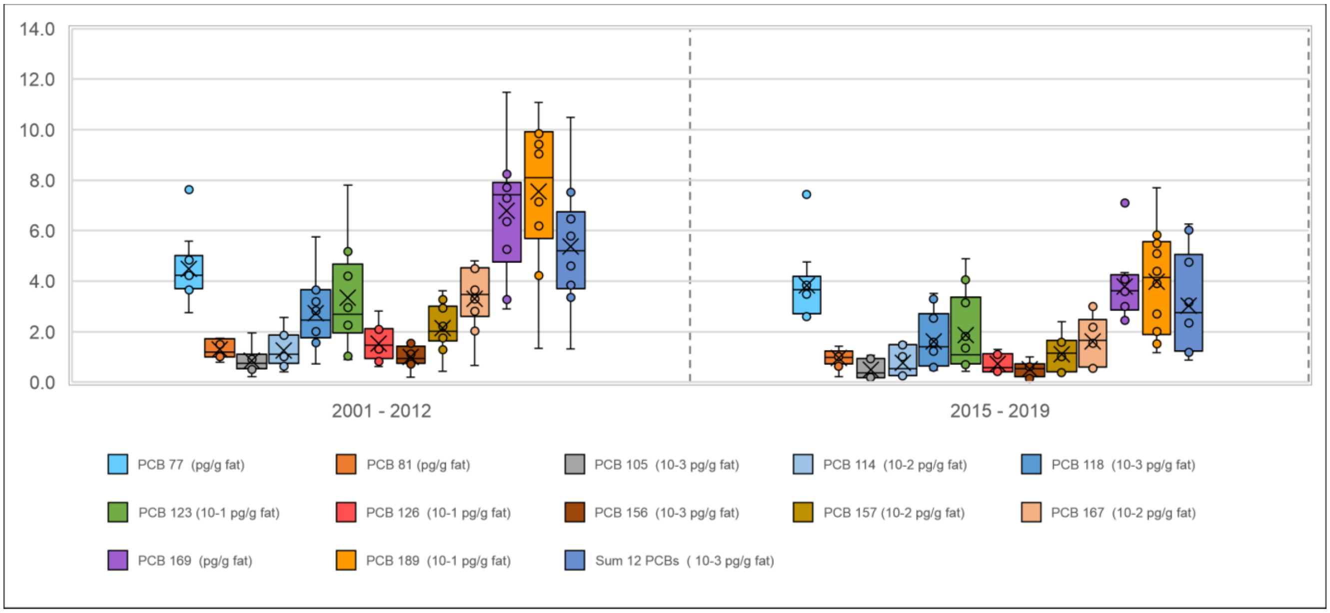


Figure 102. Behavior of PCBs with TEFs in Peru



Although Mexico in the sixth round presented increases in concentration in several PCBs, it maintains concentrations well below the median. The extreme values of PCB 77 and 169 in the sixth round are in Jamaica and Uruguay respectively. See Figure 103 Maximum values of the other PCBs are mainly in Argentina and Jamaica, as mentioned. Also see the statistical analysis in Table 78.

Figure 103. Behavior of PCB with TEFs in GRULAC



Note. The values in the figure were adjusted as follows:
10-1 pg/g fat means 10^{-1} pg/g fat, that is, the data were divided by 10.
10-2 pg/g fat means 10^{-2} pg/g fat, that is, the data were divided by 100.
10-3 pg/g fat means 10^{-3} pg/g fat, that is, the data were divided by 1000.

Table 78. Statistical analysis of PCB with TEFs in GRULAC

PCB with TEFs (pg/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
PCB 77	7.63	7.43	4.49	3.83	4.24	3.66
PCB 81	1.74	1.42	1.30	0.96	1.20	0.97
PCB 105 (10^{-3})	1.94	1.06	0.85	0.48	0.75	0.37
PCB 114 (10^{-2})	2.56	1.58	1.25	0.77	1.10	0.54
PCB 118 (10^{-3})	5.75	3.52	2.73	1.62	2.45	1.40
PCB 123 (10^{-1})	7.80	4.89	3.35	1.87	2.69	1.09
PCB 126 (10^{-1})	2.81	1.30	1.53	0.72	1.47	0.57
PCB 156 (10^{-3})	1.58	0.99	1.00	0.50	0.93	0.53
PCB 157 (10^{-2})	3.62	2.40	2.14	1.10	2.01	1.14
PCB 167 (10^{-2})	4.80	3.01	3.30	1.62	3.47	1.66
PCB 169	11.48	7.09	6.79	3.78	7.43	3.62
PCB 189 (10^{-1})	11.08	7.70	7.56	3.97	8.11	4.15
Sum 12 PCBs (10^{-3})	10.48	6.25	5.37	3.03	5.20	2.74

Polychlorinated Dibenzodioxins and Dibenzofurans and congeners

These compounds presented, in the sixth round, slight increases in the concentrations of most congeners, highlighting the Dibenzofurans 1,2,3,4,7,8-HxCDF and 1,2, 3,7,8-PeCDF in Barbados, Jamaica and Mexico, and significant increases in Jamaica mainly of OCDD and the sums of 7 PCDDs and 17 PCDDs/Fs. See summary Table 79, where 9 parameters are observed with maximum value in Jamaica, 6 in Uruguay, 4 in Mexico and one in Ecuador. The analysis of the countries is presented in Figures 104 to 108.

Table 79. Analysis' summary of Polychlorinated Dibenzodioxins and Dibenzofurans and congeners

PCDD and PCDF (pg/g fat)	Concentration values			
	From more than one round	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
1,2,3,4,6,7,8-HpCDD	✓	Jamaica	All the rest	Jamaica (2018)
1,2,3,4,6,7,8-HpCDF	✓	Jamaica	All the rest	Chile (2008), Jamaica (2018)
1,2,3,4,7,8-HxCDD	✓		All	Chile (2008), Jamaica (2018)
1,2,3,4,7,8-HxCDF	✓	Barbados, Jamaica and Mexico	All the rest	Chile (2008), Mexico (2017)
1,2,3,4,7,8,9-HpCDF	✓	Jamaica and Mexico	All the rest	Chile (2008), Mexico (2017)
1,2,3,6,7,8-HxCDD	✓		All	Chile (2008), Jamaica (2018)
1,2,3,6,7,8-HxCDF	✓	Barbados	All the rest	Chile (2008), Mexico (2017)
1,2,3,7,8-PeCDD	✓		All	Chile (2008), Jamaica (2018)
1,2,3,7,8-PeCDF	✓	Barbados, Jamaica and Mexico	All the rest	Chile (2008), Mexico (2017)
1,2,3,7,8,9-HxCDD	✓	Jamaica	All the rest	Barbados (2010), Jamaica (2018)
1,2,3,7,8,9-HxCDF	✓	Haiti and Peru	All the rest	Uruguay (2009-19)
2,3,4,6,7,8-HxCDF	✓	Jamaica and Mexico	All the rest	Chile (2008), Uruguay (2019)
2,3,4,7,8-PeCDF	✓		All	Chile (2008), Uruguay (2019)
2,3,7,8-TCDD	✓		All	Chile (2008), Uruguay (2019)
2,3,7,8-TCDF	✓	Jamaica and Peru	All the rest	Cuba (2011), Uruguay (2019)
OCDD	✓	Jamaica	All the rest	Jamaica (2018)
OCDF	✓	Jamaica	All the rest	Ecuador (2019)
Sum 7 PCDDs	✓	Jamaica	All the rest	Jamaica (2018)
Sum 10 PCDFs	✓	Jamaica	All the rest	Chile (2008), Uruguay (2019)
Sum 17 PCDDs/Fs	✓	Jamaica	All the rest	Jamaica (2018)

Parameters with increases of concentrations in three countries.

Figure 104. Behavior of PCDD and PCDF and congeners in Barbados

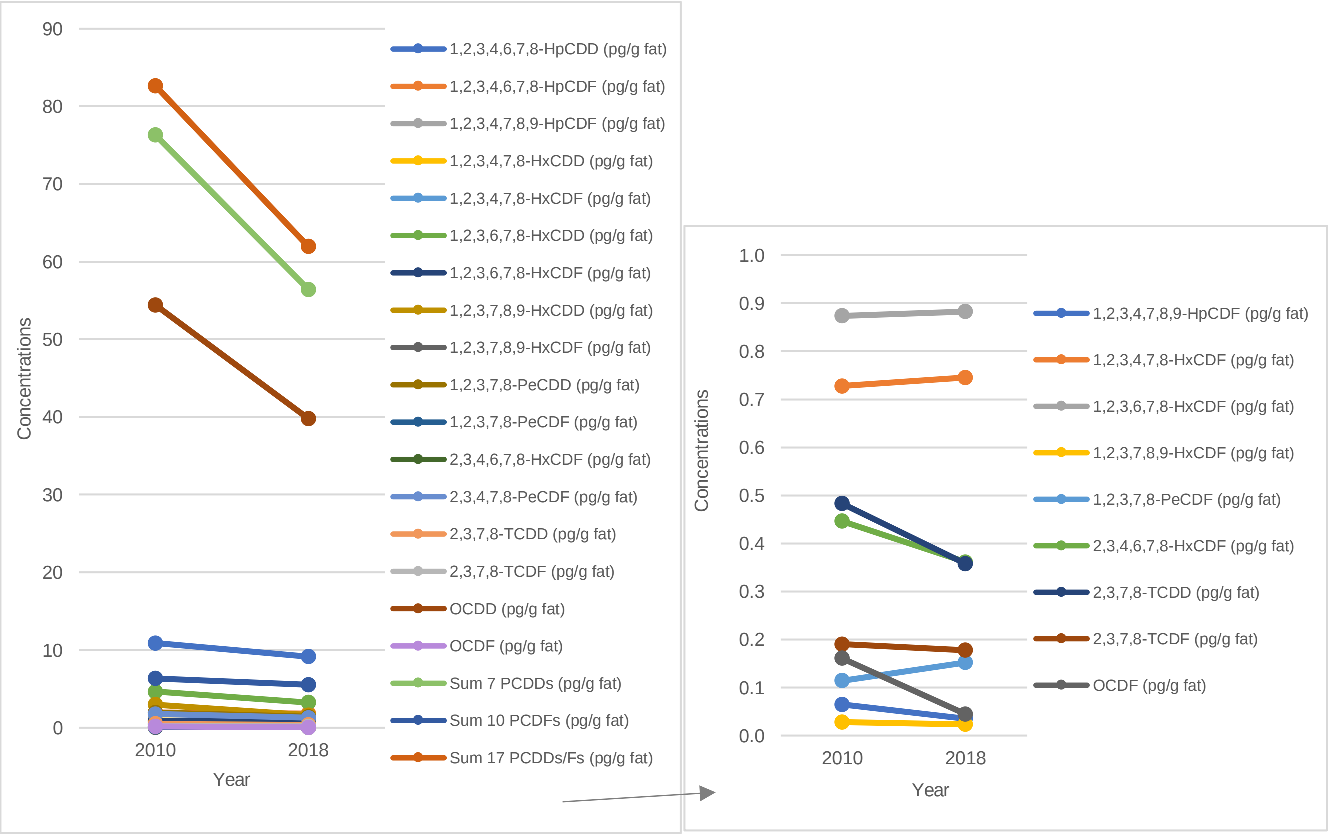
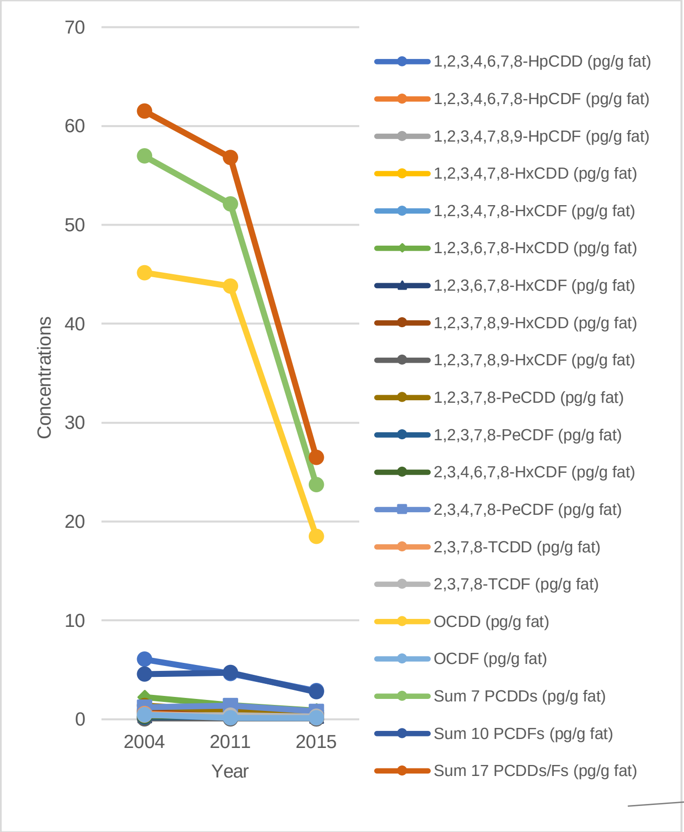


Figure 105. Behavior of PCDD and PCDF and congeners in Haiti



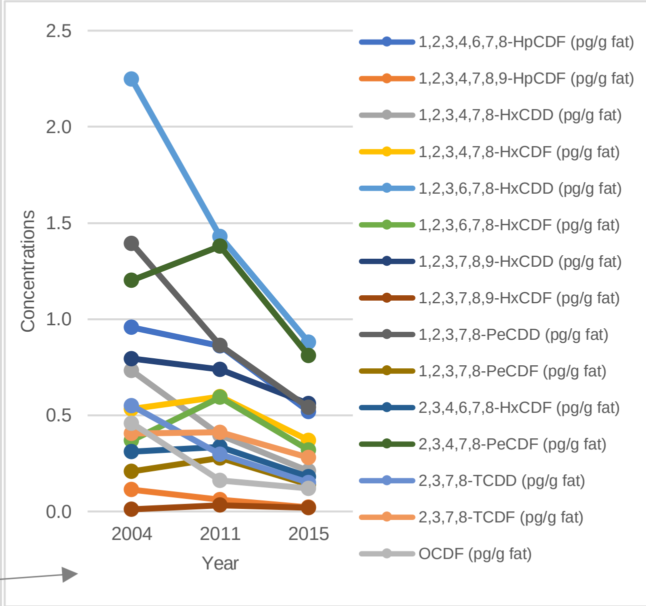
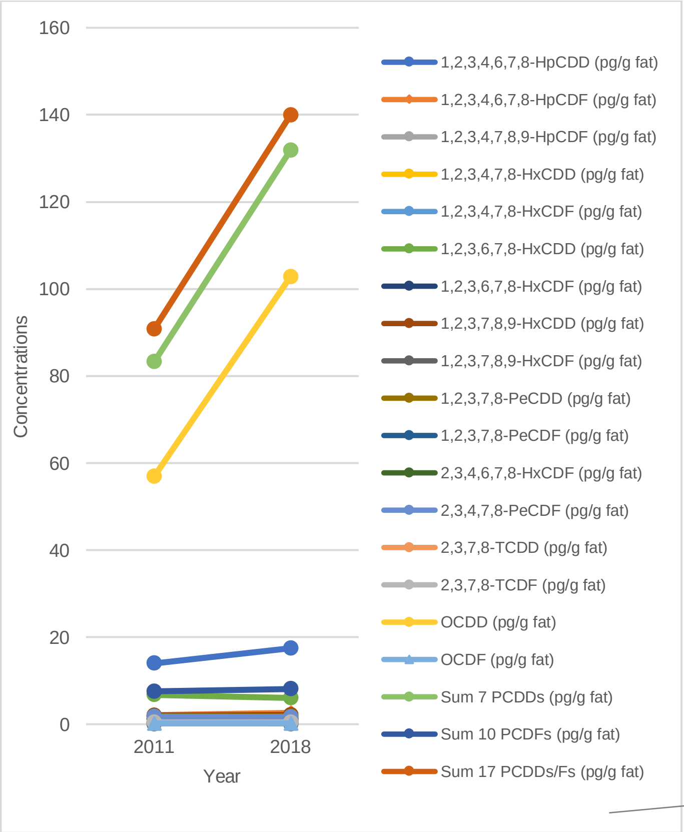


Figure 106. Behavior of PCDD and PCDF and congeners in Jamaica



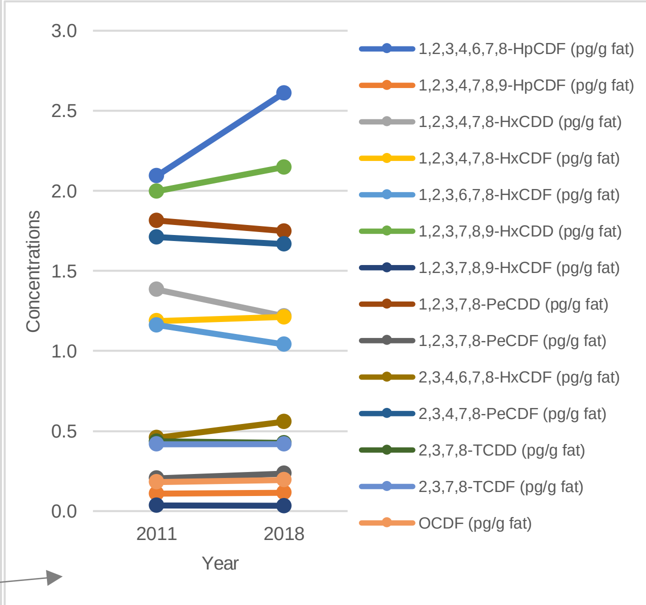


Figure 107. Behavior of PCDD and PCDF and congeners in Mexico

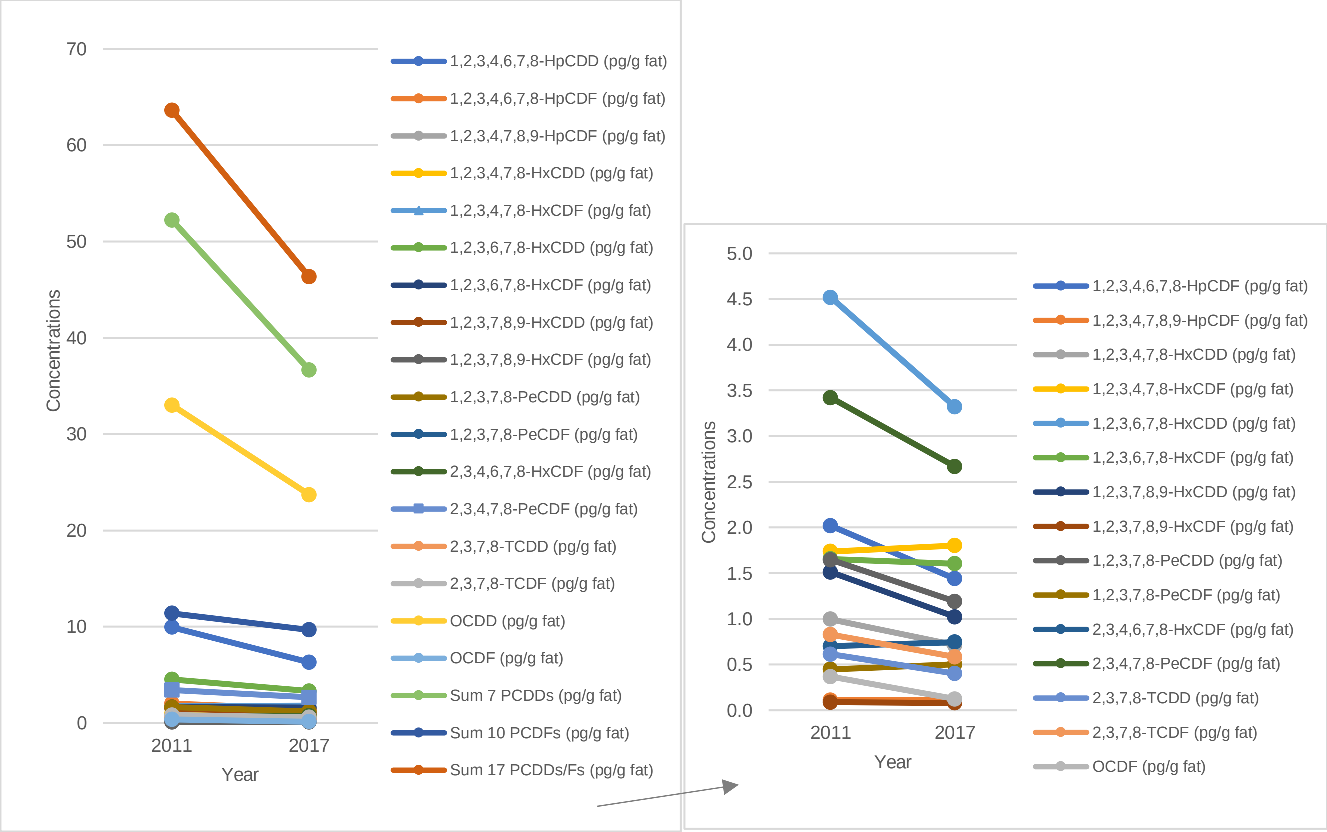
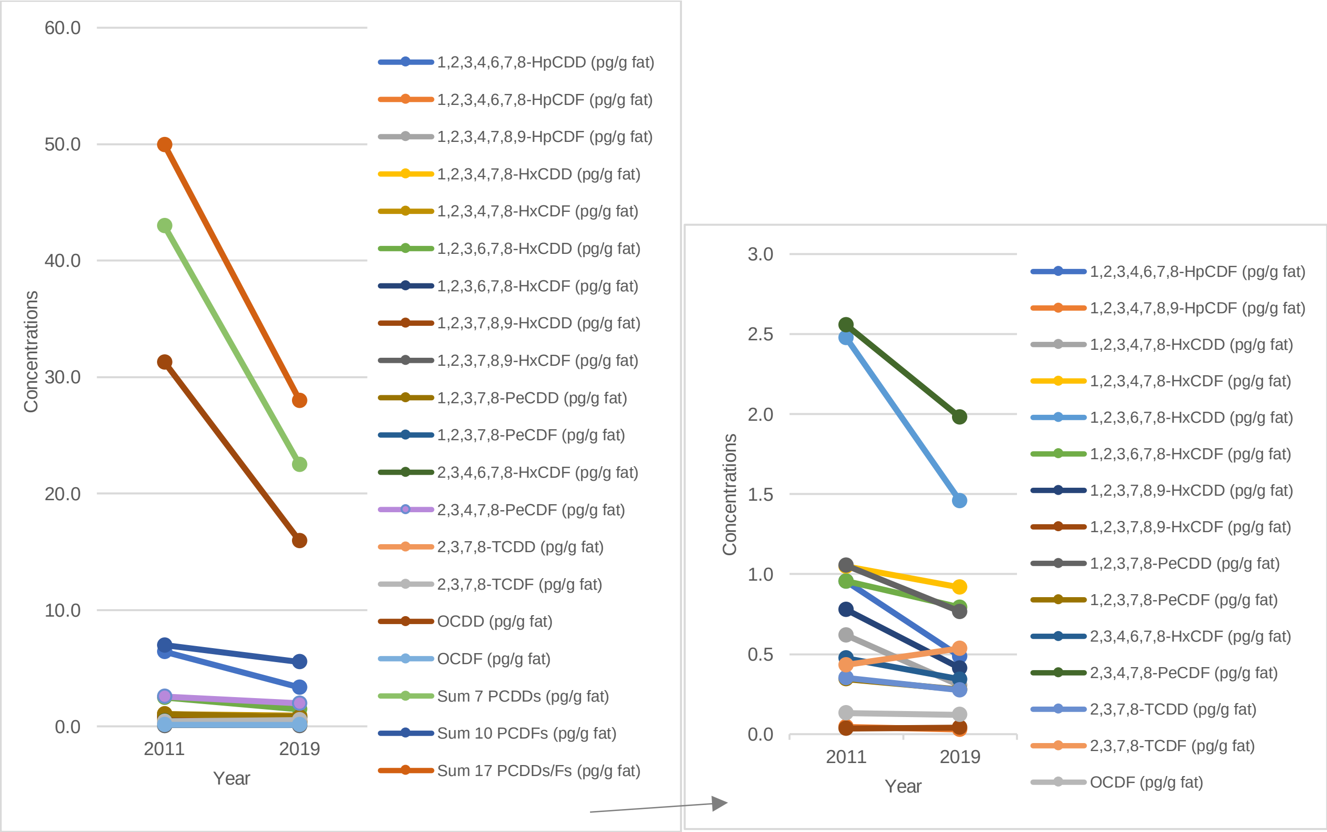
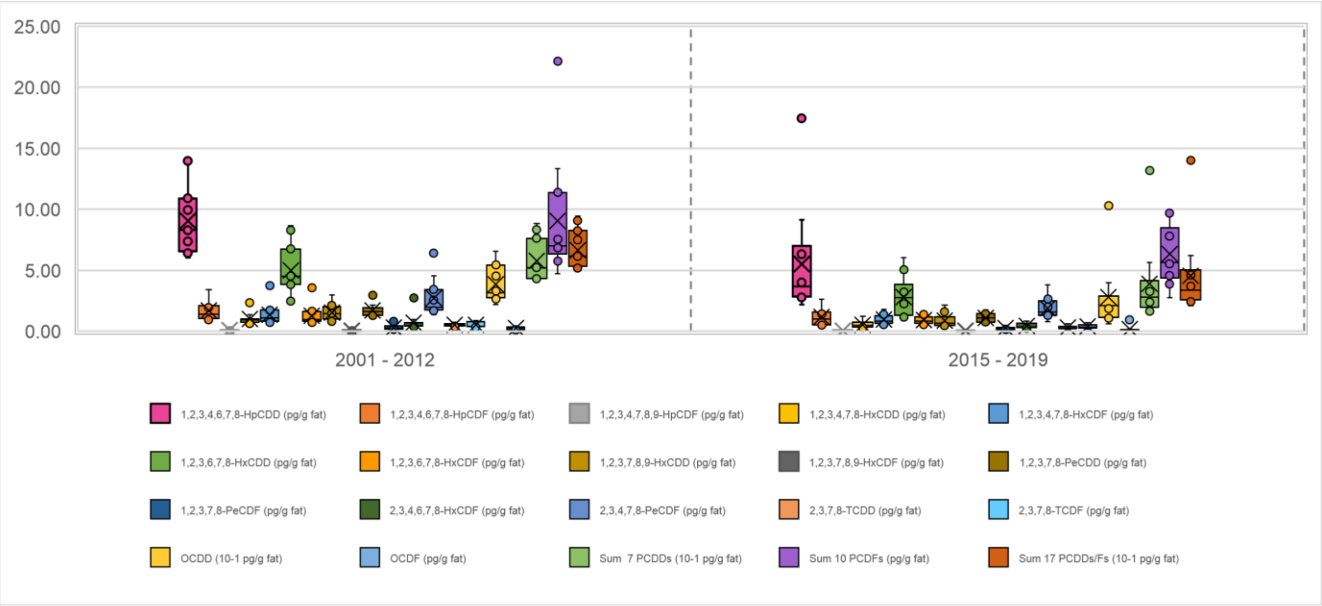


Figure 108. Behavior of PCDD and PCDF and congeners in Peru



The statistics of the medians are shown in figure 109 and table 80 where a decrease in the concentrations of all the compounds can be seen. The extreme values of the statistics of the sixth round are mainly presented in Jamaica 2018, and only the extreme value of OCDF in Ecuador.

Figure 109. Behavior of PCDD and PCDF and congeners in GRULAC



Note. The values in the figure were adjusted as follows:
10-1 pg/g fat means 10^{-1} pg/g fat, that is, the data were divided by 10.

Table 80. Statistical analysis of PCDD and PCDF and congeners in GRULAC

PCDD and PCDF (pg/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
1,2,3,4,6,7,8-HpCDD	14.07	17.46	9.06	5.52	8.30	3.67
1,2,3,4,6,7,8-HpCDF	3.41	2.61	1.70	1.18	1.39	1.03
1,2,3,4,7,8,9-HpCDF	0.26	0.12	0.09	0.06	0.07	0.05
1,2,3,4,7,8-HxCDD	2.35	1.22	1.02	0.55	0.93	0.48
1,2,3,4,7,8-HxCDF	3.74	1.80	1.36	0.96	1.09	0.83
1,2,3,6,7,8-HxCDD	8.66	6.04	4.99	2.82	4.52	2.74
1,2,3,6,7,8-HxCDF	3.56	1.60	1.27	0.91	0.96	0.84
1,2,3,7,8,9-HxCDD	2.96	2.15	1.54	0.89	1.47	0.67
1,2,3,7,8,9-HxCDF	0.14	0.13	0.06	0.05	0.04	0.04
1,2,3,7,8-PeCDD	2.98	1.75	1.70	1.10	1.61	1.11
1,2,3,7,8-PeCDF	0.83	0.50	0.32	0.25	0.26	0.21
2,3,4,6,7,8-HxCDF	2.76	0.85	0.72	0.46	0.47	0.36
2,3,4,7,8-PeCDF	6.41	3.82	2.71	1.89	1.95	1.56
2,3,7,8-TCDD	0.98	0.61	0.55	0.33	0.53	0.29
2,3,7,8-TCDF	0.90	0.71	0.54	0.39	0.42	0.35
OCDD (10^{-1})	6.56	10.28	3.86	2.79	3.16	2.11
OCDF	0.46	0.96	0.26	0.19	0.25	0.11
Sum 7 PCDDs (10^{-1})	8.85	13.19	5.75	3.91	5.22	2.81
Sum 10 PCDFs	22.12	9.86	9.05	6.34	6.98	5.64
Sum 17 PCDDs/Fs (10^{-1})	9.43	14.00	6.66	4.54	6.15	3.39

Note. The values in the figure were adjusted as follows:
10-1 ng/g fat means 10^{-1} ng/g fat, that is, the data were divided by 10.

Hexachlorocyclohexane and its isomers

The Alpha and Gamma isomers of HCH showed zero values in the sixth round in almost all countries, except for Barbados and Antigua and Barbuda. In the former there was an increase and in the latter a decrease. See Figure 110. The Beta HCH shows a slight increase in Mexico with a maximum value in Uruguay. The summary of the analysis is presented in Table 81 and the analysis of the isomers' behavior in the countries is presented in Figures 111 and 112. The statistical analysis of the region is shown in Figure 113 and table 82, where a decrease in the concentrations of all compounds in the sixth round is seen. The extreme values of Alpha and Gamma HCH correspond to Barbados and Antigua and Barbuda, respectively.

Table 81. Analysis' summary of Hexachlorocyclohexane and its isomers

HCH (ng/g fat)	Concentration values				
	From more than one round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
Alpha-HCH	✓	Except Barbados (2018)	Barbados (2018)		Barbados (2018)
Beta-HCH	✓		Mexico	All the rest	Uruguay (2009-2019)
Gamma-HCH	✓			Antigua & Barbuda	Haiti (2004) Antigua & Barbuda (2018)

Figure 110. Concentrations of Gamma-HCH by country and year

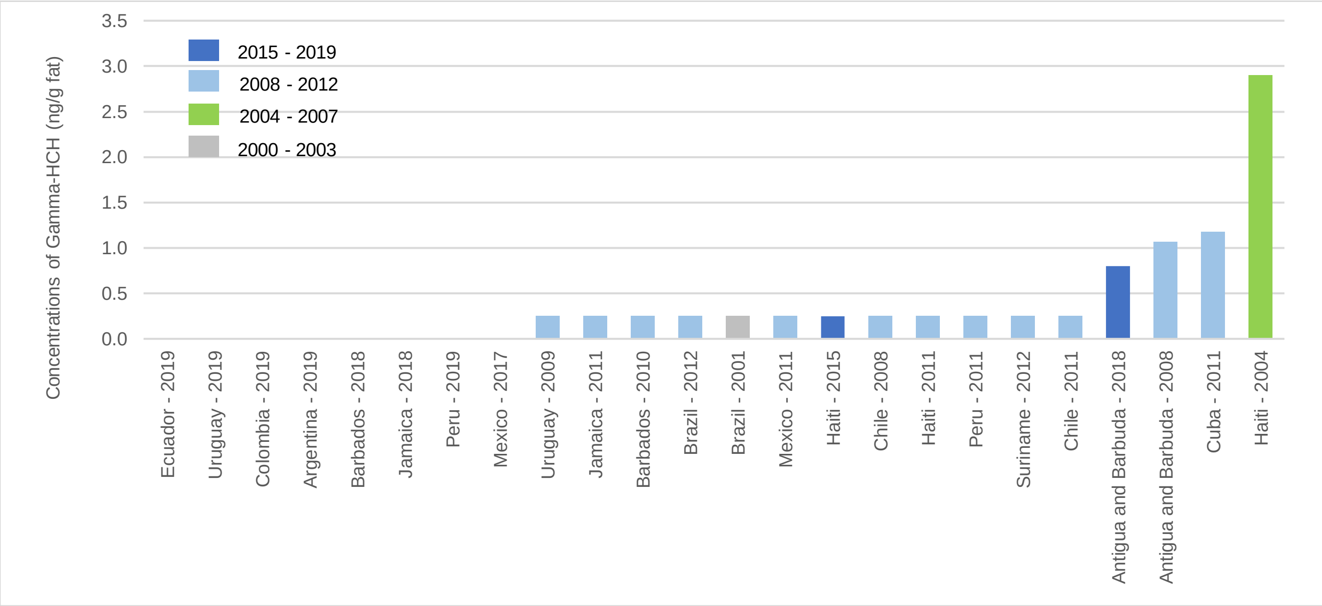


Figure 111. Behavior of HCH and its isomers in Barbados

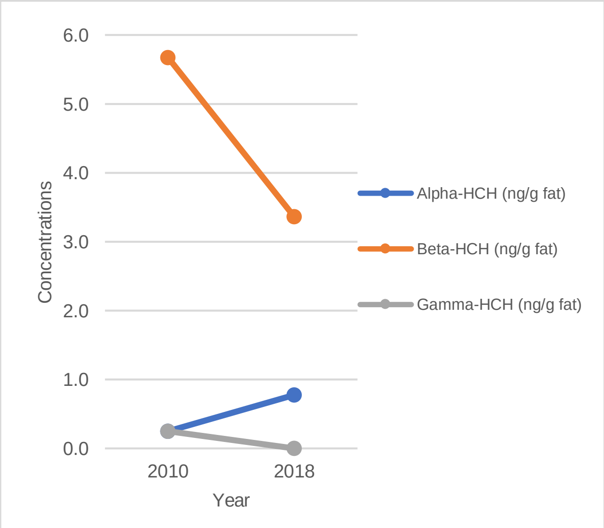


Figure 112. Behavior of HCH and its isomers in Mexico

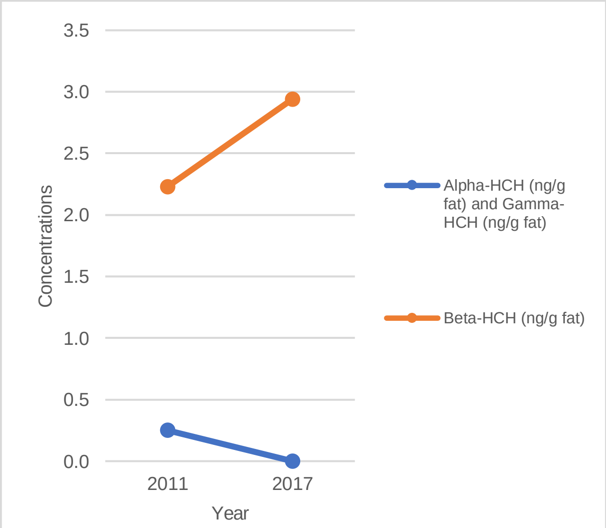
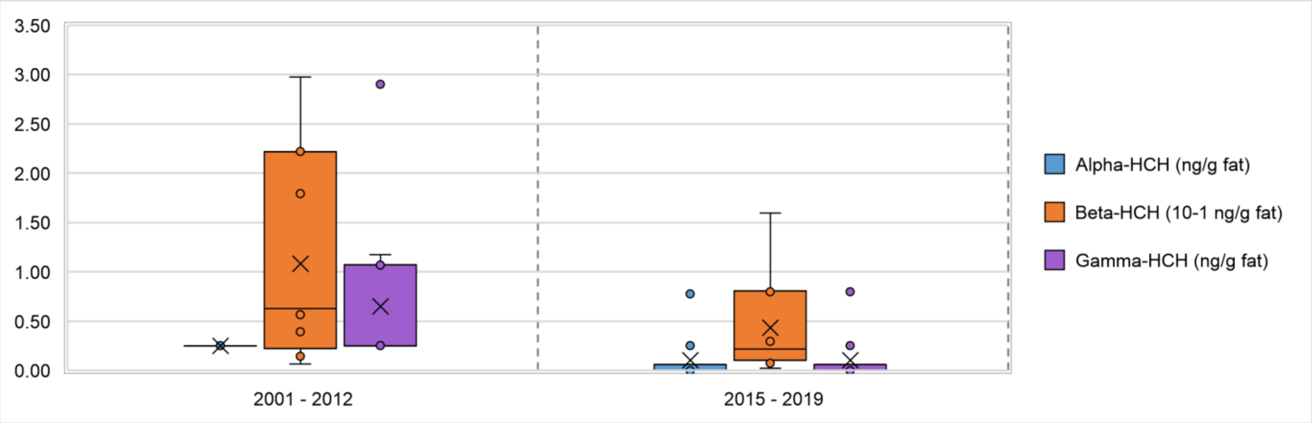


Figure 113. Behavior of HCH and its isomers in GRULAC



Note. The values in the figure were adjusted as follows:
10-1 ng/g fat means 10^{-1} ng/g fat, that is, the data were divided by 10.

Table 82. Statistical analysis of HCH and its isomers in GRULAC

HCH (ng/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
Alpha-HCH	0.25	0.78	0.25	0.10	0.25	0.00
Beta-HCH (10^{-1})	2.97	1.59	1.08	0.43	0.63	0.22
Gamma-HCH	2.90	0.80	0.65	0.10	0.25	0.00

Hexabromobiphenyl and its isomers

All PBB 153 values in the sixth round were found at zero or below the LOQ. See summary table 83, Figure 114 and statistics of the region in Figure 115 and table 84. In all the years that PBB153 has been measured in all the countries of GRULAC no values for this compound have been detected above LOQ.

Table 83. Analysis' summary of Hexabromobiphenyl and its isomers

PBB 153 (ng/g fat)	Concentrations values					
	From more than one round	Only sixth round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
PBB 153	✓		✓			

Figure 114. Concentrations of Hexabromobiphenyl and its isomers by country and year

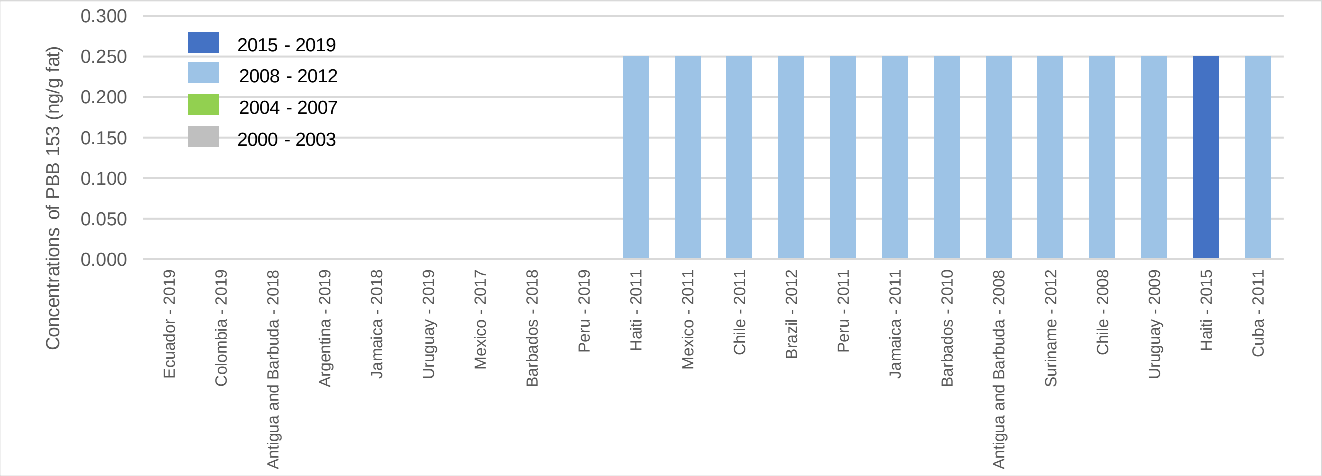


Figure 115. Behavior of Hexabromobiphenyl and its isomers in GRULAC

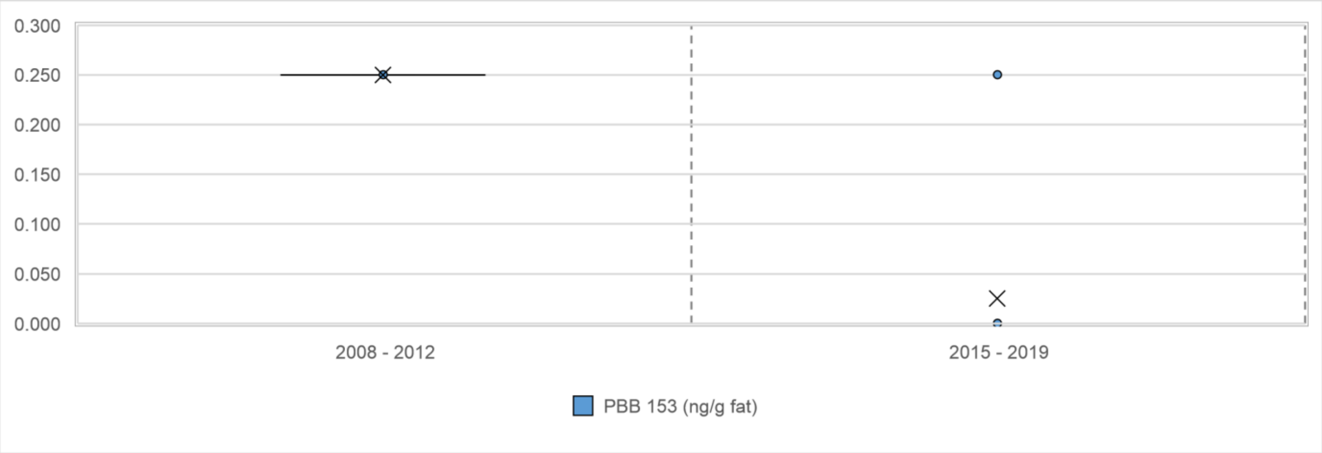


Table 84. Statistical analysis of Hexabromobiphenyl and its isomers in GRULAC

Hexabromobiphenyl (ng/g fat)						
Parameter	Maximum		Average		Median	
	2008 - 2012	2015 - 2019	2008 - 2012	2015 - 2019	2008 - 2012	2015 - 2019
PBB 153	0.250	0.250	0.250	0.025	0.250	0.000

Pentachlorobenzene

All countries presented values at zero or below the LOQ in the sixth round with the exception of Mexico, which presented a decrease in value. See summary of analysis Table 85 and figure 116. The statistics of the region show the same results with extreme value in Mexico because it presents the only value in the sixth round of the region. Figure 117 and table 86.

Table 85. Analysis' summary of Pentachlorobenzene

PeCB (ng/g fat)	Concentration values					
	From more than one round	Only sixth round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
PeCB	✓				Mexico	Mexico (2011-2017)

Figure 116. Concentrations of Pentachlorobenzene per country and year

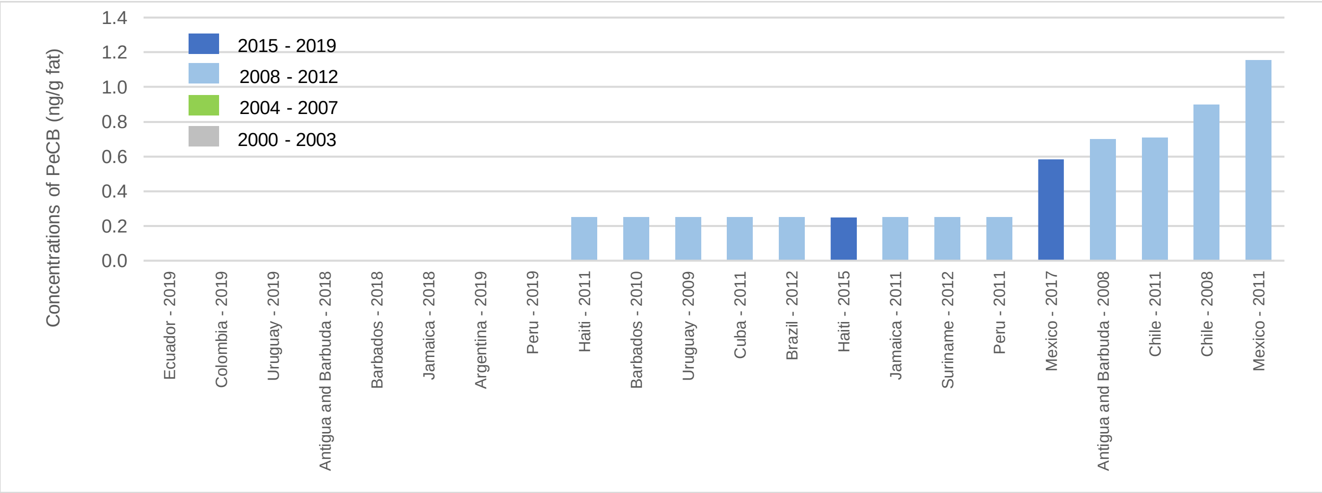


Figure 117. Behavior of Pentachlorobenzene in GRULAC

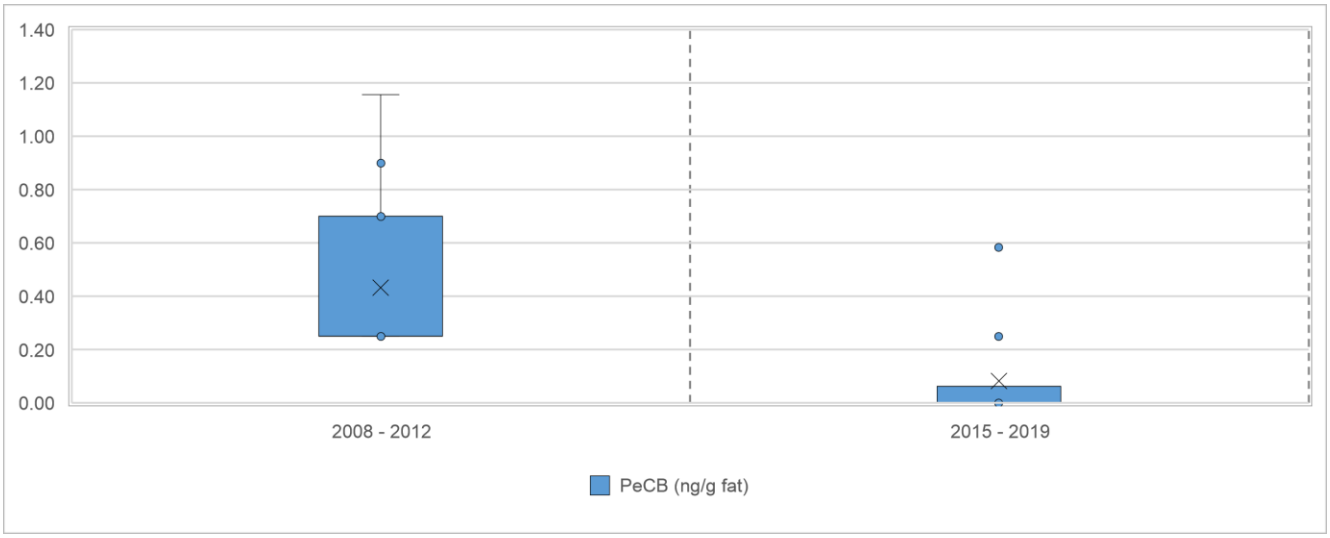


Table 86. Statistical analysis of PeCB in GRULAC

PeCB (ng/g fat)						
Parameter	Maximum		Average		Median	
	2008- 2012	2015 - 2019	2008 - 2012	2015 - 2019	2008 - 2012	2015 - 2019
PeCB (ng/g fat)	1.157	0.583	0.432	0.083	0.250	0.000

Bromine Diphenyl Ethers and their isomers

All the parameters showed a decrease in concentration values in the sixth round. However, there are several BDEs that showed slight increases in Peru and Uruguay. In addition, the BDE 153 showed a significant increase in Antigua and Barbuda; and the maximum values of three isomers are found also in Antigua and Barbuda, two more in Haiti and one in Mexico. Please see summary of the analysis in Table 87 and the behavior of the BDE in the countries in Figures 118 to 120.

Table 87. Analysis' summary of Bromine Diphenyl Ethers and their isomers

BDE (ng/g fat)	Concentration values					
	From more than one round	Only sixth round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
BDE 47	✓			Peru	All the rest	Haiti (2011) Mexico (2017)
BDE 99	✓			Peru	All the rest	Haiti (2011) Antigua & Barbuda (2018)
BDE 153	✓			Antigua & Barbuda	All the rest	Antigua & Barbuda (2018)
BDE 154	✓			Peru and Uruguay	All the rest	Haiti (2011-2015)
BDE 175/183		✓				Haiti (2015)
Optional:						
BDE 17	✓			No data		Haiti (2011)
BDE 28	✓			No data		Haiti (2011)
BDE 100	✓			Peru	All the rest	Haiti (2011) Antigua & Barbuda (2018)

Parameter measured for the first time in human milk in the region.

Figure 118. Behavior of BDE and its isomers in Antigua & Barbuda

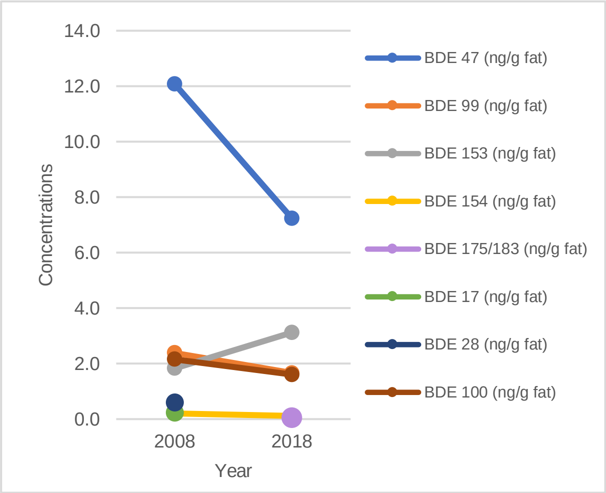


Figure 119. Behavior of BDE and its isomers in Peru

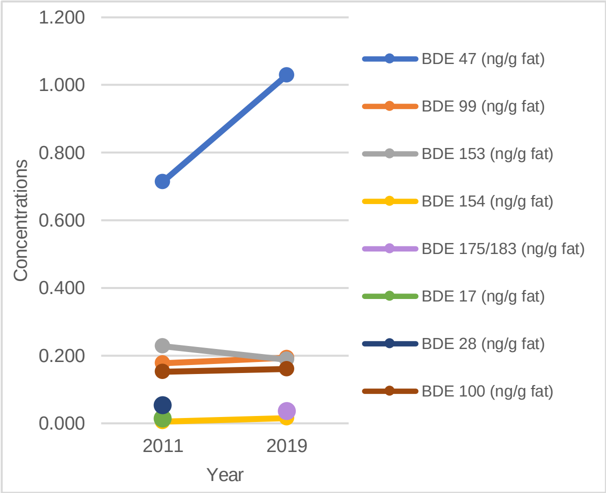
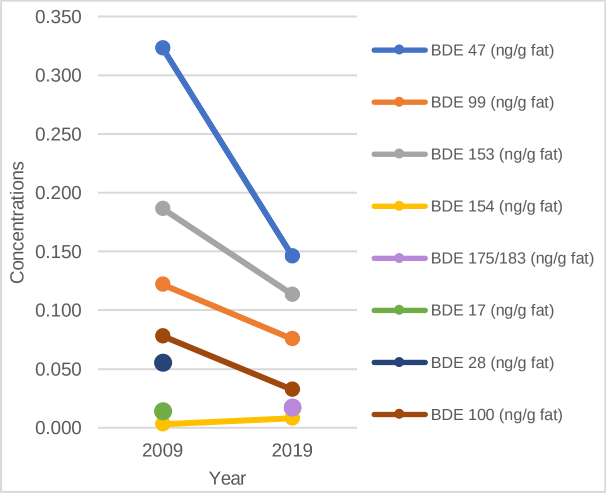
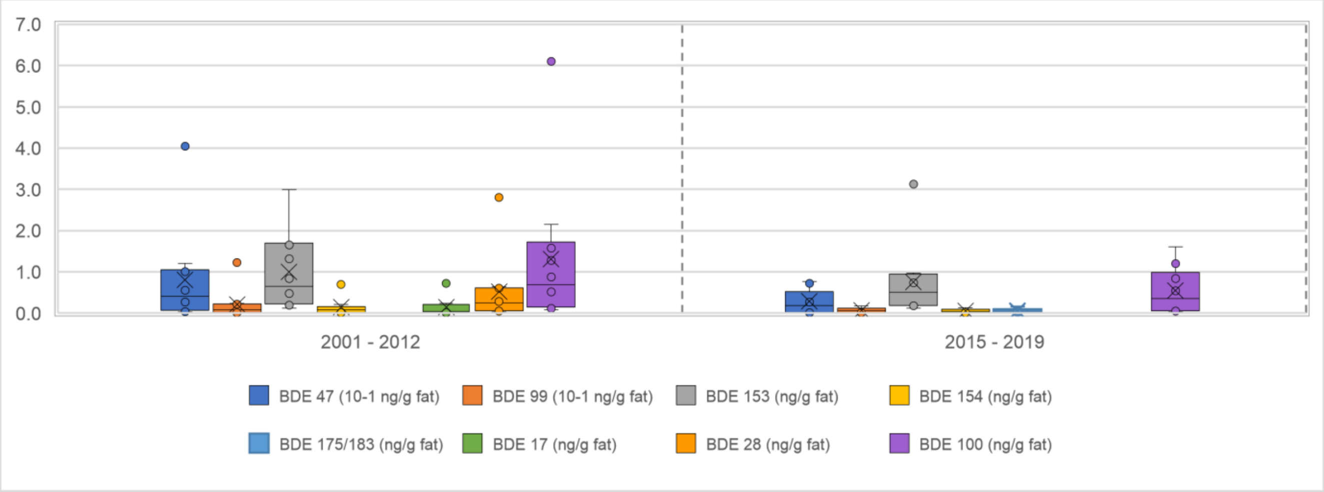


Figure 120. Behavior of BDE and its isomers in Uruguay



The statistics of the region (figure 121 and table 88) confirm this analysis, showing medians with lower values in the sixth round and an extreme value of BDE 153 corresponding to Antigua and Barbuda. Note that in the sixth round BDE 17 and 28 were not measured and BDE 175/183 was measured for the first time.

Figure 121. Behavior of BDE and its isomers in GRULAC



Note. The values in the figure were adjusted as follows:
10-1 ng/g fat means 10^{-1} ng/g fat, that is, the data were divided by 10.

Table 88. Statistical analysis of BDE and its isomers in GRULAC

BDE (ng/g fat)						
Parameter	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
BDE 47 (10^{-1})	4.04	0.77	0.80	0.28	0.41	0.19
BDE 99 (10^{-1})	1.23	0.17	0.21	0.07	0.09	0.05
BDE 153	2.99	3.12	0.99	0.75	0.65	0.50
BDE 154	0.70	0.14	0.14	0.05	0.08	0.04
BDE 175/183		0.15		0.06		0.04
BDE 17	0.72		0.14		0.04	
BDE 28	2.80		0.52		0.24	
BDE 100	6.10	1.61	1.30	0.55	0.69	0.35

Note. The values in the figure were adjusted as follows:
10-1 ng/g fat means 10^{-1} ng/g fat, that is, the data were divided by 10.

Hexabromocyclododecane (HBCD) and its isomers

In the sixth round the values of the Beta and Gamma isomers of HBCD were zero or below the LOQ in almost all countries except for Haiti 2015, which presented an increase of Gamma-HBCD concentration. However, the Alpha-HBCD isomer showed increases in five countries ranging from slight to significant as shown in the summary of the analysis, Table 89 and in the figures of the behavior of HBCD in the countries, Figures 122 to 126. Due these increases in the concentration values, the region in the sixth round showed an increase in the median and average of the Alpha-HBCD. See Figure 127 and table 90.

Table 89. Analysis' summary of Hexabromocyclododecane and its isomers

HBCD (ng/g fat)	Concentration values				
	From more than one round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
Alpha-HBCD	✓		Antigua & Barbuda, Haiti, Jamaica, Mexico, Peru	Barbados, Uruguay	Ecuador (2019)
Beta-HBCD	✓	✓			
Gamma-HBCD	✓	Except Haiti (2015)	Haiti (2015)		Haiti (2015)

Parameter with increases of concentrations in more than three countries

Figure 122. Behavior of HBCD and its isomers in Antigua & Barbuda

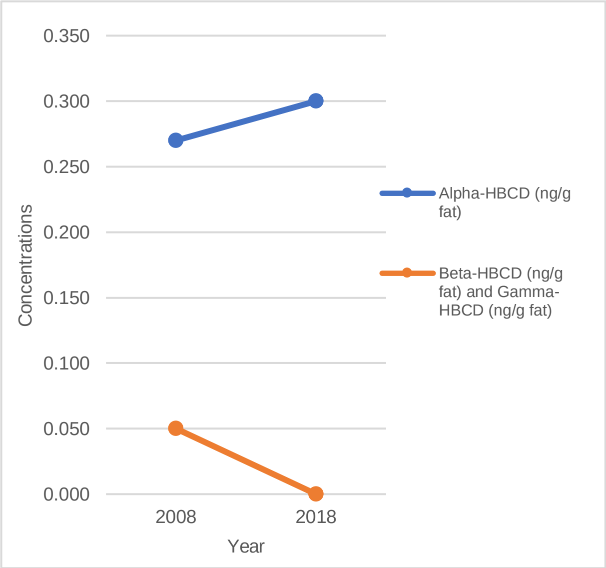


Figure 123. Behavior of HBCD and its isomers in Haiti

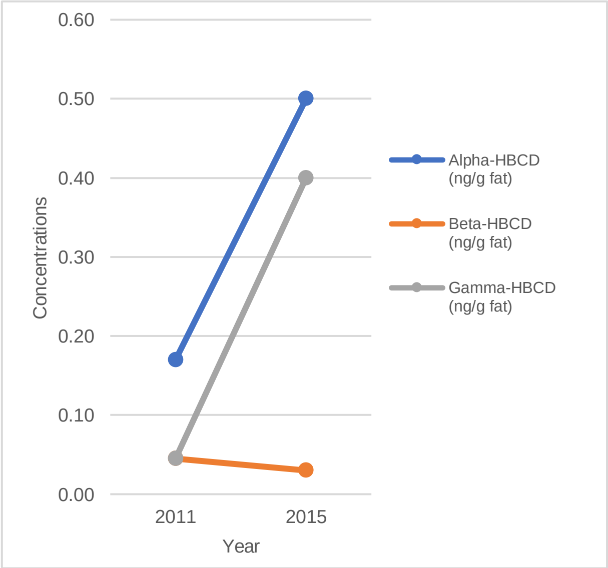


Figure 124. Behavior of HBCD and its isomers in Jamaica

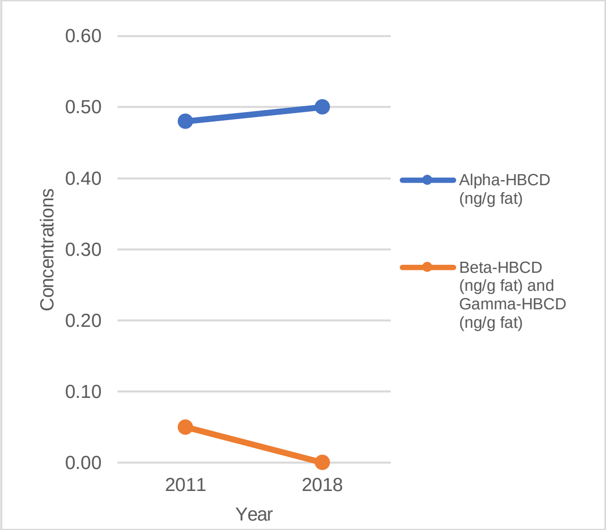


Figure 125. Behavior of HBCD and its isomers in Mexico

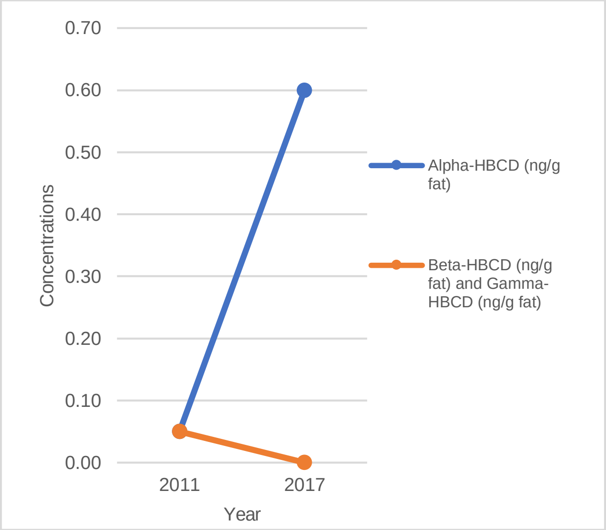
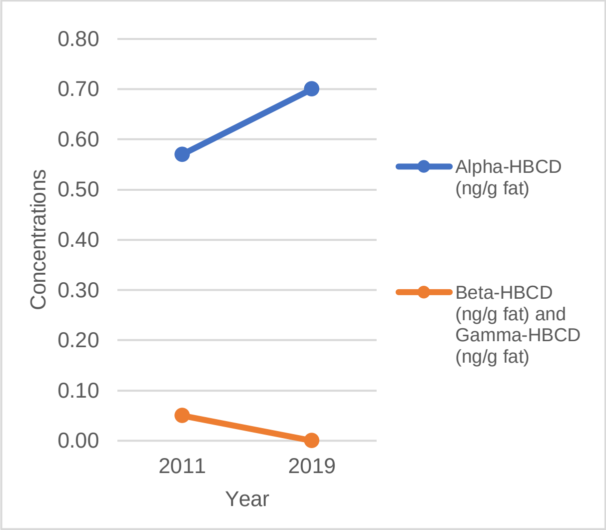


Figure 126. Behavior of HBCD and its isomers in Peru



The comparison of the medians of all participating countries in the region is presented in figure 127 and Table 90 where it is observed that only Alpha-HBCD has a slight increase in the median of the sixth round. Extreme values of Alpha and Gamma HBCD are presented in Ecuador 2019 and Haiti 2015 respectively in the sixth round.

Figure 127. Behavior of HBCD and its isomers in GRULAC

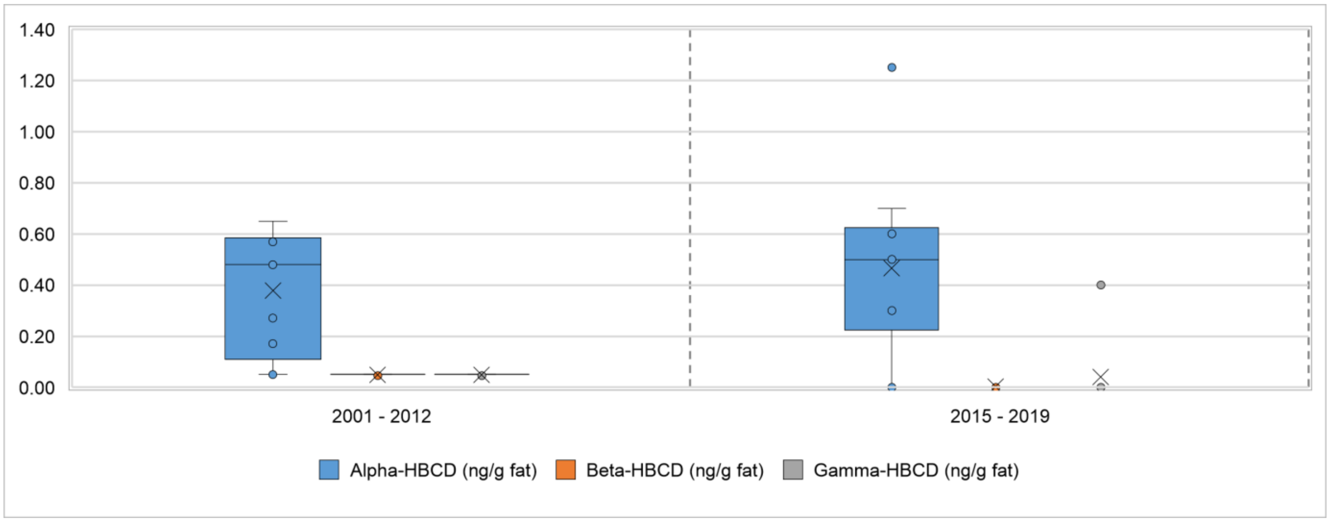


Table 90. Statistical analysis of HBCD and its isomers in GRULAC

HBCD (ng/g fat)						
Parameter	Maximum		Average		Median	
	2008 - 2012	2015 - 2019	2008 - 2012	2015 - 2019	2008 - 2012	2015 - 2019
Alpha-HBCD	0.65	1.25	0.38	0.47	0.48	0.5
Beta-HBCD	0.05	0.03	0.05	0.00	0.05	0.00
Gamma-HBCD	0.05	0.4	0.05	0.04	0.05	0.00

Toxic Equivalence Factors (TEQs). Dioxins and Furans and PCBs similar to Dioxins

All the factors showed a decrease in value in the sixth round as observed in the summary of the analysis, Table 91; and in the statistics of the region, figure 128 and table 92, which did not present extreme values in any country in the sixth round.

Table 91. Analysis' summary of Toxic Equivalence Factors (TEQs)

TEQ (pg/g fat)	Concentration values					
	From more than one round	Only sixth round	All under LOQ or equal to zero	Countries with increases in sixth round	Countries with decreases in sixth round	Countries with maximum values (year)
PCDDs WHO1998-TEQ LB	✓				All	Chile (2008), Jamaica (2018)
PCDDs WHO1998-TEQ UB	✓				All	Chile (2008), Jamaica (2018)
PCDDs WHO2005-TEQ LB	✓				All	Chile (2008), Jamaica (2018)
PCDDs WHO2005-TEQ UB	✓				All	Chile (2008), Jamaica (2018)
PCDDs/Fs WHO1998-TEQ LB	✓				All	Chile (2008), Uruguay (2019)
PCDDs/Fs WHO1998-TEQ UB	✓				All	Chile (2008), Uruguay (2019)
PCDDs/Fs WHO2005-TEQ LB	✓				All	Chile (2008), Uruguay (2019)
PCDDs/Fs WHO2005-TEQ UB	✓				All	Chile (2008), Uruguay (2019)
PCDFs WHO1998-TEQ LB	✓				All	Chile (2008), Uruguay (2019)
PCDFs WHO1998-TEQ UB	✓				All	Chile (2008), Uruguay (2019)
PCDFs WHO2005-TEQ LB	✓				All	Chile (2008), Uruguay (2019)
PCDFs WHO2005-TEQ UB	✓				All	Chile (2008), Uruguay (2019)
PCBs WHO1998-TEQ LB	✓				All	Peru (2011), Argentina (2019)
PCBs WHO1998-TEQ UB	✓				All	Peru (2011), Argentina (2019)
PCBs WHO 2005-TEQ LB	✓				All	Peru (2011-2019)
PCBs WHO 2005-TEQ UB	✓				All	Peru (2011-2019)

Figure 128. Behavior of Toxic Equivalence Factors (TEQs) in GRULAC

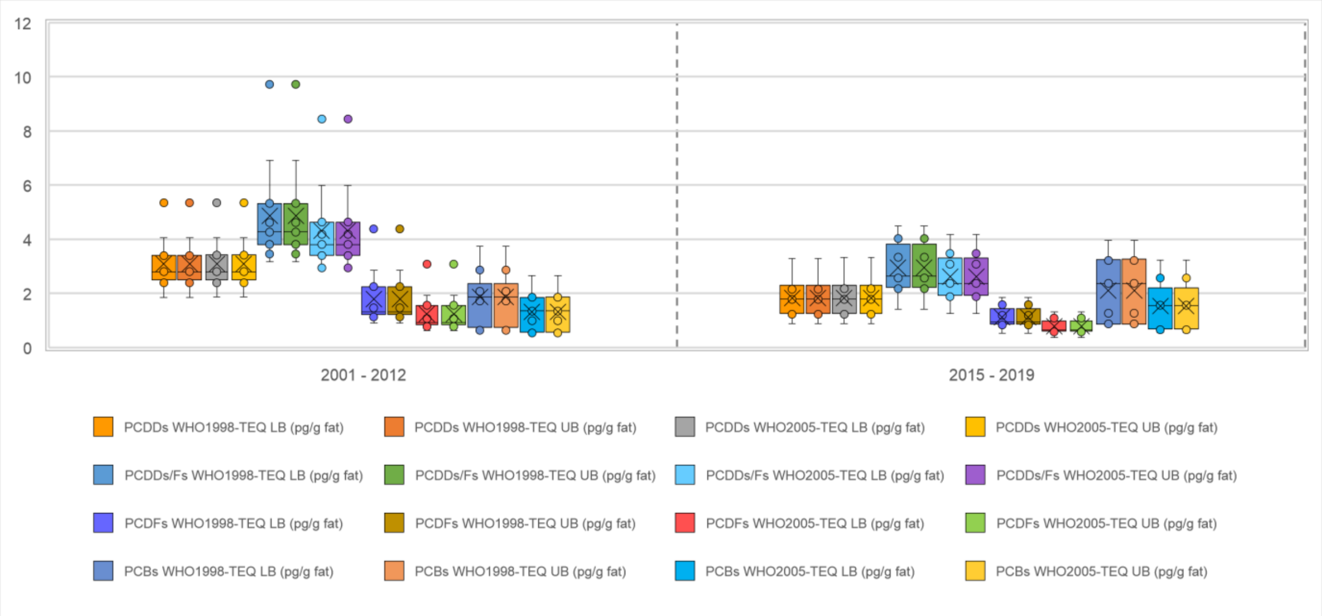


Table 92. Statistical analysis of TEQs in GRULAC

Parameter	TEQs (pg/g fat)					
	Maximum		Average		Median	
	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019	2001 - 2012	2015 - 2019
PCDDs WHO1998-TEQ LB	5.35	3.30	3.09	1.91	2.80	1.91
PCDDs WHO1998-TEQ UB	5.35	3.30	3.09	1.91	2.80	1.91
PCDDs WHO2005-TEQ LB	5.36	3.32	3.09	1.92	2.81	1.91
PCDDs WHO2005-TEQ UB	5.36	3.32	3.09	1.92	2.81	1.91
PCDDs/Fs WHO1998-TEQ LB	9.73	5.06	4.87	3.16	4.27	2.99
PCDDs/Fs WHO1998-TEQ UB	9.73	5.06	4.87	3.16	4.27	2.99
PCDDs/Fs WHO2005-TEQ LB	8.44	4.29	4.32	2.78	3.81	2.73
PCDDs/Fs WHO2005-TEQ UB	8.44	4.29	4.32	2.78	3.81	2.73
PCDFs WHO1998-TEQ LB	4.38	2.39	1.79	1.25	1.32	1.07
PCDFs WHO1998-TEQ UB	4.38	2.39	1.79	1.25	1.33	1.07
PCDFs WHO2005-TEQ LB	3.08	1.62	1.24	0.86	0.93	0.76
PCDFs WHO2005-TEQ UB	3.08	1.62	1.24	0.86	0.93	0.76
PCBs WHO1998-TEQ LB	3.95	2.38	1.88	1.32	1.87	1.07
PCBs WHO1998-TEQ UB	3.95	2.38	1.88	1.32	1.87	1.07
PCBs WHO2005-TEQ LB	3.23	1.58	1.32	0.92	1.35	0.74
PCBs WHO2005-TEQ UB	3.23	1.58	1.32	0.92	1.35	0.74

Substances measured for the first time

Eight parameters are presented in summary table 93 that were analyzed for the first time in the sixth round of the human milk survey and do not correspond to another chemical subgroup. It is important to note that among them one substance is under review and have not yet been listed in the Stockholm Convention. Four of these eight substances presented values equal to zero in all the countries of the region. The comparisons of the concentrations of the countries with values above zero are presented in the figures Figure 129 to 132; and the distribution and variability of the concentration values are presented in figure 133 where the sum of Chlorinated Paraffins (Sum SCCPs) presents an extreme value in Peru, Perfluorooctane Sulfonic Acid (PFOS) in Uruguay and maximum value of Perfluorooctanoic acid (PFOA) in Barbados. For the statistical analysis please see Table 94. It is worth mentioning that these compounds were not analyzed in Haiti (2015).

Table 93. Analysis' summary of the substances measured for the first time in the sixth round

First time measured substances	Concentration values			
	Only sixth round	All under LOQ	All equal to zero	Countries with maximum values (year)
Hexachlorobutadiene				
HCBD (ng/g fat)	✓		✓	
Pentachlorophenol				
PCA (ng/g fat)	✓		✓	
PCP (ng/g fat)	✓		✓	
Short-chain chlorinated paraffins				
Sum SCCPs (ng/g fat)	✓			Peru (2019)
Perfluorooctane sulfonic acid				
PFOS (pg/l)	✓			Uruguay (2019)
Perfluorooctanoic acid				
PFOA (pg/l)	✓			Barbados (2018)
Dicofol (ng/g fat)	✓		✓	
Candidate POP				
Perfluorohexane sulfonic acid: PFHxS (pg/l)	✓			Value 2750 for all

Figure 129. Concentrations of the Sum of SCCPs by country and year

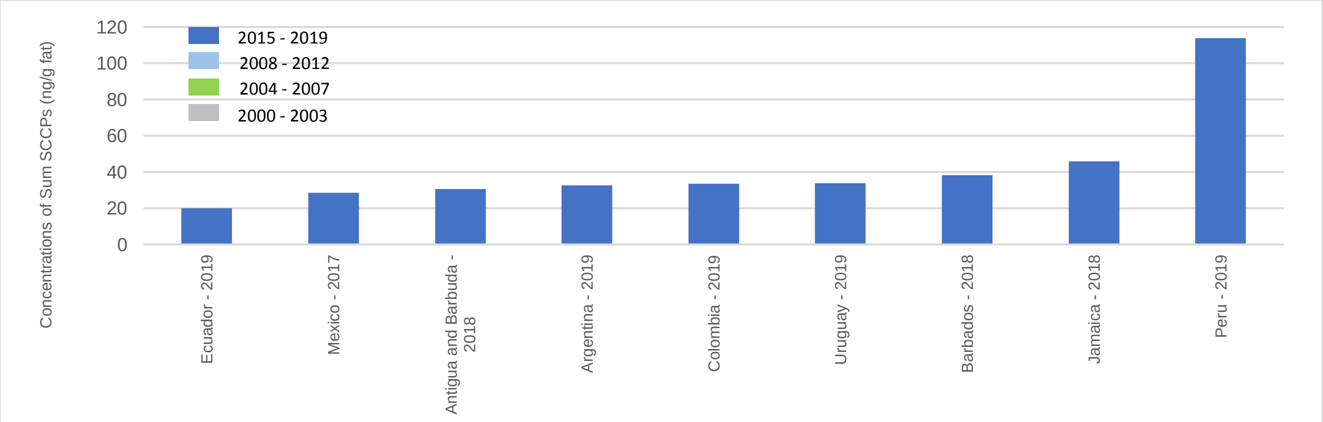


Figure 130. Concentrations of PFOS by country and year

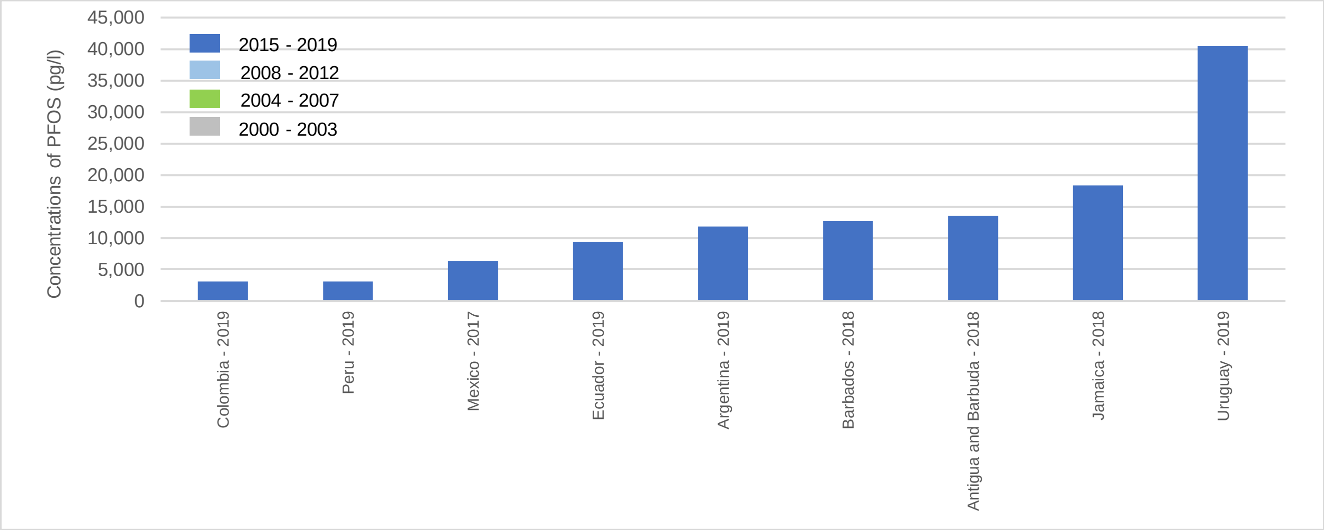


Figure 131. Concentrations of PFOA by country and year

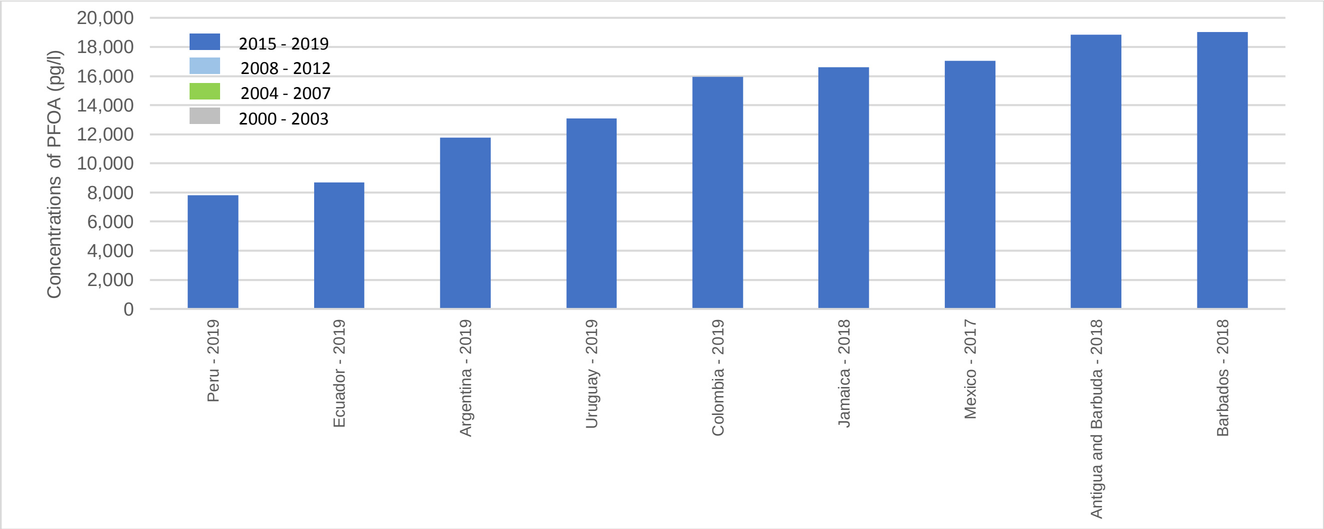


Figure 132. Concentrations of PFHxS by country and yea

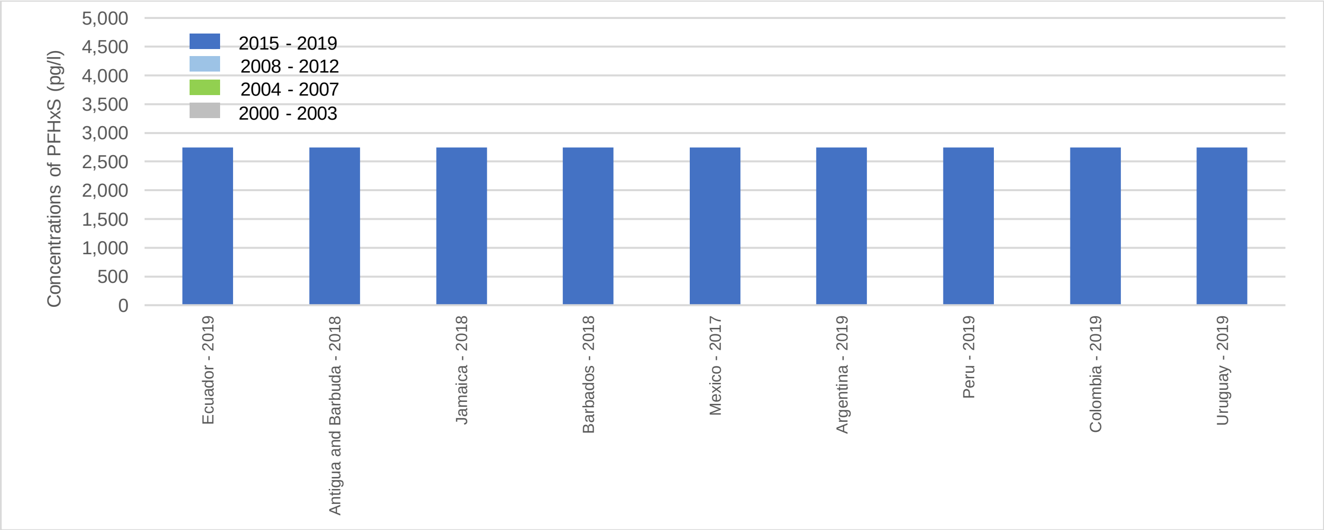
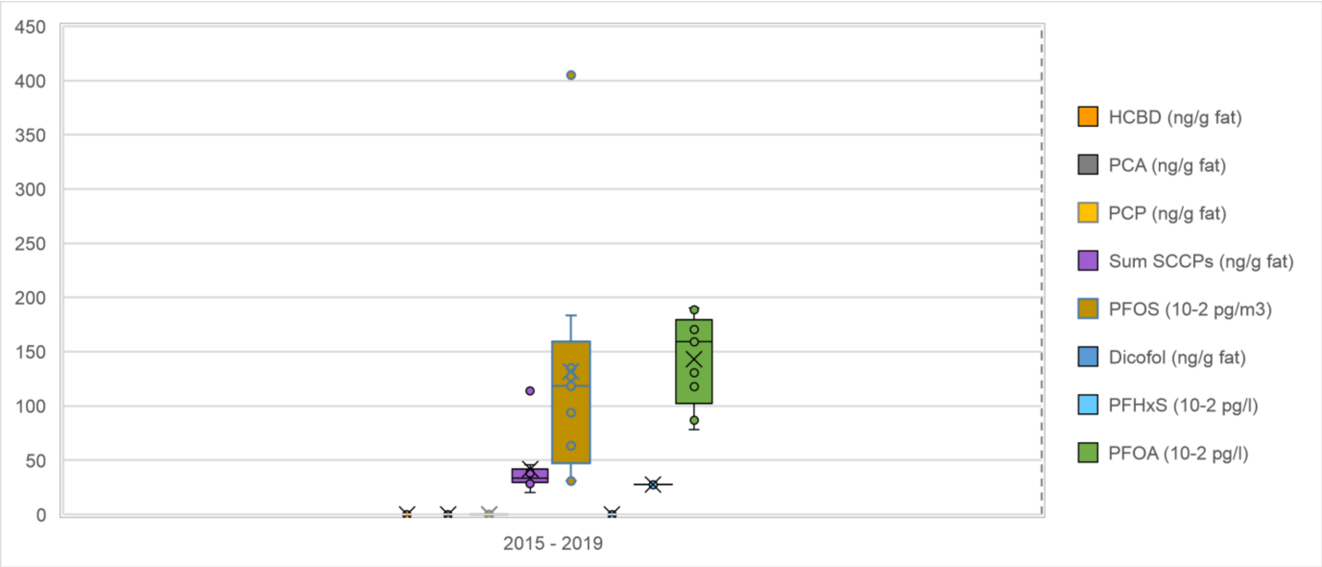


Figure 133. Behavior of the substances measured for the first time in GRULAC



Note. The values in the figure were adjusted as follows:
10-2 ng/g fat means 10^{-2} ng/g fat, that is, the data were divided by 100.

Table 94. Statistical analysis of the substances measured for the first time in GRULAC

SUBSTANCES MEASURED FOR THE FIRST TIME			
Parameter	Maximum	Average	Median
	2017 - 2019	2017 - 2019	2017 - 2019
HCBD (ng/g fat)	0.0	0.0	0.0
PCA (ng/g fat)	0.0	0.0	0.0
PCP (ng/g fat)	0.0	0.0	0.0
Sum SCCPs (ng/g fat)	114.0	41.9	33.4
PFOS (10^{-2} pg/l)	404.9	132.0	118.4
PFOA (10^{-2} pg/l)	190.3	143.2	159.3
Dicofol (ng/g fat)	0.0	0.0	0.0
PFHxS (pg/l)	27.5	27.5	27.5

6.2.3. WATER RESULTS

Water sampling data result from three sources, as described in chapter 4: GMP UNEP that recorded a PFOS data from a day sampling of Río de la Plata Uruguay, 2014; the Monet-Aqua Project, which monitored for around three months at two sites in 2016 and recorded data for 47 parameters grouped into 9 groups of compounds: organochlorine insecticides: cyclodiene subgroup, dichloro diphenyl trichloroethane and its isomers, hexachlorobenzene, polychlorinated biphenyls and congeners, polychlorinated biphenyls and congeners with TEFs, hexachlorocyclohexane and its isomers, pentachlorobenzene, bromo diphenyl ethers and its isomers, and hexachlorocyclododecane and its isomers; and the UNEP / GEF GMP II projects that monitored in 6 sites located in 5 countries in 2017 and 2018 and recorded data on PFOS, PFOA and PFHxS, compounds recommended to be measured in water by the Conference of the Parties. Figures 134, 135 and 136 show the time in which the programs were applied, the number of sites and their location.

It is worth mentioning that, at the sixth meeting of the Conference of the Parties, the media Water was added as a target matrix for monitoring perfluorooctanesulfonic acid (PFOS), its salts and perfluorooctanesulfonyl fluoride (POSF), that is, only for fluorinated compounds; and in 2018, pentadecafluorooctanoic acid (PFOA) and perfluorohexane sulfonic acid (PFHxS) were proposed, with PFOA being approved in 2019.

Figure 134. Programs' application time

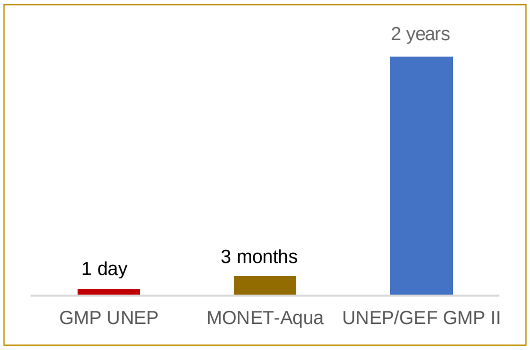


Figure 135. Sites' number per Program

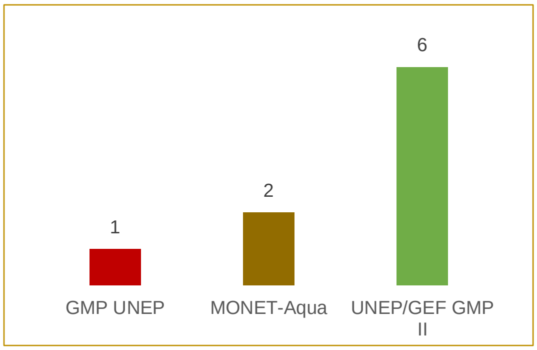
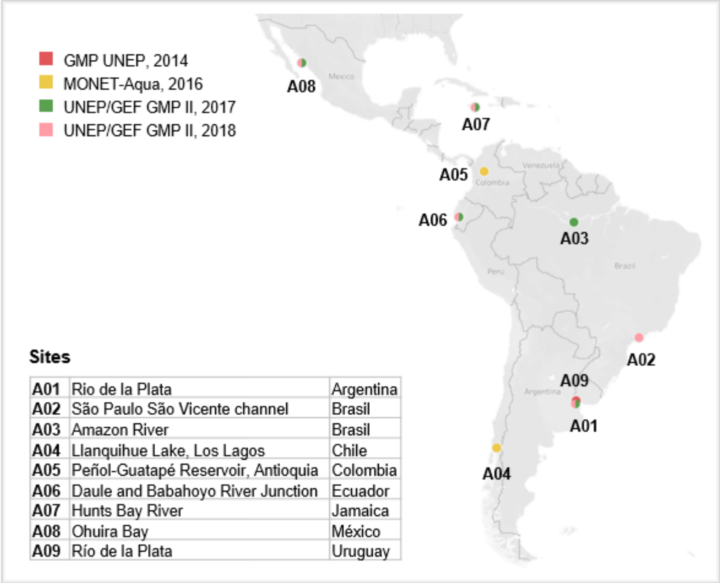


Figure 136. Sites' location per Program



From these three data sources only the UNEP/GEF GMP II projects adopted the target compounds of water matrix, protocol and sampling frequency recommended in the Guidance on the Global Monitoring Plan for Persistent Organic Pollutants. The six monitoring sites are classified as urban, three monitored surface river water and the other three coastal and ocean seawater.

The analysis of the parameters includes the integration and organization of the data, its review by sites, year and groups of compounds and its statistical observation.

The database was organized by program and compound, separating the Monet-Aqua program from the other 2 programs. To review the UNEP/GEF GMP II data, the completeness criterion was applied, monitoring at least 75% of the year, and the sites that met the criteria were selected.

Of the 6 UNEP/GEF GMP II sites which were monitored in 2017 and 2018, all sites met the completeness criteria: Rio de la Plata Argentina, the Amazon River and São Vicente São Paulo channel both in Brazil, Daule and Babahoyo River Junction in Ecuador, Hunts Bay River in Jamaica and Ohuira Bay in Mexico. In 2018, Brazil decided to change the Amazon River site to the São Vicente São Paulo channel. Therefore, each of these two sites only monitored a full year.

Analysis of the data's behavior in the region was carried out by box plots and statistical parameters and considered comparisons between all the data and data with completeness for the three target compounds of the UNEP/GEF GMP II projects.

Likewise, each of the target compounds was analyzed in the following technical sheets where all the data from UNEP/GEF GMP II and GMP UNEP were considered. The values of the medians for each year are included despite the fact that not all sites met the completeness criterion, as Uruguay 2014. Therefore, this analysis presents comparisons of concentration between years and sites by parameter. Likewise, the analysis of the data from the Monet-Aqua program compares the concentrations of the two sampling sites by groups of compounds. Relevant results are presented below.

Relevant Results

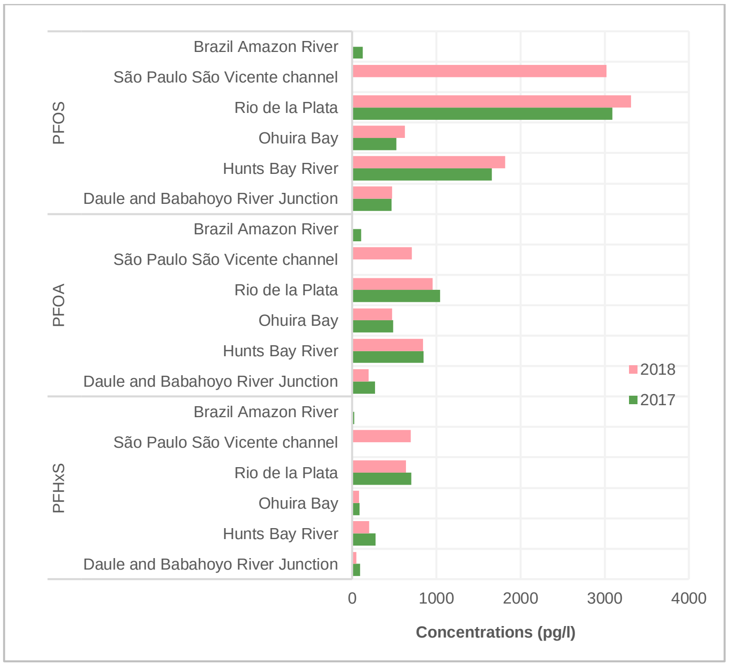
The analysis of the behavior and the corresponding statistics of PFOS, PFOA and PFHxS of the 6 UNEP/GEF GMP II sites in GRULAC, show greater dispersion and variability of PFOS data than the PFOA and PFHxS data. For the three parameters, increases in medians are observed in 2018, possibly due to the change of location of the site in Brazil.

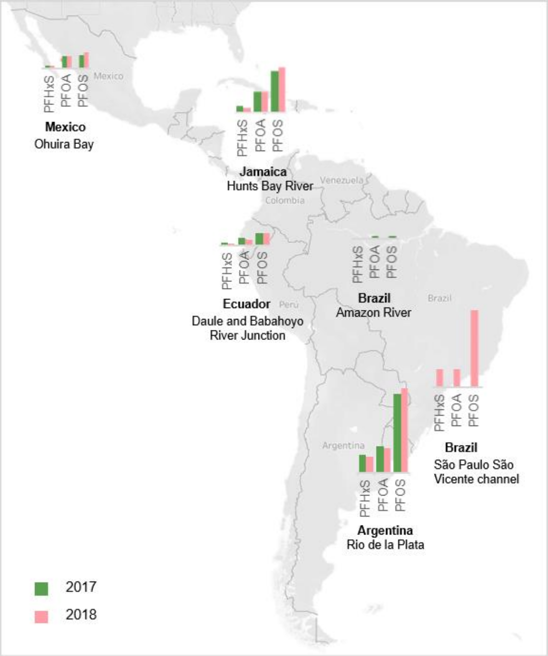
The maximum values were presented in Rio de la Plata Argentina 2017 and 2018, followed by the São Paulo São Vicente channel, Brazil 2018 and the Hunts Bay River in Jamaica 2017.

The technical sheets of these compounds measured under the UNEP/GEF GMP II and GMP UNEP projects, which include comparisons of concentrations from one year to another, show in the same way maximum values in Rio de la Plata Argentina 2017 and 2018, for the three parameters and minimum values in the Amazon River Brazil 2017, possibly due to the great dilution capacity that this river has due to its great flow.

Concentration changes can be observed at the four sites that measured the full two years Rio de la Plata Argentina, Daule and Babahoyo River Junction in Ecuador, Hunts Bay River in Jamaica and Ohuira Bay in Mexico; where increases in concentrations of PFOS and decreases in PFOA and PFHxS were seen in 2018. These changes in concentration are summarized in figure 137, where the value of Uruguay, 2014 was not included because it is not comparable.

Figure 137. Concentrations' Summary of PFOS, PFOA and PFHxS in GRULAC





Behavior of PFOS, PFOA and PFHxS in GRULAC

The regional behavior and corresponding statistics of PFOS, PFOA and PFHxS in GRULAC were analyzed by comparing the variability of the medians of both years of monitoring. Observing figure 138, in 2018 the PFOS box-and-whisker plot presents an almost symmetric distribution where the mean and median are almost equal, while PFOA and PFHxS present less variability and positive and negative asymmetries respectively. An increase in the value of the averages and medians is observed in 2018 for the three compounds, table 95. It is reiterated that the site located in the Amazon River 2017 with minimum values, changed location for São Paulo São Vicente channel site in 2018 presenting significantly higher values.

Figure 138. Behavior of PFOS, PFOA and PFHxS in GRULAC

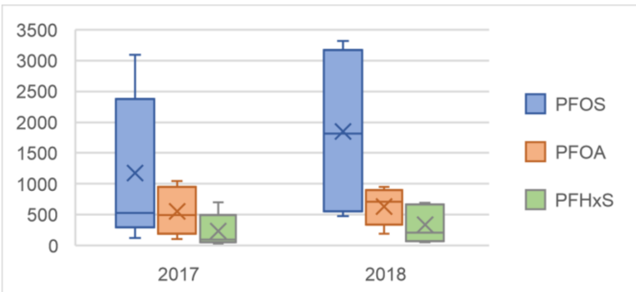


Table 95. Statistical Analysis of PFOS, PFOA and PFHxS in GRULAC

Parameter (pg/l)	Maximum		Average		Median	
	2017	2018	2017	2018	2017	2018
PFOS	3,090	3,315	1,174	1,850	525	1,815
PFOA	1,045	955	552	635	490	710
PFHxS	705	695	239	335	95	205

Technical Sheets of GMP UNEP y UNEP/GEF GMP II Programs

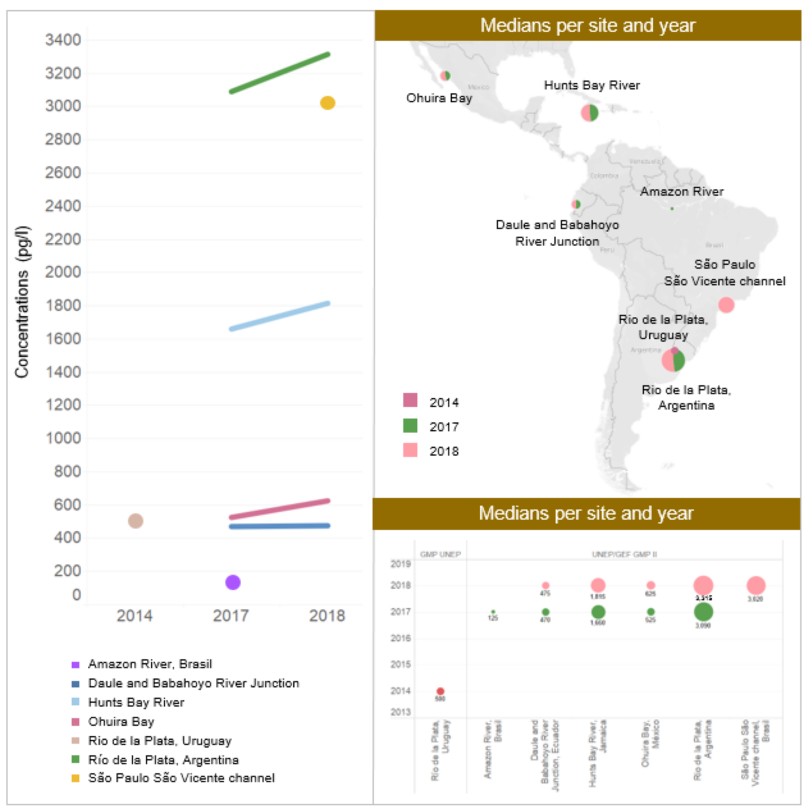
Perfluorooctane Sulfonate

Perfluorooctane Sulfonate (PFOS) was analyzed for the first time in the region in 2014 by GMP UNEP from a sampling of one day in Río de la Plata Uruguay, to corroborate the method; and in 2017 and 2018 under the UNEP/GEF GMP II projects it was analyzed at six sites in 5 countries in the region.

Figure 139 shows the comparisons of the values recorded at each site in the two years of measurement. It is observed that Rio de la Plata, Argentina, presents the maximum concentrations of PFOS in the two years of measurement, followed by São Paulo São Vicente channel, Brazil 2018. In contrast, the Amazon River 2017 site in northern Brazil, measured a full year and shows the lowest concentrations in GRULAC followed by Daule and Babahoyo River Junction in Ecuador.

All sites monitored full years as described and showed concentrations increases from 2017 to 2018.

Figure 139. Behavior of Perfluorooctane Sulfonate (PFOS) in GRULAC



Perfluorooctanoic Acid

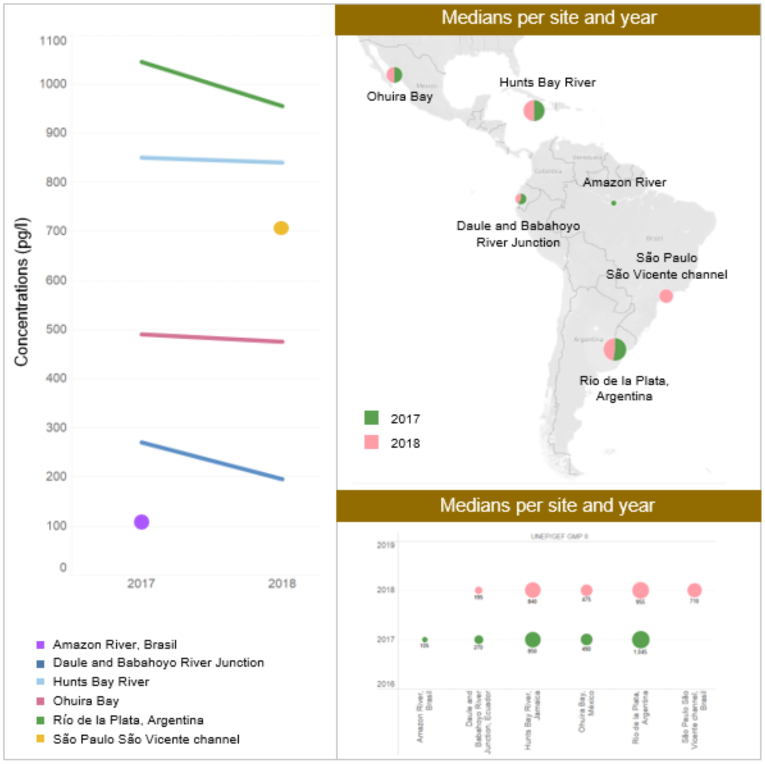
Perfluorooctanoic Acid (PFOA) was analyzed only under the UNEP/GEF GMP II projects at six sites in 5 countries that monitored during 2017 and 2018. All sites monitored full years as described.

Figure 140 shows decreases in concentrations for the case of PFOA in 2018 in the four sites with measurements in both years Rio de la Plata Argentina, Daule and Babahoyo River Junction in Ecuador, Hunts Bay River in Jamaica and Ohuira Bay in Mexico.

Again, the site Río de la Plata, Argentina presents the maximum concentrations of PFOA, in the two years of measurement followed by Río de la Bahía Hunts in Jamaica 2017.

The Amazon River site, north of Brazil, exhibits the lowest concentrations in GRULAC followed by Daule and Babahoyo River Junction in Ecuador.

Figure 140. Behavior of Perfluorooctanoic Acid (PFOA) in GRULAC



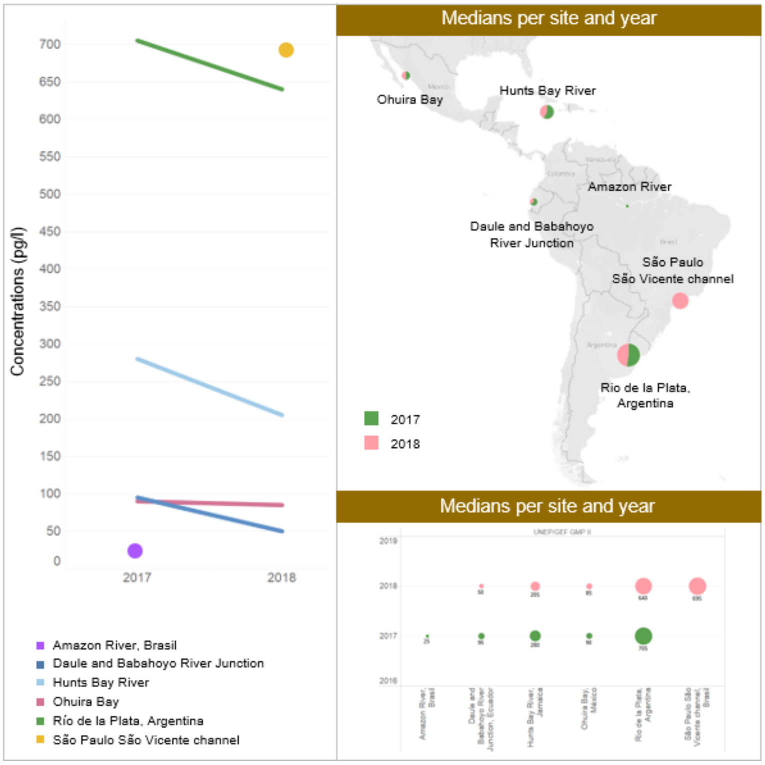
Perfluorohexane Sulfonate

Perfluorohexane Sulfonate (PFHxS) was measured, like PFOA, only by UNEP/GEF GMP II projects at six sites in 5 countries that monitored full years during 2017 and 2018.

The sites present lower concentrations values in 2018, compared to 2017 in the four sites that measured two full years Rio de la Plata Argentina, Daule and Babahoyo River Junction in Ecuador, Hunts Bay River in Jamaica and Ohuira Bay in Mexico; see Figure 141.

For this pollutant, in the Rio de la Plata, Argentina site 2017 and 2018 and in the São Paulo São Vicente channel, Brazil 2018, the highest concentrations were recorded. Again, the Amazon River, north of Brazil 2017, exhibits the lowest concentrations in GRULAC followed by Daule and Babahoyo River Junction in Ecuador 2018.

Figure 141. Behavior of Perfluorohexane Sulfonate (PFHxS) in GRULAC



MONET-Aqua Program

As mentioned, the Monet-Aqua Program, in GRULAC was only applied in 2016 at the Llanquihue Lake, Los Lagos, Chile and Peñol-Guatapé, Antioquia, Colombia. For its analysis, bar diagrams are presented below in which the concentrations of the two sites are compared by parameter analyzed. Reviewing the following figures, it is observed that most of the parameters present higher concentrations in Peñol-Guatapé Reservoir, Antioquia Colombia than those in Llanquihue Los Lagos lake, Chile. Parameters measured by this program are not target substances recommended for the water matrix by the Stockholm Convention.

Figure 142. Cyclodiene Subgroup

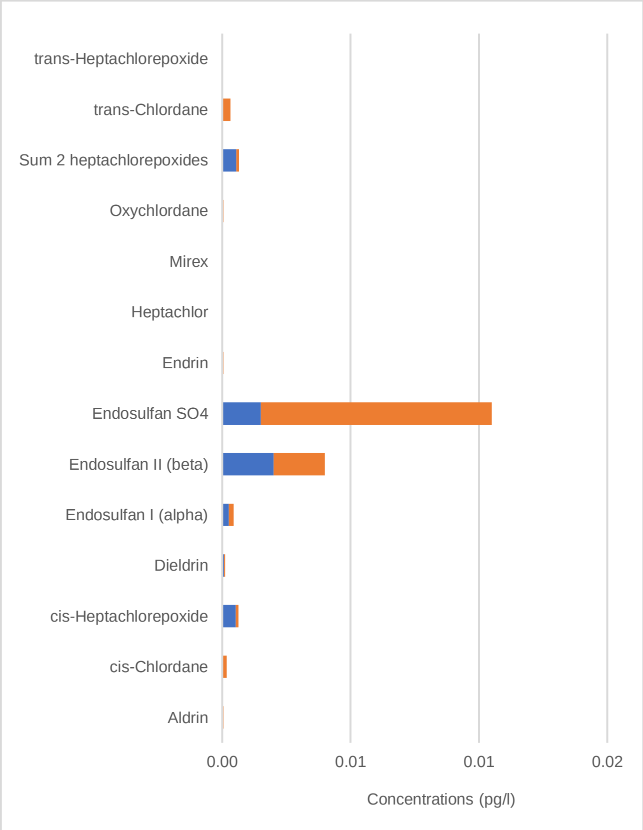


Figure 143. DDT and its isomers

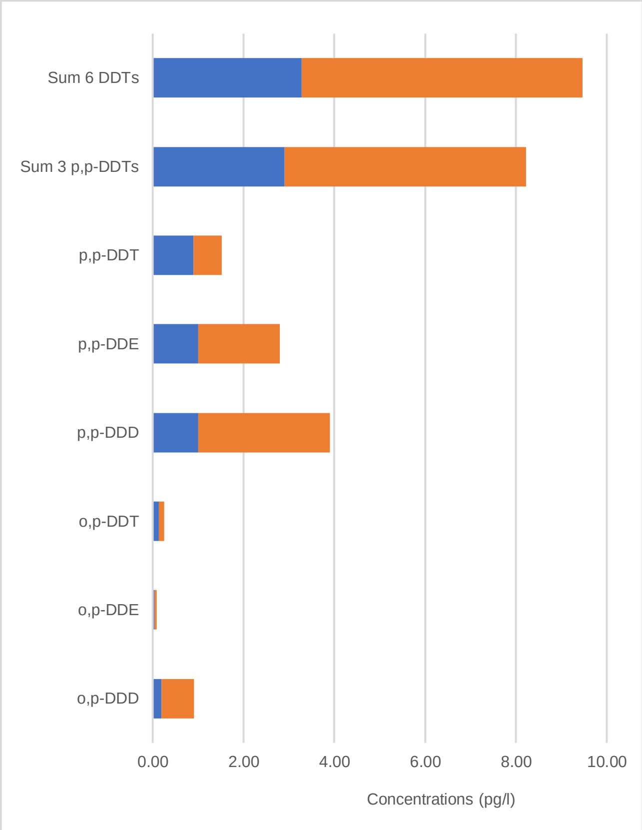


Figure 144. Hexachlorobenzene

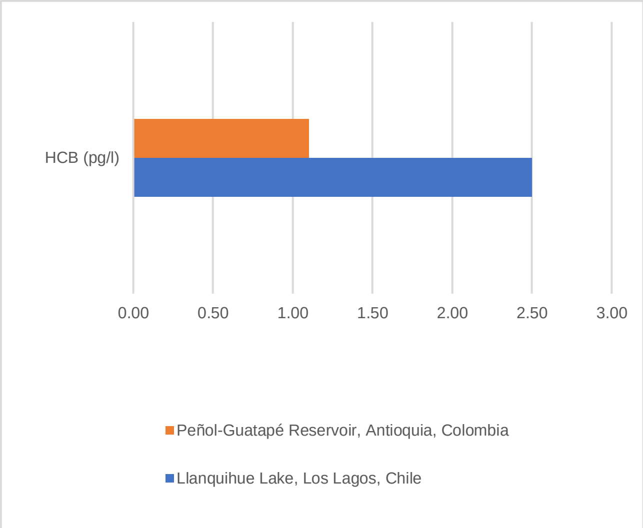


Figure 145. Polychlorinated Biphenyls and congeners

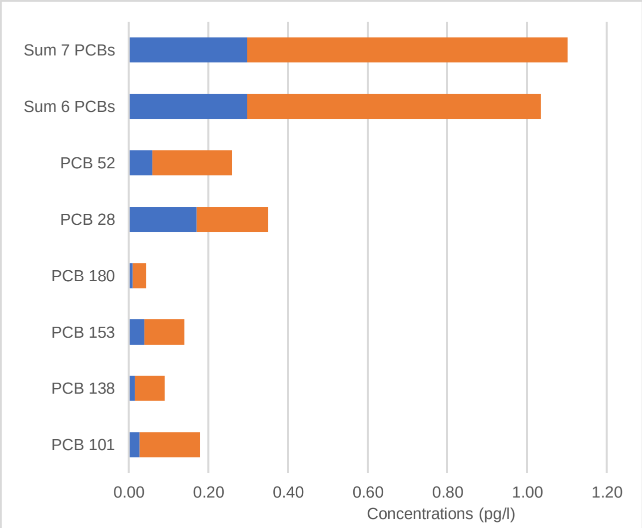


Figure 146. PCB and congeners with TEFs

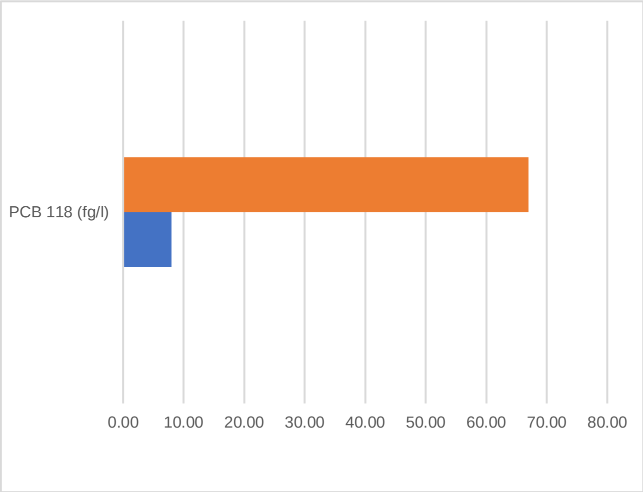


Figure 147 Hexachlorocyclohexane and its isomers

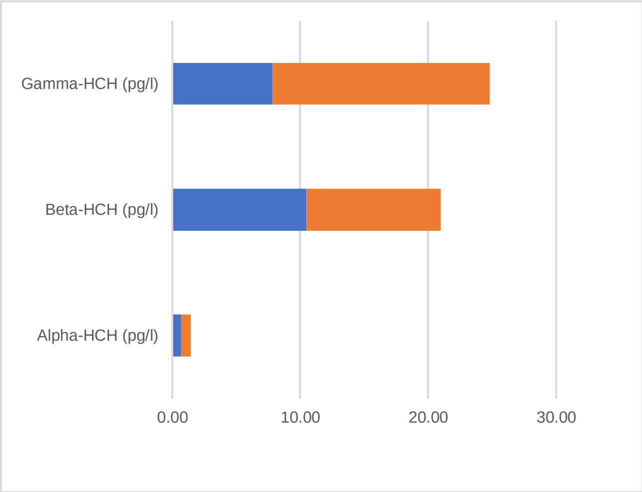


Figure 148 Pentachlorobenzene

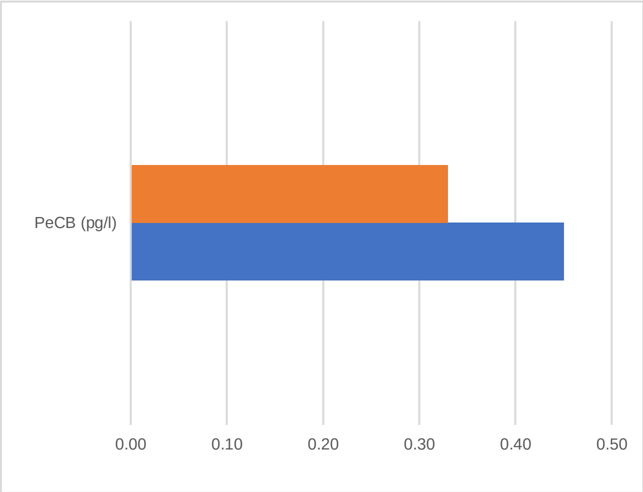


Figure 149. BDE and their isomers

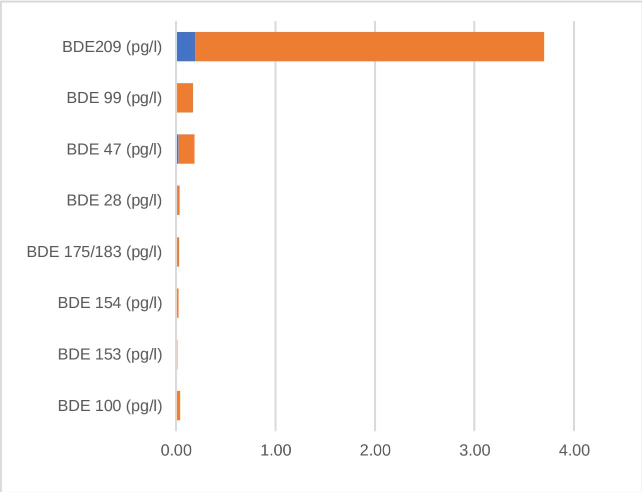
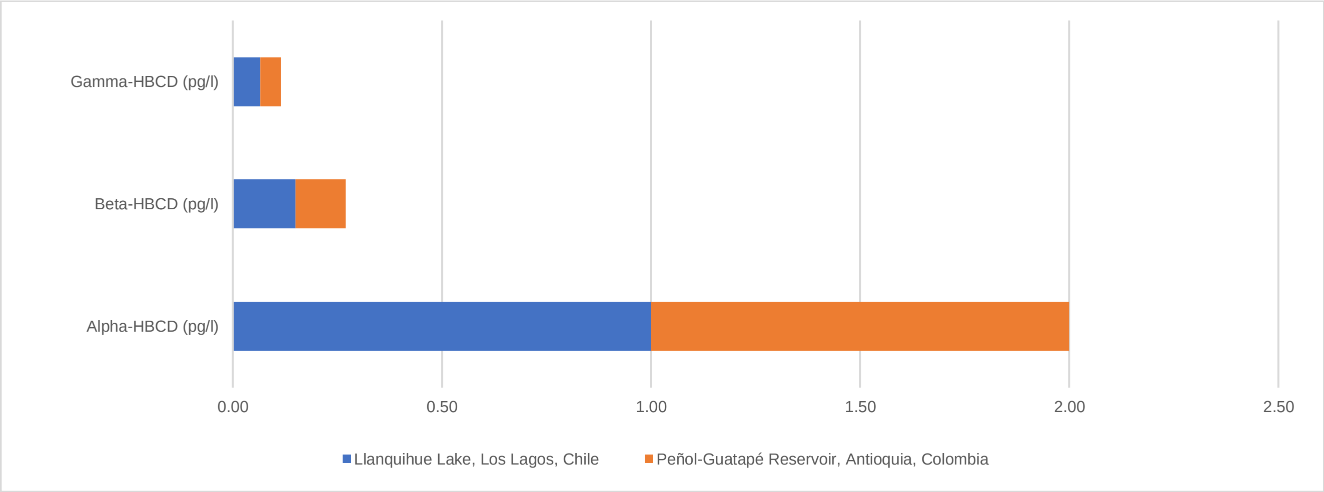


Figure 150. Hexabromocyclododecane (HBCD) and its isomers



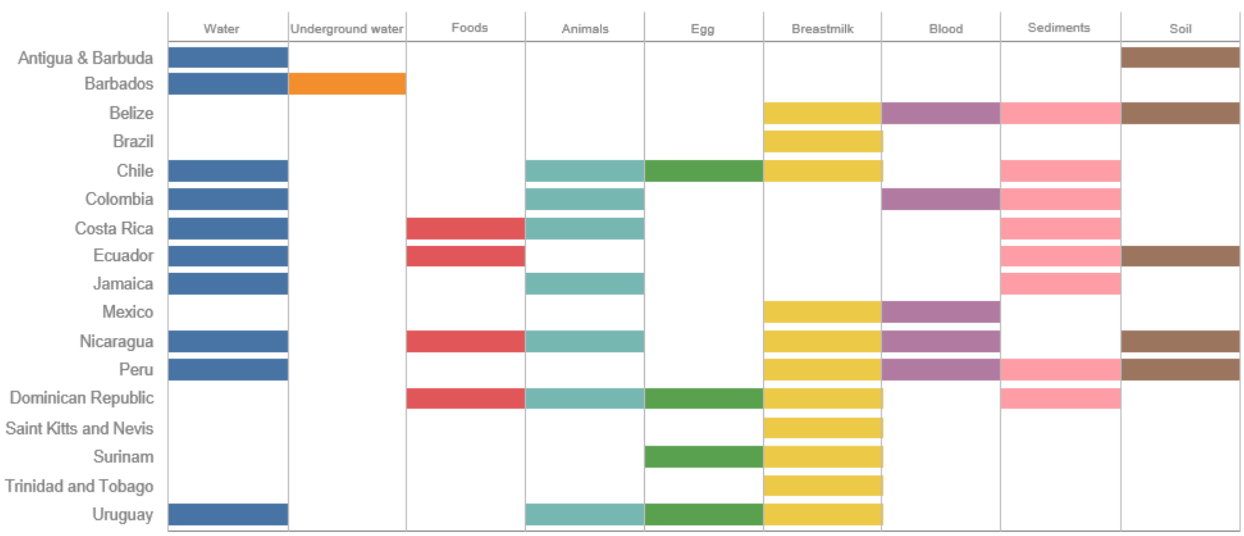
6.2.4. Additional Information. Other environmental matrices

Some countries of the GRULAC Region report having carried out POPs studies in their National Implementation Plans presented according to the obligation of the parties established in Article 7 of the Agreement. These studies include sampling campaigns in different matrices such as: water, groundwater, food, animals, blood and sediments, among others. Likewise, from the survey carried out, Colombia reported in 2021 having a Monitoring network for the Conservation and Protection of Marine and Coastal Waters called REDCAM, which carries out sampling of organochlorine pesticides in coastal waters since 2000 and marine and coastal sediments since 2014.

The summary of this information is presented in Figure 151, where under food all the samples of: lettuce, cabbage, tomato, chiltoma, potato, watermelon, cow's milk, chili pepper, garlic, sweet potato, onion, beans, okro, cucumber, leek, beet, tomato and carrot are gathered. Also, animals include fish (blood, serum, tissues), mollusks, birds, shrimp, shells, mussels, bivalve tissue, chicken and seabird eggs.

However, most studies only determine the presence or absence of POPs and the information does not provide trends or changes in concentration in the matrices analyzed. No country offers information on national POPs monitoring programs of the target substances and matrices.

Figure 151. List of countries and matrices in which POPs studies have been carried out



Source: : Created by the authors with data from National Implementation Plans: http://www.pops.int/Implementation/NationalImplementationPlans/NIPTransmission/tabid/253/Default.aspx.

6.3. INFORMATION CONCERNING LONG RANGE TRANSPORT

Long-range transport of atmospheric pollutants (LRTAP) is a major problem facing the global ecosystem. While prior attention has been paid to these issues in the United States of America, Canada, Asia, and Europe; Latin America and the Caribbean has received considerably less.

In the Latin American and Caribbean region there is evidence from LRTAP studies conducted by the EPA and the CEC in Mexico and Central America since the 1990s and 2000s (CCA, 1997; EPA, 2003). Likewise, studies that were carried out by local researchers mainly from the following countries are reported in the scientific literature and in technical reports: Brazil, Colombia (Bolaño-Truyol et al, 2021), Chile, Mexico and Uruguay (Odino et al, 2012); and other studies, such as those from Jamaica and Barbados, were carried out by entities that do not belong to the country (Boman et al, 2015). These studies show the transport of transboundary pollutants, the contribution of pollutants to the free troposphere to around 1500 meters of altitude due to events such as forest fires, long-range transportation and studies of the relationship between source and receiver, among others.

Regarding studies on persistent pollutants, the first searches show that there are few studies in the region, the vast majority are associated with agricultural burns and forest fires. In contrast to the Caribbean islands, mainly Barbados and Jamaica, studies focus mainly on ships pollution and the impact of Dust from Africa in the area (Haarig et al, 2019).

From the analysis of the air and breast milk matrices and the information in the National Reports and the National Implementation Plans, inconsistencies emerge between the origin of the concentrations observed in the Caribbean and in the Southern Cone, mainly in Barbados, Jamaica and Uruguay; and the information reported by those countries. Therefore, this third report includes an analysis of back trajectories and transport routes of pollutants to understand said concentrations and the observed changes in concentration.

To evaluate the transport of pollutants in the air, a back trajectory analysis was performed using the Hybrid Single Particle Lagrangian Integrated Path Model (HYSPLIT) and developed by the National Oceanic Atmospheric Administration (NOAA) which is one of the several tools available that are used to establish the spatial domain of the air parcels that reach the receiving or monitoring points, as well as zones or study areas based on meteorological data. The model also incorporates chemical reaction parameters during transport. This tool, combined with statistical methods, makes it possible to identify the routes and possible sources of pollutant emissions.

The use of back trajectories also allows understand, in a first approximation, the probable routes of transport, as well as the source-receptor relationships, the time scales for the transport of pollutants and their effect on the concentration of the monitoring site. In short-range transport, the routes of the air parcels trajectories are mostly influenced by the areas close to the emission source compared to long-range ones, where various exchange and mixing processes (deposit and advection), physical and chemical losses (partition, volatility) have a major influence on the composition of the receptor site.

Evaluation of monitoring sites by analyzing back trajectories during 2018

As mentioned, the analysis of the data from monitoring programs of the air matrix and the study of the mother's milk matrix, presented results of important POPs levels from three monitoring sites Barbados, Jamaica and Uruguay. In this sense, back trajectories were carried out with the HYSPLIT-NOAA model throughout 2018, in order to establish the probable routes of pollutants transportation to each of these sites, and in a second stage to define important sources at local level and where appropriate, identify potential sources at regional level.

In order to show the disaggregated seasonal behavior, the analysis of back trajectories was divided into quarters and the probable routes of transportation to the monitoring sites were evaluated weekly throughout the year of 2018 at 12 pm. site time of each site and at a height of 50 meters below the boundary layer. The results of this analysis are presented below.

Barbados

Barbados, the easternmost of the Windward Islands east of the Caribbean Sea basin, is under the influence of trade winds for much of the year, with easterly winds blowing over the island more than 95% of the time. It has a tropical monsoon climate due to the usual sea breezes, predominantly hot and humid throughout the year, with a slight drop in temperatures in the dry season.

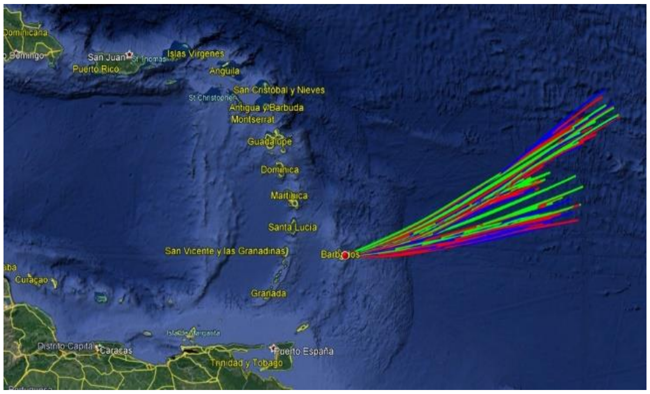
The disaggregated seasonal behavior of the analysis of back trajectories by quarter is presented in Figure 152 and the analysis of frequencies, in Figure 153. The results show an annual compartment of the winds in a predominant direction from East to West coming from the equatorial mid-Atlantic. Like the entire Caribbean area, the circulation patterns are mainly due to the trade winds, which generate wind in the direction of the equatorial zone from the southeast trade winds.

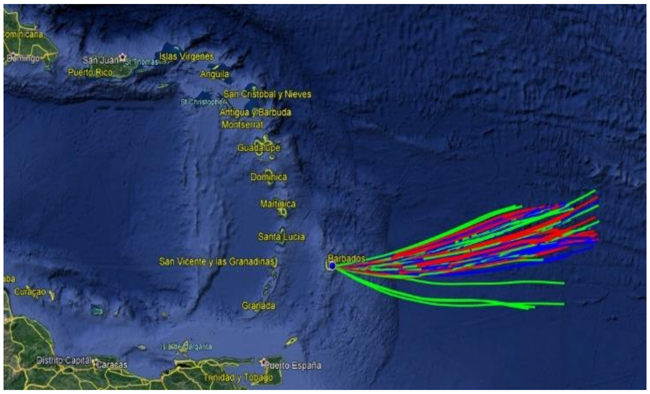
Additionally, back trajectories indicate that the 24-hour plots are well below 1,000 meters above mean sea level, showing that the pathways of potential pollutant emissions are due to the areas closest to the monitoring site, including maritime emissions and small vessels. However, it is considered important for the Barbados site to carry out long-range back trajectories in order to evaluate possible contributions from the African continent, since the literature reviewed refers to contributions from African dust and therefore the presence of persistent pollutants in Barbados.

Figure 152. Back trajectories by quarters in Barbados

January-March. Preponderant wind from the East

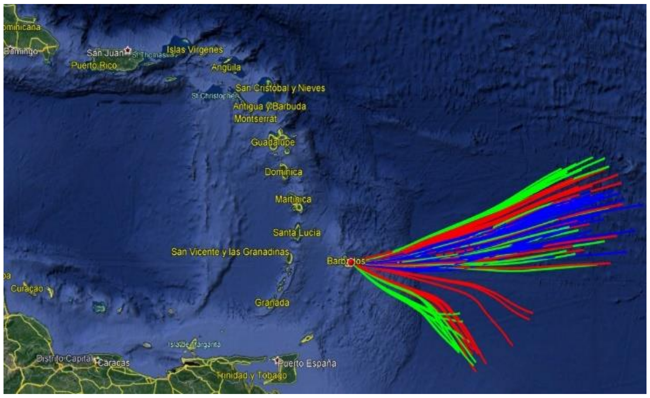
April-June. Preponderant wind from the East with some components from the South-East





July-September, prevailing wind from the East with important contributions from the South-East

October-December. Preponderant wind from the East



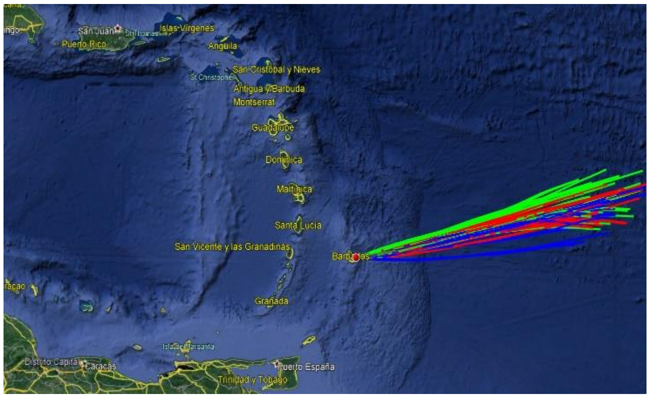
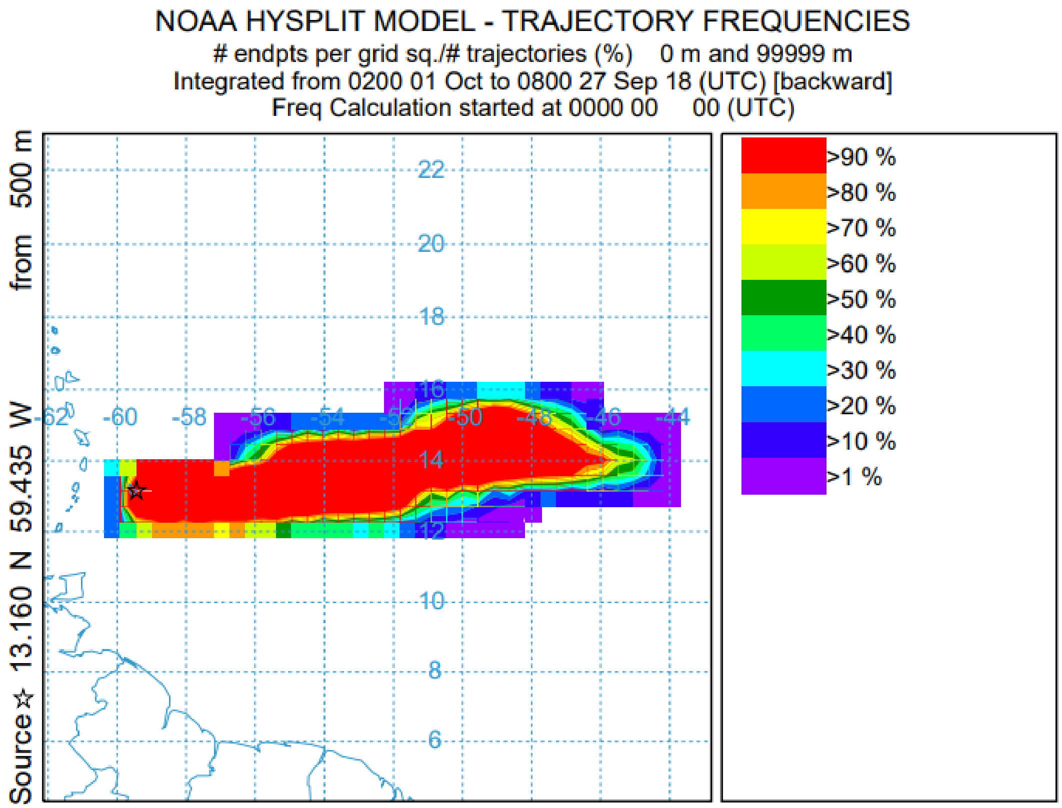


Figure 153. Frequencies of back trajectories of the Barbados site



Jamaica

In Jamaica the winds are a combination of the prevailing East and Northeast winds associated with the Upper North Atlantic Variation (NAH). On average, the strength of the wind varies inversely with the rain. Therefore, during the driest months, when the island is under the influence of the NAH, January-April and July, the wind speed is higher. Jamaica's climate is warm tropical, influenced by the sea and the northeast trade winds.

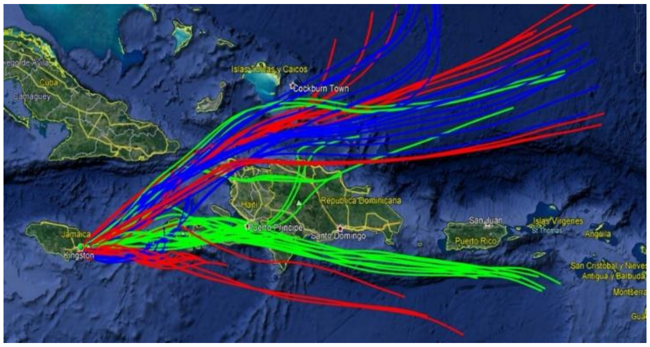
The disaggregated seasonal behavior of the analysis of back trajectories by quarter is presented in Figure 154 and the analysis of frequencies, in Figure 155. The results show an annual compartment of the winds in a predominant direction from East to West, with variable seasonal behavior of Northeast-West and Southeast-West. The phenomenon is mainly due to the trade winds, which generate wind in the direction of the equatorial zone from the southeast trade winds.

Additionally, the back trajectories show that the 24-hour plots are below 200 meters above mean sea level, showing that the pathways of possible pollutant emissions are due to the areas close to the monitoring site at the local and regional level.

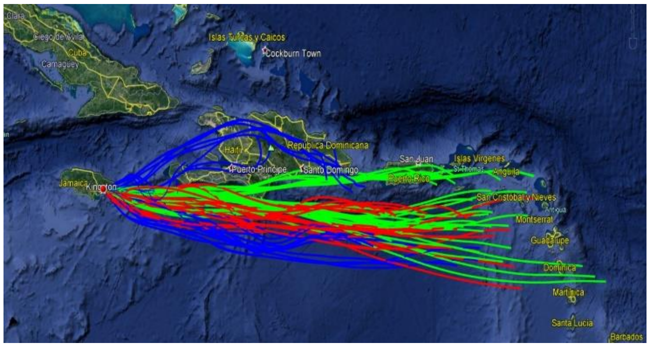
The trajectory routes pass over Haiti, the Dominican Republic, Puerto Rico, and the Caribbean Islands of Montserrat, Guadeloupe, and Dominica, among others. However, a long-range analysis is required to establish whether the pathways heights due to convection systems in the intertropical zone have any local effect.

Figure 154. Back trajectories by quarters in Jamaica

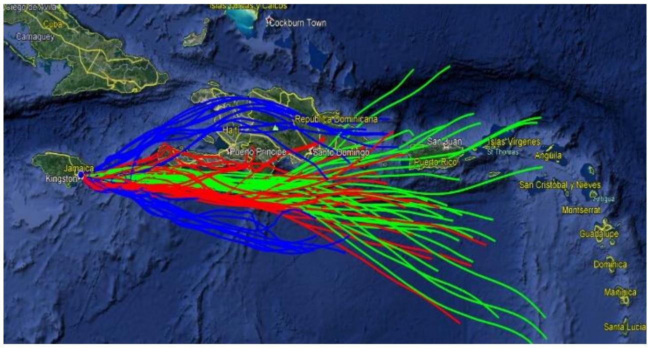
January-March. Preponderant wind from the East with components from the Northeast and South-East



April-June. Preponderant wind from the East with components from the South-East



July-September. Preponderant wind from the East with components from the South-East



October-December. Preponderant wind from the East with partial components from the North-East and main components from the South-East

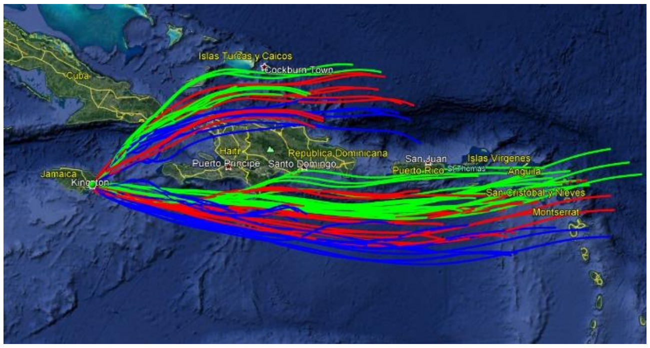
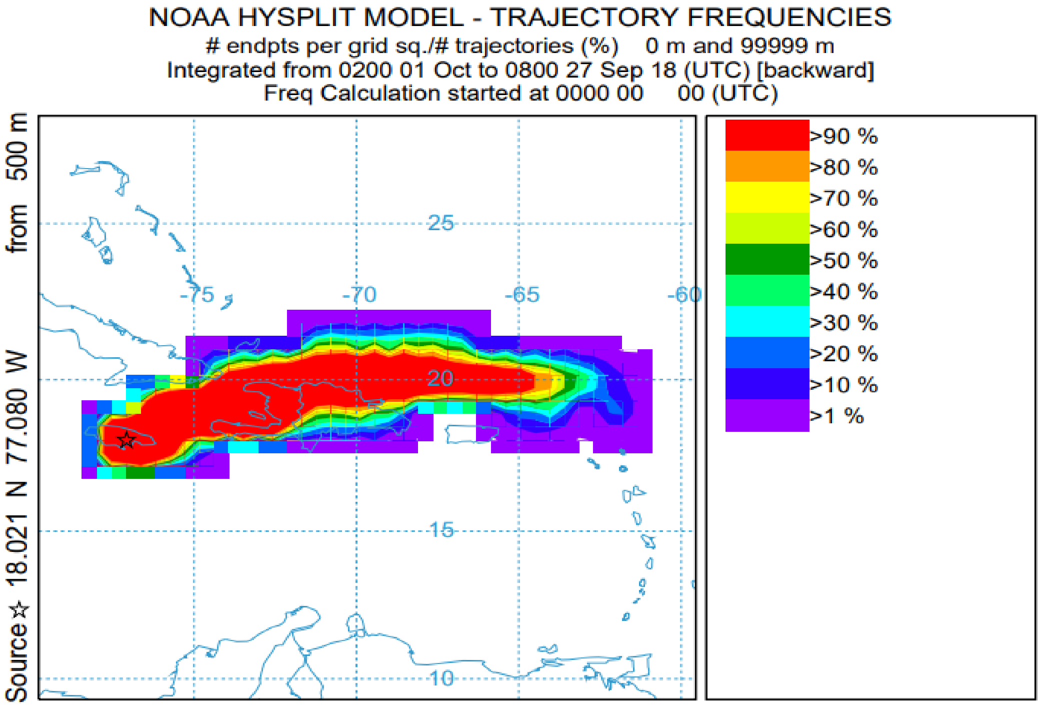


Figure 155. Frequencies of back trajectories of the Jamaica site



Uruguay

Uruguay is included in the temperate zone. The absence of important orographic systems contributes to the small spatial variations of temperature, precipitation and other parameters. The semi-permanent anticyclone of the Atlantic influences the development of the weather in Uruguay, the horizontal circulation that it originates establishes that the predominant direction of the wind is from the Northeast to the East, providing air masses of tropical origin.

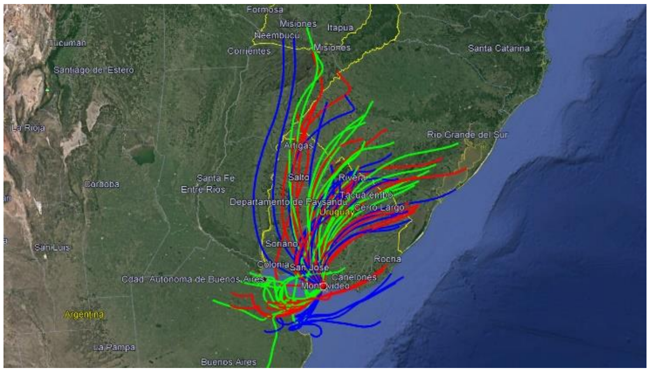
Likewise, it maintains, like the entire southern territory of South America, an important influence from the Pacific and the Atlantic, where the anticyclonic circulation generates a seasonal variation in the circulation of the winds causing masses from the south to the north and from the northeast to the southwest.

The disaggregated seasonal behavior of the back trajectories analysis by quarter is shown in Figure 156 and the analysis of frequencies, in Figure 157. In the routes of the trajectories, the anticyclonic behavior is observed, causing the trajectories to come from the North, Northeast in 70%, and from the South-West 30%.

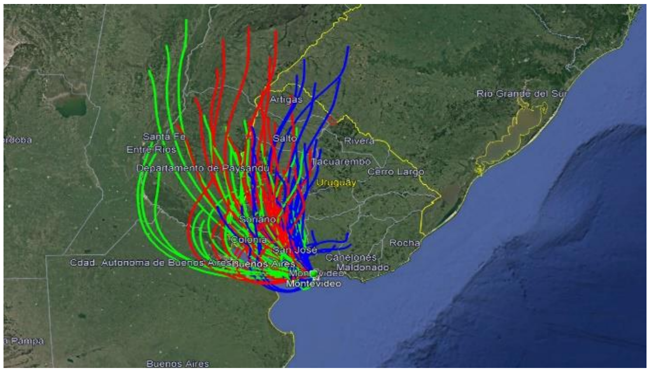
The greatest contribution comes from the North zone where the routes pass mainly through the southern zones of Brazil and Paraguay, and the rest comes from the Atlantic, due to the semi-permanent Atlantic anticyclone. With respect to the southern contribution, most of the air parcel routes pass through Argentina and a minimal portion of Chile.

Figure 156. Back trajectories by quarters in Uruguay

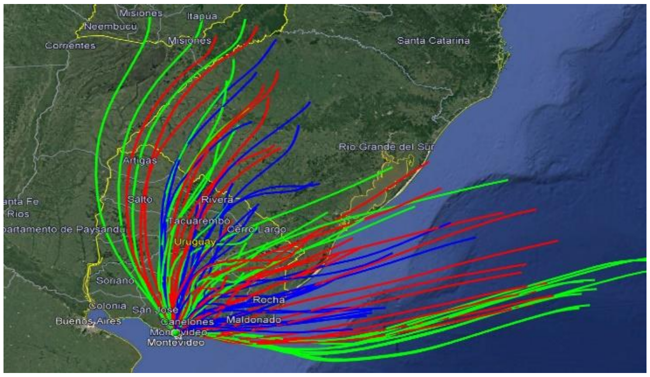
January-March. Prevailing wind from the Northeast and minor contributions from the South-West



April-June. Prevailing Northwest Wind



July-September Prevailing wind from the North and Northeast



October-December. Predominant wind from the South-West and South-East

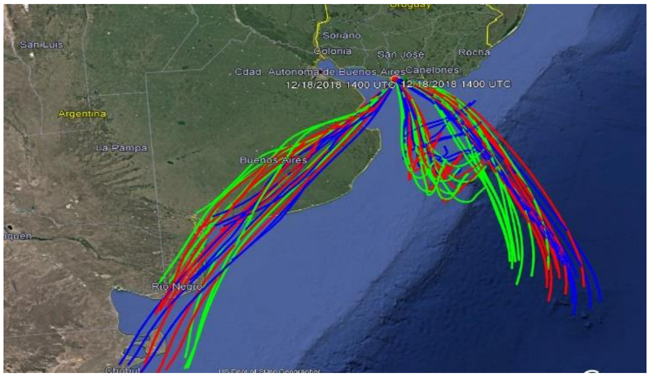
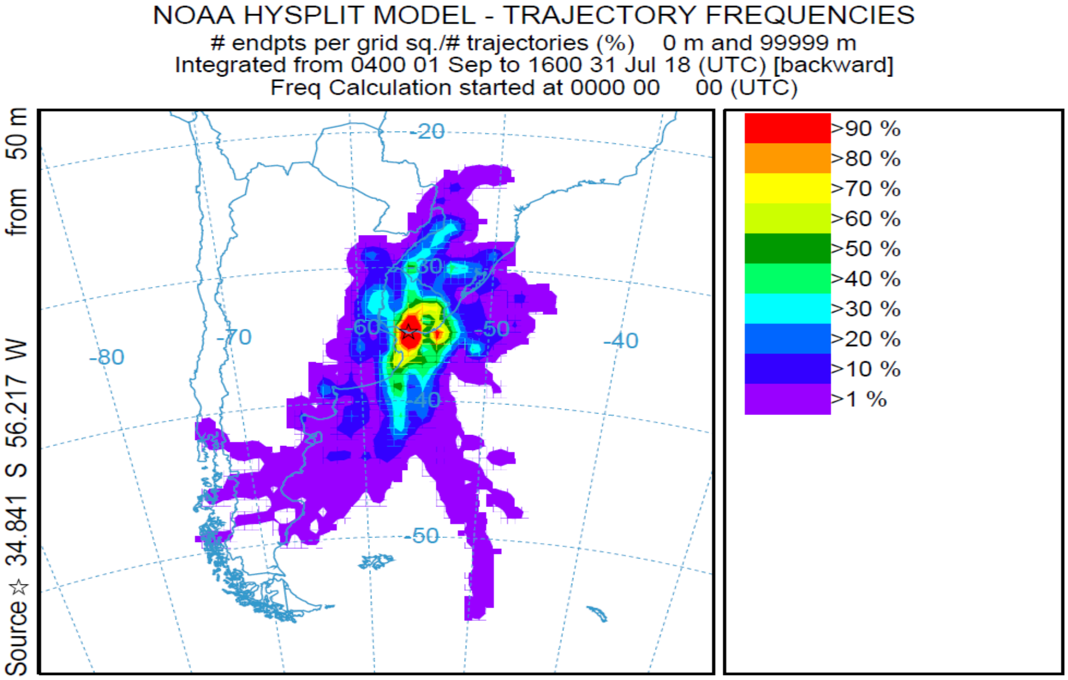


Figure 157. Frequencies of back trajectories of the Uruguay site



Agricultural fires and burns during 2018

NASA's Fire Information System for Resource Management (FIRMS) distributes active fire data in circa real time, within 3 hours of the Moderate Resolution Imaging Spectroradiometer (MODIS) and Ensemble satellite Visible Infrared Imaging Radiometers (VIIRS) observation. MODIS is a sensor that works with a resolution of one pixel per 1km, whereas VIIRS improves the spatial resolution to 375m. In addition, the night performance is much higher. FIRMS contains the LANCE fire detection product. Active circa real-time (NRT) fire locations are processed by LANCE using the standard product MODIS MOD14/MYD14 Fire and Thermal Anomalies. Each active fire location represents the centroid of a 1 km pixel that the algorithm marks as containing one or more fires within the pixel. Next, figures 158 and 159 show fires reported in the region in 2018.

Figure 158. Fires and burns reported on the FIRMS-NASA 2018 platform, South of South America

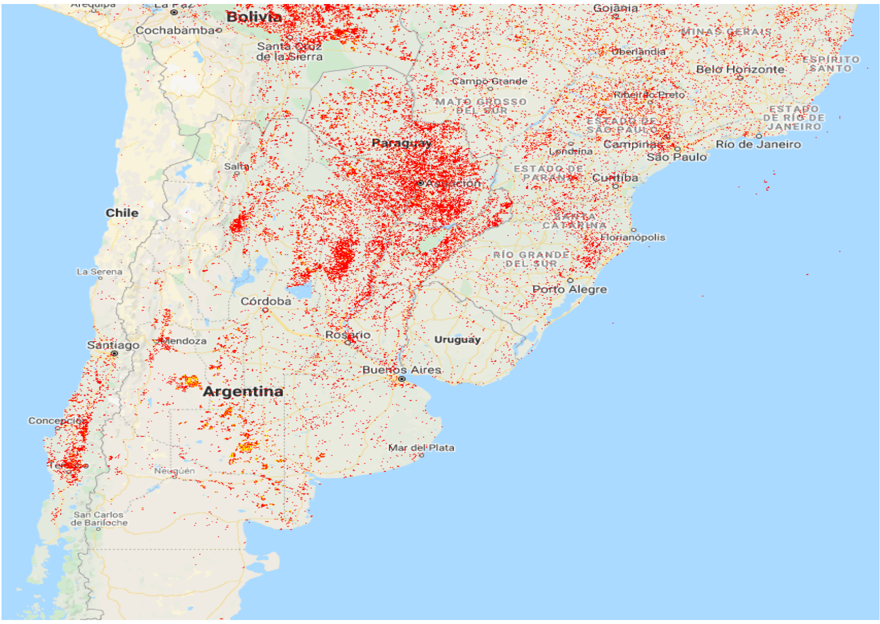


Figure 159. Fires and burns reported on the FIRMS-NASA 2018 platform, Caribbean area

Recommendations

This first analysis of back trajectories shows that to understand the transport processes to the monitoring site, it is necessary to have temporally disaggregated data to establish seasonality in order to be able to relate and understand the values of the observed concentrations with possible sources that could contribute to those values. The technical reports and scientific articles consulted show coincidences in the routes of the trajectories observed during 2018. However, the data are too few to establish a comparison with a greater level of detail.

The first images shown of the fires reported during 2018 indicate that there is an important contribution of this activity that may be generating some persistent pollutants. It is highly recommended to review these contributions in detail to identify the type of burning, agricultural, waste or other, that is taking place in the region, as shown by the satellite.

Finally, as mentioned, it is important to carry out long-range trajectories to identify sources that may be impacting the sites in order to maintain surveillance and monitoring in terms of human and environmental health.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. CONCLUSIONS

Throughout more than 15 years since the implementation of the Global Monitoring Plan, the Latin American and Caribbean region has made great strides in strengthening its capacities in the area of monitoring and analysis of Persistent Organic Pollutants and 20 of the 33 countries that make up the region have participated in some POPs evaluation program.

However, the results show that it is necessary to consolidate this effort since the participation of the countries has not been regular, their compliance with the obligations established by the Convention has decreased, and the information reported by these countries is not updated and on multiple occasions it is not consistent.

Take advantage of the experience that has been developed in the region to establish Sustainable Monitoring Programs that also provide relevant information for decisions making at national level is a pending task in the Region.

This Third Monitoring Report analyzes and compares all the information available in the GMP DWH of the three target matrices and of all the substances currently listed in Annexes A, B and C of the Convention. It also includes first back trajectory analysis of selected sites with high median concentrations values in the region. Furthermore, an analysis of the countries' compliance with the obligations established in Articles 7 and 15 of the Convention is included. It synthesizes the information contained in the National Reports and in the National Implementation Plans, and their updates. Results are presented below.

7.1.1. REGIONAL CONSIDERATIONS

The sources of Persistent Organic Pollutants in the Latin American and Caribbean Region have been decreasing due to the effect of the prohibitions applied by the countries of the region. Of the 31 GRULAC countries that are signatories to the Convention, 25 have reported some prohibition in their National Reports and 18 reported production bans since 1980, despite the fact that many of them have never produced these compounds.

Unfortunately, compliance with Articles 7 and 15 of the Convention decreased and only two countries Panamá and Trinidad y Tobago have presented the amendments to their NIPs required by COP 8. Likewise, the reports submission decrease. Twenty countries delivered the fourth report, but only four countries have presented the four reports and still six countries of the region have never presented a report.

From the information of the 20 countries of the fourth reporting cycle (2014-2018) it can be concluded that in the GRULAC Region:

- Only two countries Brazil and Mexico produce POPs
- Seven countries report exports
- Ten countries report imports
- Ten countries report final disposal of POPs

In relation to article 11 of the Convention, three countries showed the capacity to implement monitoring programs (Brazil, Colombia and Mexico), but only two countries (Argentina and Mexico) clearly establish the future planning of national POPs monitoring programs in their NIPs.

7.1.2. MONITORING RESULTS

Air Results

The data available for the assessment of changes in levels of the target POPs in Air media listed in the Annex A, B and C of the Convention come mainly from passive sampling of three monitoring programs UNEP/GEF GMP II projects (AIR-GEF program), the Global Atmospheric Passive Sampling (GAPS) program and the Latin American Passive Atmosphere Monitoring Network (LAPAN). Baseline concentrations of 13 POPs including new, emerged and the candidate PFHxS POPs were measured in air media mainly by the GAPS program.

The analysis of the POPs in air matrix involved 83 parameters and 19 countries in total, of which nine maintained monitoring sites that allowed the evaluation of concentrations' changes. It showed great variability of data and low recurrence in sites' monitoring. Comparison of medians for the periods 2004-2012 and 2013-2018 at regional level and by monitoring program showed decreases of almost 75% of the parameters measured by GAPS Program and increases in 64% and 75% of the ones measured by AIR-GEF and LAPAN programs respectively. A decrease in concentration is observed in the period 2013-2018 for PCB, PCDD and PCDF, and PeCB; and increases for the groups Cyclodienes, DDT, dlPCBs, HCH, and BDE.

The highest median values are generally present in urban sites of the three programs and the maximum values in Air-GEF program. The Southern Cone followed by the Caribbean presented most of the maximum median values. In summary, the Air-GEF program shows an increase in concentration for most of the parameters of the groups: Cyclodienes, except for Endosulphanes; DDT and isomers, HCB, HCH and PCBs with TEF, BDE and congeners and TEQ of Dioxins; and decrease for: BPC and D and F. With respect to parameters measured within the same period 2016 to 2018: PeCB presents an increase and PBB generally presents data with values below the LDC. The maximum values are presented mainly in St. James, Barbados, followed by Montevideo, Uruguay and in third place Los Mochis, Mexico.

GAPS program presents significant reductions in most of the parameters of the groups: Cyclodienes, BPC, HCH and BDE; measured at urban and NC sites. The remote sites present an increase in most of the parameters of: Cyclodienes, BPC and HCH. In general, urban sites present the highest median values, however the NC site Sonora, Mexico 2014 stands out for its extreme values in most of the parameters.

Regarding LAPAN Program, urban sites presented the highest concentration values compared to NC and Remote sites and increases in concentration values in the period 2013 to 2016, compared to 2010-2012 mainly in non-recurring sites, that is, sites that only measured in the period 2013-2016. Only Aldrin, HCB and BDE 153 showed a decrease in concentration in the three groups of sites. The maximum and extreme values of all the parameters are presented mainly in Brazil, followed by Argentina and Colombia in third place.

Changes in concentrations of recurring sites of 9 countries were observed. The countries that showed an increase in the largest number of groups of compounds were Uruguay, followed by Antigua and Barbuda and Brazil; all under Air-GEF program. In contrast, Brazil under LAPAN program, and Colombia and Mexico under GAPS program, show a decrease in most of the parameters of all groups. Nevertheless, most of the highest median concentration values were observed in Barbados and Mexico follow by Uruguay and Argentina. In general, for the same parameter, it was observed that concentration differences between the measured sites depend mainly on particular sampling location and characteristics of the sites urban, industrial, and rural (background).

The use of active atmospheric sampling in the region was limited to one site located in Brazil, which measured in 2016-2018, but data was not available; and three sites located in Manizales, Colombia, which measured from 2009-2012 delivering 6 samples per site in total.

This is a weakness detected since the second report in the region, it is necessary to strengthen the use of active samplers since at the moment their use is limited. Although, active sampling needs more infrastructure and resources, this method represents the standard methodology for analyzing air pollution that should be used for calibrating and comparing passive sampling techniques.

Human Milk Results

For this third evaluation, the MILK-WHO survey provided data from 2001 to 2019 and 14 participating countries. However, only 9 have participated in more than one round and 7 of them also participated in the sixth round (2015 to 2019) and were the foundation for concentrations comparisons.

The parameters analyzed in Milk samples during 2015-2019 period were 108 of which 13 parameters were analyzed for the first time and constitute the baseline for future evaluations. These also include emerging substances and candidate POP under review to be included in the Convention PFHxS.

From the 108 parameters measured, regional comparisons showed that most of them presented decreases in concentration; 20 parameters presented values ULOQ or zero and some had never presented values above the LOQ in any country in the region; only three showed slight increases at regional level of Alpha-HBCD, Cis-Heptachlor Epoxide and the Sum of 2 Heptachlor Epoxides. The Caribbean followed by the Southern Cone presented most of the maximum median values.

Comparisons of concentrations per parameter and countries with repeated participation in the milk survey showed in general, that six parameters from 4 groups increased their concentrations levels in three or more countries, not being significant for the PCDD AND PCDF group and significant for the others:

- Insecticides Cyclodiene group: Cis-Heptachlor epoxide and Sum 2 Heptachlor Epoxides.
- Polychlorinated Biphenyls with TEFs: PCB 77
- PCDD AND PCDF: 1,2,3,4,7,8-HxCDF and 1,2,3,7,8-PeCDF
- Hexabromocyclododecane: Alpha-HBCD

The countries that showed significant increases in the largest number of groups of compounds were Barbados and Jamaica.

Repeated participation of the countries in Human milk survey is needed in the region to better understand the exposure of vulnerable groups as indicators to protect the future generations, as stated in the Millennium Goals and the Stockholm Convention.

Water Results

Baseline concentrations of the three target substances under the Stockholm Convention surveillance PFOS, PFOA and PFHxS in 6 sites, where the monitoring took place in 2017 and 2018, were achieved. Regional statistical analysis of the 6 UNEP/GEF GMP sites in GRULAC showed median PFOS data concentration values higher than those of PFOA and PFHxS; and increases in 2018 median values compared to those of 2017 for the three substances, possibly due to the change of site in Brazil.

Comparisons between sites, parameters and years showed that the maximum median values were presented in Rio de la Plata Argentina 2017 and 2018 follow by São Paulo São Vicente channel, Brazil 2018 and Hunts Bay River, Jamaica 2017 for the three substances, and minimum values in Amazon River Brazil 2017 follow by Daule and Babahoyo River Junction, Ecuador 2017-2018. Increases in concentrations were observed for PFOS and decreases for PFOA and PFHxS in 2018 in the four sites that measured two years Rio de la Plata Argentina, Daule and Babahoyo River Junction Ecuador, Hunts Bay River Jamaica and Ohuira Bay in Mexico. Higher concentrations were detected for the three parameters in São Paulo São Vicente channel, Brazil 2018 site compared to Amazon River Brazil 2017.

With respect to the 47 parameters measured in 2016 by the Monet-Aqua program, concentration's comparisons generally show a higher concentration in Peñol-Guatapé Reservoir, Antioquia Colombia than in Llanquihue lake, Los Lagos Chile for most parameters.

7.1.3. EVIDENCE OF TEMPORAL TRENDS AND LONG RANGE TRANSPORT

To detect changes in concentrations with some reliability, the temporal and spatial resolutions must be taken into consideration to properly design a regional monitoring program and measurements must be sustain in the selected sites. Is worth to mention that from the 93 monitoring sites of GRULAC, 57% operated for only one year. Furthermore, in previous reports background values provide result from sites located far from point emission sources, and for the GMP third phase implementation some countries changed their sites location, and some new sites were included mainly in urban areas. The inconsistency of site locations in the countries, lack of regular countries participation and data variability do not allow the analysis of significant trends.

The evaluation of long range transport in the region was carried out through the search for scientific articles and the application of back trajectory analysis and the HYSPLIT-NOAA model in three sites in the region. Most of the scientific articles identified refer mainly to other parts of the world, evidencing the little attention that the region has received on this issue. There are local back trajectory studies mainly from Mexico, in the early 2000s and recent ones from Colombia and the Caribbean. It was not possible to apply the HYSPLIT-NOAA model to more sites in the region due to the lack of financial resources for its application.

The results of the back trajectory analysis and the HYSPLIT-NOAA model applied in the sampling sites located in Barbados, Jamaica and Uruguay throughout 2018, resulted in the following:

Barbados: predominant east-west wind direction from the equatorial mid-Atlantic. Circulation patterns are mainly due to trade winds. Back trajectories indicate that the pathways of potential pollutant emissions are due to the areas closest to the monitoring site, including marine emissions and smaller vessels. However, it is considered important for the Barbados site, to carry out long-range back trajectories in order to evaluate possible contributions from the African continent, since the literature reviewed refers to dust contributions from Africa over Barbados.

Jamaica: The winds are a combination of the prevailing East and Northeast winds associated with the Upper North Atlantic Variation (NAH). The results of the back trajectories, as well as the frequency analysis, show an annual trends of the winds in a predominant direction from East to West, with variable seasonal behavior from Northeast-West and Southeast-West. The trajectory analysis shows that the pathway of possible pollutant emissions are due to the areas close to the monitoring site at the local and regional level. The routes of the trajectories pass over Haiti, the Dominican Republic, Puerto Rico and the Caribbean islands of Montserrat, Guadeloupe and Dominica among others, which implies a possible pathway of emissions from other Caribbean islands. However, a long-range analysis is required to establish whether the pathways heights due to convection systems in the intertropical zone have any local effect.

Uruguay: maintains, like the entire southern territory of South America, an important influence from the Pacific and the Atlantic, where the anticyclonic circulation produces a seasonal variation in the circulation of the winds, generating air masses from south to north and north, northeast to the southwest. In the modeling trajectories, the anticyclonic behavior is observed, causing the trajectories to come from the roughly Northeast by 70%, and from the South-West by 30%; the largest contribution comes from the northern area where the pathways pass through the southern parts of Brazil and Paraguay, and the rest comes from the Atlantic, due to the semi-permanent anticyclone of the Atlantic. Regarding the contribution from the south, most of the air parcel pathways pass through Argentina and a minimum portion of Chile, between May and August.

This first analysis of back trajectories in the monitored sites shows that to understand the transport processes to the monitoring site, it is necessary to have temporally disaggregated data to establish seasonality in order to be able to relate and understand the values of the observed concentrations with possible sources that could contribute to those values. Likewise, this information will allow evaluating these sources in a second stage and defining local or regional reduction or mitigation actions.

It can be concluded that more systematic studies should be designed and implemented to address this issue within the GRULAC region. Passive air monitoring and active sampling could be used for modeling the transport of POPs between source and receptor areas. It is recommended that POPs modeling capabilities and training should be stimulated within the region.

Likewise, satellite images of the fires reported during 2018 were reviewed. They indicate that there was an important contribution from this activity that may be generating some persistent pollutants. It is highly recommended to review these contributions in detail to identify the type of burning (agricultural, waste, vegetation) that was taking place in the region.

7.1.4. Data and other Gaps

As was mention in previous Regional Monitoring Reports, the absence of a regional or national sustainable monitoring programs covering gaps in some GRULAC subregions with periodic measurement, desegregated data, active sampling and meteorological in site information is a limiting factor to the establishment of temporal and spatial trends, and relevant studies of LRTAP; and represent one of the most important gaps. Existing monitoring programs are still supported by external financing.

These lack of repeated monitoring sites and the variability of the data prevent for having significant trends in the region. The existing air monitoring networks need to be expanded by using both passive and active sampling techniques and an effort should be undertaken in order to cover all POPs of the Stockholm Convention; but compromise individual country participation is needed in this regard.

Resources will also be needed too to support the extension of existing programs and its permanency, and also to apply periodical human milk surveys or preferably continue with the WHO survey. The Ministries of Health could also be significant contributors to this work if they were made aware of the benefits of participating in such global programs.

The commitment of the countries to sustain monitoring programs should be based on the national interest in reducing the risk of exposure to these substances and on their willingness to establish a regional structure to support long-term monitoring programs. However, the commitment has decreased, and the Region has limited updated information on the sound management of chemical, inventories and releases, among others.

There are advances in LAC in terms of technical capabilities for the sampling and analysis of persistent organic compounds. In this regard, on-site training provided by the UNEP/GEF projects has been of enormous importance. Although the region has laboratories that demonstrated good performance in interlaboratory exercises, the vast majority did not achieve good performance in the last rounds of interlaboratory exercises carried out under the framework of the UNEP/GEF project activities. This shows that it is still necessary to strengthen the analytical capacities of the region, and even more considering the challenges that the Convention imposes by continuously incorporating new compounds to its lists, some being families of compounds that are difficult to analyze.

Likewise, "The Action Plan for Regional Cooperation in the management of chemicals and waste" prepared by the Intergovernmental Network of Chemicals and Waste for Latin America and the Caribbean and approved at the XXII Meeting of the Forum of Ministers of the Environment of Latin America and the Caribbean, which took place from February 1 to 2, 2021, establishes that:

“It can be observed that countries are making progress in establishing the basic frameworks for managing chemicals and waste. Infrastructure is also being strengthened through the creation of new departments or directorates in public organizations and institutions to directly address the management of chemicals. Now new challenges arise, and while countries need to enforce the sound management of chemicals, resources remain scarce. For example, key infrastructure is still lacking, such as a network of laboratories with the capacity to analyze priority chemical substances, interpret the results and provide information for decision-making” (https://www.unep.org/es/events/evento-de-onu-medio-ambiente/xxii-foro-de-ministros-de-medio-ambiente-de-america-latina-y-el)

In this sense, it is important that national governments assume the responsibility they acquired when agreeing to participate in the Stockholm Convention, providing the resources, materials and information to fulfill their commitments established in the Articles of the Convention, such as informing, updating and amend their PINs and contribute to the GMP that must be linked to their PIN and provides valuable information for decision-making in the sound management of chemicals.

7.2 Recommendations

The region should build its own capabilities since most of the monitoring programs are currently supported and managed by organizations from outside the region. Synergies between countries have to be encourage. Interaction between government, academia, industry and NGOs is needed both at national and regional levels to build a successful strategy for facing the challenge of monitoring POPs levels in the core matrices of the GMP. The regional involvement in monitoring programs requires a common strategy, ongoing financial support, human resources and capacity building to accomplish the task of gathering comparable and high quality data for contribution to the GMP and the effectiveness evaluation of the Stockholm Convention.

Spatial coverage should also be improved; Central America is still one big gap in the region as was mention in previous reports it might be possible to establish monitoring programs defining subregions sharing some similarities (e.g., eco-regions that cross country boundaries). Evidence of concentrations of POPs in several species of non-migratory endemic wildlife (birds, marine mammals, mussels, and others) as well as soils and mosses are found in scientific literature and monitoring in other media was also mentioned in the NIPs; but only Colombia reported the existence of a formal monitoring program of POPs in costal water and sediment.

A regional agreement between countries is required to define if levels in other media could be used as regional indicator or sentinels (Eco markers) of local or regional POPs contamination or as supplemental indicators for temporal trend evaluation within an interregional monitoring program for future evaluation.

The implementation of the Global Persistent Organic Pollutants Monitoring Plan as a tool for monitoring progress in achieving sustainable development goals should be encouraged by governments and environmental agencies in Latin America and the Caribbean.

The challenge to the environmental authorities responsible for the implementation of the Global Persistent Organic Pollutants Monitoring Plan is to recognize its importance and responsibility over the long term, to reduce the concentrations of POPs, to encourage the development and use of clean technologies and, implement policies to reduce environmental risks that cause damage to human and environmental health.

It is also necessary to draw attention to the situation of socioeconomic deterioration in the region, an increase in environmental degradation, especially in the Amazon Forest and loss of biodiversity, which means a threat to the public health of LA, destabilizing existing government systems, increasing consumption of outdated technologies, deterioration of the educational system, loss of well-being and human rights. This is the current scenario of LA. There is a need for a greater union of the peoples and the recognition of the importance of LA as a REGION with great potential for innovation, creativity and responsibility. It is necessary to have an economically stable and socially fair development that results in the sustainability of LAC.

Still pending are the recommendations formulated in the First GRULAC Monitoring Report: “The GRULAC should formalize a coordinating structure for developing a Regional Action Plan (RAP). The ROG could be strengthened in order to be part of the coordinating structure, which would play a key role in setting the preparation of the medium/long term Regional Action Plan (RAP). The formulation of a RAP would allow: (i) evaluation of options available and actions necessary to meet the requirements of the Stockholm Convention for POPs monitoring, (ii) development of a regional monitoring program indicating scope, limitations, costs and benefits and, (iii) identification of requirements for capacity building and external assistance in the implementation of the RAP.

The countries should make an effort to optimize the existing resources in terms of infrastructure, human resources and quality assurance and quality control systems. The more experienced countries within the region should promote capacity building activities at sub regional level through the Regional Centers. Some countries have enough human and infrastructure facilities to promote training courses and long term cooperation initiatives with their neighbors, aiming to accomplish the Stockholm Convention’s objectives.

In the future, the main functions of the ROG-GRULAC could be as follows: (i) to raise awareness within governments of the POPs monitoring and the need to develop a RAP; (ii) to facilitate co- ordination within the region to allow the successful development and implementation of the RAP; (iii) to develop the structure, framework and procedures for the development of the RAP; (iv) to establish a mechanism for planning, managing and supervising the development and implementation of the RAP; and (v) to plan and initiate information dissemination campaigns”.

Monitoring of key pollution metrics, especially of Persistent Organic Pollutants and population exposures, is a critical need in all countries. An additional need is for follow- on statistical analyses that can be used to assess the success of policy actions.

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ANNEXES

ANNEX 1. COUNTRIES AND SAMPLING SITES IN THE GRULAC REGION

Sampling sites and geographic coordinates by air monitoring program.

No.	Monitoring program	Country	Site	Site Type	Latitude	Longitude
1	AIR - GEF	Antigua and Barbuda	St. Phillips	Rural	17.069070	-61.750230
2		Argentina	Buenos Aires	Urban	-34.507500	-58.514861
3		Bahamas	Coral Harbour	NC	24.984100	-77.465400
4		Barbados	St. James	Urban	13.183333	-59.616670
5		Brazil	Sao Paulo	Urban	-23.553556	-46.672750
6		Chile	Canal Melchor	NC	-45.583332	-72.150000
7			Tome	Rural	-36.663333	-72.963667
8		Colombia	Medellin	Urban	6.260000	-75.567710
9		Cuba	Cienfuegos	NC	22.066668	-80.500000
10			Havana	NC	23.140700	-82.355000
11			Pinar del Rio	NC	22.766666	-83.550000
12			Sancti Spiritus	NC	21.916668	-80.016670
13			Santiago de Cuba	NC	20.000000	-75.466670
14		Ecuador	Quito	Urban	-0.419067	-78.542373
15			Quito (UNEP)	NC	-0.216667	-78.500000
16		Haiti	Port-au-Prince	NC	18.533333	-72.333336
17		Jamaica	Kingston	Urban	18.007700	-76.791300
18		Mexico	Los Mochis	Rural	25.814403	-108.962286
19			Monte Azules, Chiapas	NC	16.133330	-90.900000
20		Peru	Lima	NC	-11.900000	-77.050000
21		Uruguay	Montevideo	Urban	-34.836972	-56.222444
22	Colombia - POPs monitoring	Colombia	Fontibon	NC	4.670139	-74.141550
23			Liceo	NC	5.068133	-75.510730
24			Nubia	NC	5.029700	-75.471637
25			Palogrande	NC	5.056955	-75.491670
26			SENA	NC	5.030214	-75.449700
27	GAPS	Argentina	Bahia Blanca	Rural	-38.750000	-62.250000
28			Malargue	NC	-35.469800	-69.582300
29			Mendoza Province	NC	-32.709223	-68.400447
30			Pierre Auger Observatory in Patagonia Flats	Remote	-35.113727	-65.599903
31			Rio Gallegos	NC	-51.647310	-69.207310
32			Salta	NC	-25.085133	-66.126220
33		Barbados	Ragged Point, St. Philip	NC	13.165051	-59.432151
34		Bolivia	Chacaltaya	Remote	-16.350000	-68.131000
35			Huayna Potosi	NC	-16.272139	-68.136111
36		Brazil	Indaiatuba, Sao Paulo	NC	-23.157526	-47.168499
37			Itatiaia	Remote	-22.385833	-44.678889
38			Porto Velho	Urban	-8.836111	-63.938888
39			Sao Jose	NC	-28.594170	-49.818590
40			Sao Luis	NC	-2.553913	-44.250022
41			Sao Paulo	NC	-23.561140	-46.701620
42			St. Peter and St. Paul Rocks	Remote	0.917357	-29.345719
43		Chile	Chungara Lake	Remote	-18.216664	-69.166667
44			Concepción	Urban	-36.829323	-73.034153
45			Coyhaique	Remote	-45.583334	-72.033333
46		Colombia	Arauca	Rural	7.014251	-70.741970

No.	Monitoring program	Country	Site	Site Type	Latitude	Longitude
47			Manizales	NC	5.075833	-75.436669
48		Costa Rica	Tapanti National Park	Remote	9.695733	-83.865360
49		Cuba	La Palma	Remote	22.752020	-83.534866
50		Ecuador	Quito	NC	-0.250000	-78.583334
51			Santa Cruz Island	NC	-0.978458	-89.359129
52		Mexico	Sonora	NC	27.127308	-109.840471
53			Tlahuac, Mexico City	Urban	19.245557	-99.010000
54			Veracruz	Rural	19.200061	-96.133370
55			Yucatan	NC	20.859201	-90.392400
56	LAPAN	Antigua and Barbuda	Antigua and Barbuda	Urban	17.100000	-61.839000
57		Argentina	Bahia Blanca 1	Urban	-38.775889	-62.005306
58			Bahia Blanca 2	Urban	-38.699528	-62.444778
59			Chimpay	Urban	-39.193278	-66.018750
60			Comodoro Rivadavia	Urban	-45.844389	-67.477361
61			Puerto Deseado	Urban	-47.753666	-65.905890
62			Puerto Madryn	Urban	-42.808083	-65.043750
63			Rio Gallegos	Urban	-51.616017	-69.215167
64			Viedma	Urban	-40.898750	-62.881333
65			Villa Regina	Urban	-39.102333	-67.108361
66		Bolivia	Chacaltaya	Remote	-16.350356	-68.131603
67		Brazil	Abrolhos Archipelago	Remote	-17.968317	-38.684478
68			Araraquara, SP	Urban	-21.791944	-48.181111
69			Atol das Rocas	Remote	-3.856411	-33.817428
70			Barretos, SP	Urban	-20.572461	-48.574103
71			Belém, UFPA	Urban	-1.474158	-48.458358
72			Botanical Garden, POA, RS	Urban	-30.053686	-51.174864
73			Brasília, UNB	Urban	-15.768308	-47.865506
74			Chapada dos Veadeiros, GO	Remote	-14.066708	-47.461367
75			Cristalino State Park, MT	Remote	-9.597814	-55.932275
76			Curitiba, UFPR	Urban	-25.449750	-49.234233
77			Diamantino, GO	Remote	-14.129678	-57.656153
78			Fortaleza, UFC	Urban	-3.744817	-38.573894
79			Iguaáu National Park	Remote	-25.626736	-54.478653
80			Itatiaia National Park, RJ	Remote	-22.385833	-44.678889
81			Limeira, SP	Urban	-22.562233	-47.422353
82			Manaus	Remote	-2.594611	-60.209222
83			Porto Alegre, Centro	Urban	-30.034553	-51.233289
84			Porto Velho, UNIR	Urban	-8.836186	-63.938897
85			Puruzinho Lake	Remote	-7.370556	-63.059444
86			Recife, PE	Urban	-8.052883	-34.950025
87			Rio de Janeiro, Fiocruz	Urban	-22.878533	-43.246122
88			Rio Grande, FURG	Urban	-32.068906	-52.161475
89			Sao Paulo, Cetesb	Urban	-23.561097	-46.701525
90			Salto Morato State Park, PR	Remote	-25.163639	-48.297994
91			Sao José	NC	-28.594170	-49.818590
92			Sao Luis, UFMA	Urban	-2.593833	-44.211194
93			Trindade	Remote	-20.508139	-29.312140
94			Vitória, ES	Urban	-20.292603	-40.296228
95		Chile	Chacabuco	NC	-47.124138	-72.464450
96			Concepción	Urban	-36.784227	-73.051319
97			Los Leones	NC	-46.722220	-72.950500
98			Presidente Frei Montalva Base	NC	-62.328167	-58.986000
99		Colombia	Barranquilla, (Univ. del Atlántico)	Urban	11.018467	-74.872267
100			Cartagena (San Pablo)	Urban	10.402806	-75.505833
101			Leticia	Remote	-4.191528	-69.939444

No.	Monitoring program	Country	Site	Site Type	Latitude	Longitude
102			Manizales, Rio Bianco	Remote	5.000000	-75.736108
103			Pasacaballos	Urban	10.285775	-75.518683
104			Zipaquirá	Urban	5.029208	-73.996975
105		Costa Rica	Biolley, Buenos Aires, Puntarenas	Remote	9.044722	-83.029722
106		Honduras	Tegucigalpa	Urban	14.097500	-87.202778
107		Panama	Santiago de Veraguas	Urban	8.127972	-80.989361
108		Peru	Lima, PUCP	Urban	-12.073331	-77.079706
109			Puerto Maldonado	NC	-12.833472	-69.292250
110		Uruguay	Salto	NC	-31.474447	-57.099407
111		Venezuela	IVIC	NC	10.395972	-66.985389

NC = Unclassified

Countries that participated in the Human Milk study

No.	Monitoring program	Country	Latitude	Longitude
1	GMP 1	Brazil	-8.100000	-54.800000
2	MILK - WHO	Antigua and Barbuda	17.077000	-61.787000
3		Argentina	-38.419264	-63.598921
4		Barbados	13.165000	-59.544000
5		Brazil	-8.100000	-54.800000
6		Chile	-27.020000	-70.030000
7		Colombia	4.115674	-72.930137
8		Cuba	21.760000	-78.760000
9		Ecuador	-1.792967	-78.136888
10		Haiti	19.010000	-72.500000
11		Jamaica	18.151000	-77.210000
12		Mexico	23.900000	-102.100000
13		Peru	-10.680000	-75.280000
14		Suriname	4.040000	-55.670000
15		Uruguay	-32.820000	-56.100000
16	WHO	Antigua and Barbuda	17.077000	-61.787000
17		Brazil	-8.100000	-54.800000
18		Chile	-27.020000	-70.030000
19		Haiti	19.010000	-72.500000
20		Uruguay	-32.820000	-56.100000

Sampling sites in Water

No.	Monitoring program	Country	Site	Latitude	Longitude
1	GMP UNEP	Uruguay	Río de la Plata	-34.206190	-58.077310
2	MONET-Aqua	Chile	Llanquihue Lake, Los Lagos	-41.147556	-72.817250
3		Colombia	Peñol-Guatapé Reservoir, Antioquia	6.296167	-75.166861
4	UNEP/GEF GMP II	Argentina	Argentina Rio de la Plata	-34.705000	-58.214330
5		Brazil	Brazil Amazon River	-3.150083	-58.487111
6		Brazil	Brazil São Paulo São Vicente channel	-23.935667	-46.391167
7		Ecuador	Ecuador Daule and Babahoyo River Junction	-2.186000	-79.867800
8		Jamaica	Jamaica Hunts Bay River	17.977134	-76.841244
9		Mexico	Mexico Ohuira Bay	25.656917	-109.035556

ANNEX 2. LIST OF GRULAC LABORATORIES REGISTERED IN THE POPS LABORATORY DATABASE (HTTP://CHM.POPS.INT/DEFAULT.ASPX?TABID=2420)

No.	Laboratory Name	Country
1	Department Analytical Services	Antigua and Barbuda
2	INTI - Contaminantes Orgánicos	Argentina
3	LECA - Laboratorio Experimental de Calidad de Aguas	Argentina
4	CETA - Centro de Estudios Transdiciplinarios del Agua	Argentina
5	CIT - Centro de Investigaciones Toxicológicas	Argentina
6	LAQAB - Laboratorio de Química Ambiental y Biogeoquímica	Argentina
7	Public Analyst Laboratory	Bahamas
8	GAS - Government Analytical Services	Barbados
9	CIL - Central Investigation Laboratory	Belize
10	SPECTROLAB	Bolivia
11	Analytical Solutions S. A.	Brazil
12	Laboratorio de Radioisotopos Eduardo Penna Franca	Brazil
13	CONECO - Laboratorio de Microcontaminantes Orgânicos e Ecotoxicologia Aquática	Brazil
14	CETESB - Physical Chemical Division (Divisão de Análises Físico-Químicas- TLA, CETESB-Companhia Ambiental do Estado de São Paulo)	Brazil
15	Human Study Center for Worker's Health and Human Ecology/National School of Public Health, Oswaldo Cruz Foundation	Brazil
16	Laboratorio Nacional Agropecuário – LANAGRO/MG	Brazil
17	Laboratorio Farmacología Veterinaria, Universidad de Chile	Chile
18	Instituto de Salud Pública de Chile	Chile
19	CENMA - Laboratorio de Química y Referencia Medio Ambiental (LQRMA)	Chile
20	Laboratorio de Ensayos, Centro de Ciencias Ambientales EULA - Chile, Universidad de Concepción	Chile
21	CAR - Laboratorio Ambiental, Corporación Autónoma Regional Cundinamarca	Colombia
22	Laboratorio de Aguas de Corpouraba	Colombia
23	Laboratorio de Análisis de Compuestos Orgánicos Persistentes	Colombia
24	STL S.A.E.S.P.	Colombia
25	ULAB / INVEMAR - Unidad de Laboratorios, Instituto de Investigaciones Marinas y Costeras (INVEMAR)	Colombia
26	INS - Grupo de Salud Ambiental	Colombia
27	SGS Colombia S.A.	Colombia
28	UNIANDES - Laboratorio Ambiental del Centro de Investigación en Ingeniería Ambiental de la Universidad de los Andes	Colombia
29	UIS - Laboratorio de Cromatografía, Universidad Industrial de Santander	Colombia
30	IDEAM - Laboratorio del Grupo Programa de Físico Química Ambiental del IDEAM	Colombia
31	UNAL - Laboratorio de Análisis de Residuos de Plaguicidas	Colombia
32	Laboratory Research Group GICAMP, Universidad del Valle	Colombia
33	GDCON (Grupo de Diagnóstico y Control de la Contaminación) de la Universidad de Antioquia*	Colombia
34	Centro de Electroquímica y Energía Química	Costa Rica
35	Centro de Estudios Ambientales de Cienfuegos	Cuba
36	Environmental Chemistry Laboratory - CEINPET	Cuba
37	UCTB - Química, INISAV MINAG	Cuba
38	Laboratorio de Ensayos del CIMAB (Área de Tóxicos)	Cuba
39	INHA Departamento de Química y Toxicología	Cuba
40	ALCHEM Laboratory, Altol Petroleum Products Service Dominicana	Dominican Republic
41	Laboratorios de Calidad y Residuos de Plaguicidas de Agrocalidad	Ecuador
42	CEEA - Laboratorio de Ecotoxicología, Comisión Ecuatoriana de Energía Atómica	Ecuador
43	Laboratorio de Cromatografía del Instituto de Ciencias Químicas - ESPOL	Ecuador
44	INTERAGUA C. LTDA - Laboratorio Calidad	Ecuador
45	LTJVM-Laboratorio de Toxicología "Julio Valladares Márquez", Universidad de San Carlos, Guatemala	Guatemala
46	LIQA / UVG - Laboratorio de Instrumentación Química Avanzada, Universidad del Valle de Guatemala	Guatemala
47	Laboratoire Vétérinaire et de Contrôle de Qualité des Aliments de Tamarinier (LVCQAT)	Haiti
48	Centro de Estudios y Control de Contaminantes (CESCO)	Honduras
49	PRL - Pesticide Research Laboratory	Jamaica
50	CENICA - Centro Nacional de Investigación y Capacitación Ambiental	Mexico
51	Laboratorios ABC Química Investigación y Análisis S.A. de C.V.	Mexico
52	IDIAP - Laboratorio de Residuos de Plaguicidas y Ecotoxicología, Instituto de Investigación Agropecuaria de Panama	Panama
53	Environmental Laboratories Peru S.A.C	Peru
54	Laboratorio de Salud Ambiental – Sede La Molina	Peru
55	Corporación Laboratorios Ambientales del Peru SAC (CORLAB)	Peru
56	Dirección de Laboratorio de Control Ambiental	Peru
57	Unidad de Medio Ambiente, Drogas y Doping – Polo Tecnológico Pando – Facultad de Química - Udelar	Uruguay
58	LATU - Laboratorio Tecnológico del Uruguay	Uruguay
59	DINAMA - Departamento Laboratorio	Uruguay
60	Laboratorios ENVIROTEC C.A.	Venezuela
61	CAMEC - C.A. Mantenimiento Eléctrico Costel	Venezuela

Note: This laboratory is not part of the UNEP list of laboratories published on the Stockholm Convention website http://chm.pops.int/Default.aspx?tabid=2420. Colombia requested its inclusion for being a participant in the UNEP/GEF GMP II project.

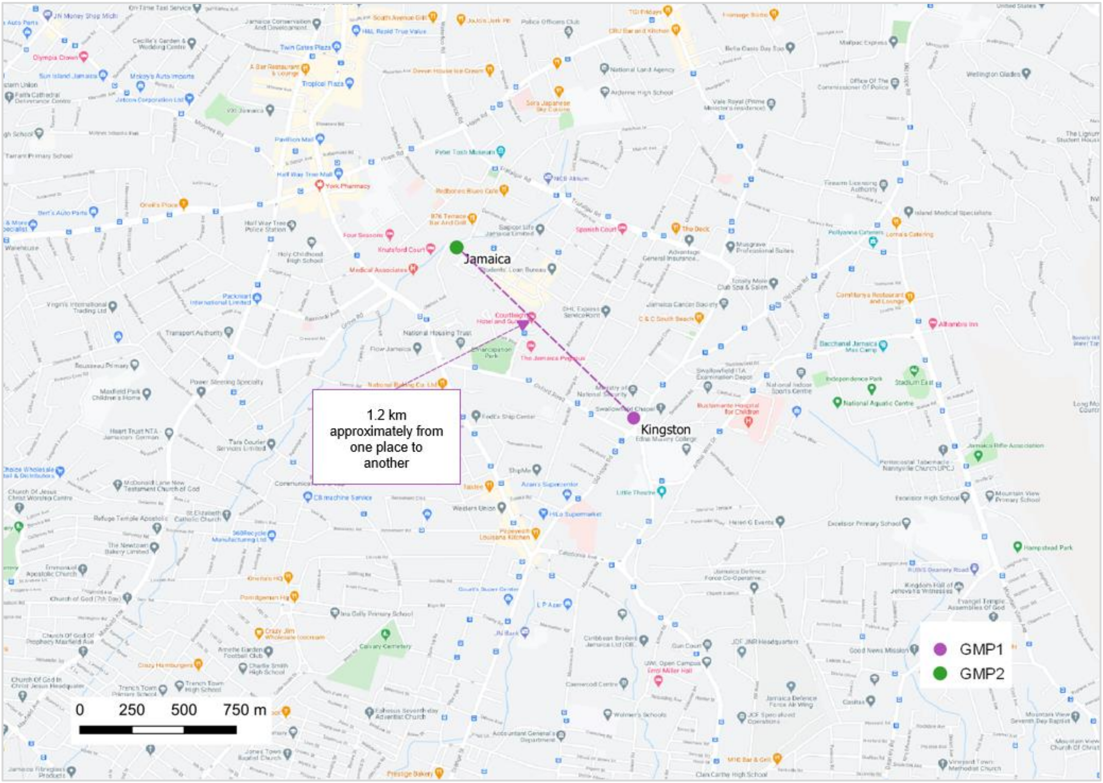
Annex 3. Location analysis of UNEP/GEF GMP I and II GRULAC sites

The following map shows the location of the UNEP/GEF GMP I and II sites.

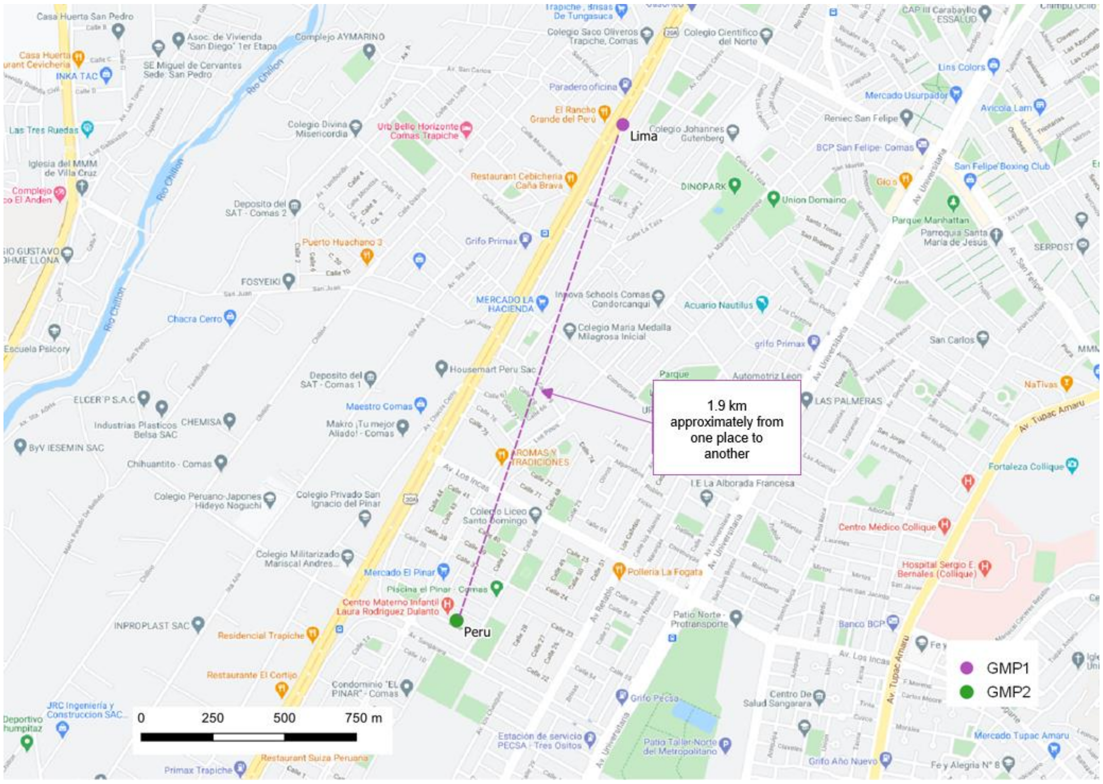
Sites are considered coincident when the distance between them is less than 10 km (UNEP/GEF GMP I and II).

GMP I Site	GMP II Site	They are considered coincident	Distance between one site and another
Kingston	Jamaica	YES	1.2 km
Lima	Peru	YES	1.9 km
Montevideo	Uruguay	YES	9.8 km
Quito	Ecuador	YES	1.1 km
Sao Paulo	Brazil	YES	4.5 km
St James	Barbados	YES	3.8 km
St Phillips	Antigua & Barbuda	YES	1.5 km
Canal Melchor	Chile	NO	995 km
Montes Azules	Mexico	NO	2,260 km
Port-au-Prince		NOT REPEAT	
Havana		NOT REPEAT	
Pinar del Rio		NOT REPEAT	
Cienfuegos		NOT REPEAT	
Sancti Spiritu		NOT REPEAT	
Santiago de Cuba		NOT REPEAT	
Coral Harbour		NOT REPEAT	
	Argentina	NEW	
	Colombia	NEW	

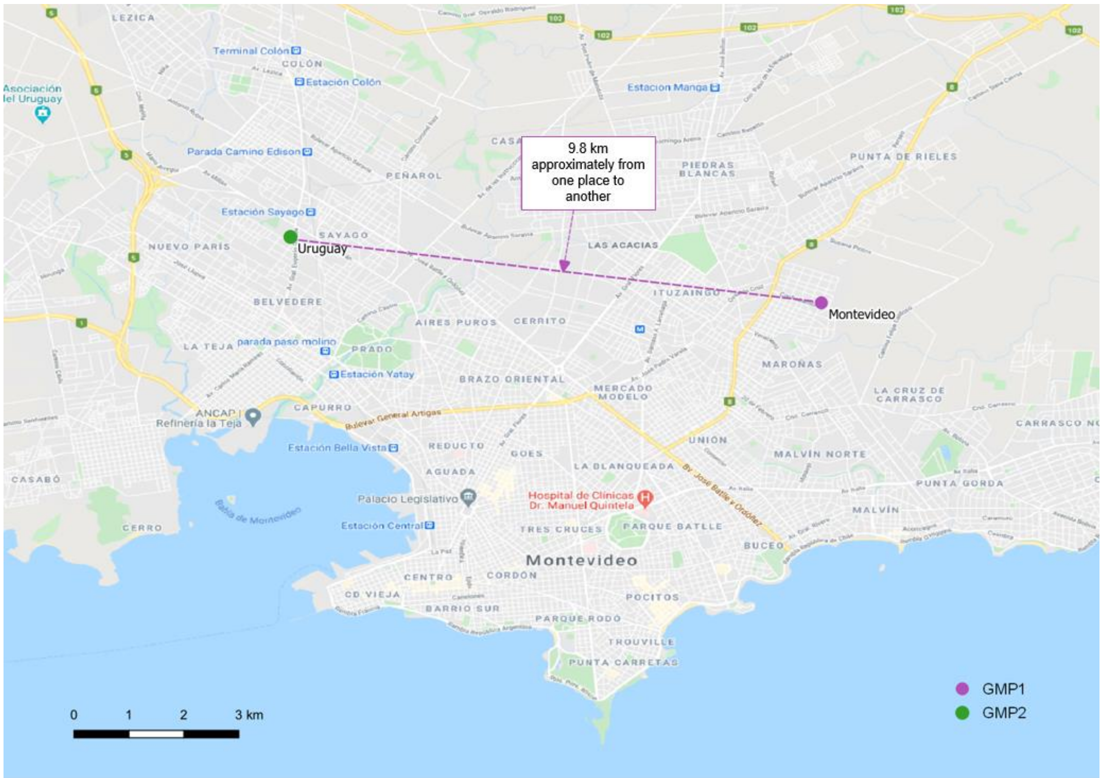
Kingston, Jamaica



Lima, Peru

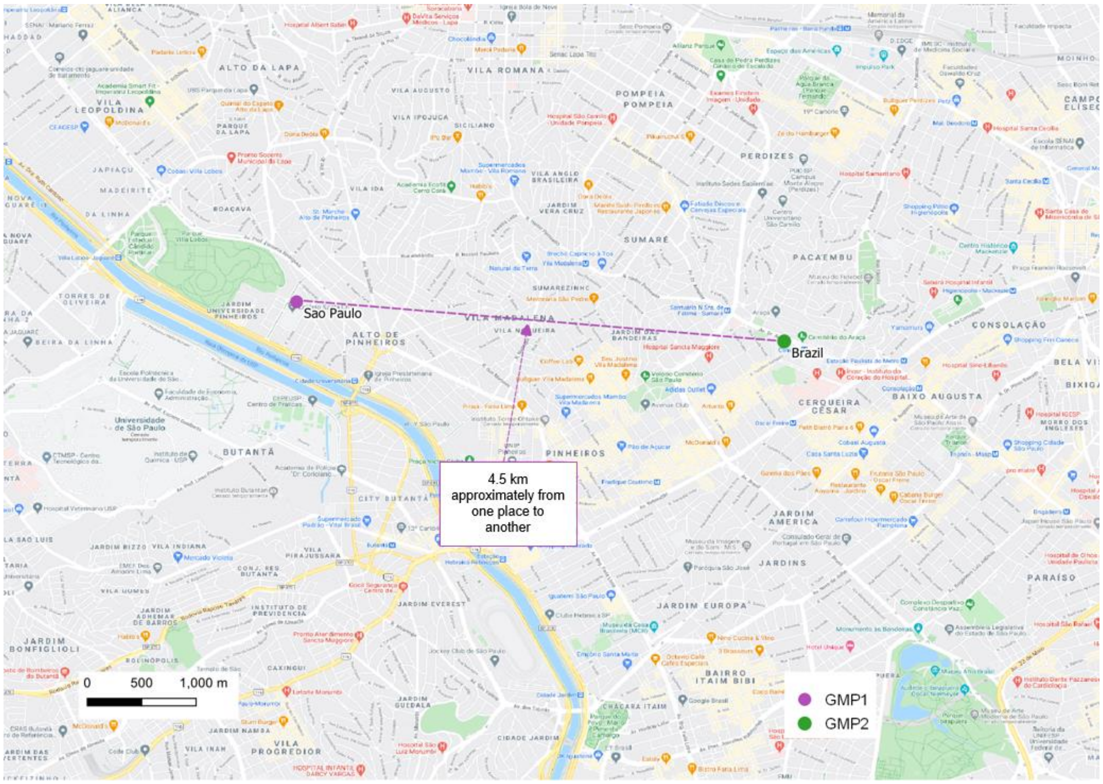


Montevideo, Uruguay



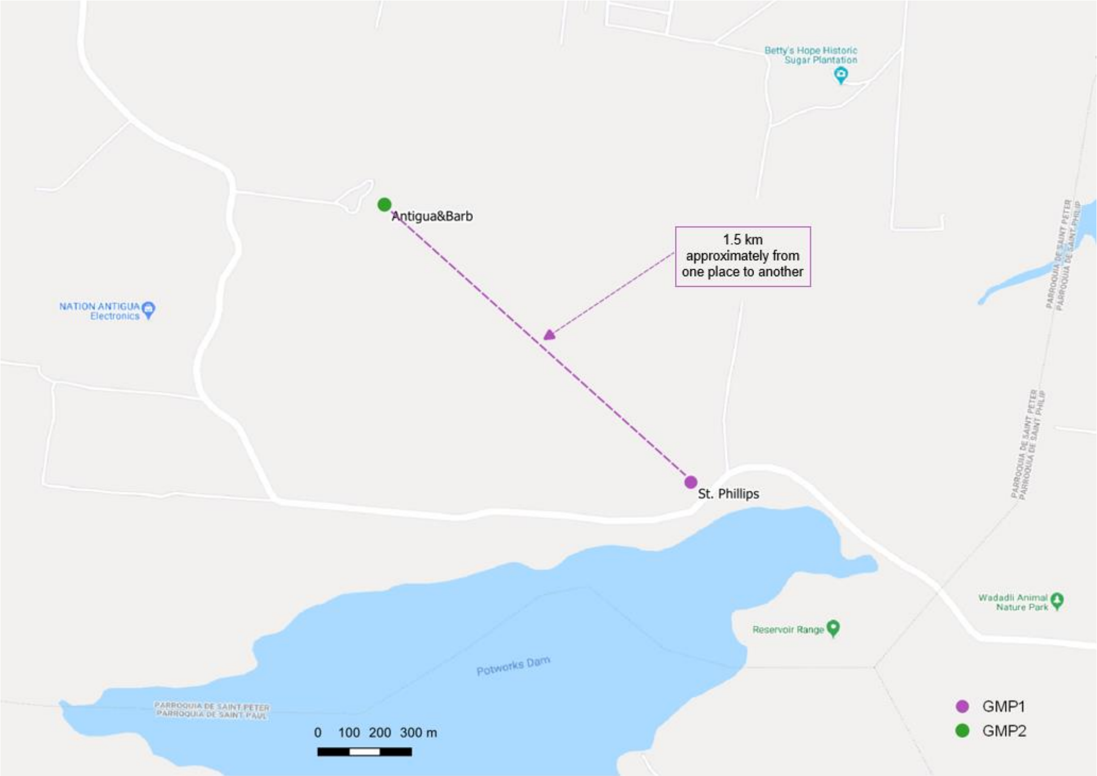
Quito, Ecuador

Sao Paulo, Brazil

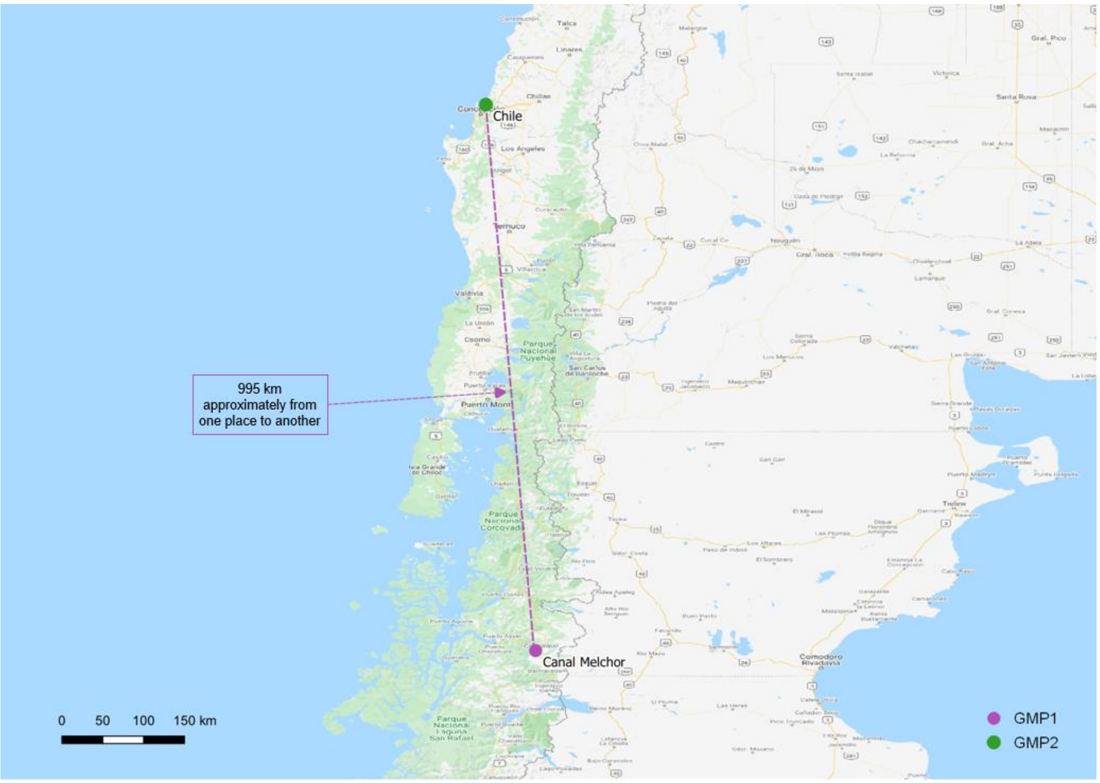


St James, Barbados

St Phillips, Antigua and Barbuda



Canal Melchor, Chile



Sonora y Montes Azules, Mexico

Location other sites (UNEP/GEF GMP I and II)