

GLOBAL INSIGHTS ON PERSISTENT ORGANIC POLLUTANTS:

# A BRIEF SUMMARY OF MONITORING REPORTS PREPARED UNDER THE POPS GLOBAL MONITORING PLAN PROJECTS OF UNEP

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## Introduction

Chemicals are continually being created and introduced into the environment. Among these, Persistent Organic Pollutants (POPs)—including those termed “forever chemicals”—pose enduring risks due to their long-lasting presence in the environment and their impacts on human health and ecosystems. Increasing scientific research has detected POPs in water, air, soil, and even human blood and milk across various countries including in remote areas.

Historical concern about POPs dates back to the 1960s and 1970s, leading to the entry into force of the Stockholm Convention in 2004. This treaty, recognizing the potential for new chemicals to possess POP-like characteristics, designs a dynamic approach to list new POPs and mandates regular evaluations of its effectiveness. Article 16 of the Convention specifically requires a Global Monitoring Plan (GMP) to collect credible and comparable data on POPs to assess their global distribution and trends. In response, the United Nations Environment Programme (UNEP), in cooperation with the Secretariat of the Basel, Rotterdam, and Stockholm Conventions and supported by the Global Environment Facility (GEF) and partners, has implemented comprehensive suite of projects aimed at enhancing POPs monitoring capacities and filling in global data gaps on environmental existence and human exposure to POPs. This also included a human milk survey jointly conducted with the World Health Organization (WHO) to evaluate human exposure to POPs.

From 2016 to 2024, the second set of the UNEP GMP projects monitored POPs in forty-two (42) countries in Africa, Asia-Pacific and Latin America and the Caribbean regions. This included the collection and analysis of over 900 samples of air, water, human milk and other matrices such as sediment and food. This effort significantly expanded the geographical and analytical scope of POP monitoring and generated a wealth of data on POPs in air, water, and human milk. The results generated and experience gained have contributed to the effectiveness evaluation of the Stockholm Convention and expanded the geographical diversity of data in the POPs data warehouse of the Convention. These findings are also captured in four regional reports, three sectoral reports, three assessment reports and highlighted in multiple scientific publications including a book entitled “Persistent Organic Pollutants in Human Milk”. These reports are shared via the [UNEP webpage](#).

This summary synthesizes the findings from these extensive efforts, providing crucial insights into the presence of POPs in data-scarce regions, their impacts, and ongoing challenges. It underscores the need for global collaboration to address the pervasive threat of POPs, particularly in enhancing the monitoring capacities of developing countries and countries with economies in transition and fostering international cooperation to mitigate the environmental and health risks associated with these hazardous chemicals.

# KEY MESSAGES

- » Ongoing studies increasingly confirm the global prevalence of POPs such as perfluorinated alkyl compounds (PFAS) and Chlorinated Paraffins (CPs) even in remote areas, emphasizing the necessity of global monitoring to inform sound management of these pollutants.
- » Developing countries and countries with economies in transition encounter profound challenges in managing contamination, emissions, and exposure to POPs. This situation is amplified by an expanding list of POPs chemicals and inadequate capacities for monitoring, regulating, and managing of POP contaminants and waste. Enhanced support and strategic interventions are critical to overcome these barriers and protect both the environment and public health.
- » The Stockholm Convention, backed by two decades of international efforts including the UNEP projects, presents an effective global cooperation on POPs monitoring. Leveraging these established mechanisms and collaboration can facilitate the generation of comprehensive data necessary for the sound management of POPs, protecting long-term environmental and human health.

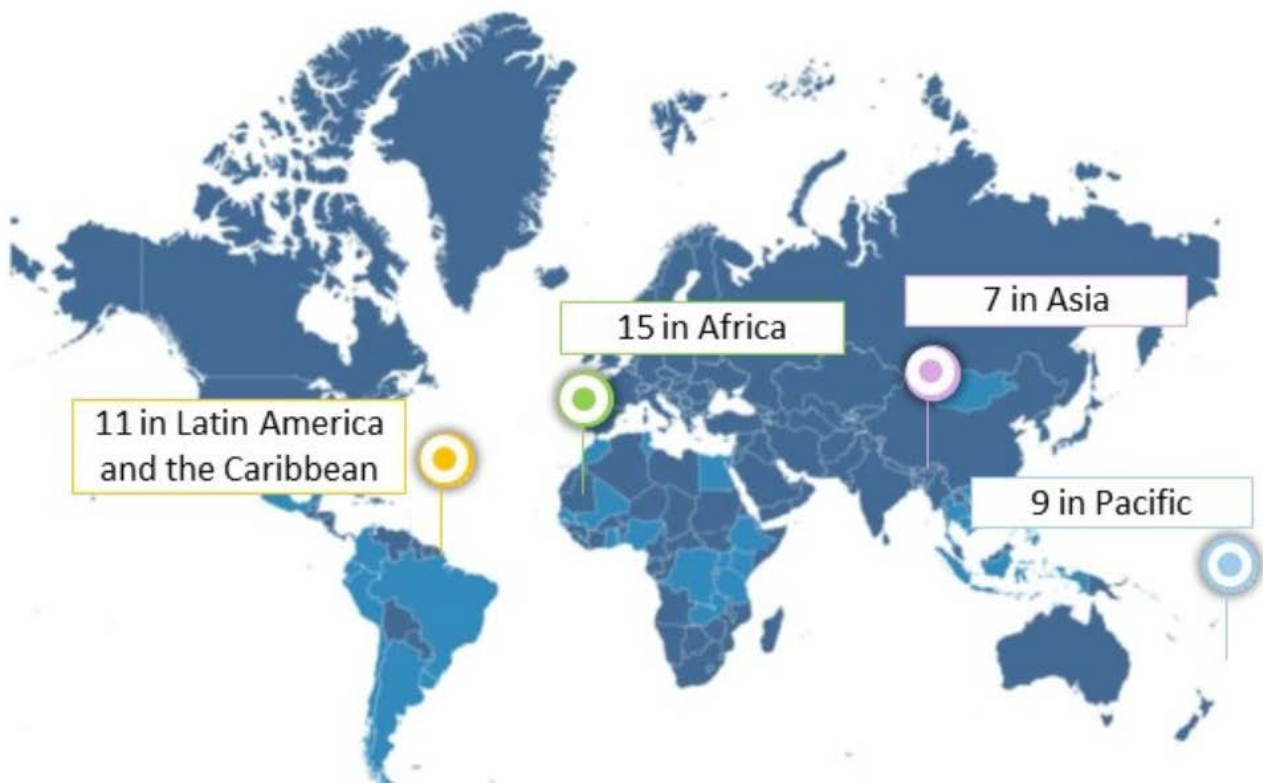


Figure 1: UNEP GMP project (2016-2024) in 42 countries

# Sectoral Reports



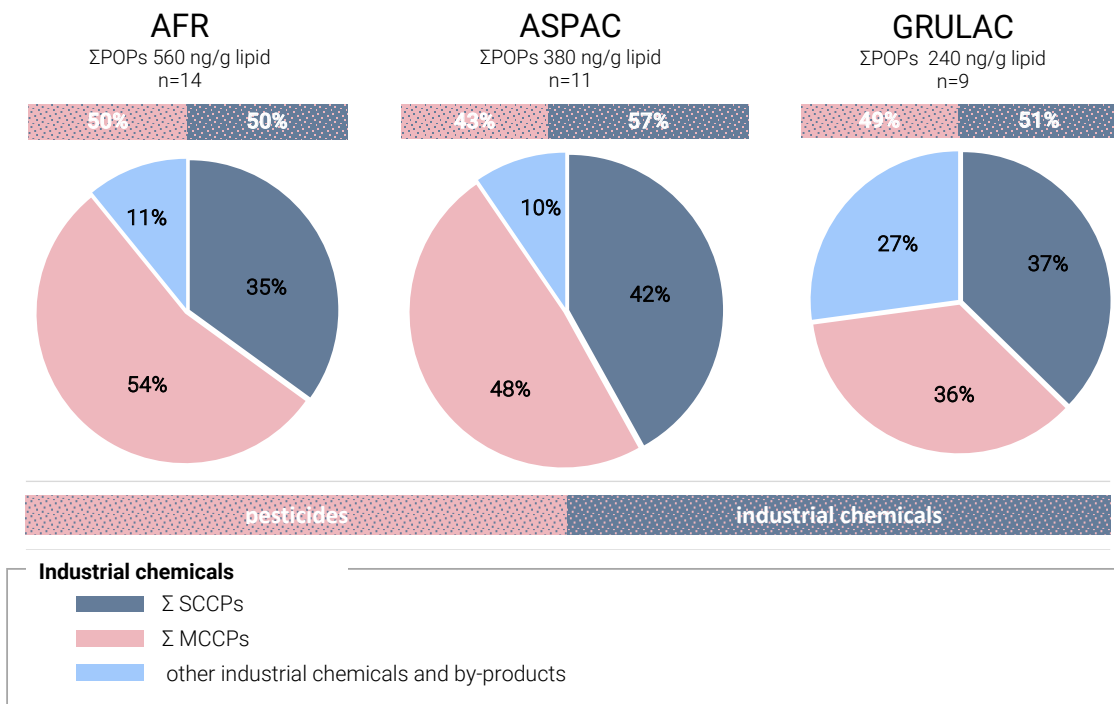
## Results of the 2016-2019 Human Milk Survey on Persistent Organic Pollutants

The WHO/UNEP human milk survey is both the largest and longest-running global study on human exposure to POPs. In total, 82 countries from all UN regions participated between 2000 and 2019. Results are presented for the 2016-2019 survey.

Thirty-six (36) countries including fifteen (15) in Africa, four (4) in Asia, eight (8) in the Pacific Islands and nine (9) in the Latin America and the Caribbean Region collected and submitted samples to this survey. Seven (7)

self-funded countries from other regions participated in this survey on a voluntary basis. Temporal trends in POPs concentrations have been analysed for twenty-four (24) of the thirty-six (36) countries with repeated participation in WHO/UNEP-coordinated exposure studies. The accumulated data of human milk surveys across eighty-two (82) countries have contributed to the derivation of statistically significant time trends at both regional and global levels.

There has been a measurable decrease in the global levels of legacy POPs such as DDT, polychlorinated biphenyls (PCBs) and dioxins-like POPs (dl-POPs). This indicates the impact of restricting or banning the production and usage of legacy POPs and improving waste and emission management has been successful. However, concentrations of POPs in some areas remain high. Globally, DDT accounted for the largest proportion of POPs on average, followed by chlorinated paraffins (CPs) and PCBs. Industrial POPs such as CPs and PCBs accounted for about 60% of the total load of POPs in human milk in the Asia-Pacific Region and 40% in the African and the Latin America and the Caribbean regions. The high levels of new POPs listed under the Stockholm Convention such as Short Chain Chlorinated Paraffins (SCCPs) raise concerns over their sources of exposure, indicating the need to reduce exposure and the benefit of monitoring to understand the nature of potential and exposures and the benefits of actions to reduce exposures.



**Figure 2:** Figure 2 Median sum of all POPs analysed in pooled human milk samples from 2016-2019, sorted by UN regions and broken down into POPs groups (bar charts) and further into components of the industrial POPs group (pie charts). MCCPs: Medium-chain chlorinated paraffins (C14-17) proposed for listing under the Stockholm Convention; AFR: Africa, ASPAC: Asia-Pacific Group, GRULAC: Group of Latin America and the Caribbean



## Results of Air Monitoring of Persistent Organic Pollutants

Under the UNEP GMP projects, two years of air sampling between 2017 to 2019 in 42 countries including fifteen (15) in Africa, seven (7) in Asia, nine (9) in Pacific Islands and eleven (11) in the Latin America and the Caribbean Region were conducted. More than two hundred ninety (290) air samples have been analysed for organochlorine pesticides (OCPs), industrial chlorinated POPs, and brominated flame retardants (BRF) and almost two hundred (200) samples have been analysed for dl-POPs. The report "Results of Air Monitoring of persistent Organic Pollutants" summarizes the results and findings of the air monitoring activities.

In general, declines were observed throughout the POPs and countries. Despite of strong decline (more than 60%) determined for DDT, it remained with the highest values by scale. The highest DDT values were found in the Democratic Republic of the Congo and Solomon Islands. Indicator PCB and dl-POPs were quantified in all countries at all times; decreases of about 30% based on median values were determined. For OCPs including indicator PCBs, relatively high levels were found in Zambia and United Republic of Tanzania. A 50% increase was found for HCB. The highest value for PFAS was found in Zambia. BFRs were found at higher levels in the samples collected from the African region than those from the other regions. Hexabromocyclododecane (HBCD) and polybrominated diphenyl (PBDE) 209 were found at relatively high levels in samples from Zambia and Mongolia. Samples collected in Egypt and Zambia were found with relatively high levels of dl-POPs than the other samples.



## Results of Water Monitoring of Persistent Organic Pollutants

The GMP defined water as a core matrix for perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonic acid (PFHxS) to evaluate changes over time caused by action of Parties to eliminate POPs according to the goals of the Stockholm Convention. The UNEP GMP projects investigated the levels of PFOS, PFOA and PFHxS in surface water samples collected in 22 developing countries and countries with economies in transition including six (6) in Africa, two (2) in Asia, nine (9) in the Pacific Islands, and five (5) in the Latin America and the Caribbean Region. In addition, some countries collected water samples on a voluntary basis and sent them for analysis. The report "Results of Water Monitoring of Persistent Organic Pollutants" summarizes the activities conducted and data generated under the projects.

A total of one hundred sixty-five (165) samples were analysed for PFAS; of these, one hundred forty-four (144) samples were seasonal samples collected over two years from 2017 to 2019 in the twenty-two (22) selected countries, and an additional twenty-one (21) were individual samples voluntarily collected by countries. The results of the one hundred forty-four (144) seasonal samples showed that the highest overall values were for PFOS found in the Pacific Islands, followed by Argentina. PFOA had lower values, with the maximum found in Kenya. PFHxS had much lower median values than PFOS and PFOA and the highest value was found in Vanuatu. Within the twenty-one (21) individual samples, the highest PFOS, PFOA, and PFHxS values were found in Asia. The global average values for PFOS (0.98 ng/L) and PFOA (0.46 ng/L) are orders of magnitude higher than the advisory levels set by the US Environmental Protection Agency (EPA) for drinking water (0.02 ng/L and 0.004 ng/L).



## Regional Reports

The UNEP GMP projects prepared four regional reports summarizing the activities conducted in Africa, Asia, Pacific Islands and the Latin America and the Caribbean regions. These reports outlined the set-up of the regional activities and include presentation of the main actors, characterize the sampling sites and other organizational structures. The reports also highlight the quantitative findings for all samples analysed for POPs.

Regional variations have been observed from the monitoring results of the projects, indicating differences in emission patterns and varying potential responses to address both the legacy and new POPs. The site-specific information and the chemical measurements serve as a data reservoir for future assessments by the Parties of the Stockholm Convention but also for researchers conducting environmental and/or human monitoring.

While some background data on POPs concentrations in the environment and human milk have been gathered, significant data gaps still exist particularly for new POPs. This challenge is attributed to the analytical difficulties of com-

plex compounds and the limited regional and national monitoring capacities. The projects have encompassed trainings in national laboratories, rounds of interlaboratory assessments, development of protocols and training courses, and have contributed to strengthened national analytical knowledge and skills. With more POPs listed under the Stockholm Convention, regional collaboration and global coordination are critical to continue strengthening regional capacities and enable sustainable data generation on environmental existence and human exposure to POPs.

Project countries have developed sustainability plans, emphasizing key areas of mutual interest. These encompass continuing POPs monitoring, capacity building, data quality control and interpretation, as well as data utilization in policy-making processes such as the development and updating of national implementation plans under the Stockholm Convention. There is also a focus on enhancing knowledge on health impacts and environmental risks, establishing a sustainable modality for POPs monitoring including financial and technical assistance, as well as fostering regional collaboration.



# Assessment Reports

During the recent phase of the UNEP GMP projects, three comprehensive assessment reports were compiled. These documents summarized the knowledge acquired from years of POPs monitoring in developing countries and countries with economies in transition. They detail the advancements achieved through successive rounds of interlaboratory assessments and outline both the existing capabilities and the ongoing needs for building sustainable environmental monitoring infrastructures for POPs in the involved regions.



## Organization and Outcomes of Four Rounds of Interlaboratory Assessments on Persistent Organic Pollutants

Accurately measuring and quantifying the concentrations of POPs is an important step towards evaluating the effectiveness of the Convention and the potential impacts of POPs in human and the environment. Interlaboratory exercises are often used for evaluating the quality assurance/quality control (QA/QC) practices across multiple laboratories and ensuring the comparability of their measurements. From 2010 to 2019, four rounds of interlaboratory assessments were organized under the UNEP GMP projects. A summary of the organization, the assessment approach and the performance of the laboratories are compiled in this report.

Two hundred eighty-nine (289) laboratories from eighty-two (82) countries across all UN regions have participated in the interlaboratory assessments at least once, with two hundred twenty-eight (228) of them submitting results

within the designated timeframe for analysis (see Table 1). The results showed that while some laboratories demonstrated excellent performance, with sixty-two (62) reporting a high ratio of satisfactory results, other submitted many results that fell below satisfactory standards (see Table 2 and Figure 3). While the analysis of PCB, OCPs, and dl-POPs is well established in laboratories across many Organization for Economic Co-operation and Development (OECD) countries, challenges were identified in laboratories in developing countries and countries with economies in transition. For example, the analyses of PFAS in Africa and the Latin America and the Caribbean regions, as well as the analyses of BFR in Africa, presented difficulties as reflected by the low satisfactory scores. There is a need to continue working on improving the quality of POPs analysis on a global scale, capitalizing on identified regional capacities.

Although an increase in the numbers of participating laboratories was observed across the four rounds of interlaboratory assessments, given the challenges for the analysis of complex organic compounds, about one quarter of the laboratories failed to submit satisfactory results in each round (see Table 1). This emphasizes the importance of routine analysis and regular interlaboratory proficiency test to enhance data accuracy and global comparability.

**Table 1:** Summary of number of laboratories registered and delivering results according to UN regions and rounds of interlaboratory assessments

Round	IL1		IL2		IL3		IL4		Total	
	Reg	Result	Reg	Result	Reg	Result	Reg	Result	Reg	Result
Africa	17	10	12	5	19	14	24	13	72	42
Asia	38	33	45	42	68	53	48	44	199	172
CEE	3	3	4	4	23	16	6	5	36	28
GRULAC	32	23	14	11	39	25	37	25	122	84
WEOG	13	13	30	27	27	25	33	29	103	94
Total	103	82	105	89	176	133	148	116	532	420

**Table 2:** Quality of the z-scores by region (as z-score interpretation with S=satisfactory, Q=Questionable, U=Unsatisfactory, C=Consistent, I=Inconsistent)

z-score	Africa	Asia	CEE	GRULAC	WEOG	Overall
	(N=2 295)	(N=19 144)	(N=2 430)	(N=4 568)	(N=13 138)	(N=41 575)
S	480	12 314	1 249	2 053	9 096	25 192
Q	199	1 744	224	431	1 393	3 991
U	1 351	4 424	788	1 693	2 049	10 305
C	18	175	16	87	288	584
I	247	487	153	304	312	1 503

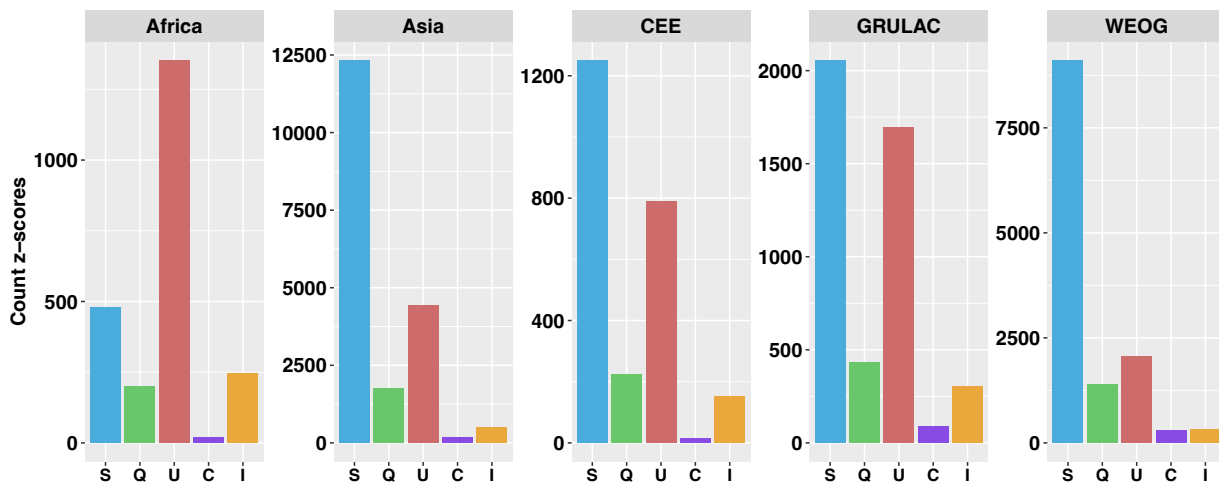


Figure 3: Number and quality of z-scores obtained by laboratories grouped by UN region (S=satisfactory, Q=Questionable, U=Unsatisfactory, C=Consistent, I=Inconsistent)



## Review of Facts, Experiences, Achievements and Challenges in relation to Persistent Organic Pollutant Monitoring Activities

With decades of experience from implementing rounds of UNEP GMP projects, a review was conducted to synthesize the experience gained and lessons learned in the organization of POPs monitoring activities. This review aims to offer valuable insights into pragmatic and workable way forward for organizing long-term POPs monitoring in the future.

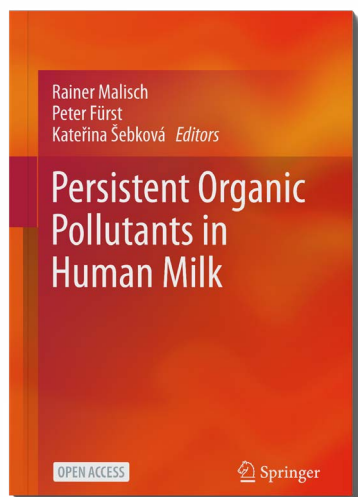
The review highlighted the significance of data generation and the efficacy of the methods and approaches employed in global monitoring of POPs, and acknowledged the crucial role of global collaboration in building capacity and generating scientifically sound information. It has also demonstrated the instrumental role of global monitoring of POPs in supporting the effectiveness evaluation of the Stockholm Convention and in providing scientifically sound evidence to facilitate informed decision-making. The report also recognized the considerable geographic disparities in the availability of monitoring capacity to provide comparable data and information for evaluating the effectiveness of the Stockholm Convention. Furthermore, it suggested solutions aimed at enhancing cost-efficiency to ensure adequate global coverage of data and to facilitate capacity development.



## Assessing Regional and National Capacities for Monitoring and Research of Persistent Organic Pollutants in Air and Water

Keeping up with the expanding list of POPs remains a significant challenge for monitoring programs, as the addition of new POPs widens the existing data and capacity gaps. This report provided a snapshot of the current situation in terms of individual and systematic POPs measurements in air and water in Africa, Asia-Pacific and the Latin America and the Caribbean regions. Moreover, current and future modalities for promoting capacity enhancement for POPs measurements were discussed, including international data quality exercises.

# Scientific Publications of Project Countries and Collaborating Researchers



## Human milk book

Human milk monitoring is an efficient and cost-effective non-invasive biomonitoring tool to evaluate human exposure to POPs and the resulting biological concentrations. Based on the data published in the Stockholm Convention GMP data warehouse and by the UNEP GMP projects, this open access book reviews the trends of POPs in human milk and discusses the main findings of rounds of global surveys that were coordinated by UNEP and WHO.

Divided into five (5) parts, the book offers an authoritative overview of human milk biomonitoring; collates the harmonized sampling requirements and analytical methods for the identification and quantification of contaminants in human milk; examines the results of the WHO/UNEP-coordinated exposure studies, including the identification of selected chlorinated pesticides, dioxin-like compounds, industrial chemicals like PCB and chlorinated paraffins, polybrominated POPs and PFAS, among others; and traces geographic, temporal and cross-substance trends and correlations, and human health risks. The book concludes by providing the reader with the summary of the main findings and outlook from these studies, in which the comparison of concentrations found for the wide range of POPs listed in the Stockholm Convention allowed the identification of possible needs for actions and follow-ups in different countries/regions.



## Chemosphere Special Issue

The special issue contains fifteen (15) papers drafted by global researchers that inform the scientific community on the results of the UNEP projects on global monitoring of POPs. This includes results of two worldwide interlaboratory studies, activities in countries in Africa, Asia-Pacific and Latin America regions, and in-depth discussion on results of groups of POPs in air, water, human milk, and other matrices varying from fish and eggs to sediments and soil, among others. The special issue shows a worldwide state-of-the-art of POP monitoring, including initial POPs such as DDT and dl-POPs but also of POPs that were later added to the Stockholm Convention list such as BFR and PFAS. It provides unique information on levels of POPs in remote areas that until now had not or only very rarely been reported such as the Pacific, Mongolia, African countries and others.

## Other related publications

Mandated by Article 16 and lead by the Secretariat of the Stockholm Convention, the GMP regional organization groups and global coordination group prepare regional and global monitoring reports every six years to support the effectiveness evaluation of the Convention. The global and regional monitoring reports are published on the [website of the Stockholm Convention](#). The recently published "Third Global Monitoring Report" has been included as an information document (UNEP/POPS/COP.11/INF/38) for the [11th Conference of the Parties to the Stockholm Convention](#). Additionally, an information document summarizing the activities and key findings of the UNEP GMP project was also prepared for the same Conference (UNEP/POPS/COP.11/INF/9).



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### Feedback and contact

The United Nations Environment Programme encourages interested readers of this summary to engage and share their views. For further inquiries, please contact us via:

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**Website:** <https://www.unep.org/topics/chemicals-and-pollution-action/pollution-and-health/persistent-organic-pollutants-pops-4>



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