Minamata Convention pre-COP-6 Online Event

Effectiveness Evaluation: Draft report of the Open-ended Scientific Group

Wednesday 15 October 2025, 13:00-14:00 CEDT

UN environment programme

MINAMATA CONVENTION ON MERCURY

Speakers (in the order of speaking)

- Eisaku Toda, Secretariat of the Minamata Convention
- Dominique Bally Kpokro, OESG Co-Chair
- Sandy Steffen, OESG Co-Chair and Air Monitoring Team Lead
- Karina Miglioranza and Olga Furman, OESG Biota Team Co-Leads
- Janja Snoj Tratnik, OESG Human Biomonitoring Team Lead
- Adrien Mestrot and Svetoslava Todorova, OESG “Other Media” Team Co-Leads
- Ronnie Frazer-Williams and Lynwill Martin, OESG Emission and Release Team Co-Leads
- Noriyuki Suzuki, OESG Integrated Analysis Team Lead
- Ben Yu, OESG Future Vision Team Lead

Effectiveness Evaluation

Article 22 of the Convention: Effectiveness evaluation:

1. The Conference of the Parties shall evaluate the effectiveness of this Convention, beginning no later than six years after the date of entry into force of the Convention and periodically thereafter at intervals to be decided by the COP.

3. The evaluation shall be conducted on the basis of available scientific, environmental, technical, financial and economic information, including:

(a) Reports and other monitoring information provided to the Conference of the Parties pursuant to paragraph 2;

COP-4 (2022), in decision MC-4/11:

- Agreed to begin the first effectiveness evaluation;
- Established the Open-Ended Scientific Group (OESG).

COP-5 (2023), in decision MC-5/14:

- Agreed to consider the outcome of the first effectiveness evaluation at COP-7;
- Established the Effectiveness Evaluation Group;
- Adopted 36 indicators to support the evaluation of effectiveness of the Convention

COP-6 Document 6/16

Progress report on the development of the first effectiveness evaluation of the Minamata Convention on Mercury

Includes an overview of work done since COP-5 by the:

A. Effectiveness Evaluation Group

- Co-chaired by Linroy Christian (Antigua and Barbuda) and Itsuki Kuroda (Japan). Note: Itsuki Kuroda resigned in August 2025. The group is expected to elect a new co-chair.
- Met 6 times on-line since COP-5.
- Conducting the initial work through 6 sub-groups.

B. Open-ended Scientific Group

- Co-chaired by Dominique Bally Kpokro (Cote d'Ivoire) and Sandy Steffen (Canada).
- Met once face-to-face in Minamata (March 2025) hosted by Japan and ten times on-line since COP-5.

INF/22: Preliminary draft outline of the first effectiveness evaluation report
INF/23: Update on the work of the Open-ended Scientific Group

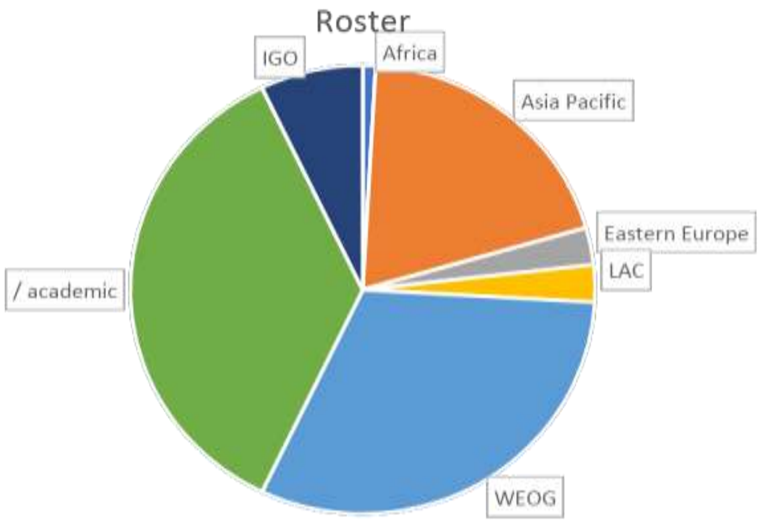
Open-Ended Scientific Group

- OESG members – one expert nominated by each Party
- Parties and observers may nominate experts to a roster, who contribute to the work of OESG
- Met online 19 times by October 2025, 1st face-to-face meeting in March 2023, 2nd face-to-face meeting in March 2025

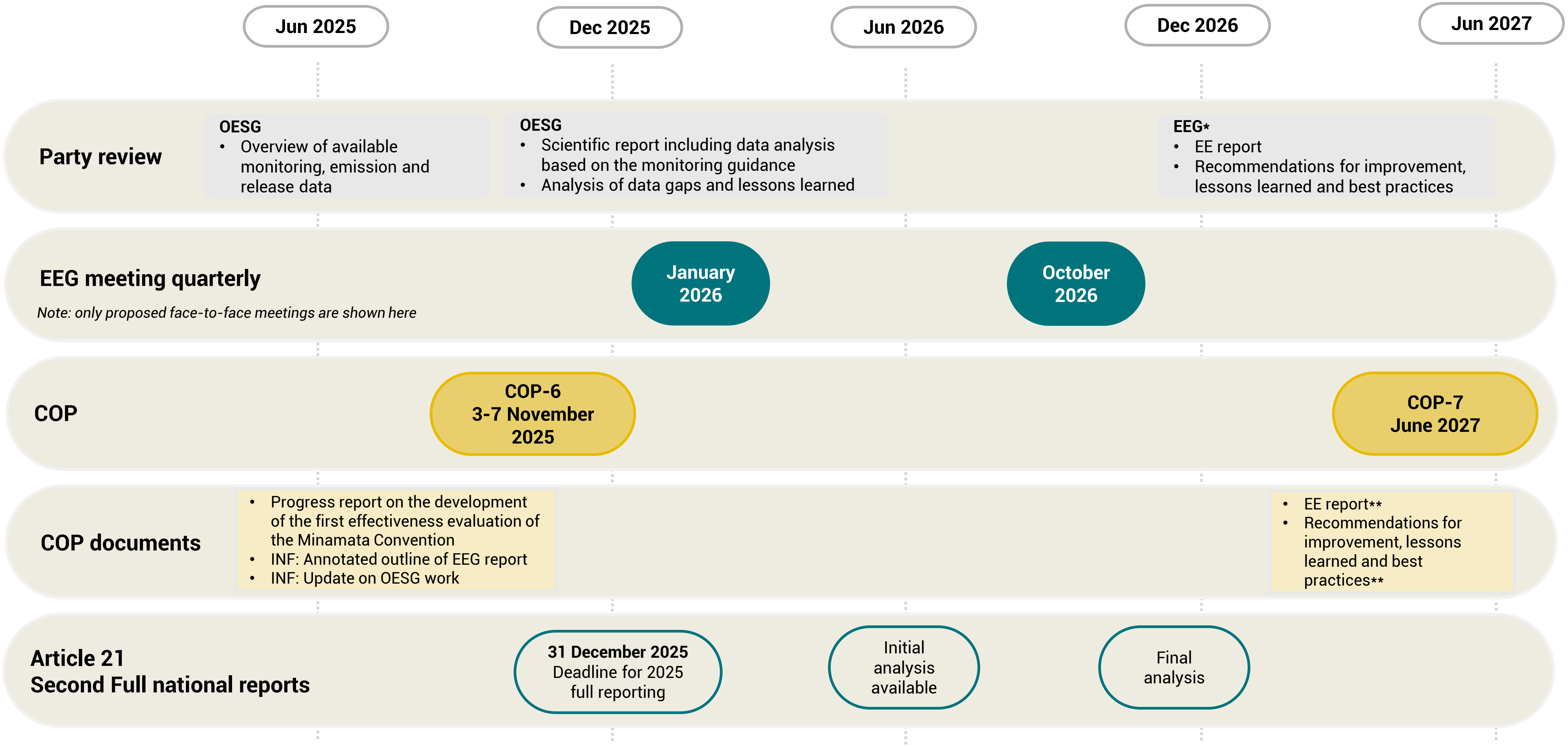
42 OESG Members

112 Experts on Roster

(As of 31 May 2024)



Timeline for the first evaluation of the effectiveness of the Minamata Convention on Mercury (Annex II)



** EEG integrates reports and develops final EE report and report on lessons learned and recomendations.*

*** As per the EEG's terms of reference, draft COP documents will be open for Party comments and finalized by the EEG at least four months before the next COP meeting.*

What does the Effectiveness Evaluation and Scientific Report address?

Policy Questions for the Effectiveness Evaluation (MC/COP.3/14)

- Have the parties taken actions to implement the Minamata Convention?
- Have the actions taken resulted in changes in mercury supply, use, emissions and releases into the environment?
- Have those changes resulted in changes in levels of mercury in the environment, biota, and vulnerable human populations that can be attributed to the Minamata Convention?
- To what extent are existing measures under the Minamata Convention meeting the objective of protecting human health and the environment from mercury?

Lessons Available to be Learned for Future Effectiveness Evaluations

- Where are the gaps in our knowledge or capabilities that are barriers to answering the policy questions above?
- What actions could be taken to address these gaps or barriers?

OESG data analysis questions

1. **Current Levels**
   - ➢ What are the current levels of Hg emissions and releases and levels of Hg observed in air, biota, humans, and other media in sites that are
     - ➢ remote from anthropogenic sources?
     - ➢ affected by local anthropogenic sources?

2. **Temporal Trends**
   - ➢ How have levels of Hg emissions and releases and Hg observed in air, biota, humans, and other media changed over the available record?
   - ➢ How do those changes compare to the timeline of the Minamata Convention?
   - ➢ What specific mitigation measures have contributed to changes in emissions and releases?
   - ➢ How are levels of Hg emissions and releases and Hg observed in air, biota, humans and other media expected to change in the future?

3. **Spatial Patterns**
   - ➢ How do current levels and temporal trends vary geographically at the global scale?

OESG data analysis questions

4. Source or Process Attribution

- What is the fractional contribution of contemporary anthropogenic emissions and releases to current Hg levels observed in air, biota, humans, and other media?
- How have these contribution levels changed over the timeline of the Minamata Convention?
- How do the contribution levels and their trends vary geographically at the global scale?
- How have drivers other than changes in emissions and releases contributed to the trend in observed Hg levels?

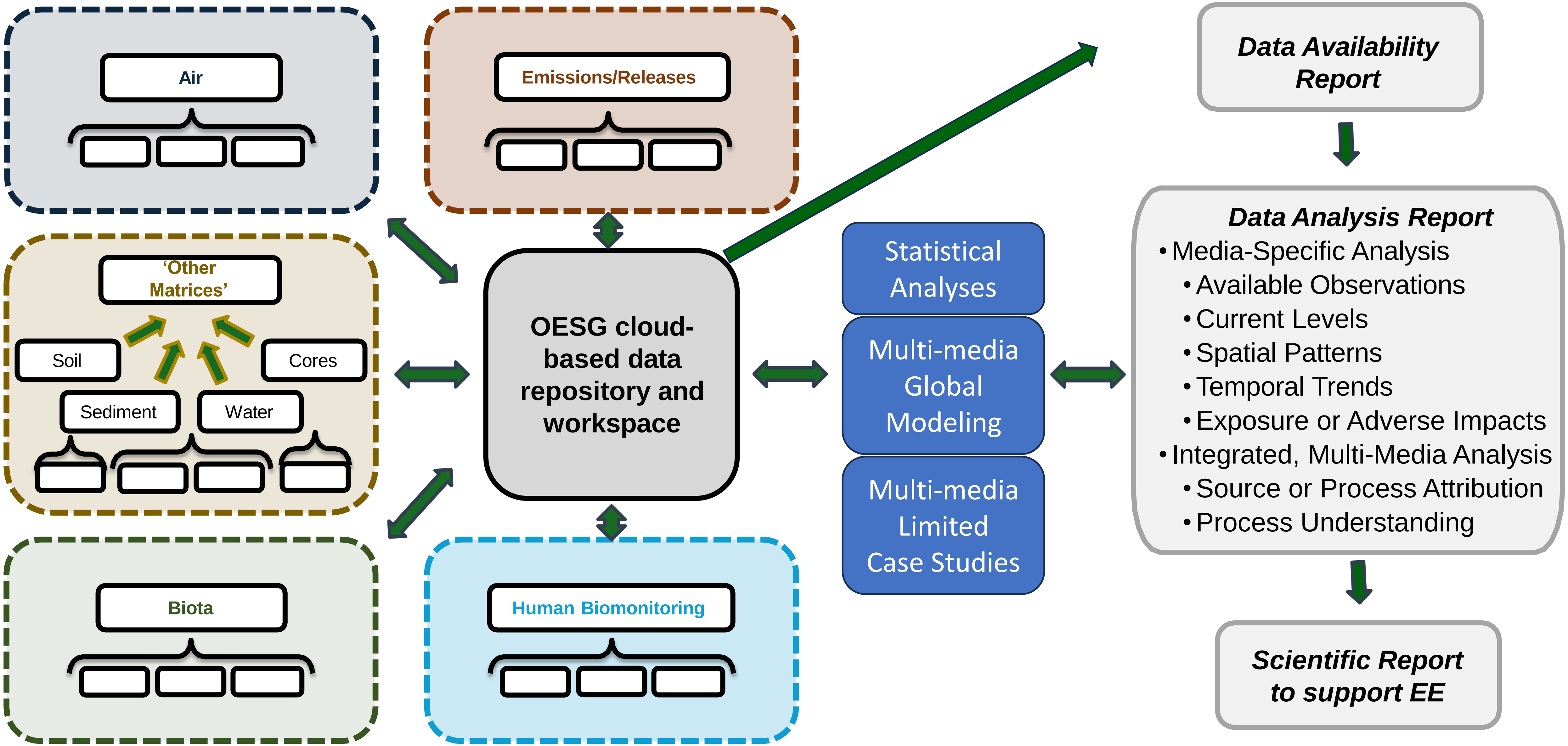
5. Exposure and Adverse Impacts

- How do current levels of Hg observed in air, biota, humans, and other media compare to levels in established guidelines, as well as to observed and projected thresholds for effects to humans, other living organisms and biodiversity based on recent research and knowledge?
- How do changes in Hg levels over the timeline of the Minamata Convention compare to those guideline levels and effect thresholds?

6. Process Understanding

- How consistent are current levels, temporal trends, and spatial patterns of Hg emissions and releases and Hg levels in air, biota, humans, and other media with estimates from current mechanistic models?

Data collection and analysis process



Open-Ended Scientific Group products

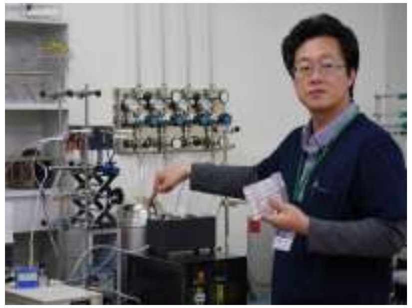
Plans	
Emissions and Releases Data Collection Plan	Presented at COP5 (2024) Document INF/24
Observational Data Collection Plan	
Data Analysis Plan	
Draft Reports for Review	
Summary of Available Data (Emissions/Releases, Observations)	UNEP/MC/OESG.2/2/Rev.1 June 2025
Data Analysis	December 2025
Gaps and Recommendations	
Revised Draft Reports	
Scientific Report (Available Data and Analysis)	June 2026
Lessons Learned: Gaps and Recommendations Report	June 2026

Atmospheric Mercury





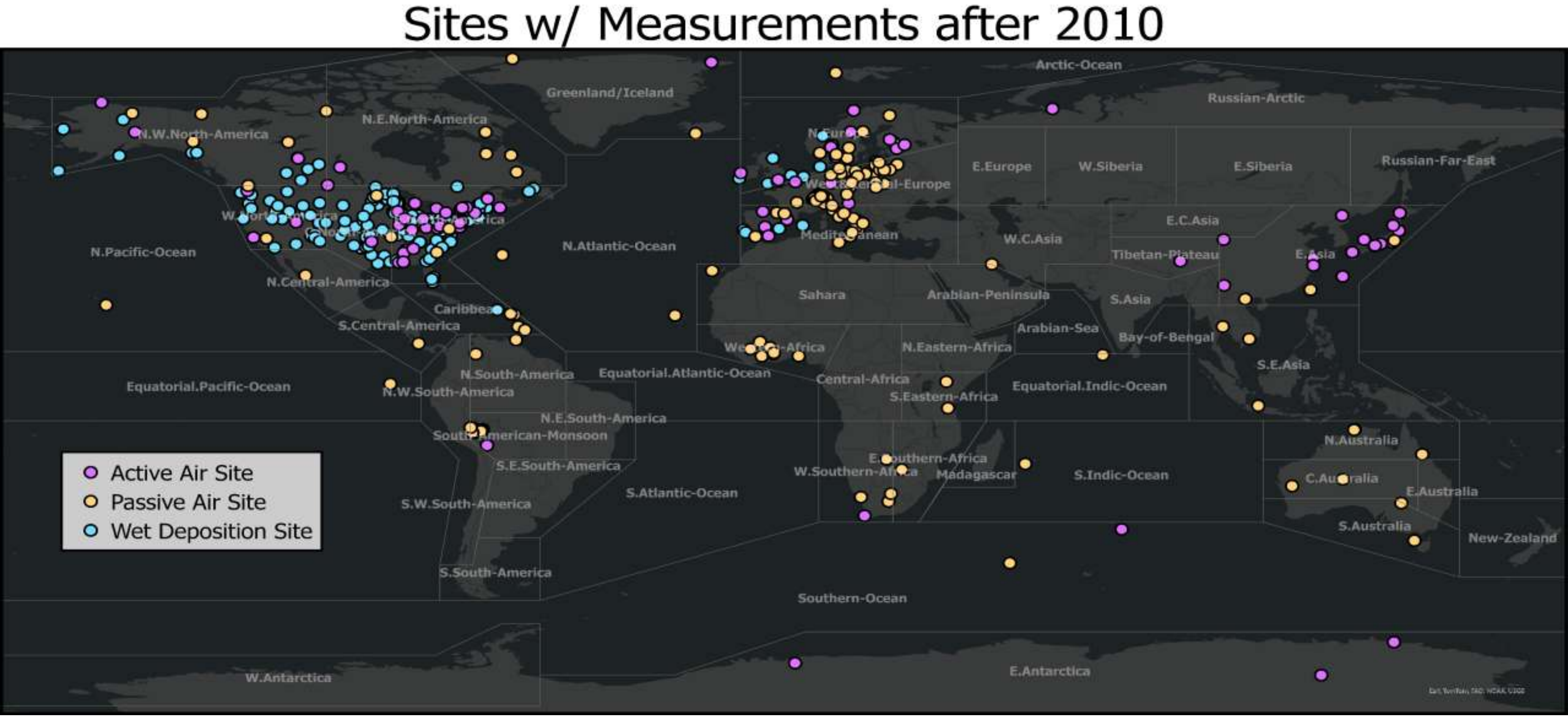








Where are the air data?



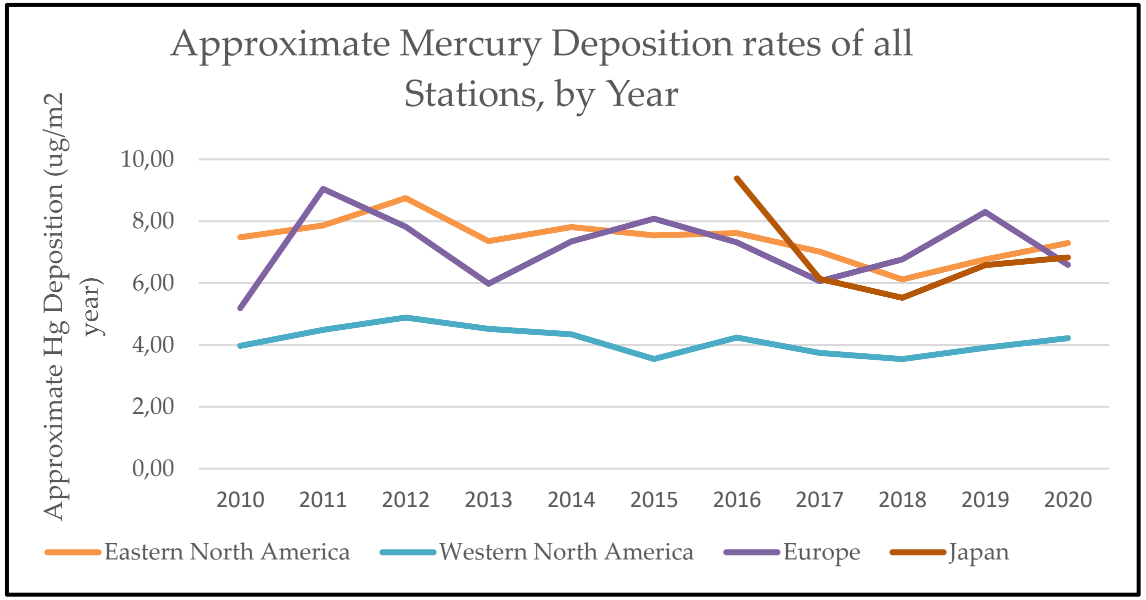
A global approach with comparable data

Collect data for same analysis

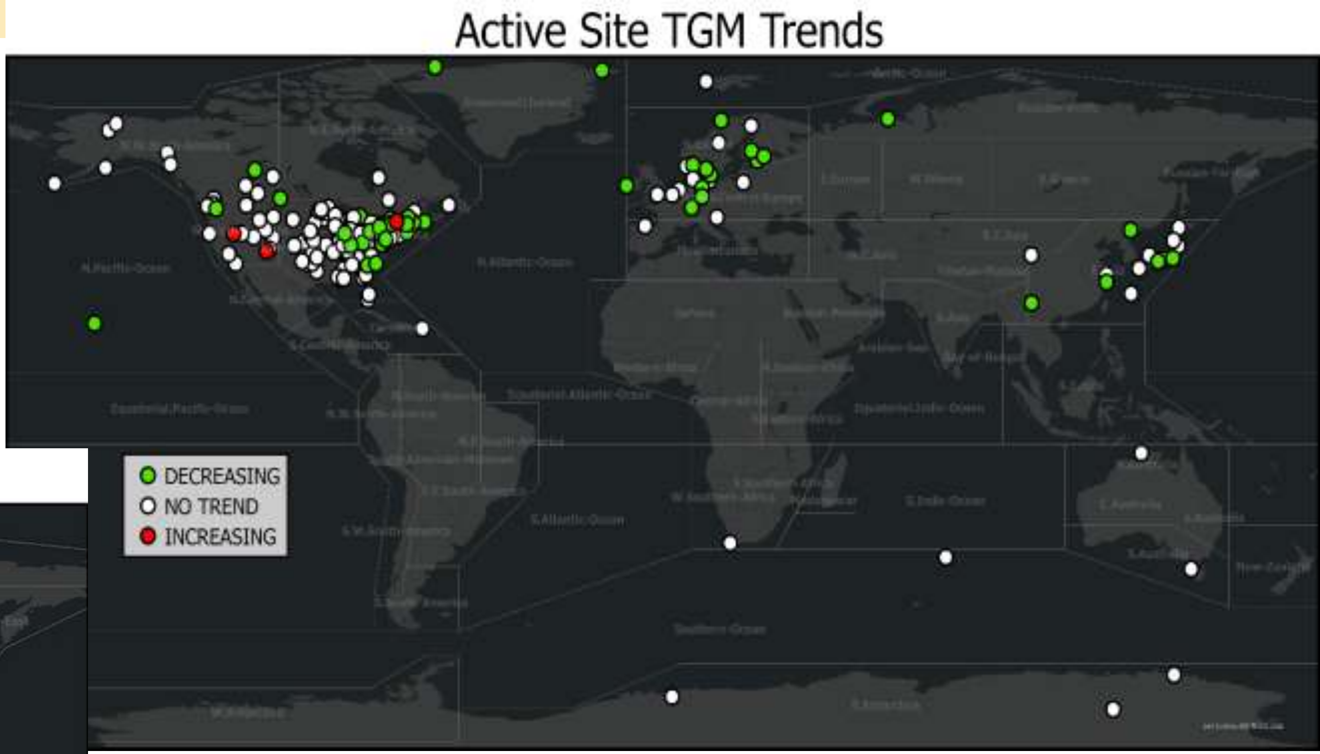
- Temporal variation
- Spatial variation
- Trend analysis
- Statistics
- Regional analysis
- Model validation

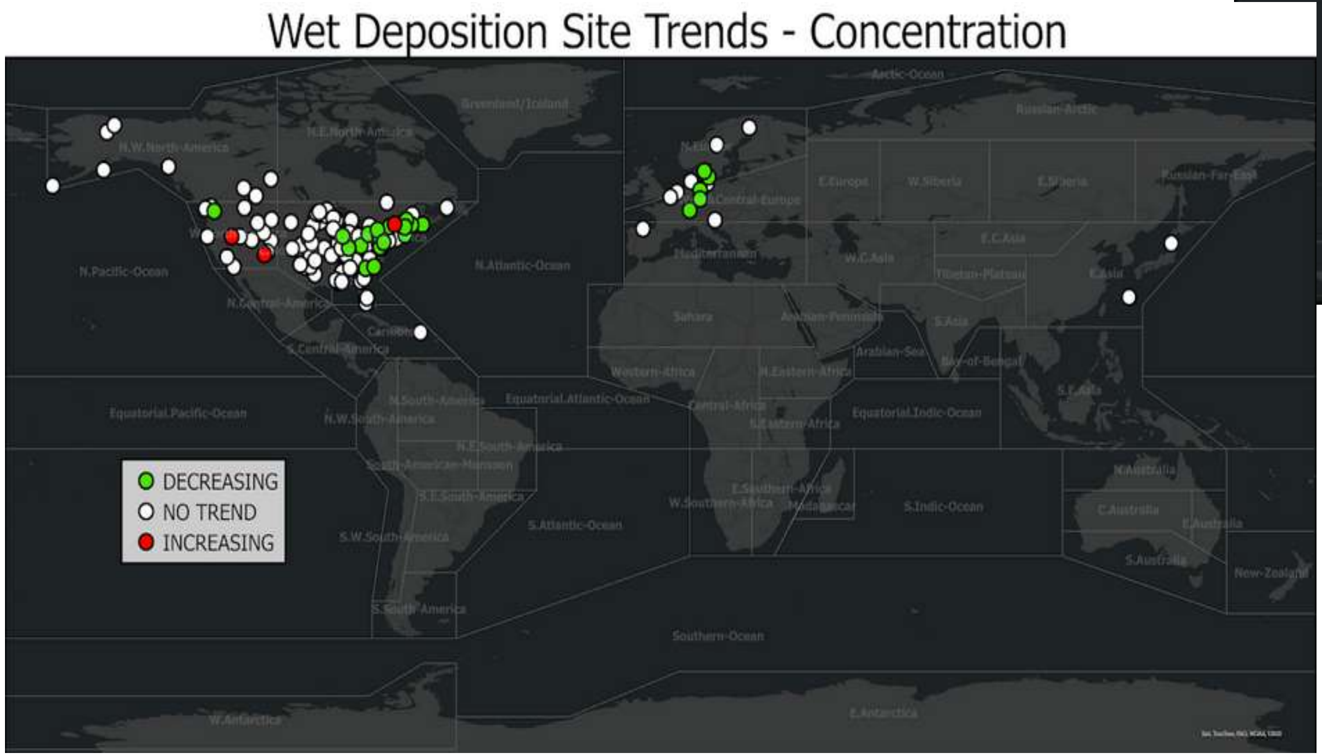
First time a global analysis of Hg in air has been done!

Preliminary Concentrations



Preliminary Trend Analysis





These are the overall trends for each data set that meets the trend criteria and for **ALL** the data (not 2010 onward)

Preliminary Statistical Analysis

Active air sampling TGM

Site	Country	Mean Concentration (ng m-3)	Minimum Concentration (ng m-3)	Maximum Concentration (ng m-3)	25th Percentile	75th percentile
DMC	Antarctica	1.00	0.06	5.42	0.75	1.20
Gunn Point	Australia	0.99	0.18	3.53	0.91	1.08
Kennaook-Cape Grim B	Australia	1.05	0.69	6.48	1.00	1.09
Kennaook-Cape Grim X	Australia	1.07	0.72	4.53	1.03	1.10
Houtem	Belgium	0.68	0.30	1.00	0.65	0.70
Chacaltaya	Bolivia	1.08	0.46	3.98	0.81	1.32
Maido	Brazil	0.85	0.21	1.28	0.78	0.93
Alert	Canada	1.41	0.00	10.85	1.26	1.62
Bratts Lake	Canada	1.44	0.38	12.23	1.27	1.59

Passive air sampling GEM

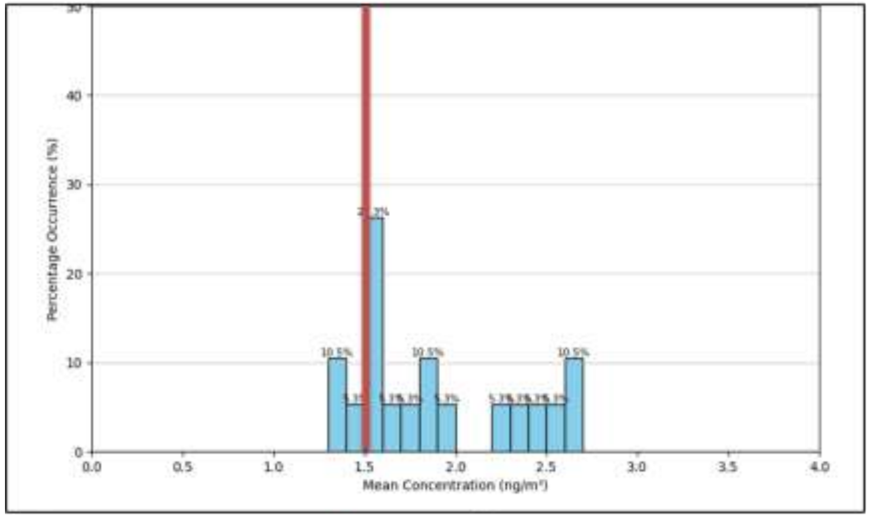
Site	Country	Mean Concentration (ng m-3)	Minimum Concentration (ng m-3)	Maximum Concentration (ng m-3)	25th Percentile	75th percentile
St John	Antigua	1.55	0.96	1.88	1.40	1.75
Alice Springs	Australia	1.25	1.04	1.40	1.15	1.38
Cape Grim	Australia	1.23	0.93	1.46	1.12	1.30
Darwin	Australia	1.21	0.79	1.54	1.14	1.30
Fowlers Gap	Australia	1.18	0.77	1.49	1.04	1.32
Geraldton	Australia	1.26	1.03	1.54	1.10	1.42
Orpheus Island	Australia	0.94	0.72	1.10	0.83	1.06
Zobelboden	Austria	1.43	1.32	1.65	1.37	1.46
Ragged Point	Barbados	1.52	0.78	2.12	1.40	1.71

Wet deposition sampling (THG)

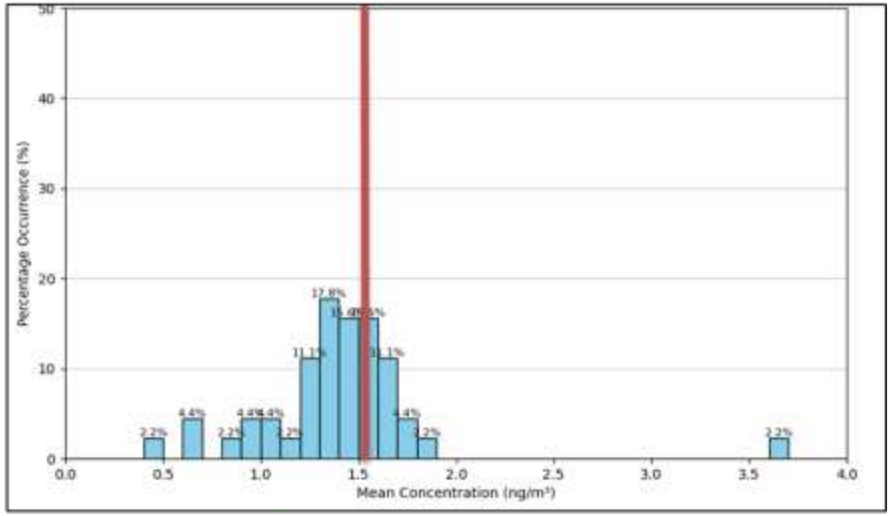
Site	Country	Mean Concentration (ug m^{-2} $year^{-1}$)	Minimum Concentration (ug m^{-2} $year^{-1}$)	Maximum Concentration ((ug m^{-2} $year^{-1}$)	25th Percentile	75th percentile
Bratts Lake	Canada	94.60	0.00	1436.83	0.0	123.20
Burnt Island	Canada	141.43	0.00	1005.84	29.1	196.51
Chapais	Canada	104.31	0.00	782.41	23.4	132.50
Cormak	Canada	98.19	0.00	1588.29	26.1	123.06
Dorset	Canada	127.43	0.00	1124.57	29.4	161.46
Egbert	Canada	121.82	0.00	2951.71	30.9	156.39
Egbert Forest	Canada	160.94	17.60	436.17	67.2	224.44
Esther	Canada	50.79	0.00	356.01	0.0	60.08

Preliminary Regional Analysis (TGM)

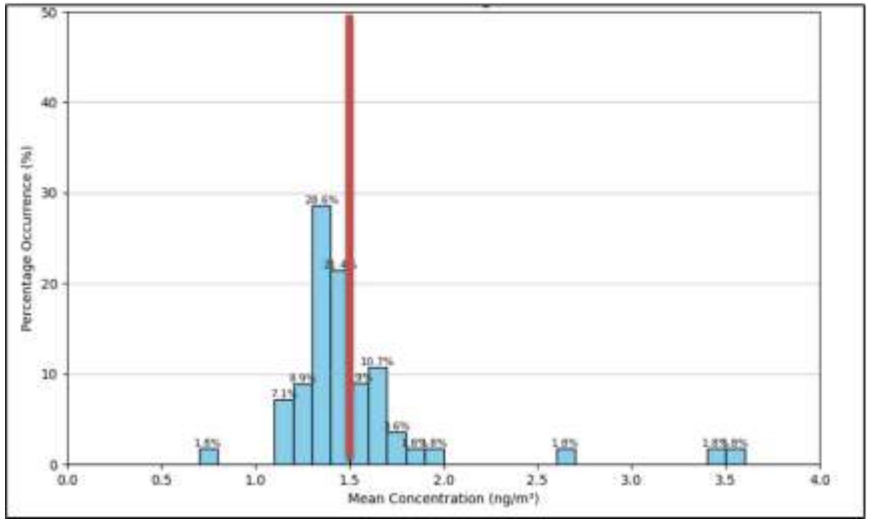
Asia



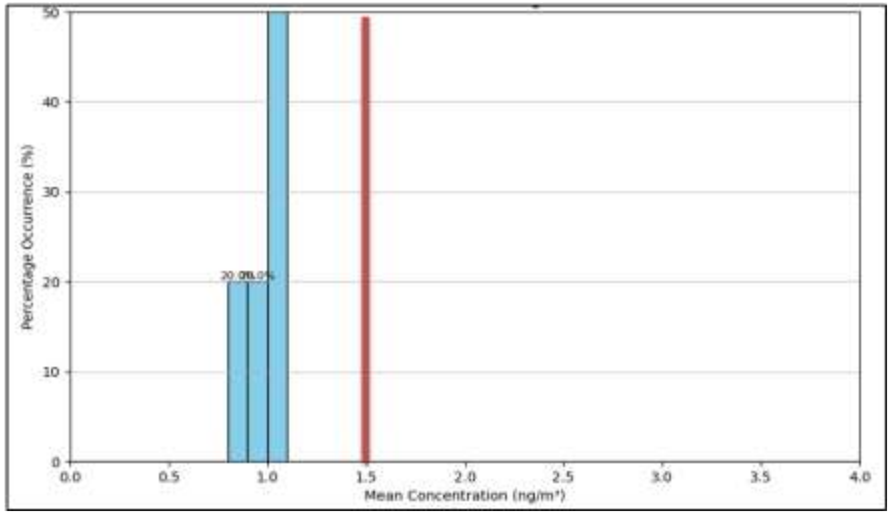
Europe



North America



Oceana



Thoughts thus far

- Air is relatively easier than other media *but not easy*
- Data intake was complex, difficult and cannot be repeated without assigned data management
- Lessons learned so far
  - The disconnect between the COP and those doing the work is a challenge
  - Need more engagement for data delivery from Parties
  - Time frames over which data is collected needs to be the same or similar
  - Need global monitoring program
  - Need one common spot to put the data
  - Politics are tricky to navigate with science
  - Set expectations with everyone early on

MINAMATA CONVENTION ON MERCURY

Effectiveness Evaluation: Draft report of the Open-ended Scientific Group

BIOTA Group

Dra. Karina Miglioranza

On-behalf of Biota Group OESG-Minamata Convention

Lab. de Ecotoxicología y Contaminación Ambiental, Mar del Plata University, Argentina

October 15th 2025

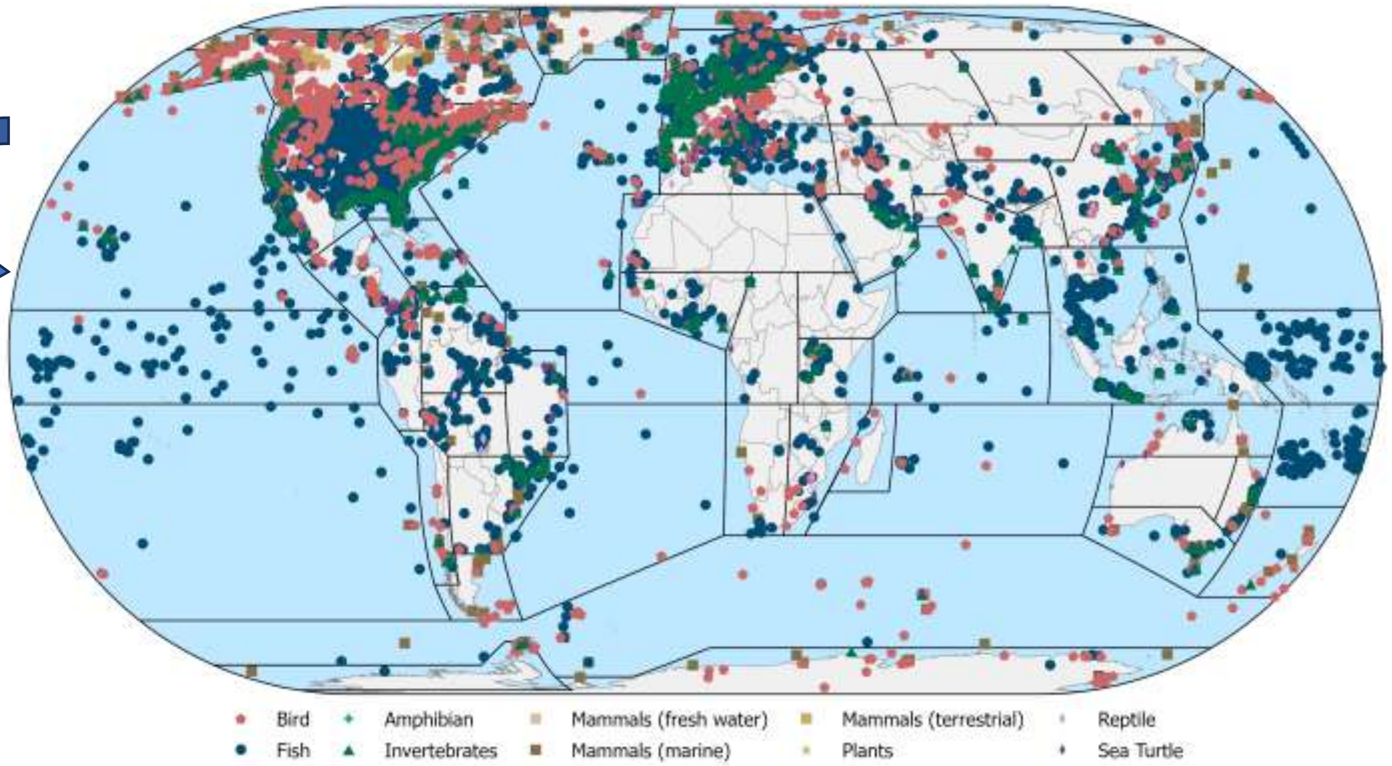






BIOTA Group: Received and Acquired Data

Individual Hg measurements and aggregated data



56 submissions

Invertebrates, fish, amphibians, reptiles, **birds, mammals,** and plants (excluding moss)

Contributors:

- Arctic Monitoring and Assessment Programme **(AMAP),**
- **OSPAR** Convention (North-East Atlantic)
- Helsinki Commission **(HELCOM)**
- **National and subnational organizations** from Canada, the United States, Norway, France, Finland, Switzerland, the Netherlands, the United Kingdom, Germany, Peru, Australia, Sweden, Japan and other countries.
- Biodiversity Research Institute **(BRI)** provided data from about 1648 published articles

BIOTA Group: Key findings about Hg current levels

Current levels? → Total [Hg] measured between **2014 and 2024**

Most Hg data come from **North America, Europe,** and **East Asia**

Monitoring is <u>required</u> in Africa (AF) and Latin America and the Caribbean (LAC)

Only a small set of submitted data represents samples collected during the last decade

Most frequently sampled matrices: fish (muscle), birds (feathers and eggs), invertebrates (soft tissues), and mammals (liver and muscle)

Limited geographic coverage and broad variability in species and trophic position

Data no suitable for global-scale spatial pattern analysis

Regional spatial comparisons

[Hg] significantly elevated in sites with known sources, such as artisanal and small-scale gold mining (**ASGM**) and **metal smelting,** compared to control sites.

Matrix	[Hg] range (ng/g dry weight)
Bivalves	10.2 – 2,070
Fish muscle	1 – 38,220
Bird eggs	3 – 6,000
Bird feathers	2 – 72,790
Marine mammals (liver)	16.6 - 5962000
Marine mammals (muscle)	33 - 472000

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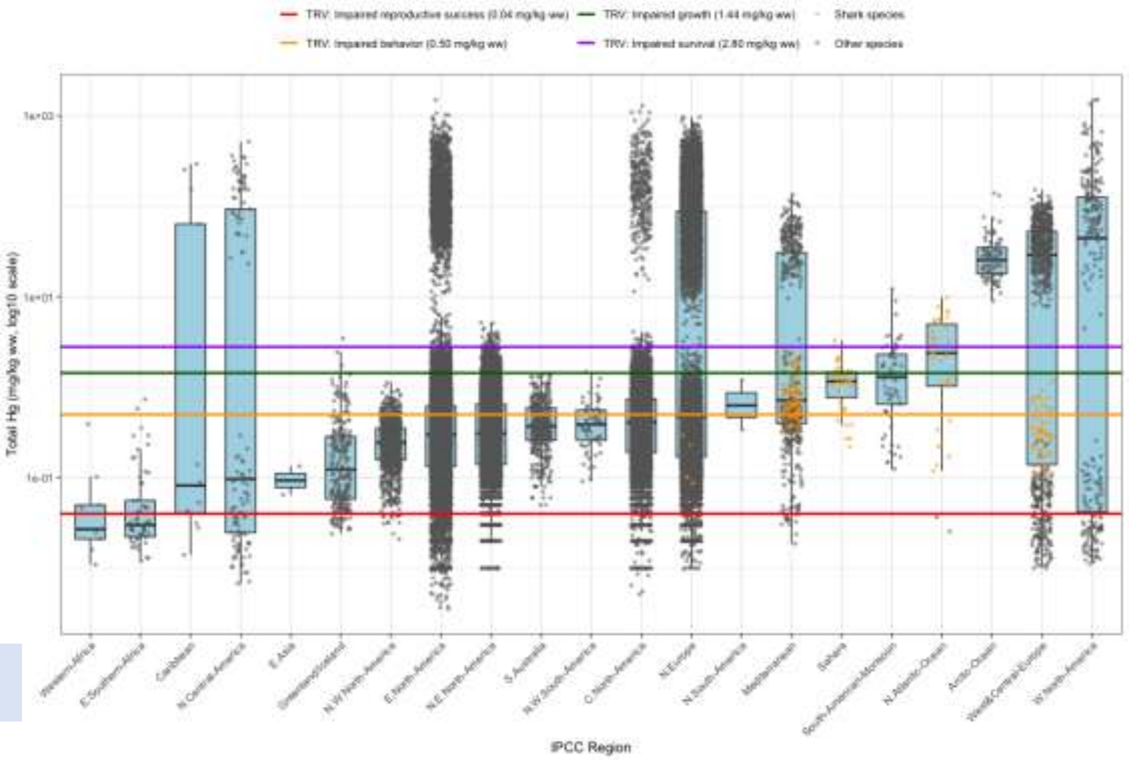
BIOTA Group

❖ [Hg] **observed *vs*** established national and international **benchmark levels**

-Species at highest risk of mercury toxicity (marine mammals, certain fish and bird species)

Some **marine mammals** (liver), certain **fish species** (shark) and others particularly from Europe the Mediterranean, and the Arctic; and some **bird species** (feathers)



Fish muscle to [THg] (ww) vs. TRV

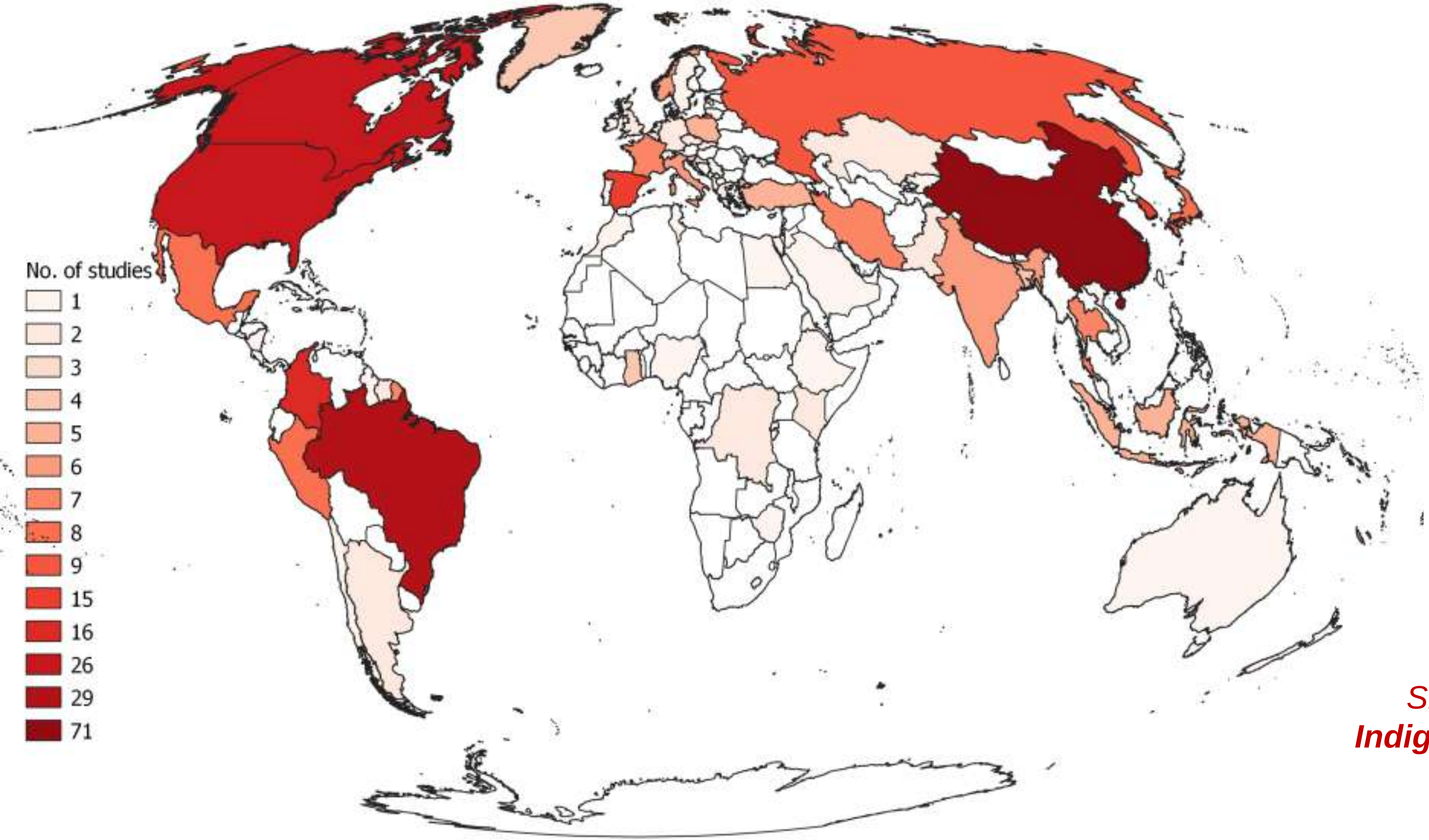
❖ How do THg in species **vary geographically over time** ?? – Temporal trends

- Due to the limited availability of global-scale data**, temporal analyses of THg** concentrations in certain taxa were primarily based on a small number of **case studies**, conducted at local or regional levels.

HBM data obtained

1) **OESG Data template (Repository)**
2) **Literature search**
3) **National HBM programs**

Number of cross-sectional studies or birth cohorts by countries



Cross sectional studies: 280
Birth cohorts: 50

All study groups: 589

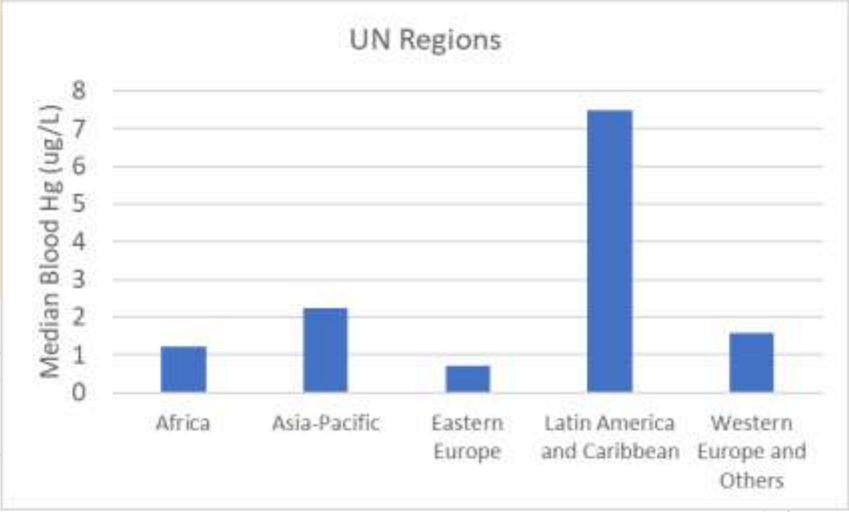
- General population: 324
- Indigenous: 104
  - Arctic (40)
  - Other (64)
- Contaminated sites: 42
- ASGM: 41
- Dental workers: 1
- Occupation-other: 18
- Cosmetics use: 3

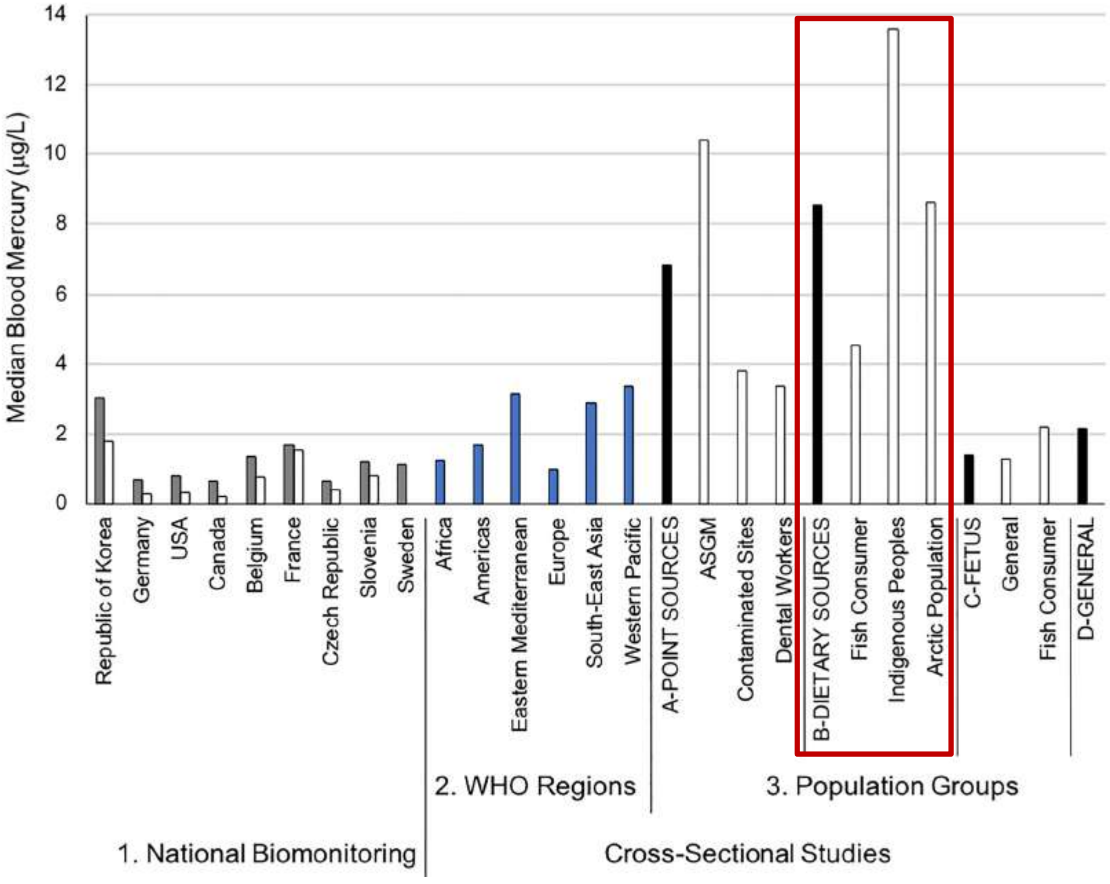
*Significantly more studies for **Indigenous** and **ASGM** populations compared to GMA2018*

HBM Preliminary summary

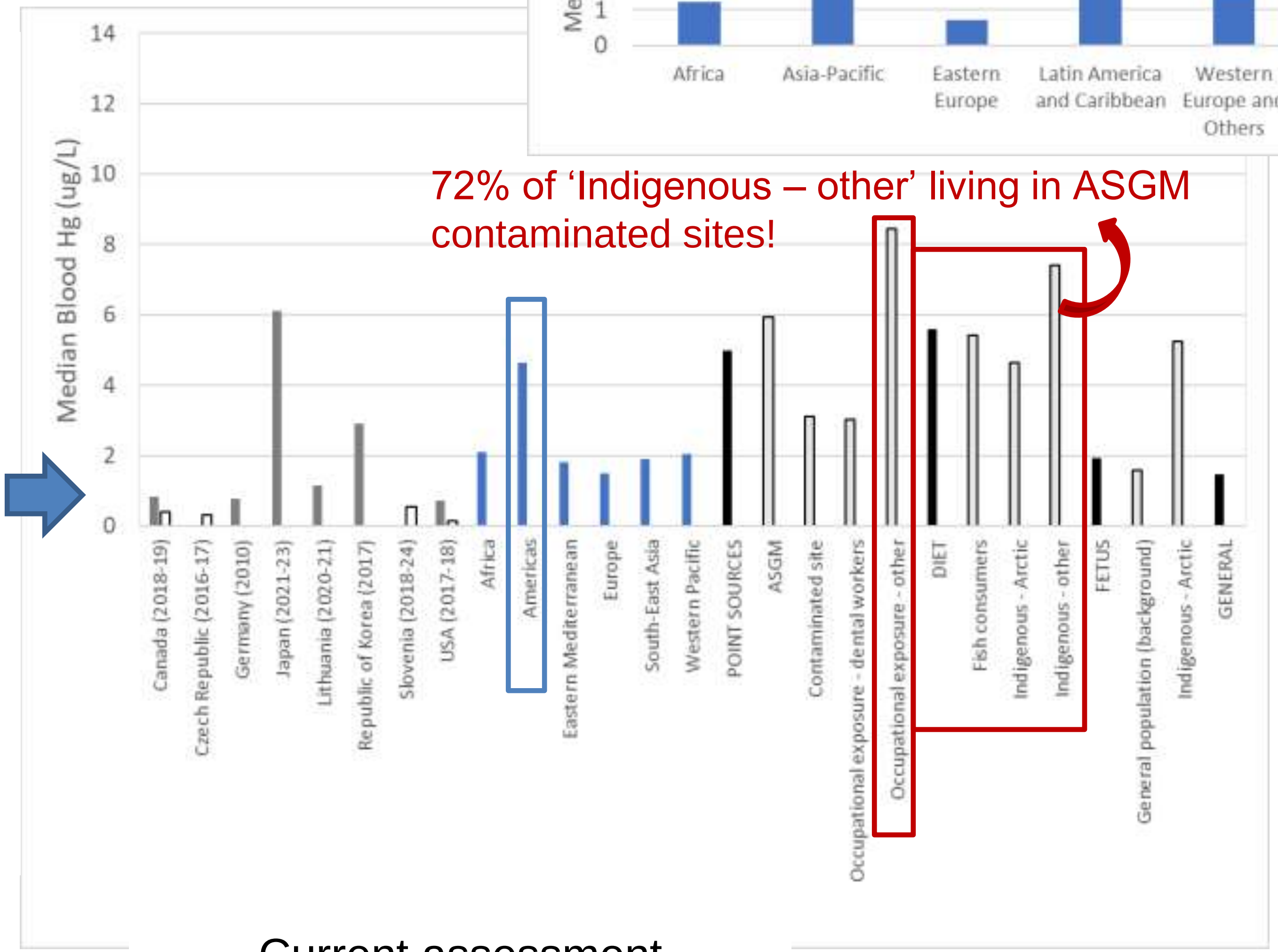
1) Current Hg levels

All age groups





GMA2018 (Basu et al., 2018)



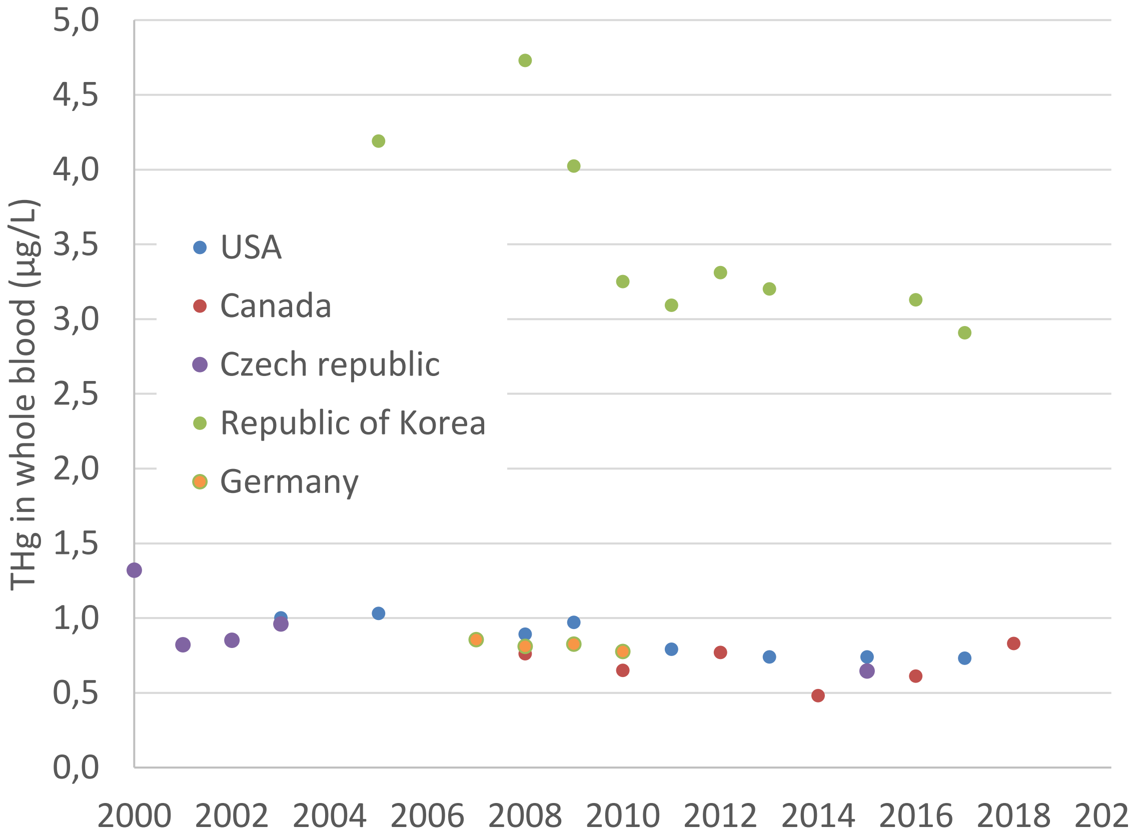
72% of 'Indigenous – other' living in ASGM contaminated sites!

Current assessment

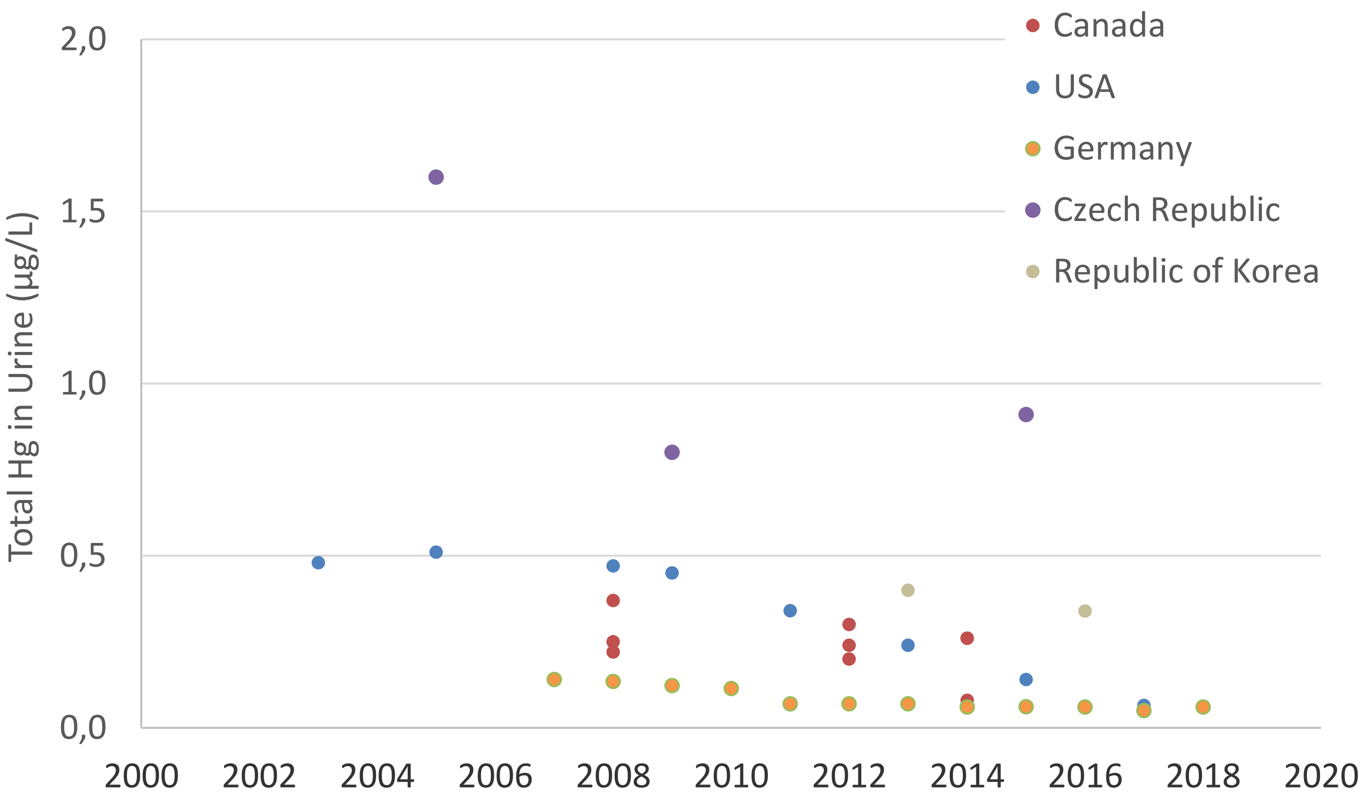
HBM Preliminary summary

2) Time trends: national HBM programs

BLOOD, adults



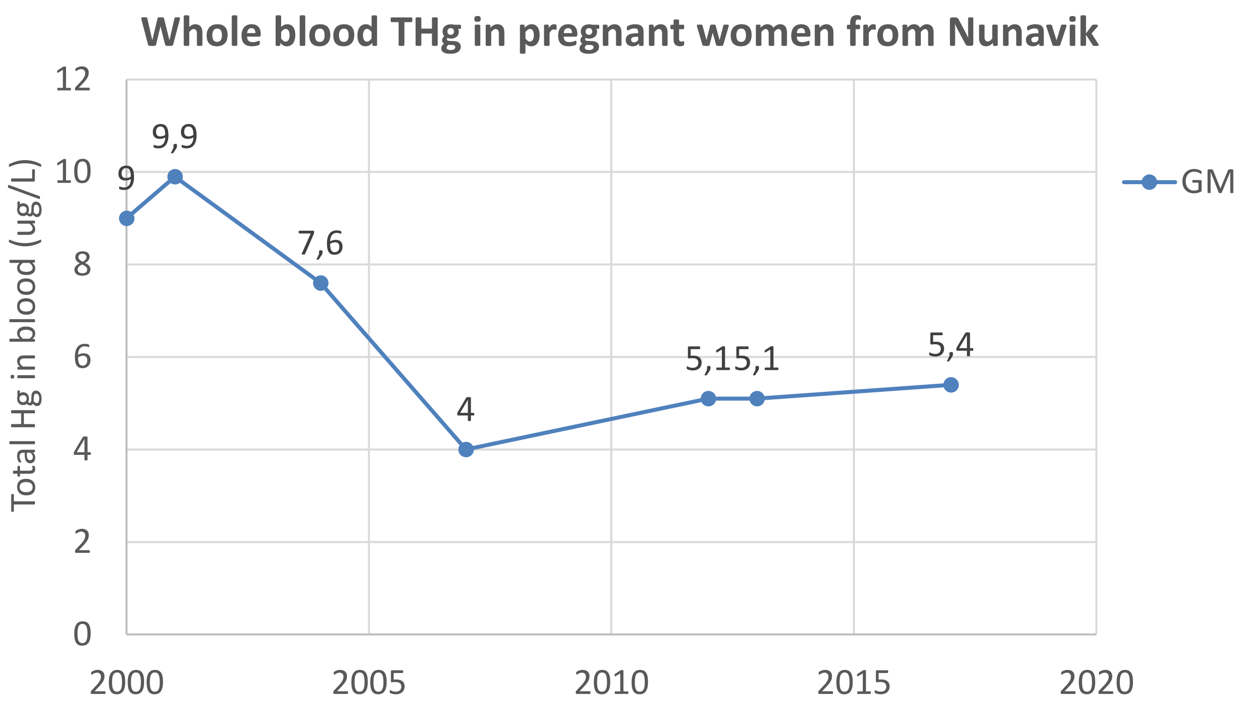
URINE, adults

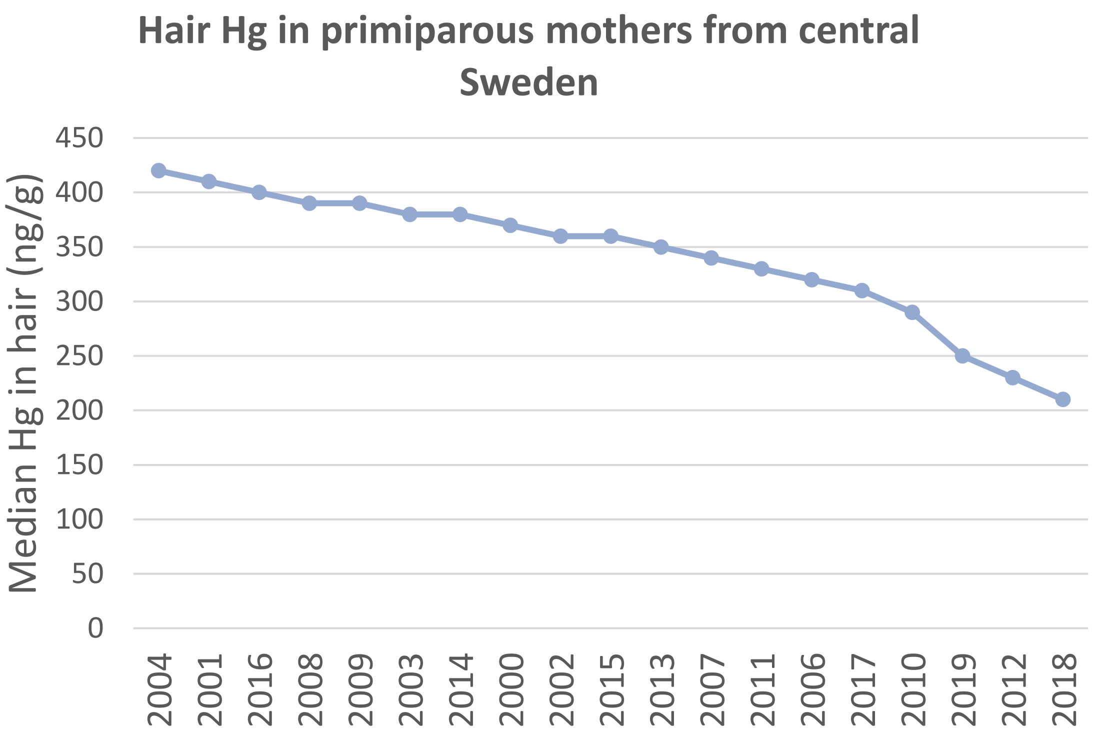


Updated figures from Basu et al., 2018

HBM Preliminary summary

2) Time trends





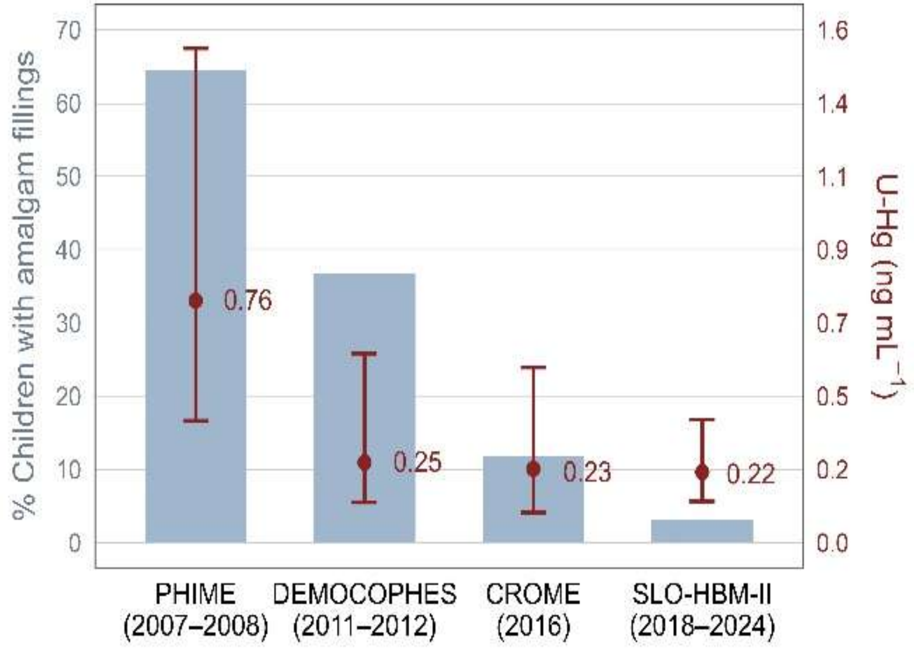
AMAP Assessment 2021: Human Health in the Arctic

Kippler et al., 2021

HBM Preliminary summary

2) Interventions, case studies

Dental amalgam phase-out for children < 15 years (case study in Slovenia)



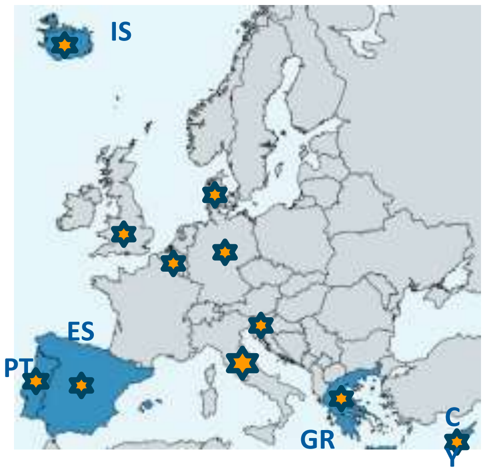
Usenik & Alilović Osolin et al, submitted

Dietary recommendations and interventions across Arctic regions (Indigenous Peoples!)
Protecting health without discouraging the consumption of traditional foods

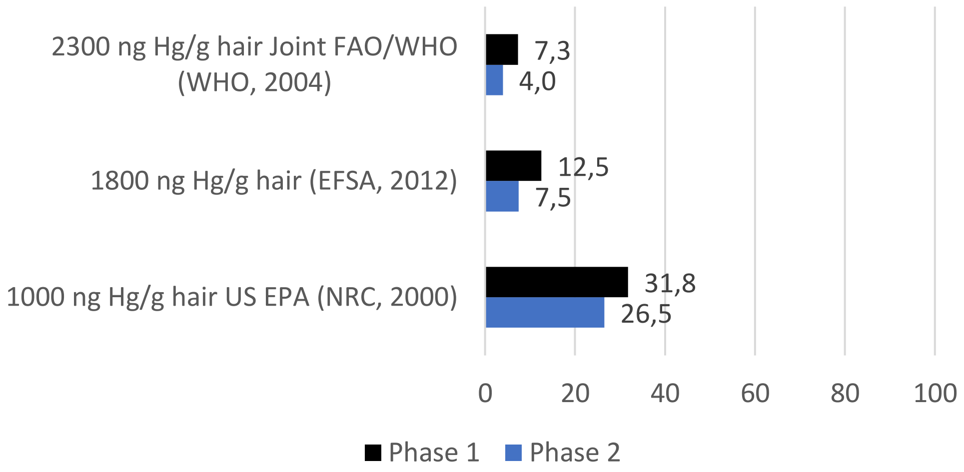
Declines in Hg exposure observed where HBM time trends exist

AMAP 2021, Weihe et al., 2016

HBM4EU-Mom study



% participants exceeding cut-off values



Katsonouri et al., 2023

HBM - Challenges

Enhance reporting mechanisms:

Strengthen national institutional capacity to manage and report this data.

Support the routine submission of HBM data using harmonized templates

Foster cross-matrix integration:

Establish systems to link HBM data with environmental Hg measurements (especially biota), allowing for a more robust assessment of mercury exposure pathways and improved attribution modelling.

Interoperable databases created within centralized or regional platforms.

Prioritize vulnerable and Indigenous populations:

Ensure that monitoring programs include sensitive groups such as children, pregnant women, subsistence fishers, and Indigenous Peoples who face elevated risks from Hg exposure.

Support Indigenous-led biomonitoring efforts with appropriate technology transfer and ethical frameworks for data governance and more involvement in their representation in the OESG and Effectiveness evaluation process.

Minamata Convention pre-COP-6 Online Event

Other Matrices

Adrien Mestrot

Svetoslava Todorova

UN environment programme

MINAMATA CONVENTION ON MERCURY

Team Members

TEAM LEADS: Adrien Mestrot and Svetoslava Todorova	
Matrices	**Team members**
Ocean water	Anne Sørensen
Freshwater	Svetoslava Todorova, Vivien Taylor, Chris Eckley, John Munthe, Valentin Mansanarez
Soil	Adrien Mestrot, Sylvain Bouchet, Manuel Gabriel Velásquez
Peat/sediment/ice cores and tree rings	Jane Kirk, Una Jermilova, Taylor Luu
Other team members: Semia Gharbi, Larissa Schneider, Luis Angel Ancco Pichuilla, Semerkhae Jongthammanurak	

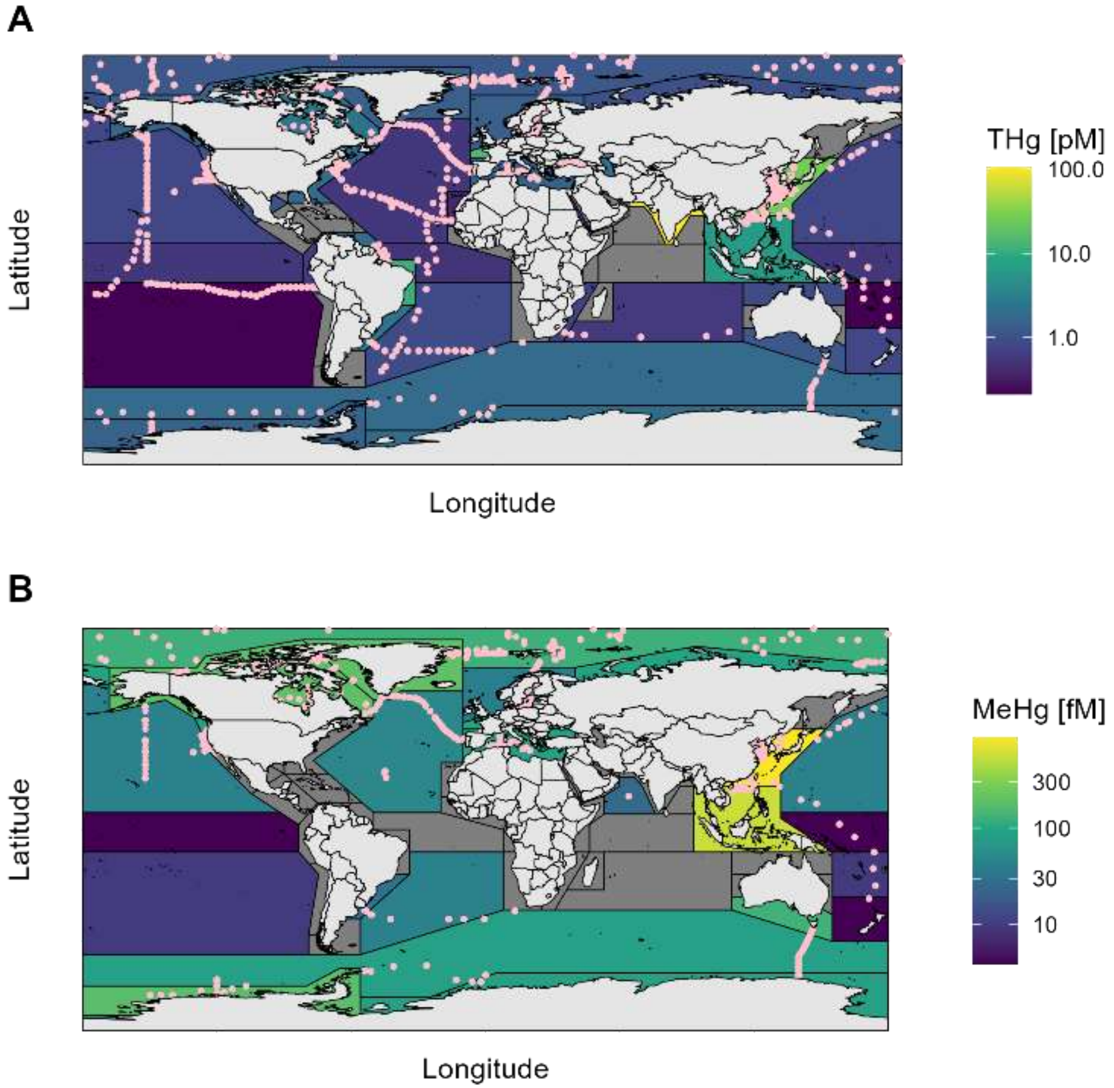
Ocean water column Hg

<u>Data Availability</u>:

No water column Hg monitoring data exists

The data was compiled from scientific publication:

- ➢ Datasets contained THg and MeHg
- ➢ Downloaded from data depositories and supporting information tables from scientific publications
- ➢ 20 years of data: 2005- 2024



Ocean water column Hg

<u>Data Analysis and Conclusions</u>:

- ***The data from scientific work is not sufficient to conduct an evaluation of temporal trends***
- The compiled data for THg and MeHg from scientific publications covered 62% and 42%, respectively, of the 55 IPCC open ocean and coastal regions.
- For both THg and MeHg, highest concentrations in the surface ocean were found in Polar regions and lowest concentrations in the South Pacific Ocean.
- For both THg and MeHg, highest coastal to open ocean concentration ratios were found in midlatitudes and equatorial regions, while little difference was seen for the Polar regions.
- %MeHg varied between 2 and 15% for the surface, open ocean and coastal waters. Lower %MeHg in the Southern Hemisphere open ocean.
- THg correlated with salinity outside of the Polar regions while no correlation was found between MeHg and salinity. Low salinity (coastal) Hg concentrations varied several orders of magnitude.

<u>Needs</u>:

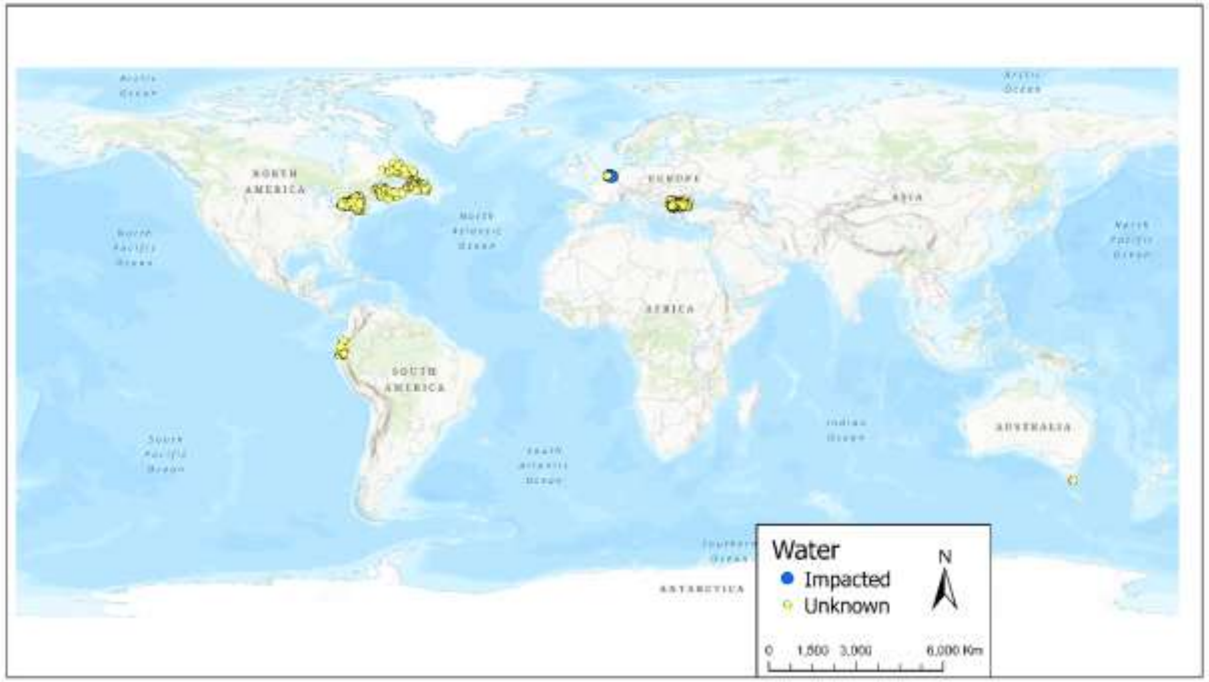
- Better data coverage including more coastal regions
- Method development and more laboratory/method intercomparison studies
- Utilization of passive samplers
- Creation of official database extending the current compilation and including more ancillary data

Freshwater Hg

<u>Data Availability</u>:

Lack of Hg monitoring data

- Seven submissions for surface water measurements in rivers and lakes were received from four continents:
  - Australia
  - Europe
  - North America
  - South America
- Limited spatial coverage. Most data are site-specific or local
- All submissions included total Hg, none reported methyl Hg.



Freshwater Hg

<u>Data Analysis and Conclusions</u>:

- ***Inadequate spatial coverage*** makes it difficult to assess regional and global patterns
- Data usability for trend analysis is limited due to analytical uncertainties and inconsistent methodologies
  - Detection limits vary, with older data often falling below current thresholds
- Based on conducted scientific literature review
  - ***Few multidecadal scientific monitoring studies exist*** on total Hg and methyl Hg in freshwater systems away from point sources, restricting quantitative assessments of change over time.
  - In rivers, Hg variability is driven by flow and particle transport, and its mobility is closely linked to dissolved organic carbon (DOC), especially during high discharge.
  - In lakes, Hg and methyl Hg are influenced by sediment interactions, seasonal redox conditions, lake water level oscillations, or upstream inflow, with DOC playing a stabilizing role.
- Case studies:
  - <u>Rivers in Sweden</u>: decreasing THg trends between 2000-2015 in some rivers but increasing trends in more sites from 2015–2020, highlighting shifting patterns.
  - <u>Three different lake ecosystem from the United States without point sources:</u> global and regional sources still control THg concentrations in some lakes; others appear to have responded to atmospheric declines but fish population did not respond due to association with other parameters controlling MeHg production.

Freshwater Hg

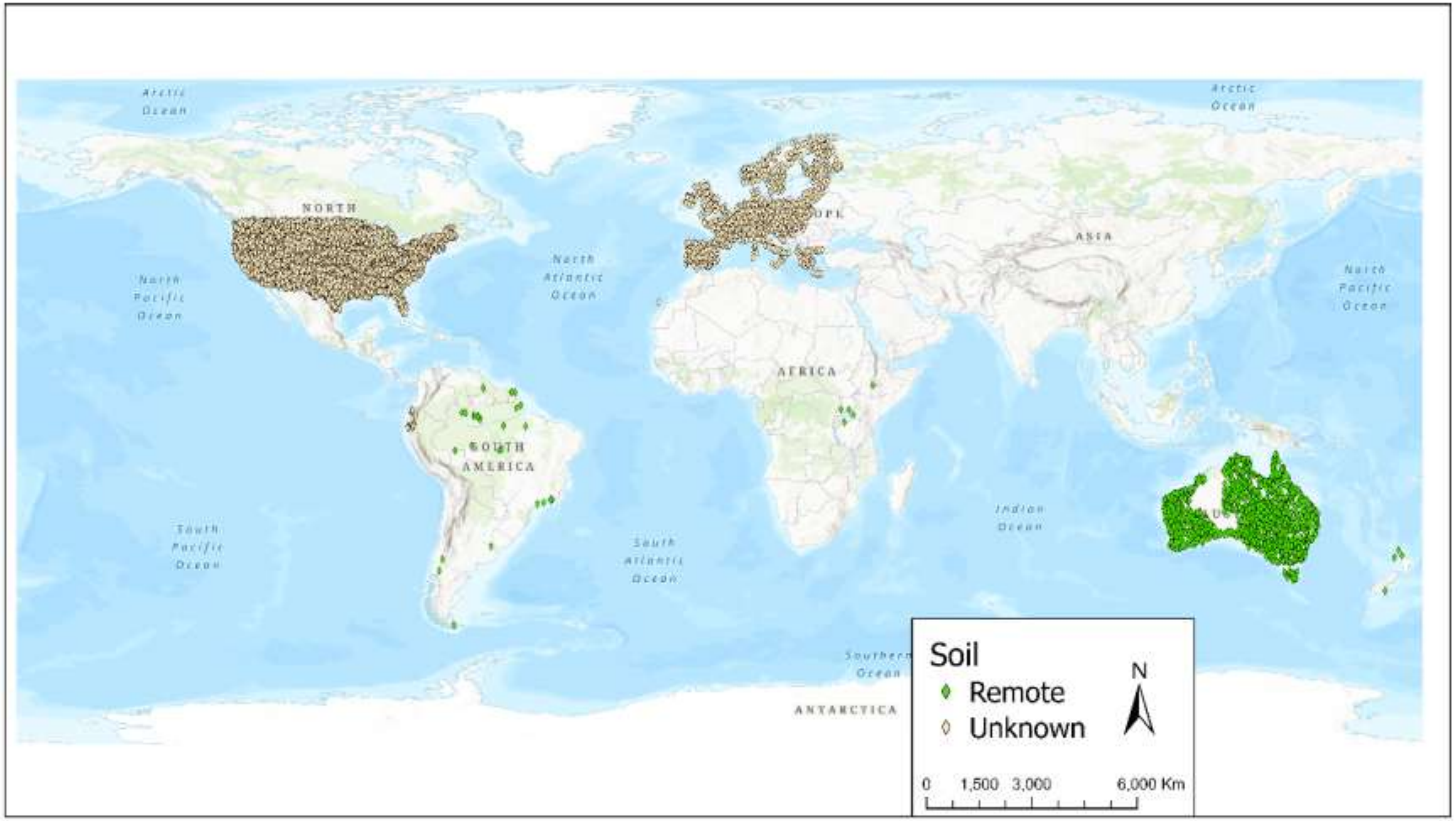
<u>Needs</u>:

- Most existing scientific studies connecting Hg depositions to biota and humans rely on indirect inferences about concentrations of different Hg species in water. **Planned monitoring activities in freshwater system close to and away from point sources is needed**.
  - Strategically selected river basins and lakes from different regions could serve as representative sites.
- **Inclusion of MeHg in future monitoring activities** because it is the critical Hg species transferred through the food chain and responsible for bioaccumulation in higher trophic levels.
- Freshwater data collected and analyzed using appropriate trace-metal sampling methodologies and analyzed using instrumentation that has a reporting limit able to capture the range of ambient concentrations.

Soil

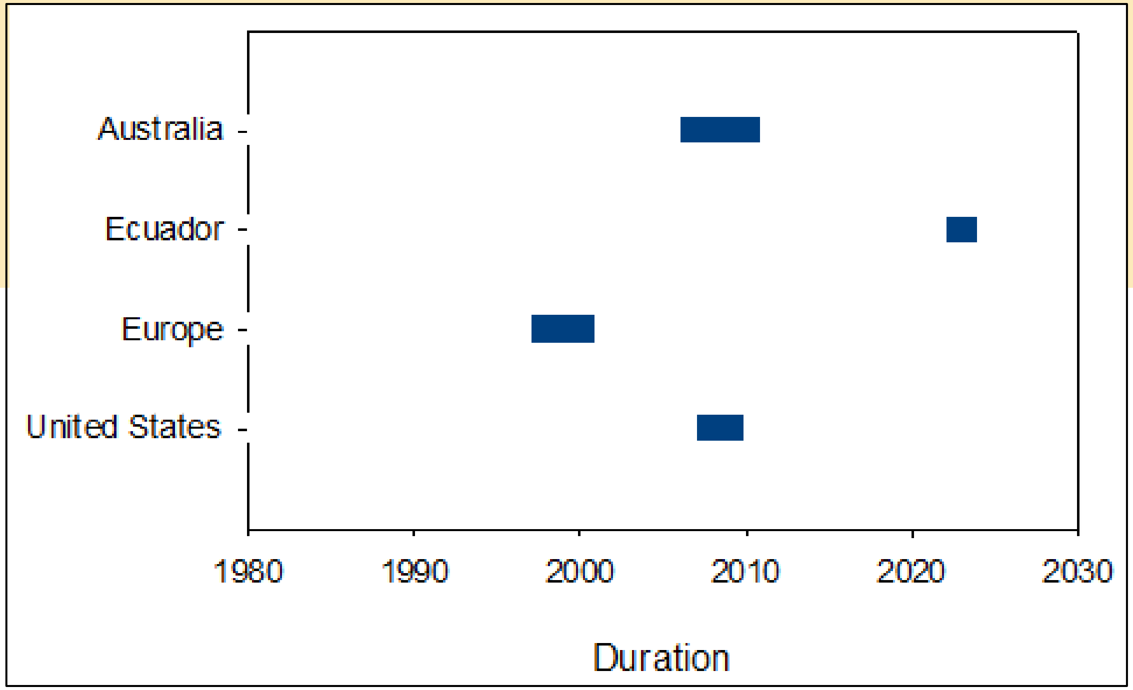
<u>Total mercury (THg)</u> soil data received from:
- USA and Australia: good coverage
- Europe, Ecuador and Peru: medium coverage
- Africa: very limited information was provided for two African countries
- **Rest of the world: <u>No data received or found</u>**

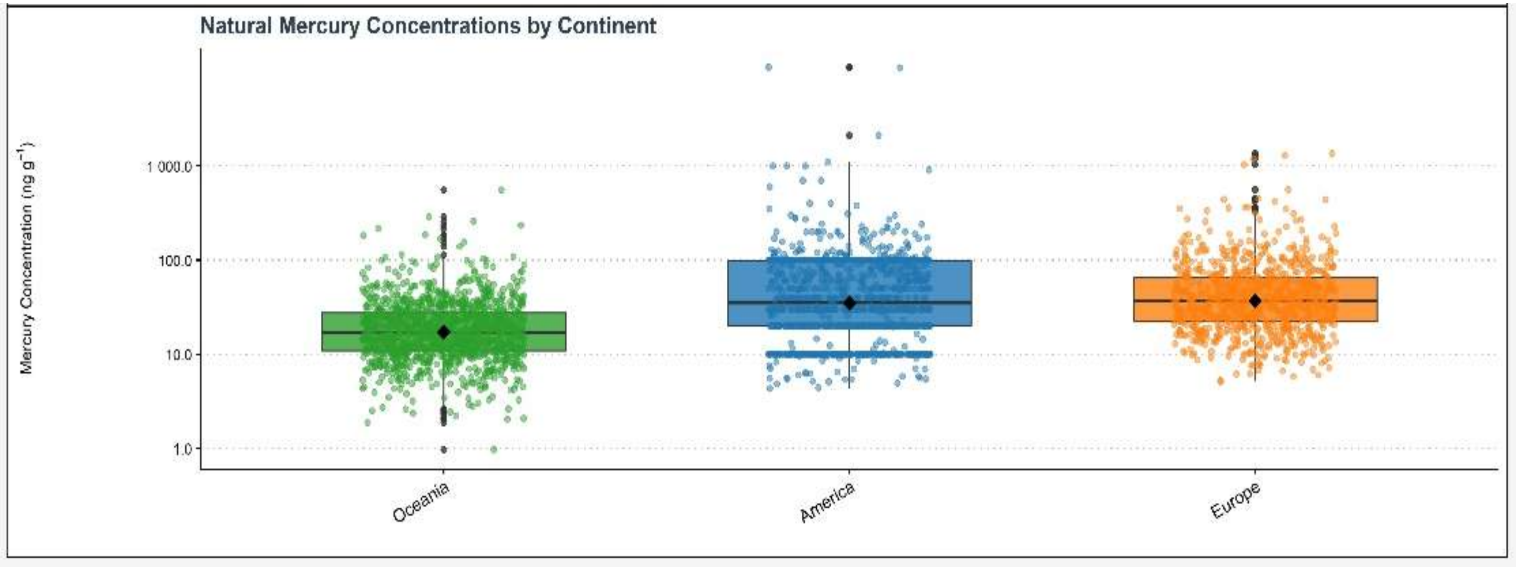
<u>No monomethylmercury (MMHg) data</u>



Soil

Data covers different time periods
→ <u>No temporal trends possible</u>





<u>Key Findings and Limitations I</u>

THg spatial variability within and across countries/continents **is large**
→ Land-use / land-cover
→ Geogenic Hg
→ Anthropogenic activities

Soil

Key Findings and Limitations II

THg levels in soils seem to be **regulated** by the presence of **soil organic matter** and/or **pedogenic oxides** but the relationships observed can strongly vary depending on the intensities of Hg inputs.

Monitoring programs are needed for Africa, Asia and South America

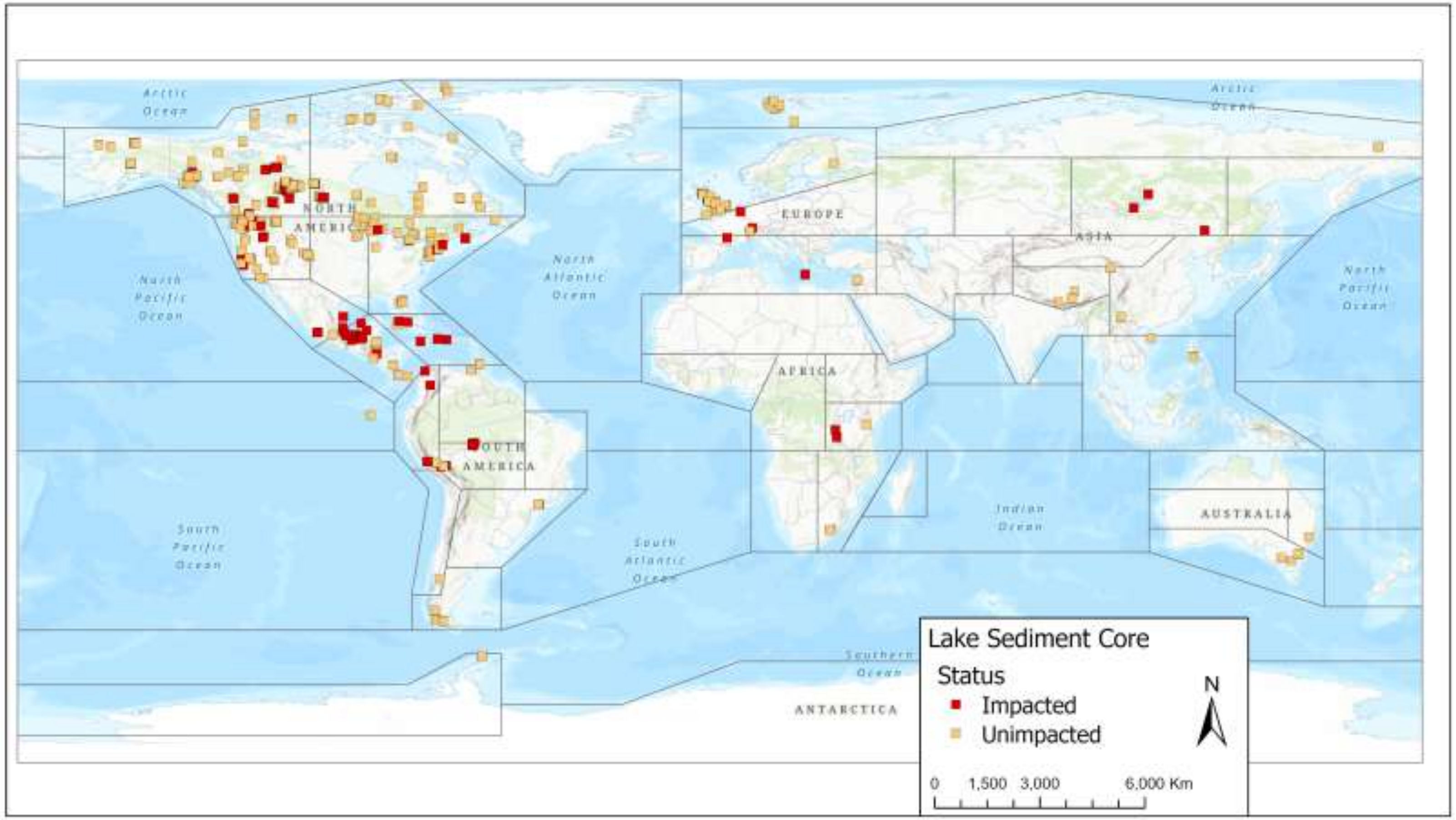
Consistent sampling/extraction/analysis needed to be able to compare soil Hg data

THg, MMHg and ancillary parameters (e.g. SOM) over time needed from selected sites to assess temporal trends.

Environmental archives (peat/sediment/ice cores and tree rings)

<u>Dataset heavily weighted toward North America</u> (67–81% of cores), with major gaps in Africa (6 cores), Oceania (4 cores), and regions of Eastern Europe/ Mediterranean/ Middle East (1 core).

Much **<u>less data for the most recent time period</u>** → need for new lake sediment core collections, especially at previously cored lakes, to enable more robust assessments.



Environmental archives (peat/sediment/ice cores and tree rings)

Key Findings:

Hg concentrations and fluxes: low and comparable between unimpacted and impacted sites **during the pre-industrial period**.

Since then:

Unimpacted/**remote sites show steady increase** to 2010–2020

Impacted sites collectively **peaked around 1990–2000** and declined thereafter

Hg concentrations: positively **correlated with organic matter** in unimpacted regions

→ Co-transport of Hg and organic matter to lake sediments.

Modern (2010-2020) Enrichment Factors (EFs):

→ Significantly **higher in impacted regions** (~7.3) than in unimpacted regions (~3.6).

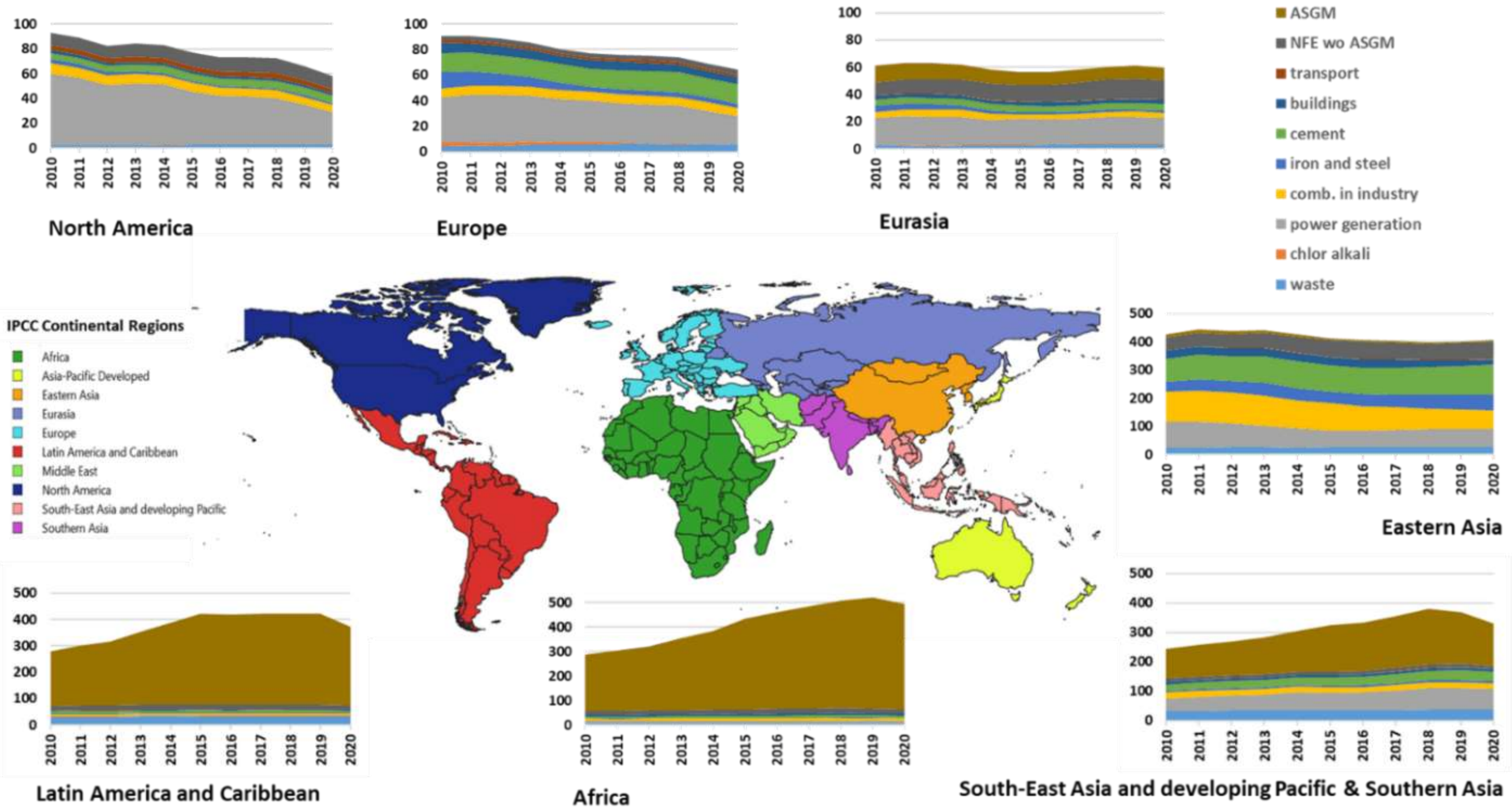
→ **Highest** in **Northern Europe**, the **Tibetan Plateau**, and the **Arctic.**

→ **Lowest** in South and Southwest-South America.

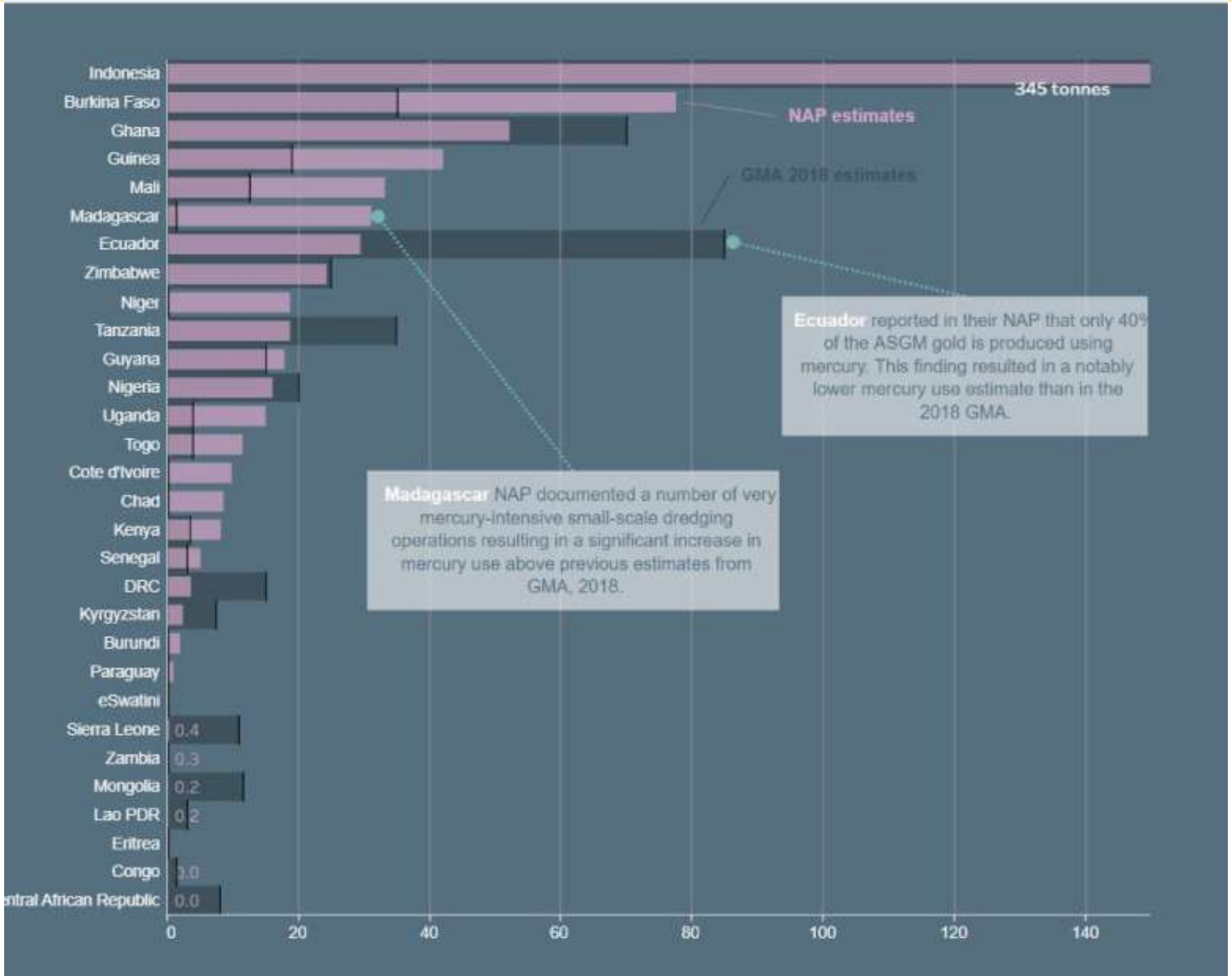
Hg fluxes: strongly correlated with aluminum

→ **dominant role of sedimentation** rates

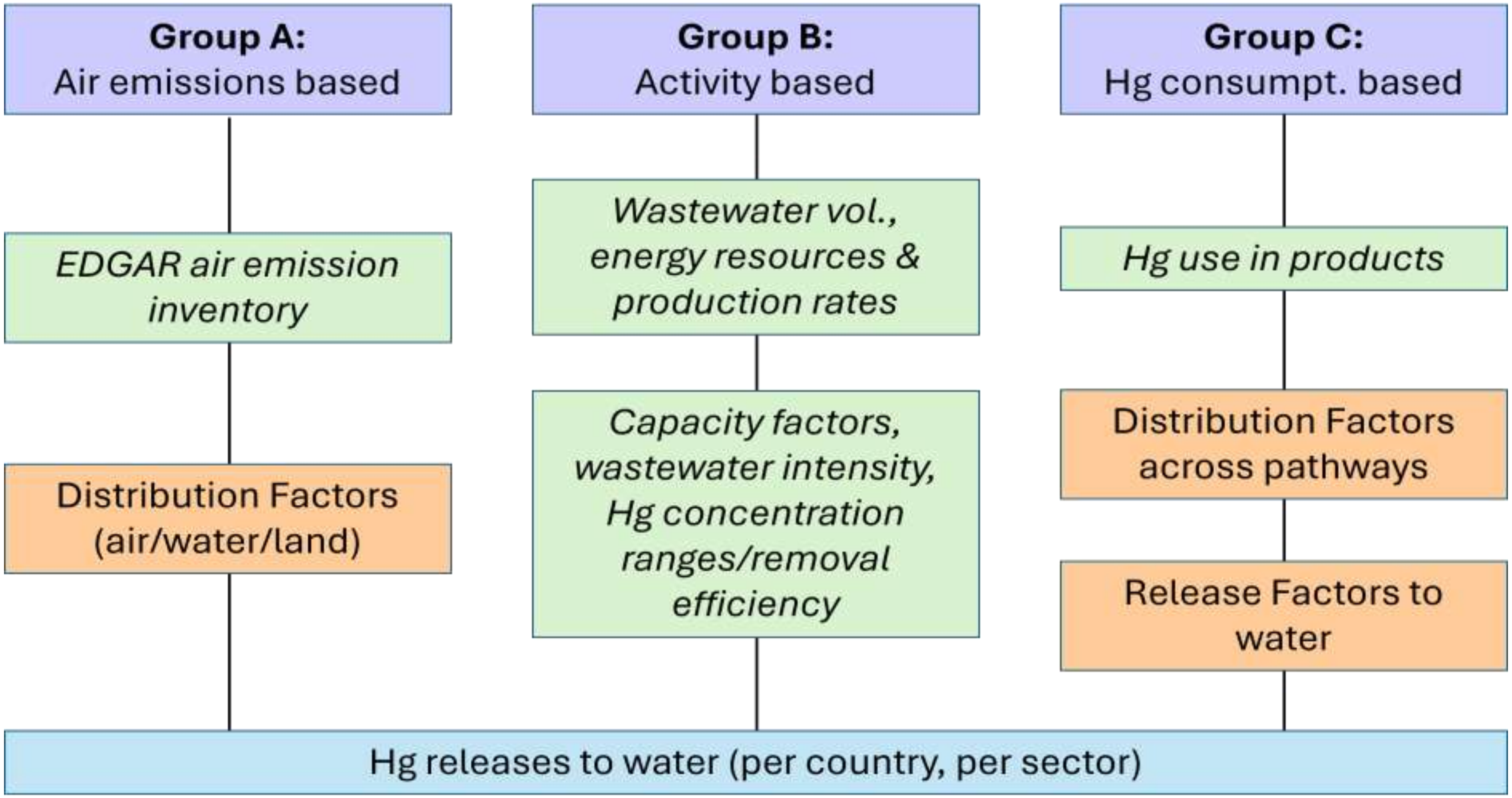
Emissions and releases – EDGAR emission estimates



Challenges in estimating ASGM emission



Estimating releases to land and water



Integrated Analysis : Key questions and information

Cross Media Comparisons of Observed Trends and Patterns

Process and Source Attribution for **Biota, Humans, and Other Media**

Process Understanding and **Model Evaluation**

Process and Source Attribution for **Air and Oceans**

Comprehensive "Integrated Analysis" is not yet achieved in the current stage of the effectiveness evaluation, because of the lack of comprehensive data and scientific methodologies now available for the evaluation. Local to regional scientific studies that would be case studies to imply potential integrated analysis in future.

Topic	Leading experts
Model Assessment of Hg Levels, Spatial Patterns and Temporal Trends (Progress Report)	The Multi-Compartment Mercury Modelling and Analysis Project (MCHgMAP)
Impacts of reductions in mercury emissions on the Flin Flon ecosystem	Marlene Evans
Integrated Analysis Study of Mercury in Tropical Tuna Species	Robert Mason, Anaïs Médieu, Raphael Lavoie, and Mi-Ling Li
Mercury in the Mediterranean Region and the Minamata Convention	Milena Horvat, Jože Kotnik, Igor Živkovič, Jan Gačnik, Oleg Travnikov, Adna Alilović, Janja Snoj Tratnik, Vanja Usenik, David Kocman, Ermira Begu
Mercury Pollution from Artisanal Gold Mining in Madre de Dios, Peru: A Cross-Media Case Study	Claudia Vega
Great Lakes Regional Case Study	Mark Burton and Celia Chen
Integrated Analysis of Mercury in Sweden	Pianpian Wu, Kevin Bishop, Karin Eklöf, John Munthe, Anne Sørensen, Erik Björn, Claudia von Brömssen
Integrated Analysis of Mercury in the Derwent Estuary, Australia	Olha FURMAN
Oceanic mercury monitoring in the East China Sea	Koji Marumoto and Akinori Takeuchi

The Multi-Compartment Mercury Modelling and Analysis Project (MCHgMAP) combines atmospheric, ocean, terrestrial, and multi-media mass balance models. (https://gmd.copernicus.org/articles/18/2747/2025/gmd-18-2747-2025.html).

Model	*Institution*
Atmospheric models	
GEM-MACH-Hg	Environment and Climate Change Canada (Canada)
GEOS-Chem	Massachusetts Institute of Technology (USA)
WACCM	Institute of Physical Chemistry Blas Cabrera (Spain)
GLEMOS [(1)]	MSC-E, Jožef Stefan Institute (Slovenia)
Ocean models	
ICON-MERCY	HEREON (Germany)
MITgcm	Tulane University (USA)
Terrestrial model	
2D air-land Hg exchange model	Lamar University (USA), Institute of Geochemistry, CAS (China)
Multi-media mass balance model	
GBBM	University Grenoble Alpes, CNRS (France), Harvard University (USA)

Integrated Analysis : Key questions and examples of results

Cross Media Comparisons of Observed Trends and Patterns

Process and Source Attribution for **Biota, Humans, and Other Media**

Process Understanding and **Model Evaluation**

Process and Source Attribution for **Air and Oceans**

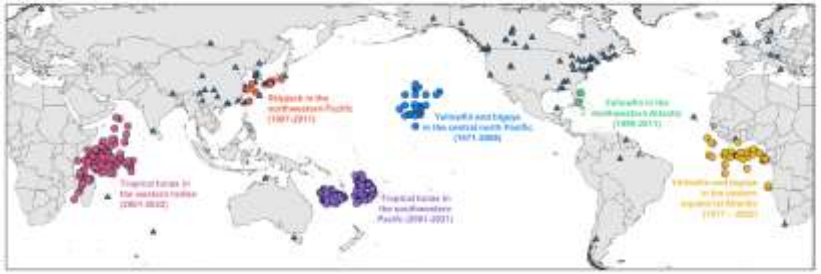


Figure 1. *Spatial distribution of tropical tunas analyzed for Hg (colored circles) and atmospheric Hg level observation sites (blue triangles), adapted from Médieu et al. (2024).*

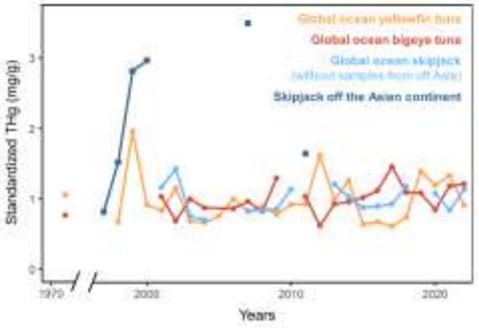


Figure 2. *Temporal variability of standardized Hg concentrations (mg/g) in tropical tunas: yellowfin (orange), bigeye (red), and skipjack (blue), adpated from Médieu et al. (2024). The colored dots represent average annual concentrations measured in the global ocean, except in the northwestern Pacific, off Asia. In that area, average annual concentrations are represented by dark blue squares.*

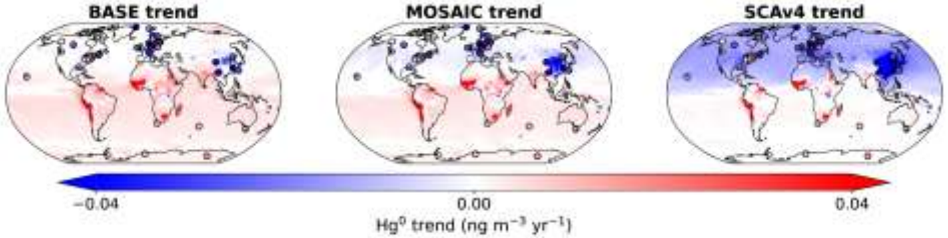


Figure 10. *Spatial distribution of modelled Hg(0) trends over 2010–2020, compared to available measurements in the OESG datasets. Ensemble mean model simulations and observations (sites > 8 years) are deseasonalized and analyzed with quantile regression for the median trends in monthly mean values. Only grid boxes with trends significantly different from zero (trend < 2 × trend error) are shown in colour.*

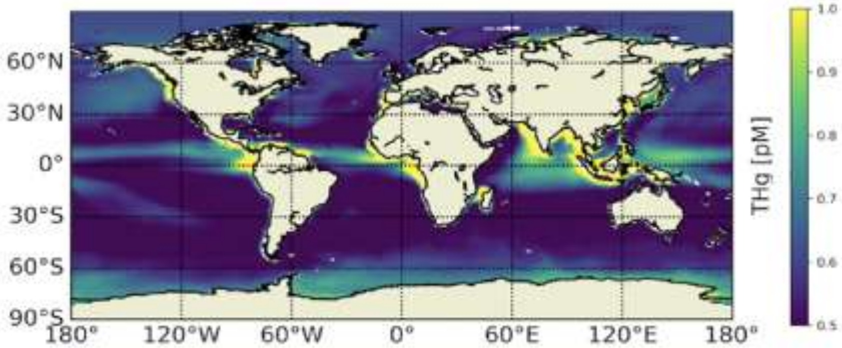


Figure 8: *Average modeled spatial distribution of total Hg in the surface ocean 2010-2020. Highest Hg concentrations are found in upwelling regions and near major anthropogenic source regions.*

Future Vision, Gaps, and Lessons Learned

Chapter	Theme	Content
1 and 2	Introduction	Introduction to the Future Vision team, including work basis, tasks, personnel composition, working timeline, etc.
3	Vision	Envision monitoring and data analysis for future effectiveness evaluation from the four aspects of **practicality, sustainability, robustness, and efficiency**, describing the **minimum and necessary requirements** for monitoring and data analysis applicable to effectiveness evaluation.
4	Gaps, Lessons learned, and recommendations	Identify **current urgent** gaps and lessons learned from six aspects: air monitoring, biota monitoring, human monitoring, other media monitoring, emission and release data, and integrated data analysis, and propose **targeted recommendations**.
5	Comprehensive recommendations	Provide some comprehensive recommendations, mainly focused on **mechanisms that address multiple gaps in a holistic manner**.

Future Vision, Gaps, and Lessons Learned

2024

Oct: establish the future vision team

Nov: release zero-draft of report framework & call for comments

2025

Feb: confirm the outline of Vision chapter

Mar: confirm the outline of Gaps, Lessons learned, and Recommendations chapter

Apr: release updated draft report & call for comments

Sept: release updated draft report & call for comments (2nd round)

Two common gaps and corresponding recommendations

Gaps	Recommendations
GAP1: Uneven distribution of monitoring data, with severe underreporting in developing countries and regions, especially those affected by ASGM	**Monitoring guidance and support:** Provide funding, technical assistance, and personnel support for these regions to improve monitoring. **Long-term monitoring:** Strengthen long-term measurements and data accumulation to better understand trends.
GAP2: Restricted data access, especially where some existing data is not effectively shared, and submission formats are inconsistent, preventing the widespread use of the data.	**Establish centralized data centers:** Suggest setting up regional or global data centers for organizing, cleaning, and storing data. **Standardize reporting requirements:** Simplify reporting formats and ensure that all countries and regions can submit data according to unified standards.