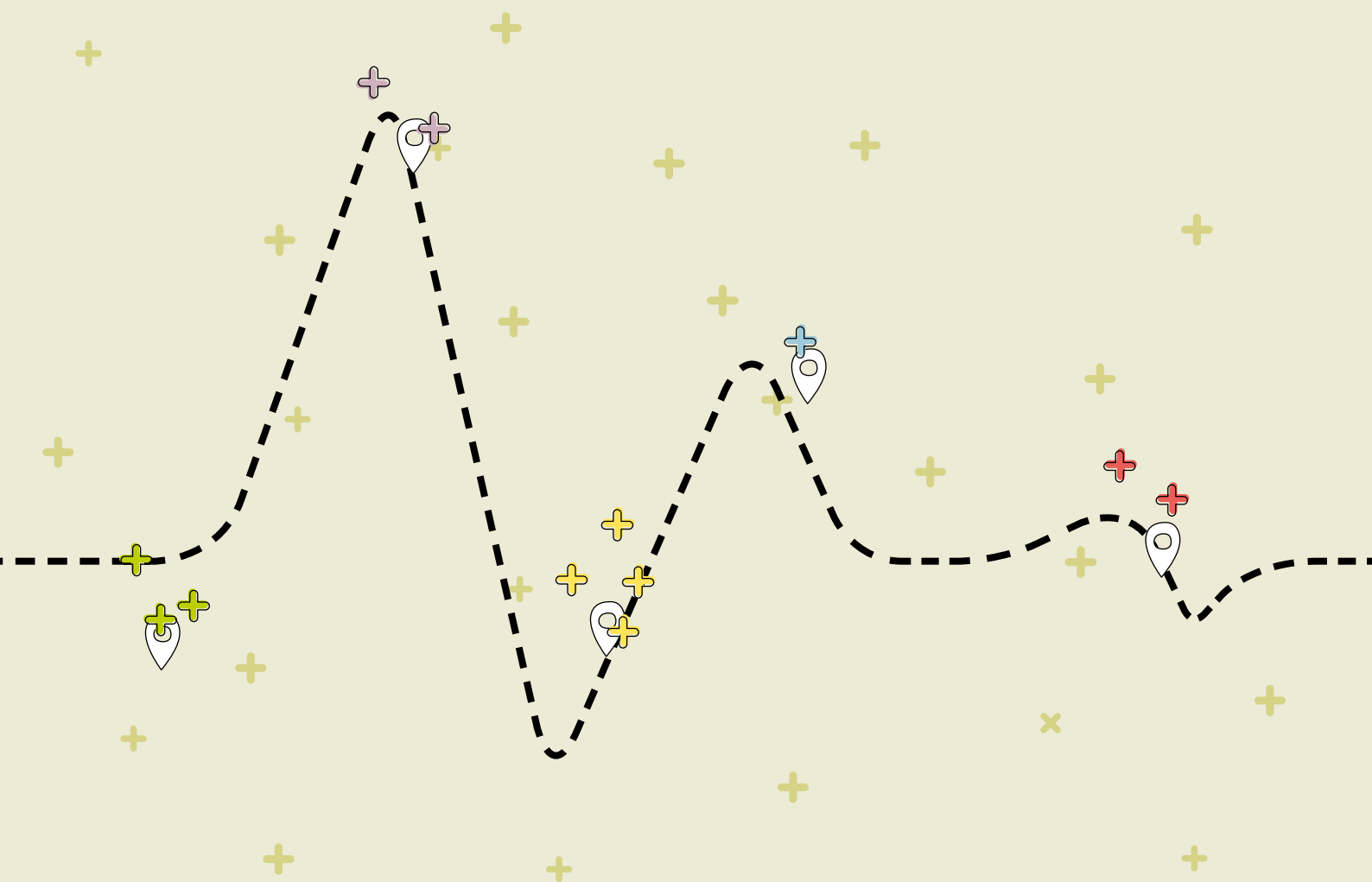


Synthesis
Report
on the

Road map for securing conditions for

Sustainable Monitoring
of POPs



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ABBREVIATIONS

AMAP	Arctic Monitoring and Assessment Programme
COP	Conference of the Parties
DDT	Dichlorodiphenyltrichloroethane
dl-PCB	Dioxin like Polychlorinated biphenyls
DQO	Data Quality Objectives
EMEP	European Monitoring and Evaluation Programme
US-EPA	United States Environment Protection Agency
GAPS	Global Atmospheric Passive Sampling
GCG	Global Coordinating Group of the Global Monitoring Plan of the Stockholm Convention
GEF	Global Environment Facility
GMP	Global Monitoring Plan
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
GRULAC	Group of Latin American and Caribbean States
IAEA	International Atomic Energy Agency
MONET	Monitoring Network for POPs
NGOs	Non-Governmental Organizations
NIP	National Implementation Plan of the Stockholm Convention
OCP	Organochlorine Pesticides
PCB	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PFOS	Perfluorooctane sulfonic acid
POPs	Persistent organic pollutants
PUF-PAS	Passive air sampling using polyurethane foam disks
ROG	Regional Organization Group of the Global Monitoring Plan of the Stockholm Convention
SAICM	Strategic Approach for International Chemicals Management
UN	United Nations
UNEP	United Nations Environment Programme
WEOG	Western European and Others Group
WHO	World Health Organization

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SECTION:

BACKGROUND

01



1. Background

Persistent organic pollutants (POPs) are a group of chemicals with a unique set of properties of that resist degradation once released to the environment, transported through air, water and other environmental transport mechanisms across international boundaries and deposited far from their place of release, accumulate in terrestrial and aquatic ecosystems and cause serious adverse human health and environmental impacts. The Stockholm Convention on Persistent Organic Pollutants, entered into force in 2004, aims to protect human health and the environment from the harmful effects of POPs. The Convention implements various measures at both national and international level to achieve its goals.

Among the provisions under the Convention, Article 16 requires the Conference of the Parties to the Convention (COP) to evaluate whether the Convention is effective in achieving its objective, including a Global Monitoring Plan (GMP) to collect data on the presence of POPs in the environment and in humans in order to identify trends and regional and global environmental transport and distribution (Secretariat of the Stockholm Convention 2009). It provides scientific evidence for the evaluation of effectiveness of the Convention and sound basis for actions towards achieving the objectives.

The eight meeting of the COP, in 2017, by its decision SC-8/18 welcomed the effectiveness evaluation report (United Nations Environment [UNEP] and Secretariat of the Stockholm Convention 2017), including the recommendation that the GMP should be sustainable in the long term (UNEP and Secretariat of the Stockholm Convention 2017). The COP10 decision SC-10/19 reiterated the request to the Secretariat on training and capacity-building activities and encouraged Parties to engage in the monitoring of core media to support the further development and long-term implementation of the GMP (Secretariat of the Stockholm Convention 2021a; UNEP 2022). Decision SC-10/16 requested the Global Environment Facility (GEF) to consider the implementation of the activities related to the global monitoring plan and capacity building (Secretariat of the Stockholm Convention 2021a).

UNEP, in collaboration with several partners and funding support by GEF, has undertaken a number of activities in support of the implementation of the Stockholm Convention GMP on POPs through a series of projects (UNEP 2019a).

During the 10th meeting of the COP, the parties expressed appreciation to UNEP and GEF for the POPs monitoring projects and highlighted the need for strengthening science-policy interface in relation to POPs for improved decision-making and to evaluate the impacts of actions being taken at the national or regional level (UNEP 2022).

An effective, well-coordinated and cost-efficient global monitoring of POPs strategy is essential for the long-term and sustainable generation of high quality and comparable data to assess the environmental presence and human exposure to POPs, as well as their temporal and spatial trends, for scientifically sound decision making both at national and global level towards achieving the goals of the Stockholm Convention.

The extensive knowledge and experience acquired through years of monitoring POPs and activities implemented to strengthen the capacities, provide a robust foundation for securing sustainable conditions in future monitoring efforts. The purpose of this report is to present an overview of the main messages and facts to assist creating conditions that will facilitate the retention and advancement of capacities developed at the national and regional levels by various stakeholders through different programs and initiatives, with a particular emphasis on the deliverables of GEF funded projects. The ultimate goal is to provide support in meeting the Convention's obligations and objectives.

SECTION:

02

METHODOLOGY



2. Methodology

The report has been developed by thorough review of a diverse range of information. This encompasses extensive knowledge derived from various sources, including two decades of global monitoring of POPs since the Stockholm Convention came into force. The sources of this knowledge are broad and encompass a wide array of scientific findings, and lessons learned from related topics and activities. These include the outcomes of project activities, reports from workshops and consultation meetings, reports from partner countries and institutes, as well as working documents from the Conferences of the Parties to the Stockholm Convention. The report was further subjected to commenting by topic experts through the peer review process, and during the deliberations on the report at final regional meetings of the UNEP/GEF POPs Global Monitoring Plan project.

This consolidation is aimed at ensuring that the report presents a comprehensive overview of the subject matter, crucial for facilitating meaningful discussions regarding practical and cost-efficient approaches for the sustainable and robust future monitoring of POPs. Particularly, the aforementioned sources of information are of noteworthy.

The report of the “Stakeholder Consultation on Securing Sustainable Conditions for the Monitoring of Persistent Organic Pollutants (POPs) under the Stockholm Convention” held in Brisbane, Australia in December 2019, which synthesizes outcomes from a thorough review conducted by key stakeholders. This review highlighted technical aspects crucial for optimizing global monitoring efforts, ensuring sustainability to support the GMP of the Stockholm Convention, and evaluating its effectiveness (UNEP 2019b). Additionally, national reports from the project countries of the GEF funded POPs global monitoring projects, titled “Continuing Regional Support for the POPs Global Monitoring Plan under the Stockholm Convention” in the Africa, Pacific Islands, Latin America, and the Caribbean Regions, and “Implementation of the POPs Global Monitoring Plan under the Stockholm Convention” in the Asia Region, were analyzed. These reports provided insights into country-specific contexts, national roadmaps for sustainability, future needs, challenges, and opportunities, all of which were systematically considered in the preparation of this report.

The assessment conducted on “Assessment of national POPs monitoring capacity and needs of Africa, Asia and Pacific, and Latin America and the Caribbean countries” entailed a comprehensive evaluation of existing monitoring capacities through literature reviews, survey responses, and information available under the Stockholm Convention.

The “Assessing Regional and National Capacities for Monitoring and Research of Persistent Organic Pollutants in Air and Water” presented a comprehensive global review of available capacities and expertise as well as innovative approaches and new partnerships for monitoring POPs in the future (UNEP 2024a).

The “Roadmap for the Design of National POPs Monitoring Program” focused on providing guidance for establishing a national POPs monitoring program to generate scientifically sound information on the levels of POPs in the environment, supporting national policymaking and actions as well as providing opportunities to support the GMP (Martínez and Manuweera 2023).

Furthermore, a range of technical reports have been generated through specific deliverables of POPs monitoring projects across Africa, Asia, the Pacific Islands, and Latin America and the Caribbean. These reports encompass sectoral reports detailing the results of POPs monitoring in air, water, and human milk, outcomes of the interlaboratory assessments offering a comprehensive review of the knowledge generated (UNEP 2023a; UNEP 2023b; UNEP 2024b; UNEP 2024c). A handbook summarizing the findings from the six rounds of the UNEP/WHO POPs human milk survey has been compiled (Malisch, Fürst, and Šebková 2023). Moreover, a special issue in the *Journal Chemosphere* includes 18 articles that delve into the scientific findings of POPs monitoring (Fiedler, Abad, de Boer 2023a). Several other scholarly articles have also been published in peer-reviewed journals by project partner countries and institutions. These reports and articles provided essential insights to enhance the overall understanding and highlight important considerations regarding the subject matter.

The background reports, prepared to support discussions at the Stockholm COP, project stakeholder meetings, and expert consultations, were also carefully examined to capture the key messages and lessons learned.

SECTION:

03

THE LANDSCAPE OF POPS MONITORING



3. The landscape of POPs monitoring

3.1. Stockholm Convention global monitoring plan and its partnership

The GMP established under the Stockholm Convention plays a pivotal role in tracking POPs in the environment and humans and assessing the efficacy of the Stockholm Convention. Three core matrices - human tissues (predominantly mothers' milk or human blood), air, and water (only for fluorinated POPs) - are the primary focus of the GMP's monitoring efforts. Regional Organization Groups (ROG), as described in the Convention guidance of the GMP, "have been established to define and implement the strategy for regional information gathering, including facilitating capacity enhancement, and to produce the regional monitoring reports. A global coordination group (GCG), comprising of three members from each regional organization group, is in place to harmonize and coordinate implementation activities among the UN regions, to produce the global monitoring report, and to maintain up-to-date the guidance on the GMP" (UNEP and Secretariat of the Stockholm Convention 2021).

High-quality, comparable data on the level of POPs across different human and environmental matrices and geographical locations as well as the time trends are essential for effectively evaluating the Convention's impact and for the reviewing of control actions in place for enhanced outcomes. In this endeavour, longstanding monitoring programs that pre-dated the Stockholm Convention on POPs, as well as subsequent efforts by several other monitoring networks have been instrumental in providing valuable data for assessing global trends.

Monitoring the levels of POPs in air has been carried out through strategic collaboration with several monitoring networks across the five UN regions (UNEP and Secretariat of the Stockholm Convention 2023). Figure 1 details the spatial distribution of monitoring networks that contributed data to the Stockholm convention data warehouse, among others these networks included the Arctic Monitoring and Assessment Programme (AMAP), Global Atmospheric Passive Sampling (GAPS) network, POPs Monitoring Project in East Asian countries (POPsEA) project, European Monitoring and Evaluation Programme (EMEP), Integrated Atmospheric Deposition Network (IADN), Great Lakes Basin Monitoring programme, and the Monitoring Network for POPs "(MONET) (UNEP 2024a)".

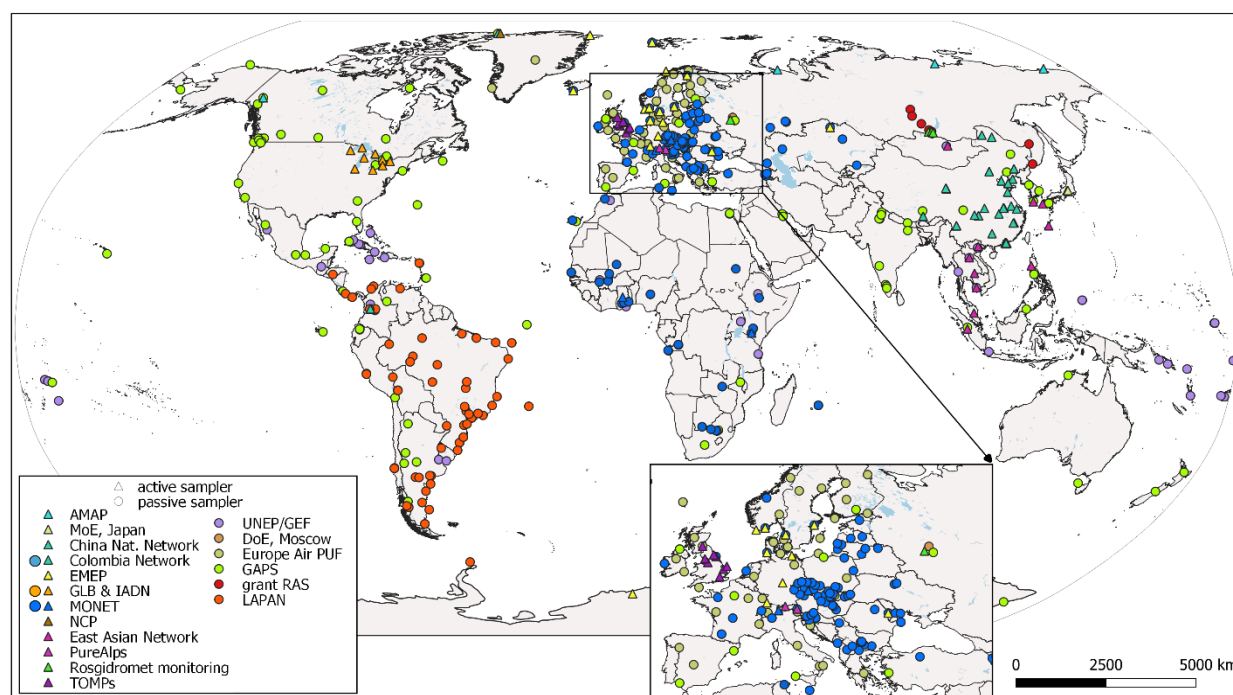


Figure 1. Map of the ambient air monitoring sites colour-coded according to the programmes as of 2022 (UNEP 2023c, p. 9).

The impetus for the human milk survey of POPs under the Stockholm Convention stemmed from two successive rounds of human exposure studies carried out by the World Health Organization (WHO) during the mid-1980s and 1990s. These early studies aimed to ascertain the concentrations of polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzofurans in human breast milk. Following the adoption of the Stockholm Convention in 2001, and the entry into force in 2004, UNEP collaborated with WHO to expand the human milk survey to accommodate all POPs listed in the Convention as part of the GMP on POPs and completed six rounds in 2019 (Malisch, Fürst and Šebková 2023, see Figure 2).

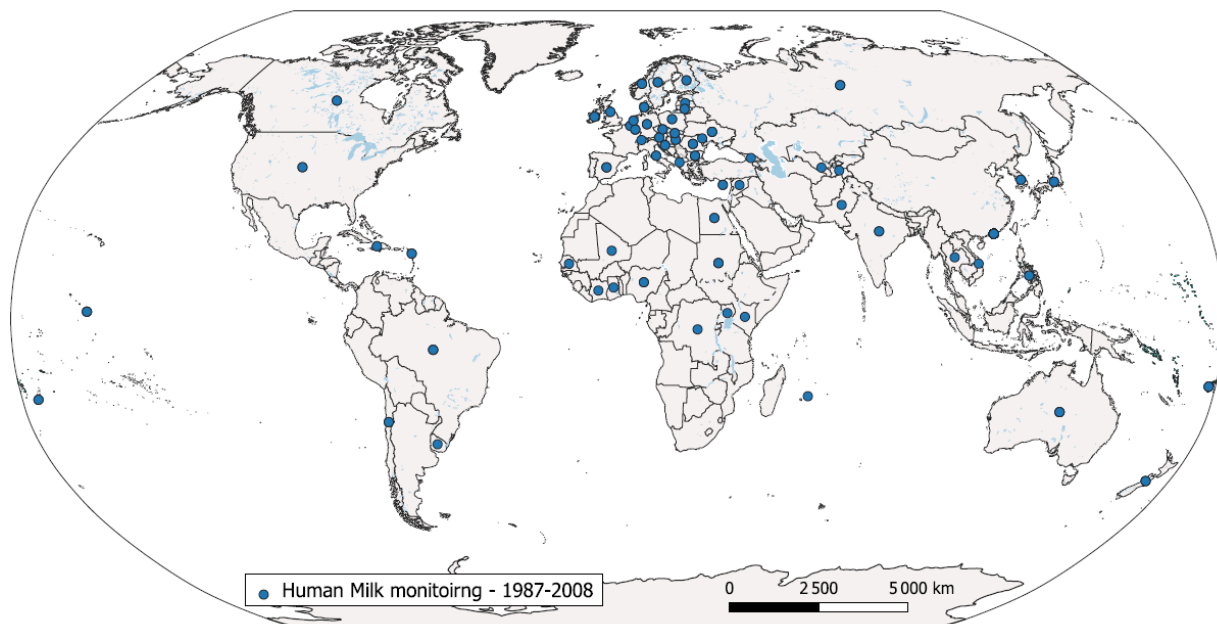


Figure 2. Map of the Human Milk monitoring countries that participated at least to one assessment round.

Of particular significance for a comprehensive strategy to monitor POPs is the pronounced variation in susceptibility, influenced by factors such as gender, notably, women of childbearing age, children and vulnerable communities (UNEP and Secretariat of the Stockholm Convention 2017). Incorporating a gender dimension into monitoring through human milk survey has ensured enhanced protection against the adverse effects of POPs on human health, including gender considerations.

3.2. UNEP's contribution for monitoring POPs

There are many initiatives contributing to strengthen the generation of data for the global monitoring of POPs under the Stockholm Convention. UNEP has been playing a pivotal role in contributing to generate high-quality and comparable data for the global monitoring of POPs under the Convention, since its inception. Additionally, UNEP has led the implementation of technical assistance programs to enhance monitoring capacities for POPs, with a particular focus on developing countries, and to address data gaps in the Global Monitoring Plan of the Stockholm Convention.

Following the Convention's entering into force in 2004, the UNEP partnered with WHO to sustain and broaden the monitoring of human milk. This collaboration initially focused on the original 12 POPs listed by the Convention, but it evolved over time to encompass the expanding list of POPs covered by the Convention, reaching a total of 30 POPs as of the year 2019. The UNEP/WHO Human Milk Survey has supplied long-term trend data on POPs in human milk for 82 countries over the past 20 years (Malisch, Fürst and Šebková 2023).

The capacity-building efforts by UNEP commenced with a scoping study in 2004 to gauge the interest and needs of developing countries. Based on the outcomes of the initial work on 2004, UNEP identified priority areas for technical assistance in follow-up projects and activities. Some of the focus areas included, development of guidelines and standard operating procedures for sampling and analyses, hands-on training on the analysis of core media and technical workshops.

3.2.1. Generation of data

Through the implementation of the second phase of the UNEP/GEF POPs GMP projects, over 900 samples of air, water, human milk and matrices of national interest were collected across all the regions, and over 50,000 data points on concentrations of POPs in various matrices were generated (Table 1). These data, to our knowledge, contributed to about 60 percent of the data on air and 75 percent of data on water from developing countries in the data warehouse for the Stockholm Convention GMP programme that were used on the regional monitoring reports covering the period of 2016-2019. The UNEP/WHO human milk survey served as the major source of data on human exposure to POPs for the Stockholm Convention.

Table 1: Overview of data generated under the UNEP/GEF GMP2-Projects

POPs groups	Analytes			Total N° of Samples		
	PUF & Nat.S.	HBM	PUF-PAS	Nat. Samples	HBM	Water
dl-POPs	29	29	195	~276	44	
OCPs(all)+PCB(6)	31	31	295		44	
PBDE+PBB+HBCD screening	13	29	295		43	
toxaphene/chlordecone	4	4	295		44	
PFAS	11	4	308		44	144
PCNs	-	21	-	-	40	
CPs (SCCPs + MCCPs)	-	2	-	-	42	
Data for single analytes produced			23,203	~ 20,000	5,163	432
				Approx. 50,000		

From 2000 to 2022, UNEP and the World Health Organization (WHO) jointly conducted six rounds of global surveys on concentrations of POPs in human milk, through the implementation of the about projects. The most recent round was carried out during the period from 2016 to 2019 (Table 2).

Table 2: Number of countries and number of pooled samples submitted for the WHO/UNEP-coordinated surveys during the five rounds performed between 2000 and 2019 (reproduced from: Malisch, Fürst and Šebková 2023).

Group	Countries	No. of samples	Number of countries participating in the period				
			2000– 2003	2004– 2007	2008– 2011	2012– 2015	2016– 2019
African	19	40	1	1	12	3	15
Asian	12	29	2	1	6	0	4
Pacific Islands	10	24	1	2	9	0	8
Latin American and Caribbean	14	36	1	1	10	3	9
Eastern European	11	43	8	3	3	7	2
Western European and Others	16	60	13	5	5	4	5
Total	82	232	26	13	45	17	43

3.2.2. Capacity Building

Capacity building activities for monitoring POPs by UNEP started with a scoping study in 2004 to explore interest and needs of developing countries in a view to equip them with the necessary tools and knowledge to contribute to the GMP (UNEP 2008).

Consequent to the pilot project, capacity assistance was a major component of the two rounds of the UNEP/GEF POPs GMP projects, including development of guidelines and training for sampling and analysis of POPs in 32 countries from 2008 to 2012, and in 37 countries from 2019 to 2023 (Table 3). The participation to the trainings disaggregated by gender, showed that globally a total of 239 participants joined the trainings and among them, a total of 115 were female (48%) and 124 were male (52%). In this regard, almost gender parity was achieved.

Table 3: Trainings in project countries planned and progress made

Region	UNEP/GEF GMP1 2019-2012		UNEP/GEF GMP1 2016-2023	
	No. of trainings conducted	No. of countries participated	No. of trainings conducted	No. of countries participated
Africa	8	12	9	10*
Asia			5	6**
Pacific Islands	1	8	2***	9
GRULAC	9	12	10	10
Total	18	32	27	35

Note: * Senegal and Mali jointed the same training. ** Myanmar joined the training in Indonesia. *** Upon request, the planned laboratory training in the Pacific Islands region was converted into a hands-on course in air and water sampling for all nine participating countries complemented by theoretical lectures.

Four rounds of international interlaboratory assessments were conducted to assess the effectiveness of QA/QC systems in place among the participating laboratories and to provide a measurement of the inter-comparability of the data generated (Table 4). The inter-laboratory comparison tests have garnered international recognition as a standard, highlighting their importance. The network of POPs monitoring specialists and POPs laboratories serve as a key component in creating the conditions for future sustainable monitoring of POPs in the participating countries, as well as on a regional and global scale (UNEP 2023b).

Table 4: Summary of number of laboratories registered and delivering results according to UN region and round (UNEP 2023b).

Region	1st round		2nd round		3rd round		4th round		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

Through these capacity building activities, it was observed that most labs in developing countries are still far from being able to generate data of high quality. Analysis on a regular basis is needed in order to maintain the built-up knowledge. It was observed that labs continuously participated in interlaboratory assessments showed improved performance. A number of labs from developing countries submitted good results in the 4th interlab. Their capacities could potentially contribute to sustainable monitoring of POPs. Mechanisms should be in place to support creating conditions for sustainable analysis of POPs in labs in developing countries, including enhancing national demands on data, policy and governmental support on sustainable monitoring of POPs at the national level. Support the usage and interpretation of results at the national level for informed decision making.

3.2.3. Communication and knowledge sharing

Information on the activities undertaken, the results generated as well as scientific reviews of data and the outcomes of the project deliverables are captured under different themes and topic reports targeting different audience.

Several scholarly articles by scientists and experts in the filed reviewing the data generated under the project activities have contributed immensely to enhance the knowledge on POPs in the environment and their behaviours (Tables 5 and 6).

Table 5: Special issue in Chemosphere (Fielder, Abad and de Boer 2023a).

Title	Reference
Air monitoring with passive samplers for perfluoroalkane substances in developing countries	(Camoiras González <i>et al.</i> 2021)
Regional occurrence of perfluoroalkane substances in human milk for the global monitoring plan under the Stockholm Convention on persistent organic pollutants during 2016–2019	(Fiedler and Sadia 2021)
Priority perfluoroalkyl substances in surface waters - a snapshot survey from 22 developing countries	(Baabish, Sobhanei and Fiedler 2021)
Occurrence and distribution of persistent organic pollutants (POPs) in the atmosphere of the Andean city of Medellin, Colombia	(Avila <i>et al.</i> 2022)

Global interlaboratory assessments on PCBs, organochlorine pesticides and brominated flame retardants in various environmental matrices 2017/2019	(de Boer, van der Veen and Fiedler 2022)
Interlaboratory assessments for dioxin-like POPs (2016/2017 and 2018/2019)	(Fiedler, van der Veen and de Boer 2022a)
Assessment of four rounds of interlaboratory tests within the UNEP-coordinated POPs projects	(Fiedler, van der Veen and de Boer 2022b)
POPs monitoring in Mongolia – core matrices	(Surenjav, Lkhasuren and Fiedler 2022)
Air monitoring with passive samplers for dioxin-like persistent organic pollutants in developing countries (2017–2019)	(Abad, Ábalos and Fiedler 2022)
Perfluoroalkane substances in national samples from global monitoring plan projects (2017–2019)	(Fiedler <i>et al.</i> 2022a)
Persistent organic pollutants in air from Asia, Africa, Latin America and the Pacific Islands	(de Boer <i>et al.</i> 2023)
Dioxin-like POPs in national samples from global monitoring plan projects (2017-2019)	(Fiedler <i>et al.</i> 2023b)
Preliminary trends over ten years of persistent organic pollutants in air - Comparison of two sets in the same countries	(Fiedler, Abad and de Boer 2023b)
Assessment of the per- and polyfluoroalkyl substances analysis under the Stockholm Convention – 2018/2019	(van der Veen, Fiedler and de Boer 2023)

Table 6: Other published articles with data from the UNEP/GEF GMP II projects

Title	Reference
Applying the Global Monitoring Plan and analysis of POPs results in atmospheric air in Mexico (2017–2018)	(Martínez <i>et al.</i> 2022a)
Persistent organic compounds in human milk and evaluation of the effectiveness of the Stockholm Convention in Mexico	(Martínez <i>et al.</i> 2022b)
Perfluoroalkane acids in human milk under the global monitoring plan of the Stockholm Convention on persistent organic pollutants (2008–2019)	(Fiedler <i>et al.</i> 2022b)
Persistent organic pollutants in human milk from primiparae – correlations, global, regional, and national time-trends	(Fiedler, Li and Zhang 2023d)
Persistent organic pollutants in air across the globe using a comparative passive air sampling method	(Fiedler, de Boer, and Abad 2024)

A number of technical reports covering various aspects of the projects are being developed under the categories of sectoral, regional and other overview reports (UNEP n.d. a).

The Sectoral reports consists of a compilation and interpretation of the results of the human milk survey, air and water monitoring conducted under the UNEP/GEF POPs GMP-2 projects in the four regions, including a summary of the outputs and outcomes (UNEP 2023a; UNEP 2024b; UNEP 2024c).

Regional reports have focused on the activities undertaken in the four respective regions and the results generated in support of the GMP as stipulated by the Stockholm Convention and coordinated by the UNEP (UNEP 2024d; UNEP 2024e; UNEP 2024f; UNEP 2024g).

The projects have yielded invaluable data, bridging critical knowledge gaps for many developing countries and offering substantial support in assessing the effectiveness of the Stockholm Convention. Concentrations of POPs have been measured globally in air, human milk, water, and other matrices of national interest, such as fish, butter, and sediment. To facilitate easy exploration of the various project components and the data generated, an interactive dashboard has been established (UNEP n.d. b). The dashboard is freely accessible on the UNEP webpage and allows navigating through the different components of the projects, accessing the material produced and visualizing the data generated. Furthermore, information on the activities undertaken by the UNEP to support the Stockholm Convention on Global Monitoring of POPs has been made available for the public through a dedicated webpage (UNEP n.d. c).

3.3. Financial and political sustainability

The GMP lacks sustainable and predictable financing to effectively contribute to the evaluation of the Stockholm Convention on POPs. Sustainable funding for the GMP is essential, as it is integral to the Stockholm Convention and aligns with the Sustainable Development Goals, particularly SDGs 3.9 and 12.4.

The GEF has played a crucial role in initiating and continuing the GMP program, but most activities have been dependent on external funding rather than core government support. The main objectives of the GEF funded POPs Global Monitoring Projects were to strengthen the capacities, with special emphasis on developing countries, to implement the updated POPs GMP, and to create the conditions for sustainable monitoring at regional level. The GEF has funded two phases of GMP projects focusing both on national capacity building and the generation of quality and comparable data for the effectiveness evaluation process of the convention.

A sustainable GMP model should consider economic, social, and environmental aspects, as well as gender dimensions, to ensure secure financing in the future. Prioritizing the GMP at national and regional levels involves strengthening national POPs management and establishing evidence-based policymaking processes alongside effective evaluation of existing regulations. Establishing regional and sub-regional POPs monitoring networks and joint programs is recommended to contribute effectively to global compliance efforts.

Connecting private and public sectors within countries and regions is essential for the success of the GMP. External funding is still required to establish a solid foundation for the GMP program's effectiveness.

An effective communication strategy highlighting the benefits of the Stockholm Convention and showcasing the GMP's importance can help maintain political attention and support. Integrating a gender dimension in GMP approaches aligns with SDG 5 and can contribute positively to sustainable development efforts. Preparing and presenting well-justified arguments at the Stockholm Convention COP can emphasize the need for sustainable financing for the GMP program from GEF and gain support from relevant stakeholders.

3.5. Opportunities for future partnerships

In addition to these regionally and internationally coordinated environmental monitoring efforts, the contributions of national researchers and their independent studies cannot be underestimated. A literature review on air monitoring of POPs since 2005 highlights significant studies conducted in the Asia-Pacific and the Western European and Others Group (WEOG) (UNEP 2024a). However, regions such as Africa, Latin America, and the Caribbean are still underrepresented.

Monitoring studies on POPs in water across Africa, Asia-Pacific, and the Group of Latin American and Caribbean States (GRULAC) regions have often encompassed assessments of various matrices and contaminants, such as sediment, air, fish or biota tissues, drinking water, and groundwater. This suggests the laboratories' capability to handle a broad spectrum of organic contaminants in diverse environmental media (UNEP 2024a).

The initiative of interlaboratory assessment and quality control programs for POPs in air and water have been launched in multiple regions. These efforts demonstrate the feasibility of conducting proficiency testing and emphasize capacity-building endeavours to ensure standardized analysis of POPs, leading to reliable results (UNEP 2023a).

The monitoring networks, alongside other global efforts, have made remarkable strides in generating data and advancing the monitoring of POPs. However, there are still growing gaps in the temporal and geographical coverage of POPs reporting. These gaps could jeopardize the GMP's ability to generate representative information critical for supporting the Convention's Effectiveness Evaluation. Besides, challenges remain in reporting sources of emissions and hotspots of contamination, temporal trends and concentrations of newer POPs, highlighting the need for enhanced strategies and broader expert engagement to enable a sustainable and active role of POPs monitoring in the sound management and elimination of these toxic chemicals.

To address these gaps, the conditions (e.g. technical, operational) at global as well as national levels have to be comprehensively reviewed for the identification of critical areas for improvement and implement measures supported by facts and the wealth of experience gained through the monitoring and capacity assistance activities.

Enhancing national and regional technical capacities and securing sustainable funding are essential to enable sustainable data generation. Collaborative efforts from the global community remain the cornerstone of effective POPs monitoring, driving closer to a cleaner and healthier future for all. These expectations and demands should be reflected in the future design of POPs global, regional, and local monitoring programs and framework for collaboration.

SECTION:

04

FACTS AND FINDINGS ON MONITORING
OF POPS

4. Facts and findings on monitoring of POPs

The facts emerged from the generation of data on the levels of POPs in various matrices, the reviews presented in thematic reports developed, and the experiences of project countries, experts and partners in delivering the project outputs shared during several consultations and through surveys should form the basis of the future approach to capacity assistance in monitoring POPs. The outcomes of those deliverables highlighted four major findings, which were also presented at the eleventh COP to the Stockholm Convention.

- a. Generation of high quality and comparable data remains a key pillar for assessment and decision making at, both, national and global level;
- b. It is essential to continue investing in generation of critical data to support the effectiveness evaluation of the Stockholm Convention;
- c. Understanding of data is key for effective implementation of the Stockholm Convention at national level;
- d. Prevention of regrettable substitutions is essential to avoid continuous additions of new POPs.

A review of over 15 years of monitoring and capacity assistance activities implemented through by strategic partnerships and by the UNEP/GEF supported projects (UNEP 2023c) highlights the number of facts on how those projects have been complementing other long-term monitoring programmes towards enhancing the capacities in developing countries. Overall, the key messages emphasize the importance of building monitoring capacity, maintaining strategic partnerships, and addressing emerging challenges in POPs monitoring to achieve the goals of the Stockholm Convention effectively.

In 2008, the Stockholm Convention's effectiveness evaluation revealed significant disparities in monitoring capabilities across different regions. Developing nations benefited from capacity building initiatives and strategic partnerships, yet some areas continued to be challenged with limited capacities to monitor all POPs in all matrices. While monitoring capacities for Polychlorinated Biphenyls (PCB) and Organochlorine Pesticides (OCPs) improved gradually worldwide, the analysis of more complex analytical compounds, such as dioxin-like POPs (PCDD/PCDF and dl-PCB) remained confined to a select few laboratories. The addition of new POPs to the Convention heightened the demand for monitoring, necessitating adjustments in protocols and resource allocation. Partnerships and optimized analytical methods were identified as strategies to alleviate this pressure. A more efficient approach advocated for supporting a few promising laboratories in each region to serve as regional reference laboratories, enhancing POPs laboratory capacities for the future. Notably, advancements in monitoring POPs in ambient air were observed, particularly through passive sampling in UNEP/GEF project countries, significantly improving geographical data distribution.

Human milk monitoring programs, active for nearly three decades, have proven to be a cost-efficient and non-invasive means to estimate humans' exposure to POPs and track time trends in diverse regions. This dynamic survey on POPs in human milk consistently includes newly listed and candidate POPs, with UNEP/GEF projects playing a pivotal role in bolstering global capacity for human milk sampling and analysis.

The monitoring of POPs in water, a relatively recent addition to the GMP in 2009, is an emerging field. Ongoing projects are expected to lay the foundation for future harmonized water monitoring efforts.

Recognizing the expanding scope of the Stockholm Convention, the imperative to strengthen laboratory capacities is emphasized, necessitating a novel approach for future support provision. Quality control and inter-laboratory assessments are underscored as crucial mechanisms to evaluate the performance of chemical laboratories and promote improved and standardized infrastructures on a global scale.

4.1. Concentrations of POPs

The results from monitoring POPs contain a wealth of knowledge. Numerous scientific articles have delved into various aspects informing this data. Within these findings lie crucial messages and trends backed by scientific facts. Considering these insights is essential for shaping future strategies to effectively achieve the goals of the Convention and to sustainably monitor POPs.

Continued emphasis on strengthening mechanisms for generating high-quality, comparable data is imperative. Additionally, strategies aimed at enhancing our understanding of how this data informs effective decision-making, both globally and nationally, remain crucial.

4.1.1. Presence and distribution

Evidence of decreasing levels, such as the decline of DDT in Africa (UNEP 2023a) and PCB in Europe, supports the effectiveness of global community actions and their ability to yield positive results.

DDT is still the most detected in all sample analyzed. Several legacy POPs, which have been banned many years ago are still present in several locations. Some legacy POPs are still major contributors to the overall environmental burden of POPs. Their levels have plateaued, declining very slowly and in a few instances (e.g. HCB) are slightly increasing.

New POPs, in particular some industrial POPs such as chlorinated paraffins (CPs) and PFAS are of emerging concern. They were detected in most samples including in human milk and in environmental matrices from remote locations.

There is an overall global declining trend in the concentration of POPs in core matrices but emerging new POPs (e.g. CPs) are showing increasing levels that are difficult to control under the Stockholm Convention. Also, regrettable substitutions of those listed under the Convention with POPs properties continue to pose a serious risk. Furthermore, unintentionally produced POPs like HCB or HCBd have recently show some increasing trends (UNEP n.d. b).

4.1.2. Gaps in data

The impact of gaps in data are multifaceted. Although many existing air monitoring programs are reporting data on POPs to the GMP, there continue to have significant data gaps in GMP reporting. These gaps include both regional/sub-regional gaps as well as missing information for specific POPs almost entirely. Availability of adequate data-sets to assess the exposure risks are often lacking, leading to challenges in developing effective risk mitigation measures.

Except for a few cases, assessment of spatial and temporal trends in the levels of POPs at global level for the purposes under the GMP are still challenging. Full coverage of data on all POPs (31+) and from all regions and matrices is lacking, due to high cost and complexity associated with analysis. The situation is further aggravated by the limited set of quality and comparable data available.

Given that the focus of GMP on contributing to the effectiveness evaluation of the Convention, the data to inform the identification of hotspots/sources of releases for control actions is lacking in many cases.

4.2. Knowledge gaps

There are several key knowledge gaps when it comes to establishing comprehensive mechanisms for monitoring POPs as well as addressing the associated risk effectively. The scientific community faces challenges developing reliable methods to accurately measure the concentrations of growing list of new POPs and complex mixtures in both environmental matrices and humans.

New priorities are emerging for considering “chemical mixtures”, transformation products of parent POPs, and related health effects associated with exposure to human populations (urban and indoor air) and to the wildlife and environmental ecosystems.

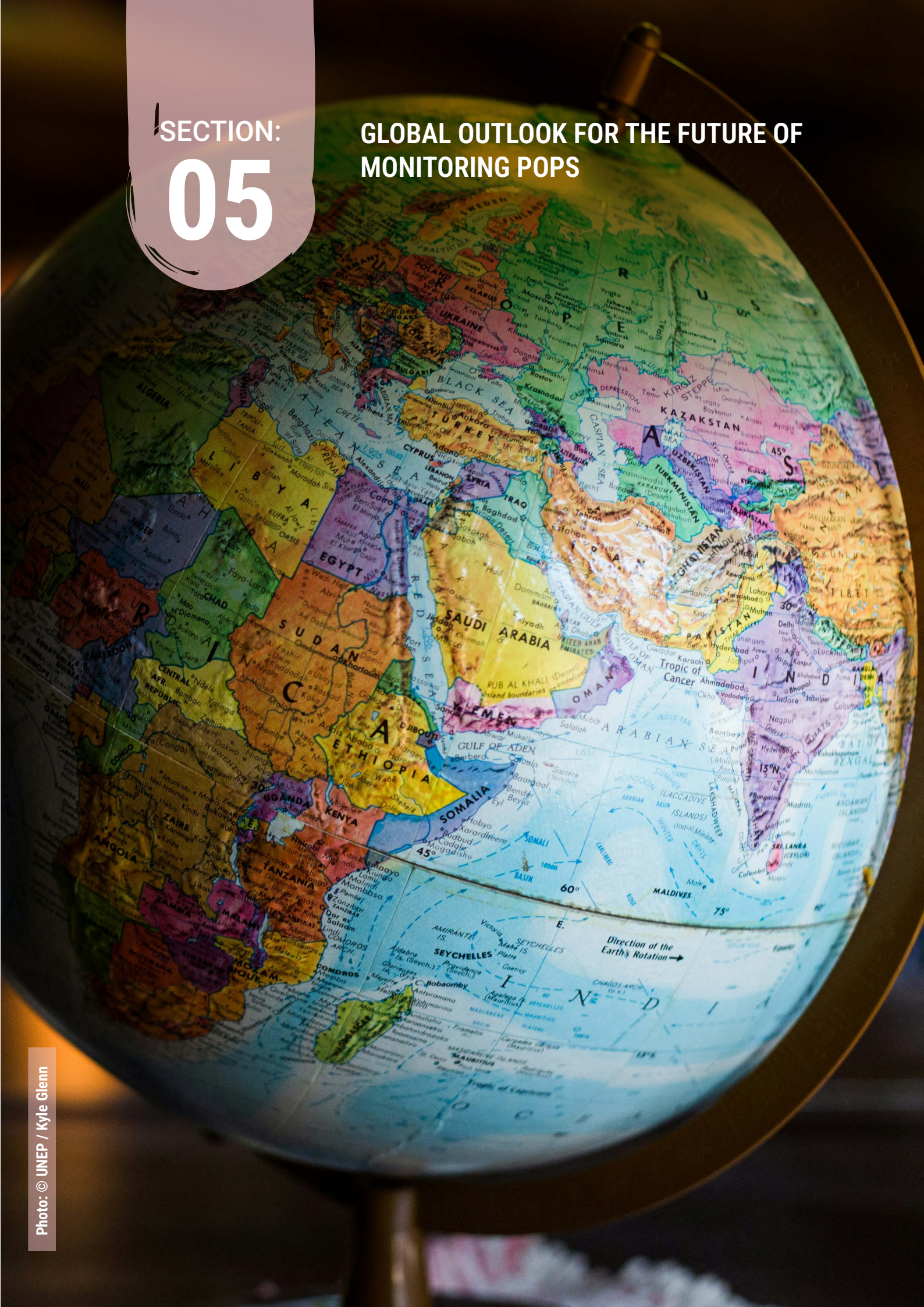
Understanding the broader context of POPs, including their long-range transport through various vectors such as microplastics, waste streams, and biovectors, is crucial but currently lacking.

There's also limited knowledge about how POPs intersect with and are influenced by the climate crisis (e.g. Arctic Monitoring and Assessment Programme [AMAP] 2021) and the loss of biodiversity and ecological balance. To address these gaps and work towards sustainable monitoring of POPs, it's essential to focus on developing knowledge in these areas, which will contribute to addressing global priorities.

SECTION:

05

GLOBAL OUTLOOK FOR THE FUTURE OF MONITORING POPS



5. Global outlook for the future of monitoring POPs

Monitoring of POPs is undertaken by various stakeholders with diverse objectives, ranging from generating scientific evidence to identify new POPs and understanding the behaviour and potential impacts of existing ones, to measuring levels in biotic and abiotic matrices for research and policy review purposes. Several assessments have been conducted to learn from the activities in the past and to suggest best practices in the future. Presented below are some key messages from the assessment of landscapes POPs monitoring in core matrices (human milk, air, and water) under the Stockholm Convention, highlighting potential new opportunities for enhancing the conditions for effective outcomes.

5.1. Monitoring POPs in human milk

The WHO and the UNEP have conducted a series of studies on POPs in human milk from 2000 to 2019. These studies have expanded from the 12 initial POPs to include all POPs listed under the Stockholm Convention, with the participation of 82 countries participating from all UN regions, contributing to the GMP for the Stockholm Convention. The studies involve the collection of individual samples, their pooling, and analysis in dedicated Laboratories, ensuring data reliability and cost-effectiveness. By minimizing sources of variation through the analysis of pooled samples by centralized laboratories, it becomes possible to reliably estimate regional differentiation and identification of time trends, with a focus on broader patterns. They reveal variations in the concentrations of individual POPs between and within the five UN Regions (Malisch, Fürst and Šebková 2023).

The ability to assess future exposure and measure the effectiveness of adopted measures by the Convention relies on having comprehensive datasets. To achieve this, it's crucial to adapt to new methods while retaining well-established ones, such as the periodic WHO/UNEP human milk survey on POPs. Coordinated studies by UNEP and WHO, using standard protocols and reliable analytical methods every four or five years, play an irreplaceable role in generating reliable, harmonized, and validated datasets. To enhance the dataset, it's important to encourage the repeated participation of countries that have already taken part in the milk studies and to engage additional countries to improve regional and global coverage. Additionally, advancing modern technology and sustainable data mining efforts such as science-policy research partnership, including computer-based systems and networks for exposure research, will be essential for supporting ongoing research and providing open access to researchers and other stakeholder communities.

Continuation of current model of human milk survey with further improvements by adapting new knowledge and methodologies, where needed, is essential to ensure scientifically sound basis for the continuation of tracking changes in the concentrations of the POPs over time, which is vital for evaluating the effectiveness of policy and management measures in line with the Stockholm Convention.

5.2. Monitoring POPs in air

There are many existing air monitoring programs reporting data on POPs to the GMP but continue to be significant data gaps in reporting on global POPs monitoring under the Convention. The review conducted under the topic (UNEP 2023a) shows that the gaps include both spatial and temporal gaps, regional/sub-regional gaps as well as missing information for specific POPs almost entirely. The existing gaps are expected to continue and/or increase especially in developing regions as more POPs are listed under the Convention. To take advantage of broader sources of existing data, it is important to re-assess the current approaches for reporting and how data are evaluated for inclusion in the GMP.

The expansion and better integration of passive air sampling using polyurethane foam disks (PUF-PAS) monitoring into the GMP is a cost-effective measure towards resolving data gaps for both gas-phase and particle-phase POPs; it may also lead to other co-benefits. For instance, by having a more inclusive framework under the GMP that better recognizes POPs experts in the field, this will lead to improved communication and collaboration across the science-policy interface; this, in turn, can foster new and diverse teams and partnerships for enhancing POPs measurements in air and resolving information gaps. The improved air monitoring data will support model development and testing, including "top-down" approaches to better understand regional and global transport of POPs in air. Although many labs are shown to perform adequately in terms of data quality, there are definite advantages (e.g., comparability of data) and efficiencies to be gained from using central labs at regional/sub-regional level.

The future model should focus on closing substantial data gaps through cost-effective approaches, including promoting centralized testing facilities while continue to assist national capacities to conduct monitoring of POPs, improving data quality, and fostering collaboration among a broader community of experts in the field of POPs monitoring. This approach aims to enhance effective generation and interpretation of data to inform national and global policy actions and the trends in transport of POPs in the air.

5.3. Monitoring POPs in water

The need for monitoring POPs in water was emerged as a global priority relatively recently as the listing, under the Stockholm Convention, of more hydrophilic POPs such as fluorinated POPs. Much work is still needed to contribute to the ongoing efforts to lay the foundation for future harmonized water monitoring towards establishing robust monitoring mechanism. This includes protocols for sampling and monitoring as well as analytical technics for the generation of reliable data and their interpretation.

A global review of published literature on monitoring of POPs in water (UNEP 2023a) indicates that all four UN regions possess significant capabilities for conducting analysis of POPs in water. However, the majority of studies have focused on a limited range of POPs.

The available data on POP concentrations in surface waters can serve as a valuable resource for initial assessments of geo-spatial and temporal trends in future GMP reports. The feasibility of incorporating data on non-polar POPs in water into regional GMP reports as part of “other media” has been demonstrated. Consequently, comparing geo-spatial trends in POPs concentrations at the global GMP reporting level can help identify contamination hotspots that may not be apparent in air and human milk studies.

Ideally, a future framework for water sampling and analysis should be centered around passive sampling methods, which are widely acknowledged for integrating temporal and spatial dimensions, including assessing non-polar organic compounds.

Strengthening the capacity to conduct analyses of POPs in water at the national level would connect the GMP to other studies such as measurements in air, sediments and biota many laboratories involved with water sampling and analysis were also involved in such studies.

There have been numerous successful citizen science projects focused on monitoring standard water chemistry parameters, such as UNEP’s “Citizen Data for SDG Indicator 6.3.2” program but they do not usually cover POPs. A carefully planned application of “Citizen Science” to POP studies in water could align with the passive air sampling program, potentially involving environmentally conscious members of the public.

5.4. Developing country capacities for national POPs monitoring

An assessment of information available under the Stockholm Convention and responses to a questionnaire indicates that most developing countries in the African, Asia, Pacific and Latin America and the Caribbean regions have the capacity to conduct POPs monitoring studies, but their capabilities are limited to basic POPs (OCPs and PCB). Many countries rely on strategic partners to analyze all POPs in monitoring samples (UNEP 2024h).

Although many countries have participated in various training and research programs for POPs monitoring and generated data on environmental concentrations, this data is not considered in the regional assessments due to its lack of comparability for inclusion in the Global POPs Monitoring Programme under the Convention. Despite receiving training and technical support under various programs, countries reported a lack of human resources and technical capacity.

The main obstacle identified in the analysis is the financial capacity of countries, not only to equip and update their laboratories with advanced technology but also to sustain the routinely operation of national POPs monitoring programs.

Some countries still have a gap in the latest update of national information accessible at the global level. In some countries, political will and financial mechanisms at the national level are lacking to strengthen the institutional structure for monitoring POPs and ensure its long-term sustainability.

Sustaining existing global and regional monitoring programs and continuing to support UNEP/GEF projects is needed to ensure the continuity and consistency of sampling activities at every site. This will provide adequate data for evaluating temporal and spatial trends, spatial distribution, and long-range transport of POPs in all regions as well as to inform national policy makers of more targeted and concrete actions.

5.5. Lessons learnt from capacity assistance

The scientific facts and knowledge generated under the present round of UNEP/GEF projects inform the priorities of technical aspects to be focused in future monitoring. The lessons from challenges encountered and opportunities present in implementing the activities play an important role for the effective delivery of outputs and achieving the sustainability of expected outcomes, especially in developing country context. The following sections discusses highlights from national reports of project countries focusing on the sustainability of project

outcomes and the continued monitoring of POPs at the national level as well as the lessons learnt from the inter-laboratory assessments.

Countries have recognized the importance of developing cost-effective national monitoring plans aligned with the Stockholm Convention's objectives and their specific national goals. There is a need for guidance to establish a cost-efficient monitoring structure that identifies monitoring purposes and parameters effectively. Countries require support and direction on how to effectively analyze and utilize POPs monitoring data for informing policy decisions and evaluating control measures including linkages to the National Implementation Plan (NIP), which provides a framework for managing and reducing POPs.

Moving forward, effective laboratory analytical capacities are crucial for generating high-quality and comparable data. Priority areas for strengthening laboratory capacities include improving equipment readiness, streamlining sample shipment and logistics, enhancing regional analysis capabilities, improving laboratory infrastructure, implementing quality control measures, developing sustainable business plans, and utilizing POPs analysis for policy and research. Collaboration, communication, and awareness play essential roles in driving informed actions and strengthening monitoring efforts at the national and regional levels.

5.6. Key messages from the national roadmaps of the project countries

As part of their project deliverables, the participating countries developed sustainable monitoring roadmaps for POPs in their respective countries. These roadmaps were informed by the valuable experience gained from implementing activities aimed at achieving the project's expected outputs and outcomes.

Outlined below are the key features of the sustainable roadmaps, as documented in the final national project reports of the participating countries. These roadmaps were further examined and discussed during the final regional project meetings, with a particular focus on ensuring the enduring effectiveness of the project's outcomes and the ongoing necessity for monitoring POPs at the national level (UNEP n.d. b).

- **Establishing National Monitoring Plans:** Countries expressed the need to develop their own national monitoring plans that align with the goals of the Stockholm Convention as well as their specific national objectives and National Implementation Plans. These plans should be cost-effective, considering the local context, available resources, and national needs and priorities.
- **Guidance for Cost-Efficient Monitoring:** Further guidance is needed to establish a cost-effective monitoring structure to enable comprehensive but focused monitoring of POPs to provide a basis not only for action on POPs, but also to contribute to other cross-cutting issues of national and global concern, such as health effects and biodiversity loss.
- **Enhanced Usage of Data:** There is a need for guidance on the enhanced use of POPs monitoring data at the national level. This entails providing support and direction on how to effectively analyse, interpret and utilize the collected data for national needs, such as informing policy decisions and evaluating the effectiveness of control measures.
- **Policy Briefings:** It is important to develop policy briefings that emphasize the importance of establishing and maintaining a monitoring program, as well as communicating the results. These briefings should highlight the value of monitoring data in addressing national priorities and promoting sustainable development.
- **Updating Inventories:** Regularly updating inventories, especially regarding newly listed POPs in products, is crucial to inform priorities for monitoring and facilitate appropriate actions at the national level.
- **Strengthening National and Regional Laboratories:** The importance of having regional laboratories and supporting the development of national laboratories is emphasized to enhance monitoring capabilities and ensure reliable and accurate analysis of samples.
- **Capacity Building:** Continuation of capacity building efforts is necessary to empower countries in monitoring POPs. This includes providing technical training, knowledge sharing, and resource mobilization. It is important to leverage both national and external resources for sustainable capacity development, also taking into account the cross-cutting policy issues and opportunities for integration of other topics of concerns such as the chemical waste, health, climate change and biodiversity loss.
- **High-Priority Monitoring Activities:** There is a willingness to explore options for interim continuation of high-priority monitoring activities, such as human milk sampling, air, and water, until future projects can provide necessary support. Ensuring the continuity of crucial monitoring activities is essential for effective assessment and risk management of POPs.

- **Communication and Awareness:** Effective communication is highlighted as a critical component throughout the monitoring process, starting from the planning stage. It is essential to raise awareness among decision-makers about the importance and implications of monitoring results to drive informed actions. Adequate awareness of the public about possible sources of exposure to POPs, preferably supported by local data and general understanding of the associated risks, in particular among the vulnerable population, such as women and children, are critical in reaching the goals of national monitoring.
- **Feedback Mechanisms:** Establishing feedback mechanisms is important to encourage information sharing between governments, non-governmental organizations, and community-based organizations. This promotes collaboration, knowledge exchange, and strengthens the overall monitoring efforts.
- **Role of Regional Centres:** Regional centres of the Convention and other relevant institutions play a key role in facilitating monitoring, knowledge sharing, coordination, and technical assistance to sustain POPs monitoring and research. They can provide valuable guidance and support in utilizing monitoring data effectively at the regional and national level.
- **National Implementation Plan (NIP):** The sustainability of POPs projects and monitoring activities in each country is directly linked to the NIP, which provides a framework for managing and reducing POPs. It is important to align monitoring efforts with the objectives and strategies outlined in the NIP.
- **External Support for Capacity Building:** Countries with limited capacities for monitoring POPs require external technical and financial support. Partnering with international organizations and leveraging global initiatives can help bridge the capacity gaps and strengthen national monitoring programs.

5.7. Lessons learnt from four rounds of interlaboratory assessments capacities

Over some ten years and four rounds of UNEP/GEF inter-laboratory assessments, a total of 289 laboratories from 82 countries have participated in one or more inter-laboratory assessments to test the performance of laboratories analysing POPs in core matrices and many other matrices of interest (UNEP 2023c).

Based on the assessments and lessons learned from their implementation, the following priority areas were identified for strengthening the laboratory analytical capacities:

- **Improve equipment and method readiness:** Address the issue of non-operational analytical equipment, especially detectors, in registered laboratories. Ensure that laboratories use and have regular functioning equipment and methods to effectively analyze samples.
- **Streamline sample shipment and logistics:** Enhance coordination between coordinating and recipient laboratories to ensure smooth and efficient sample shipment. Address issues to prevent delays or sample loss during transportation.
- **Enhance regional analysis capabilities:** Focus on improving the analysis of specific pollutants and matrices in certain regions, such as PFAS in Africa and GRULAC and brominated flame retardants in Africa. This will contribute to a more comprehensive understanding of the global distribution and impact of persistent organic pollutants (POPs).
- **Improve laboratory infrastructure:** Ensure that laboratories have the minimal necessary instrumentation for extraction, clean-up steps, and analyses, as well as the materials, consumables (certified standards, high-purity solvents, and high-quality gases), and skilled personnel to carry out reliable POPs analysis. Strive for gender parity within laboratories to promote diversity and inclusivity.
- **Implement quality control/quality assurance measures:** Emphasize the importance of quality control, quality assurance measures in routine laboratory operations. This will help maintain and improve the accuracy and reliability of POPs analysis.
- **Develop sustainable business plans:** Encourage laboratories to create business plans that support routine POPs analysis. This will ensure the long-term sustainability and maintenance of laboratory infrastructure and instruments.
- **Utilize POPs analysis for policy and research:** Recognize the value of high-quality POPs analysis in generating information for policy makers and researchers. Promote the exploration of complex and cross-cutting issues related to POPs, such as gender and age-differentiated windows of exposure, health and the impact on vulnerable groups, chemical waste, climate change, biodiversity loss, including linkages of POPs with the triple planetary crisis.

By addressing these key action items, future work can contribute to the improvement of POPs analysis worldwide, enhance data quality, and facilitate informed decision-making regarding POPs management and regulation.

SECTION:

06

**APPROACHES TO STRENGTHEN
CONDITIONS FOR SUSTAINABLE
LONG-TERM MONITORING:
CONNECTING THE DOTS**



6. Approaches to strengthen conditions for sustainable long-term monitoring: connecting the dots

The knowledge and information generated through the implementation of activities outlined in the preceding chapters provide a solid foundation for formulating cost-effective and sustainable strategies for monitoring POPs in the future. However, there are significant challenges that need to be addressed as a priority towards establish the foundation for generation of POPs monitoring data to meet the present and future needs. The key challenges include a lack of long-term sustainable financing plans, limited access to technical resources and expertise at regional and national levels and effective mechanisms to contribute to policy and actions, in particular at the national level.

6.1. Key pillars

The foundation of future approaches to strengthen the conditions should form on the following pillars to ensure addressing the major challenges for sustainable monitoring of POPs and to facilitate advancing on meeting the future needs.

First key pillar: Sustainable financing

Efficient management of available limited resources: Enhance collaboration among POPs monitoring networks, research and academic initiatives, technical assistance programmes in planning and the delivery of outcomes to avoid overlaps and enhanced focus on the delivery of the global priorities.

Enhanced opportunities for country ownership and mobility of national resources: Promote integration of local/national and regional priorities for monitoring POPs for greater involvement and ownership of individual countries in the monitoring process, enabling them to utilize their resources effectively and share expertise with other nations.

Effective business plans for national and regional laboratories: Facilitate the development of robust business plans for laboratories to ensure the continuity of technical capabilities strengthened and upgrade where applicable, which is vital for generating reliable and consistent data.

Establish new partnerships: Explore opportunities and establish new partnerships at national and global level within as well as outside the chemical cluster including other global topics such as biodiversity, one-health, climate change, sustainable development goals, human rights, megacities, etc.

Second key pillar: Access to technical resources and expertise for cost-efficient monitoring

Enhanced collaboration between chemicals monitoring networks and initiatives: Facilitate establishing mechanisms for resource, expertise and information sharing among different networks and initiatives focused on monitoring chemicals, including POPs.

Effective and efficient access to resources, expertise and information: Map capacities and priorities available at national, regional and global level. Establish effective coordination mechanisms at regional level. Develop strategic plans that outline the objectives, priorities, and resource allocation strategies, while promoting resource sharing to achieve cost efficiency.

Supporting policy environment: Create a favourable policy environment that supports monitoring activities and promotes using monitoring data in periodic review of national policies related to POPs, including the implementation of relevant regulations, standards and sharing resources at national, regional level.

Method developments and experts networking: Foster the development of new monitoring methods and promote networking among experts to enhance the accuracy and reliability of data and for the development of scientifically sound and cost-efficient monitoring programmes.

Guidance on generating quality and comparable data: Develop guidelines and protocols to ensure the generation of high-quality, comparable data across different monitoring programs.

Inter-laboratory quality assurance mechanisms: Establish guidance and quality assurance mechanisms at sub-regional or regional level to ensure consistency and comparability of data generated by different laboratories within a specific region.

Training and technical assistance: Continue to provide effective training programs and technical support to enhance the capacity of personnel involved in sampling, analysis, and data management.

Third key pillar: Science to action at all levels

Guidance on data interpretation: Provide guidance and enhance capacities at national level with emphasis on developing countries, on how to interpret monitoring data effectively to inform decision-making processes.

Enhanced involvement of experts in policy and action review: Encourage the active participation of experts in reviewing policies and actions related to POPs monitoring and management.

Effective feedback systems: Establish mechanisms for receiving feedback from stakeholders and incorporating it into the monitoring and decision-making processes.

National chemicals management: Integrate the findings from monitoring activities into national chemicals management plans and strategies. Strengthen field enforcement measures and take appropriate actions based on the outcomes of monitoring.

Policy and NIP review: Review and update policies and NIP based on the findings and recommendations from monitoring activities.

Civil-society engagement: Engage civil society organizations and communities in the monitoring process to ensure inclusivity and transparency. Encourage the active participation of civil society organizations and consumers in knowledge sharing and awareness-raising initiatives.

National stakeholders: Involve national stakeholders, including government agencies, non-governmental organizations, civil society and industries, in knowledge management and information sharing efforts.

Regional support: Define the specific roles of regional entities such as the Stockholm Global POPs Monitoring Regional Organization Group (ROG) and Regional Centers in coordination, knowledge management and information sharing, facilitating collaboration and exchange of information among countries in the region.

6.2. Strategic priorities for creating conditions for sustainable monitoring of POPs.

The strategic priorities for action focus on fundamental essentials that are crucial for establishing sustainable monitoring systems for POPs while facilitating continuous improvement over time. Presented below are the key elements to be focused at various level in the management hierarchy of global monitoring of POPs.

National actions

Enhance Data Utilization: Maximize the usage of data generated from monitoring activities to inform and drive national actions and priorities, including the effective implementation of NIPs.

Strengthen Policy and Regulatory Governance: Support the development and enhancement of robust policy, regulatory frameworks and the NIPs that ensure the long-term sustainability of POPs monitoring programs and taking into consideration the monitoring results for national policy and action reviews and also to align the national monitoring programme with national policies and priorities.

Facilitate Access to Analytical Infrastructure: Promote effective coordination within and between countries to share resources, expertise, and analytical infrastructure for POPs monitoring. Additionally, empower the national laboratories, as appropriate, to enhance monitoring capabilities and contributing to the national efforts.

Tailored National Monitoring Plans: Encourage countries to develop national monitoring plans that are cost-effective and tailored to their specific contexts, available resources, and unique national needs and priorities, while contributing the global monitoring, where possible.

Regional focus

Resource Sharing and Coordination: Foster resource sharing and effective coordination among experts and countries within the regions, preferably through the Stockholm Convention Regional Centers, to optimize monitoring efforts and enhance data quality and comparability.

Strengthen Regional Networks: Establish more inclusive frameworks for the recognition of regional POPs experts in the field and engaging them in reviewing the monitoring activities and outcomes. Empower and enhance the roles of regional networks such as Latin American Atmospheric Passive Sampling Network (LAPAN) or Environmental POPs Monitoring Project in East Asian Countries (POPSEA), in monitoring and managing POPs.

Promote information exchange: Strengthen information sharing platforms among regional entities including Stockholm Convention GMP Regional Organization Groups, Regional Centers, and POPs monitoring initiatives by the academic community and external networks.

Foster technical capacities: Develop regional and sub-regional rosters of experts and establish group of expert trainers, ideally affiliated with educational institutions, to provide comprehensive training and technical assistance for laboratory technicians and personnel involved in sampling, analysis, quality control, and data management. Additionally, establish and empower regional laboratories of excellence to enhance monitoring capabilities.

Global support

Priority Setting: Collaboratively set priorities for monitoring POPs at both the global and national levels. Identify and address gaps in temporal/spatial coverage, POPs monitored, resources, knowledge, expertise, and technical capacities.

Engaging with Regional Groups: Establish and strengthen connections with regional centers, the Global Coordinating Group (GCG), and other relevant networks dedicated to monitoring POPs such as Arctic Monitoring and Assessment Programme (AMAP), Global Atmospheric Passive Sampling (GAPS) and the Monitoring Network for POPs (MONET). Foster global collaboration and facilitate knowledge sharing including extension to cross-cutting issues such as toxicogenomics (health indicators).

Guidance and Protocols: Develop and disseminate comprehensive guidance and protocols that facilitate the establishment and advancement of national monitoring efforts for POPs. Ensure alignment with both national and global goals and best practices. Engage international bodies such as International Atomic Energy Agency (IAEA) to support enhancing the laboratory capacities to generate quality comparable data.

Robust financial mechanisms: Sustain existing global and regional monitoring programs, including UNEP/GEF projects, to maintain continuity of sampling activities and ensure consistency in data collection across all regions. Explore and expand the donor community for environmental monitoring.

Targeted Funding and Technical Assistance: Provide targeted funding and technical support to enhance the science-policy interface, leverage opportunities (e.g. Special Programme and Issues of Concern of UNEP, SAICM) synergies with global priorities and initiatives (e.g., biodiversity, climate change), and support from other chemical monitoring efforts (e.g., mercury).

6.3. Essentials for strengthening global monitoring plan under the Stockholm Convention

Implementing the strategies outlined above and ensuring the presence of critical elements at the national, regional, and global levels, allows creating conditions that facilitates the generation of high-quality and comparable monitoring data. However, it is equally crucial to focus on the priorities of the technical aspects of global POPs monitoring, initially, to ensure sustainability and cost-efficiency of the system. This approach will effectively address both global priorities and national needs in the development of a national monitoring program.

A comprehensive deliberation on priorities for monitoring POPs on technical, financial and political aspects for enhanced sustainability through undertaken by a multi-stakeholder consultation (UNEP 2019), focused on the following topics in short-term and long-term targets to be achieved. A brief highlight of the targets and concrete actions to be considered in strengthening the capacities are presented in the Annex 1 to this report.

6.3.1. Monitoring human exposure to POPs

The assessment of human exposure to POPs is conducted through the human milk monitoring program based on the GMP guidance of the Stockholm Convention. It is imperative to sustain this initiative to monitor the dynamic trends of exposure to POPs in the human population. The existing framework, supported by the UNEP and WHO for monitoring POPs in human milk, is efficient and cost-effective. This program has yielded a valuable repository of samples and results, serving as a crucial resource for ongoing and future analyses.

Continuing the established model of human milk surveys and advancing it by integrating new knowledge and monitoring methodologies is essential. Encouraging the continued participation of countries that have previously contributed to milk studies, while actively engaging additional countries, will enhance regional and global coverage. This approach fortifies the scientific rigor of assessing human exposure risks to POPs, playing a vital role in evaluating the effectiveness of policies and control measures established under the Stockholm Convention, both globally and nationally.

Moreover, is crucial the collection and analysis of gender-disaggregated data for understanding the varying impacts of POPs on different demographic groups. This inclusive approach ensures a comprehensive monitoring strategy, thereby contributing to a more thorough understanding of the differential effects of POPs on diverse

populations.

6.3.2. Environmental monitoring

Air matrix

Existing air monitoring programs report data on POPs to the Global Monitoring Plan (GMP), but significant data gaps persist. We need to re-evaluate reporting approaches, to take advantage of a broader sources of existing data, and to improve collaboration to address these gaps, especially as more POPs are listed under the Convention.

Cooperation and coordination with relevant air monitoring networks such as GAPS Network and MONET must be further strengthened. The sampling sites and the substances measured by the future UNEP project should be reviewed and adjusted considering the other monitoring programs with a focus on supporting optimum global coverage, measurement of the background concentrations, inclusion of newly listed POPs, and with priorities for the measurement of long term trends and long range transport.

Water matrix

Considerable effort is still required to contribute to the ongoing initiatives aimed at establishing a robust and harmonized water monitoring framework. This includes refining sampling methods, sites and monitoring procedures and adopting analytical techniques to ensure the generation of reliable data. There are substantial capabilities available for POPs analysis in water.

The future framework for water sampling and analysis should also explore passive sampling methods, which are widely recognized for their effectiveness, especially in evaluating non-polar organic compounds. Enhancing the capacity for conducting POPs analyses at the national level will also facilitate connections between the Global Monitoring Plan (GMP) and other studies, such as those involving air, sediments, and biota. Many laboratories engaged in water sampling and analysis are also involved in these broader environmental investigations.

The existing knowledge should be further explored to inform the establishment of monitoring system and coordination with other relevant monitoring networks.

6.3.3. Matrices of national interest

National POPs monitoring should be mainly focused on matrices of national concerns and identification of priorities and hot spots within the national context towards contributing to reviewing and updating related national policies and programmes, in particular the NIPs, while global POPs monitoring requires measuring the background levels. In order to have a higher level of country commitment and interest in global POPs monitoring, it is vital that country specific needs are reviewed and addressed in a more sustainable and cost-effective manner.

6.4. Long-term strategy to secure sustainable conditions for monitoring of POPs

There are several initiatives and networks, globally and regionally, engaged in generating high quality data on the levels of POPs in biotic and abiotic media contributing to the GMP and consequently to the effectiveness evaluation process of the Stockholm Convention. Addressing gaps existing in the spatial coverage of these initiatives and the sustainability of continued generation of core data needed for the assessment of temporal trends are vital for meaningful to the GMP process.

6.4.1. Harmonizing global and national POPs monitoring objectives

The monitoring of POPs requires a unified approach that aligns national and global objectives. Such a harmonized strategy not only facilitates the assessment of the Stockholm Convention's effectiveness on a global scale but also contributes to local and national efforts to protect human and the environment. This alignment is achieved through the establishment of National Monitoring Plans, which address national priorities, such as addressing potential hotspots, while also contributing to global POPs monitoring. These plans provide guidance for cost-efficient monitoring and enhance the utilization of monitoring results for national actions and policy briefings outlined in the NIPs.

6.4.2. Engaging a diverse community of experts

To gain a comprehensive understanding of environmental dynamics, collaboration with a diverse community of

experts from various disciplines is imperative. This interdisciplinary collaboration ensures that the data produced is both of high quality and relevant to national and global priorities related to POPs and other overarching environmental issues. Involving experts at all levels fosters a strong connection between scientific findings and policy decisions, enhancing the credibility and applicability of environmental assessments. Establishing a more inclusive framework under the GMP that recognizes POPs experts in the field will improve communication and collaboration across the science-policy interface, leading to the development of new and diverse teams and partnerships for enhancing POPs measurements and addressing information gaps.

6.4.3. Enhancing regional monitoring capacities

While many laboratories demonstrate capacity to meet adequate data quality, there are distinct advantages, such as data comparability and operational efficiency, in utilizing central laboratories at regional or sub-regional levels. Promoting selected regional or sub-regional laboratories as centers of excellence helps address regional priorities more effectively by leveraging local knowledge to tackle specific challenges. Furthermore, their contributions extend beyond regional boundaries, enriching the global framework of environmental monitoring with nuanced insights and data.

The importance of regional laboratories and the support for the development of national laboratories are emphasized to enhance monitoring capabilities and ensure the reliable and accurate analysis of samples. Sustained capacity building efforts are necessary to empower countries in monitoring POPs. The regional laboratories can offer guidance for national laboratories for the generation of quality and comparable data.

6.4.4. Facilitating regional collaboration and networking

Enhanced regional collaboration and resource-sharing mechanisms among regional entities and national agencies are essential for the sustainability of POPs monitoring and the capacities developed at the national level. Regional centers of the Convention, GMP Regional Organization Groups (ROG), and other relevant organizations play a key role in facilitating monitoring, sharing knowledge, coordinating efforts, and providing technical assistance to sustain POPs monitoring and research. They offer valuable guidance and support for effectively utilizing monitoring data at the national level.

Collaboration extends further through regional monitoring networks, which offer localized perspectives on environmental challenges. Enhanced regional coordination ensures efficient resource utilization and a unified approach against shared environmental threats. This collaborative spirit enhances the impact of environmental monitoring efforts, creating a resilient and interconnected network dedicated to protecting the planet. Regional centers of the Stockholm Convention are well-positioned to serve as platforms for coordinating national needs and sharing resources, including maintaining a pool of regional experts on POPs.

6.4.5. Linking with cross-cutting issues

Recognizing the interconnected nature of environmental challenges, it is essential to acknowledge that POPs monitoring cannot exist in isolation. It is intricately linked to broader issues, such as chemical and plastic waste, health impacts including the integration of gender dimensions, biodiversity loss, and climate change. Embracing an integrated approach allows for collective action to address these challenges, pooling resources and insights for more effective and sustainable solutions. Further guidance is needed to establish cost-efficient monitoring plans that enable comprehensive yet focused monitoring of POPs, informing actions not only on POPs but also on related concerns such as health impacts, biodiversity loss and inclusive policies and actions to effectively address the specific vulnerabilities and the needs of different gender groups and populations. This includes defining the purposes of monitoring and determining which parameters to focus on.

6.4.6. Communication and awareness

Effective communication and awareness play pivotal roles in advancing measures to prevent POPs releases and exposure. Customized communication strategies for various stakeholders, including civil society, local authorities, and the media, are essential. Awareness campaigns serve as bridges that connect scientific endeavors with public understanding, garnering support and active participation in environmental protection initiatives.

6.4.7. Addressing regrettable substitutions

Significant gaps exist in various aspects, including spatial and temporal gaps, regional or sub-regional gaps, and missing information for specific POPs. As new POPs are regularly added to the Convention, these gaps are expected to persist or even expand, especially in developing regions. Proactive interventions are vital to prevent regrettable substitutions in chemical usage. Researching and promoting eco-friendly alternatives before harmful substitutions occur ensures a forward-thinking and environmentally conscious approach. Emphasizing sustainable substitutions safeguards ecosystems and promotes the well-being of present and future generations.

Global measures, including those at the Conferences of the Parties to the Stockholm Convention, are essential to advance in these vital aspects of sustainable monitoring of POPs and prevent continued regrettable substitutions and their catastrophic consequences.

6.5. Essentials for establishing a robust national POPs monitoring programme.

A guidance developed under the project to address the critical elements in designing, implementing and communicating the results for actions by stakeholders towards assisting the developing countries provides an important insight for national monitoring of POPs (UNEP 2024i). It presents a roadmap for countries with the steps to follow in designing a program that meet the generation of scientifically sound information for needed for the review of national policies to protect the health of the population and the environment.

The guidance on national roadmap for establishing a POPs monitoring programme consists of the following components:

1. Situation Analysis: The primary goal is to create a comprehensive profile of the country's current state regarding POPs, as well as its capacity and needs to address and eliminate these compounds. Conducting this analysis is crucial to understanding the country's POPs management situation, identifying specific issues, and determining the information required. The NIP provides the basis for sound management of POPs under national context, including the necessary information vital for the scope and objectives of monitoring POPs.

2. Definition of Monitoring Objectives: To begin, it is essential to clearly outline and define the problem that necessitates monitoring data. Subsequently, the study's objectives should be identified. The use of the DQO (Data Quality Objectives) process, an effective US-EPA tool, can assist in precisely defining these objectives and the characteristics of the monitoring network.

3. Characteristics of the Monitoring Plan: The monitoring network's key features include specifying the substances of interest, the matrices or media to be monitored, the number and locations of sampling sites, monitoring timeframes, and the selection of appropriate sampling methods and analysis techniques. Emphasizing stratigraphic planning is advised to ensure the data's reliability.

4. Definition of a Quality Assurance Plan: In an environmental monitoring program, ensuring data quality is paramount. A comprehensive quality assurance plan should encompass actions carried out and documented to guarantee the data's accuracy. This plan should be implemented from the project's planning stage and span the entire program, covering planning, implementation, and evaluation phases.

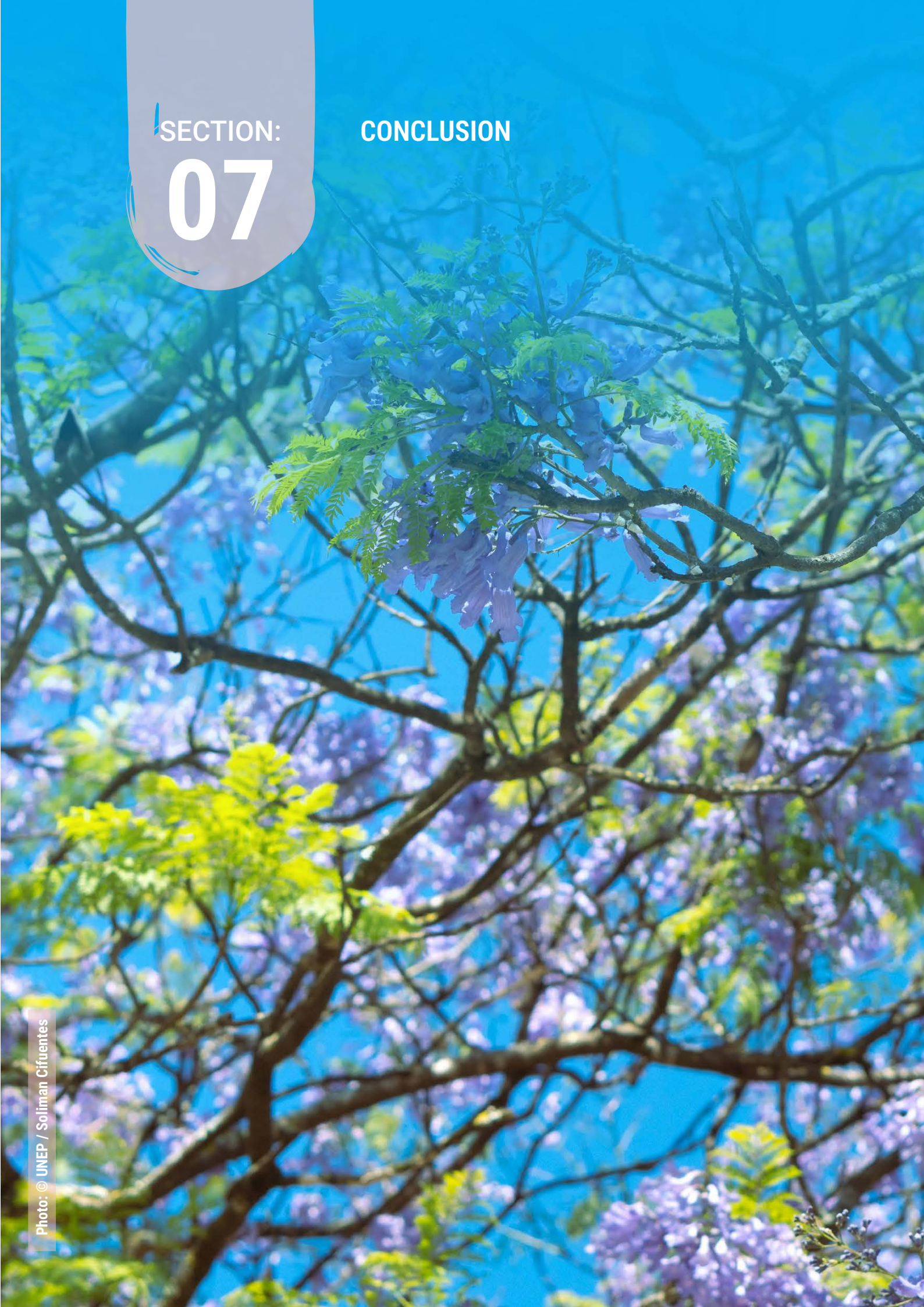
5. Effective networking and defining responsibilities: To ensure the project's success, it is crucial to engage relevant stakeholders in the program development process. Early on, a stakeholder engagement plan should be created to involve government agencies, academic institutions, industry representatives, NGOs, and local communities. Their active involvement in program design, implementation, and evaluation is highly recommended.

By adopting and focusing on these strategic priorities, stakeholders can work collectively to build robust and sustainable monitoring systems for POPs. These efforts will not only address current challenges but also pave the way for a healthier and safer environment for future generations.

SECTION:

07

CONCLUSION



7. Conclusion

The monitoring of POPs demands a high level of expertise, cutting-edge technology, scientifically robust systems, and substantial human, physical, and financial resources. However, the contributions it makes to protecting both humans and the environment from the harmful effects of POPs are extensive and invaluable.

A well-planned and properly executed global strategy can yield multiple benefits. Not only does it ensure the successful achievement of the intended outcomes of the Stockholm Convention, but it also addresses crosscutting issues, including health impacts and biodiversity losses. Furthermore, it establishes a scientifically sound foundation for assessing the impact of donor contributions and evaluating the cost-efficiency of various technical assistance options, undertaken.

With over two decades of experience in monitoring POPs in both human and environmental matrices, a wealth of knowledge has been amassed. This knowledge serves as a guide for shaping the future landscape of POPs monitoring. Over time, the portfolio of POPs, associated concerns, understanding of their behaviour in the environment, and potential impacts have evolved significantly. Therefore, there is a pressing need to re-evaluate the subject by leveraging current knowledge, lessons learned, and the broader context of global priorities and available resources.

The rational path forward involves strategically integrating top-down and bottom-up approaches to generate high-quality data. It also entails tapping into a broader pool of expertise on POPs-related subjects, harmonizing global and national priorities and objectives, regional focuses in technical assistance, and using results effectively for scientifically sound decision-making within the context of sound POPs management, both on a global and national scale. Additionally, it encompasses addressing overarching global issues such as health impacts, biodiversity loss, climate change.

A comprehensive review of GEF-funded POPs monitoring projects, ongoing monitoring activities by global and regional programs (such as MONET, GAPS, POPsEA, and LAPAN), and the roles of regional players in coordination and support (e.g., ROG and Stockholm Convention Regional Centers) discussed in the report provides clarity and a solid foundation for future planning.

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Annexes 1

Stakeholder Consultation on Securing Sustainable Conditions for the Monitoring of Persistent Organic Pollutants (POPs) under the Stockholm Convention Brisbane: Targets and objectives for capacity assistance

Brisbane, Australia, December 2019

Target 1: Sustainable Global Monitoring of POPs for the effectiveness evaluation of the Convention

This will facilitate the delivery of the core data on global monitoring of POPs in a sustainable manner for the assessment of global status and long-term trends in POPs concentration in core media, human milk, air and water for the consideration of effectiveness evaluation of the Stockholm Convention, including the review of related global and local policies and regulatory actions.

A long-term POPs monitoring program includes the following forms of monitoring and capacity building activities.

Filling gaps and ensure sustainability in the generation of core and long term data on POPs in the abiotic and biotic matrices using improved cost-effective design

Taking into consideration the ongoing initiatives and networks for monitoring levels of POPs in core matrices by various stakeholders, and based on the experiences of the current arrangements, UNEP will support undertaking selected monitoring of POPs in the core matrices; Air, water and human milk, in an efficient and cost-effective way for the generation of high quality, comparable and reliable data. In cooperation with external stakeholders, it will support the gaps, so GMP will cover all UN regions and represent the relevant population to facilitate prioritizing policy and actions at local and global levels. Results will lead to an effective and efficient evaluation program covering all regions of the planet in a scientifically sound and coherent way over a long-term.

A system with enhanced capacity for the generation of high quality comparable monitoring data

Selected labs are able to generate and guarantee high quality POPs monitoring data's. Tools and training mechanisms for effective use of data for the production of long term trends and long range transport models, for policy reviews at national level are established, in addition to purposes of effectiveness evaluation under the Stockholm Convention. It also includes the procedure to assure the quality of the data generated on levels of POPs in core matrices by the optimization of the inter laboratory assessment.

A sustainable long-term POPs global monitoring system

To monitor the long term impact of the Stockholm Convention and to evaluate the concrete impact of all the technical POPs elimination projects implemented globally, including policies to forbid or restrict the use of POPs, a long term, sustainable and scientifically sound monitoring system will be established. According to the Convention, the program will provide a harmonized organizational framework for the collection of a minimum set of comparable monitoring data on the presence of POPs from all regions, in order to identify changes in their concentrations over time, as well as on regional and global environmental transport.

A long term POPs monitoring system needs a clear strategy with an institutional setup and a sustainable financing mechanism, otherwise it will be very difficult to get POPs results over a period of 40 to 50 years, which will be necessary to evaluate the real, facts based impact of the policy measures of the Stockholm Convention and all the technical reduction projects implemented all over the world.

Target 2: Developing countries generate and use monitoring information to protect their people and the environment and to fulfil their obligations under the Stockholm convention at country level

While global monitoring of POPs helps to evaluate the impacts of global actions on elimination of POPs, at national level, it is essential to have the capacity to evaluate national needs and priorities based on the concrete measurement of levels of POPs, from taking concrete actions on regulating the production and use of POPs in national markets, to public awareness raising on protection of wild life and habitats from the use of POPs pesticides.

At national level, the policy reviews will focus on measures in place for reduction and/or elimination of releases of and exposure to POPs, including the consideration of priorities related to SDGs and biodiversity as well as remediation of polluted sites.

Enhanced capacity at national and sub-regional level for the generation/measurement of high quality comparable POPs monitoring data,

Countries willing and committed to develop and operate their own national POPs monitoring program get technical assistance. The national monitoring system has to be included in the National Implementation Plan (NIP) and may target also national hot spots. It will contribute to a Sustainable support for GMP and help countries to make evidence based decisions on POPs at national level.

Enhanced data usage for sound management of POPs at national level and sub-regional level,

To increase the impact of the monitoring results and to allow countries to make better policy decisions in POPs management, including the identification of hot spots, technical assistance and trainings in the use, interpretation and formulation of policies, technical measures and remediation technologies are conducted. Toolkits and Guidance on the application of data are in place.

Capacity building and technical assistance will support developing countries in the assessment and application of POPs monitoring results. Data of external monitoring networks, regional networks and from the national monitoring will be interpreted, reviewed and published. Developed and developing countries are encouraged to publish their national POPs action plans.

Countries' commitment for GMP is improved and strengthened.

Countries use NIPs funds to develop and operate national monitoring networks that contribute data to the GMP and help countries to evaluate the impact of implemented policies and technical POPs reduction measures.

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