Insights from Stockholm Convention on POPs Global Monitoring Plan, Phase 3: Monitoring Focus vs. Modelling Focus

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1 Introduction

The Global Monitoring Plan (GMP) is a key element of Effectiveness Evaluation, Article 16, of the Stockholm Convention on Persistent Organic Pollutants (POPs), which came into effect in 2004. The GMP reports on changes in levels of POPs in core media – air, human tissues and water (for PFOS (perfluorooctanesulfonic acid) and PFOA (perfluorooctanoic acid)) – following developed guidelines for reporting (UNEP, 2021). The GMP also reviews existing assessments of POPs conducted by other major monitoring initiatives. A secondary and key element of the GMP report is a section on modelling, which provides context on important processes, long-range transport and sources and informs the interpretation of levels and trends of POPs in air and how they may reflect effectiveness of control measures.

The GMP is a synthesis of the reports from the 5 United Nations (UN) regions, as shown in Figure 1, which are compiled on a 6-year cycle by a 6-member Regional Organizational Group (ROG). The five regional reports form the basis for the global report and in turn the global report is one of the key resources for Effectiveness Evaluation of the Convention.

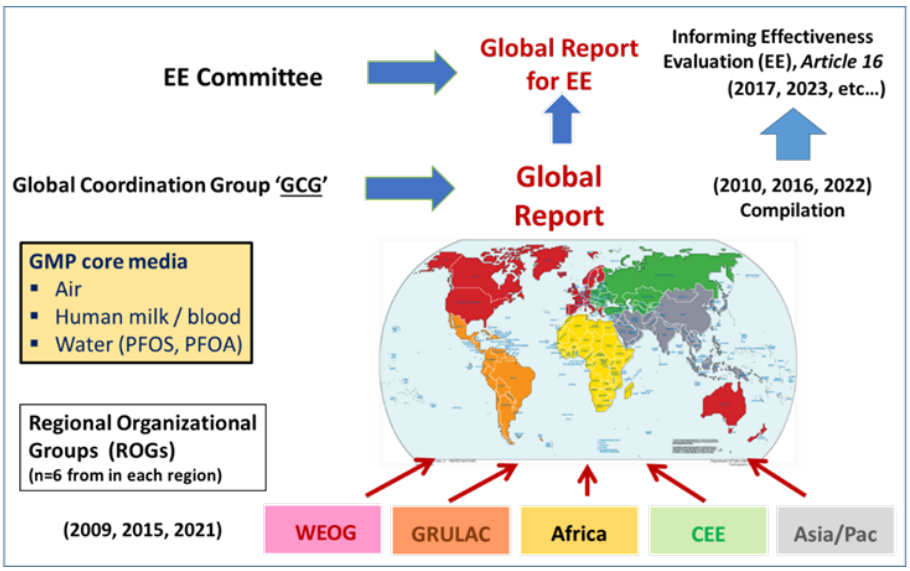

Figure 1: Regional reporting scheme under the Global Monitoring Plan of the Stockholm Convention on POPs.

This paper provides highlights from the third phase of reporting under the GMP - GMP3, which will be completed in Fall 2022 (UNEP, 2022). Progress and limitations with POPs monitoring data as well as insights stemming from the modelling context are presented. The challenges and opportunities for the GMP are also discussed.

2 Results

The following sub-sections highlight findings from the GMP3 report. The sections on monitoring deal with key messages on monitoring trends for POPs in core media as well as a synthesis of information for other media. The sub-sections under modelling deal with strategies to better link measurements and models to better understand the global fate of POPs.

Monitoring: Although the GMP has helped to stimulate new monitoring activities, there is still a lack of data for many POPs and for many regions / sub-regions. In addition, it will be a challenge for the GMP to keep up with the growing list of POPs, some of which are complex mixtures and analytically challenging. In order to be sustainable

and keep up with these growing challenges, the GMP should tap into existing monitoring capacity for POPs (within and outside of the GMP) and forge partnerships to address the monitoring gaps.

Air: Declining trends continue for many legacy POPs at the global scale, with only a few exceptions. There is a need for efficiencies and partnerships to meet growing challenges for air monitoring to support the GMP. The adoption of passive samplers has greatly improved spatial resolution of sampling and generated unique data sets, which include both gas-phase and particle-associated POPs, Fig. 2. Air monitoring data for PFASs (polyfluoro alkyl substances) is limited and could be supplemented by the inclusion of precipitation and ice core data in future reporting. Linking air monitoring data with toxicity endpoints through the use of techniques such as, inter alia, transcriptomics /bioassays may be useful to provide a more cumulative assessment of the toxicity burden in air.

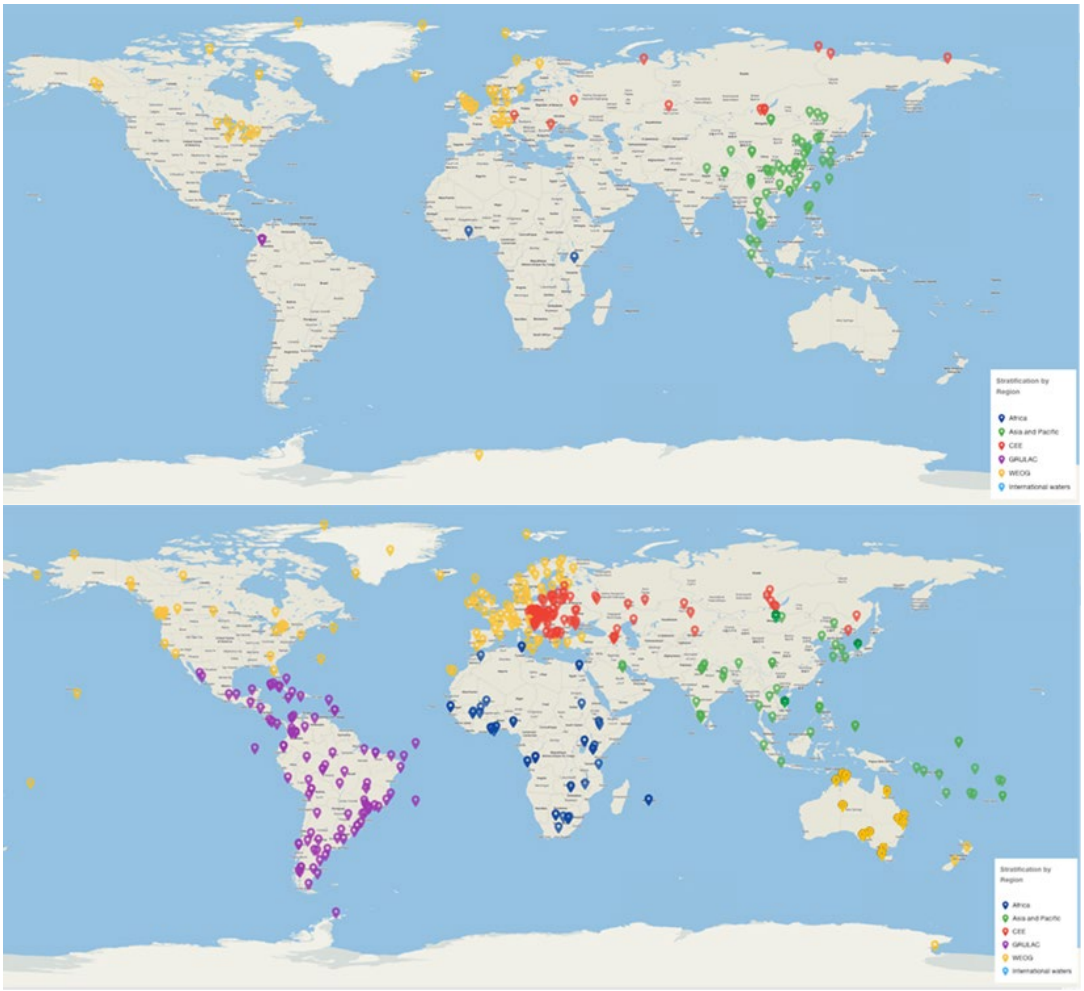

Figure 2: Active (top) and passive (bottom) air monitoring stations contributing data to the Third GMP Report (UNEP, 2022)

Human Tissues: The UNEP/WHO Human Milk Survey continues to reveal temporal trends of legacy POPs and could be improved through more consistent and greater participation by countries and expansion of the target list to include some of the newer POPs. A human tissues sample archive would be useful for future reporting under the GMP.

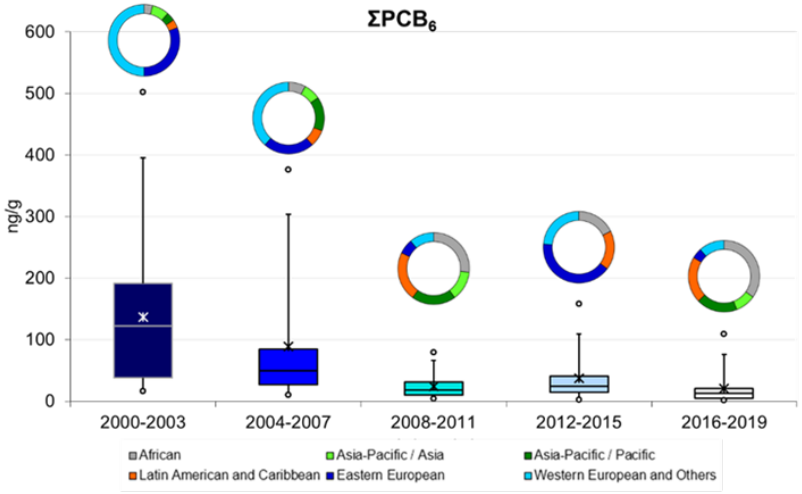

Figure 3: UNEP/GEF Human Milk temporal trend data for sum of six indicator PCBs. (Interpretation of trends is complicated by inconsistency in the make-up and number of participating countries, during each phase.) (UNEP, 2022)

Water: The UNEP/GEF water study project has been successful and provides a good design approach for future reporting of the listed PFASs in water. River data is promising for trends assessment due to higher levels of target analytes and the fact that rivers are likely to respond quickly to changes in regulation/emissions. There is a need to improve detection for PFASs, especially for ocean data. Techniques for targeting precursors of PFOS, PFOA and PFHxS and "total" methods e.g. TOP assay, should also be considered for future reporting.

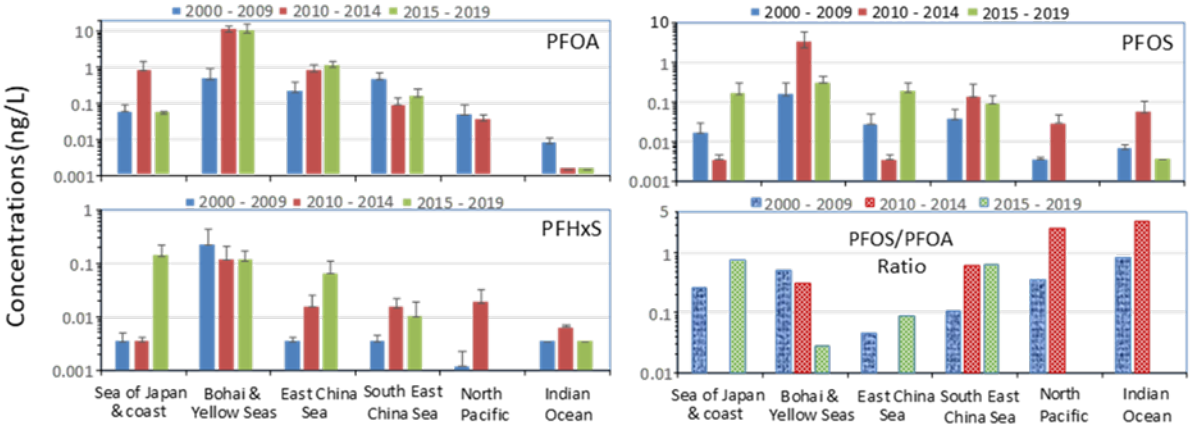

Figure 4: Compilation of PFASs concentrations over time (2000-2009; 2010-2014; 2015-2019) from open-ocean and coastal seas. Wide range in concentrations and trends are observed, reflecting different use patterns in different regions of the world. (PFHxS – perfluorohexanesulfonic acid) (UNEP, 2022)

Other Media: Vast amounts of very valuable data for non-core media exist from a substantial number of long-term national and international POPs monitoring programs and are summarized in GMP3. These programs include, inter alia, AMAP (Arctic Monitoring and Assessment Programme), OSPAR (Oslo-Paris Conventions - Focus on the protection of the marine environment of the North-East Atlantic), HELCOM (Helsinki Commission – Protection of the Baltic Marine Environment), Great Lakes, as well as programs in Japan and Antarctica. The data for non-core media should continue to be studied and made more meaningful to support GMP interpretation of available data and to address data gaps that currently exist in GMP3 reporting in core media. Climate effects on ecosystem structure, toxicity and POP trends in biota need to be better understood and more work is need at interface of POPs and Biodiversity.

Modelling: A variety of modelling tools exist to assess and provide context for POP trends. Because of the lack of emissions information for many of the newer POPs, future modeling will require an "integrated" or "top-down" approach, which will benefit from monitoring data (measurement-model fusion) to estimate emissions. Models are indicating that chemical management affects POPs levels more than climate does. Future modelling needs include data on partitioning, degradation rates and emissions, especially for the newer POPs.

Measurement/Model Fusion and "Top-Down" approaches: Spatial data for POPs under the GMP is increasing due to widespread adoption of passive sampling for air and water. This will benefit measurement-model fusion approaches and help to address lack of information on emissions for many newer POPs.

Vectors for the LRET of POPs: The long-range environmental transport (LRET) of POPs associated with plastics (including micro- and nanoplastics) and biological vectors (e.g., migratory birds) is not well characterized and presents a modelling challenge; it also has implications for the assessment and listing of POPs, especially those contained within plastics (e.g., UV-328).

Role of local sources vs long-range transport: It is recognized that local sources of POPs may confound interpretation of POPs monitoring data, especially at background and remote sites. The impact of local sources and long-range transport on POPs is currently being investigated by the POPs expert group under AMAP.

Modeling transformation products and chemical mixtures in air: Many listed POPs are transformed in the environment to chemicals that have POP-like properties and are currently unknown and not monitored in air. Non-targeted analysis and process studies are needed to reveal these chemical mixtures so that the full toxicity burden (cumulative toxicity) of POPs can be assessed.

GMP Outlook and Potential Intersections:
Moving forward, although the GMP has made significant progress, there have been calls for greater collaboration and inclusiveness under the GMP to address existing gaps and future pressures related to an increasing POPs target list (Wang et al. 2021, 2022). Greater communication across science-policy interface and policy-policy interfaces (e.g. health/toxicity, climate, biodiversity, waste, plastics) could help to raise awareness, opportunity, and the impact of POPs research and monitoring.

3 Acknowledgements

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4. References

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