

# OESG Scientific Report

## Executive Summary

*We propose to draft this section after we complete the rest of the document and to use this section as the official report under the Minamata Convention for the OESG's "Scientific Report." It will be subject to length restrictions and will be translated into official languages. We propose to make the full document available as an informal document.*

## Introduction

### OESG Mandate

### Summary of OESG Activities or Tasks

### Organization of Report

*We propose that the following sections comprise the technical support for the Scientific Report (the executive summary above). The main objectives of the following sections are to describe the data that we collected and to address the questions for analysis that we identified in our plans for data collection and analysis. At our first in-person OESG meeting, we drafted these questions and identified sources of information, methodologies, expected results, approaches for characterizing uncertainty, and other considerations for addressing these questions. The proposed approach for completing the following sections is to respond to each question in about 2 pages or less per question, not including figures or tables. If it is not possible to answer the question given the available data, then an explanation should be provided describing what information would be needed to address the question. To help with this approach, we've provided prompts under each question for the information that may be included in the response. Some of these elements correspond to the spreadsheet of analysis questions developed at the first meeting.*

*This approach can be modified, and the questions can be subdivided, combined, or refined as necessary. However, to the extent possible, we would like to maintain consistency with the analysis plans that we have provided in our progress reports to the Parties.*

## Current Levels, Temporal Trends, and Spatial Patterns

### Anthropogenic Emissions to Air

What data are available?

Questions for Analysis

- What are the current levels of Hg (THg, GEM, GOM, PBM) emissions to air, [by country and by world region,] from
  - Each Convention Annex D source category
  - ASGM sources
  - Other anthropogenic sources covered by the Convention (not Annex D, not ASGM)

- Anthropogenic sources not covered by the Convention
  - Information used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of anthropogenic Hg emissions to air from (each Annex D source category, ASGM activities, other covered source categories, or non-covered source categories) by world region changed over the available record? Have the estimated trends changed over the available record, and how do those changes compare to the timeline of the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of specific mercury mitigation measures to the change in anthropogenic Hg emissions to air from (each Annex D source category, ASGM activities, other covered source categories, or non-covered source categories) by world region over the available record?
  - Information used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- [What would levels of anthropogenic emissions to air from (each Annex D source category, ASGM activities, other covered source categories, or non-covered source categories) by world region be currently without implementation of obligations related to the Convention?]
  - Information used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- [How are levels of anthropogenic Hg emissions to air from (each Annex D source category, ASGM activities, other covered source categories, or non-covered source categories) by world region expected to change by 2030, including consideration of implementation of the Convention? ]
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)

- Evaluation of Confidence
- Information and Capacity Needs

## Anthropogenic Releases to Land and Water

What data are available?

Questions for Analysis

- What are current levels of THg releases to fresh waters (rivers and lakes) from ASGM activities [by country/world region]? By Hg species?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are current levels of THg releases to coastal waters from ASGM activities [by country/world region]? By Hg species?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are current levels of THg releases to fresh waters (rivers and lakes) from non-ASGM anthropogenic activities (examples - agriculture, gold plating, dental offices,...) [by country/world region]? By Hg species?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are current levels of THg releases to coastal waters from non-ASGM anthropogenic activities (examples - agriculture, gold plating, dental offices,...)[by country/world region]? By Hg species?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are current levels of THg releases to land (separate from water) from ASGM activities, including tailings and sediments [by country/world region]? By Hg species?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology

- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- What are current levels of THg releases to land (separate from water) from non-ASGM anthropogenic activities (examples - agriculture, gold plating, dental offices,...) [by country/world region]? By Hg species?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of anthropogenic Hg releases to water from (ASGM, non-ASGM activities) by world region changed over the available record? Have the observed trends changed over the available record and how do those changes compare to the timeline of the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of specific mitigation measures to the change in anthropogenic Hg releases to water from (ASGM, non-ASGM activities) by world region over the available record?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- [What would levels of anthropogenic Hg releases to water from (ASGM, non-ASGM activities) by world region be currently without implementation of the obligations related to the Convention?]
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- [How are levels of anthropogenic Hg releases to water from (ASGM, non-ASGM activities) by world region expected to change by 2030, including consideration of implementation of the Convention?]
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology

- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- How have levels of anthropogenic Hg releases to land from (ASGM, non-ASGM activities) by world region changed over the available record? Have the observed trends changed over the available record and how do those changes compare to the timeline of the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of specific mitigation measures to the change in anthropogenic Hg releases to land from (ASGM, non-ASGM activities) by world region over the available record?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What would levels of anthropogenic Hg releases to land from (ASGM, non-ASGM activities) by world region be currently without implementation of the obligations related to the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- [How are levels of anthropogenic Hg releases to land from (ASGM, non-ASGM activities) by world region expected to change by 2030, including consideration of implementation of the Convention?]
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Natural Primary Emissions and Releases

What data are available?

Questions for Analysis

- What are current levels of primary Hg emissions to air from natural sources?
  - Information Used (including applicable indigenous and traditional knowledge)

- Methodology
- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- What are current levels of primary Hg releases to a) fresh water and b) oceans from natural sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are current levels of primary Hg releases to land from natural sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of natural primary Hg emissions to air changed over the available record? Have the estimated trends changed over the available record and how do those changes compare to the timeline of the Minamata Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of natural primary Hg releases to water changed over the available record? Have the observed trends changed over the available record and how do those changes compare to the timeline of the Minamata Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of natural primary Hg releases to land changed over the available record? Have the observed trends changed over the available record and how do those changes compare to the timeline of the Minamata Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response

- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs

## Air

What data are available?

### Questions for Analysis

- What are current levels of (TGM/GEM, Bulk/ Wet Dep) observed in ambient air or deposition in different regions of the world?
  - at sites that are remote from anthropogenic sources
  - at sites that are expected to be affected by local anthropogenic sources
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- What are current levels of (GOM/ PBM, Litterfall, Dry Dep, Isotopes) in the air around the world?
  - at sites that are remote from anthropogenic sources
  - at sites expected to be affected by local anthropogenic sources
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- What is the spatial representativeness of current levels of Hg observed in air? Do we have geographic gaps in our observations?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of mercury species observed in the air in different regions of the world changed over the available record? Are there differences in the trends observed at sites that are a) remote from anthropogenic sources and b) expected to be affected by local anthropogenic sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence

- Information and Capacity Needs
- Is there a change in the observed trends over the record of the data, where adequate data to establish a trend is available, and how do those changes in trends compare to the timeline of the Minamata Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do the changes in (TGM/GEM) observed in air between circa 2010 and the present compare to established national and international guidance or levels identified in recent scientific literature that are associated with adverse effects on human health, wildlife and environmental sustainability?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Biota

What data are available?

Questions for Analysis

- What are current levels of THg observed (in fish, birds, marine mammals, sea turtles, invertebrates) at sites based on proximity to known anthropogenic or natural sources and taking into consideration their migratory range and trophic level?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of THg changed in (fish, birds, marine mammals, sea turtles, invertebrates) before to 2010 and after 2010 (Consider: trophic levels, food species and tissues, biodiversity indicators - threatened species (follow IUCN), sensitive ecosystem terrestrial/freshwater and coastal/marine, migratory pathways)?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)

- Evaluation of Confidence
  - Information and Capacity Needs
- How do levels of THg observed in species that display different degrees of site fidelity (fish, invertebrates, plants, mammals, birds) vary geographically at the global scale over time (example ICP survey, for example once every EEG cycle)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do observed spatial patterns and temporal trends for Hg in biota compare to patterns and trends for other pollutants or environmental variables?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- How do current levels of THg observed in (fish, birds, marine mammals, sea turtles, invertebrates) compare to established national and international benchmark levels associated with adverse effects on human health, wildlife and environmental sustainability?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- How do the changes in levels of THg observed (in fish, birds, marine mammals, sea turtles, invertebrates) between circa 2010 and the present compare to established national and international benchmark levels associated with adverse effects on human health, wildlife and environmental sustainability?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response

- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs

## Humans

What data are available?

### Questions for Analysis

- What are current levels of THg observed in (blood, urine, hair) of (vulnerable sub-populations including indigenous people, highly exposed population (occupationally exposed at ASGM, non occupationally exposed at ASGM, use of skin lightening creams) and the general population - ) that are a) remote from anthropogenic sources (i.e. indigenous vs others) and b) at anthropogenic sources (highly exposed population; iHg, orgHg exposure)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of THg observed in (vulnerable subpopulations including indigenous populations, general population) changed over the available record? Is there a change in the observed trends over the available record and how do those changes in trends compare to the timeline of the Minamata Convention?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- How do current levels of THg observed in (blood, urine, hair) of (vulnerable sub-populations and the general population) vary geographically at the global scale?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do current levels of THg observed in (blood, urine, hair) of (vulnerable sub-populations and the general population) compare to established national and international guidance levels associated with adverse effects on human health?
  - Locally
  - Regionally

- Globally
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do the changes in the levels of THg observed in (blood, urine, hair) of (vulnerable sub-populations and the general population) between circa 2010 and the present compare to established national and international benchmark levels associated with adverse effects on human health?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- How are the changes in the levels of THg observed in (blood, urine, hair) of (vulnerable sub-populations and the general population) attributable to the mitigation measures influenced by the Convention?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs
- How do are changes in anthropogenic emissions and releases and levels observed at contaminated sites and in sensitive ecosystems related to mercury levels in human samples (hair, urine, blood) and how can these changes be attributed to different sources?
  - Locally
  - Regionally
  - Globally
    - Information Used (including applicable indigenous and traditional knowledge)
    - Methodology
    - Answer/Response
    - Consistency of Answer with Existing Literature (especially the 2018 GMA)
    - Evaluation of Confidence
    - Information and Capacity Needs

## Soil

What data are available?

Questions for Analysis

- What are current levels of THg and MMHg (and other species/fractions if applicable) observed in soil that are remote from or near anthropogenic sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of THg and MMHg (and other species/fractions if applicable) observed in soil changed over the available record?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do temporal trends of Hg levels observed in soils compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary temporally in soils?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local THg and MMHg levels (and other species/fractions if applicable) found in soils differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence

- Information and Capacity Needs
- How do local temporal trends in THg and MMHg (and other species/fractions if applicable) found in soils differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local THg and MMHg levels (and other species/fractions if applicable) found in soils differ by watershed land cover or land use?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary spatially in soils?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do spatial trends of Hg levels observed in soils compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Sediment

What data are available?

Questions for Analysis

- What are current levels of THg and MMHg (and other species/fractions if applicable) observed in sediment that are remote from or near anthropogenic sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)

- Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of THg and MMHg (and other species/fractions if applicable) observed in sediment changed over the available record?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do temporal trends of Hg levels observed in sediments compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary temporally in sediments?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local THg and MMHg levels (and other species/fractions if applicable) found in sediments differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local temporal trends in THg and MMHg (and other species/fractions if applicable) found in sediments differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

- How do local THg and MMHg levels (and other species/fractions if applicable) found in sediments differ by watershed land cover or land use?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary spatially in sediments?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do spatial trends of Hg levels observed in sediments compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

### Fresh Waters (rivers, lakes, and coastal estuaries)

What data are available?

Questions for Analysis

- What are current levels of THg and MMHg (and other species/fractions if applicable) observed in surface water that are remote from or near anthropogenic sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of THg and MMHg (and other species/fractions if applicable) observed in surface water changed over the available record?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence

- Information and Capacity Needs
- How do temporal trends of Hg levels observed in surface waters compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary temporally in surface waters?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local THg and MMHg levels (and other species/fractions if applicable) found in surface waters differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local temporal trends in THg and MMHg (and other species/fractions if applicable) found in surface waters differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local THg and MMHg levels (and other species/fractions if applicable) found in surface waters differ by watershed land cover or land use?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary spatially in surface waters?

- Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do spatial trends of Hg levels observed in surface waters compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?

## Ocean Water

What data are available?

Questions for Analysis

- What are current levels of THg and MMHg (and other species/fractions if applicable) observed in ocean water that are remote from or near anthropogenic sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have levels of THg and MMHg (and other species/fractions if applicable) observed in ocean water changed over the available record?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do temporal trends of Hg levels observed in ocean waters compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary temporally in ocean waters?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)

- Evaluation of Confidence
  - Information and Capacity Needs
- How do local THg and MMHg levels (and other species/fractions if applicable) found in ocean waters differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do local temporal trends in THg and MMHg (and other species/fractions if applicable) found in ocean waters differ by world regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do THg and MMHg levels (and other species/fractions if applicable) co-vary spatially in ocean waters?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do spatial trends of Hg levels observed in ocean waters compare to or co-vary with variations and trends of related pollutants or environmental variables over the available record? (TOC, SOM, DOC, TSS)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Integrated Analysis

### Cross Media Comparisons of Observed Trends and Patterns

#### Questions for Analysis

- Are the spatial patterns and temporal trends of Hg observed in air consistent with trends in estimated emissions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology

- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- Are the spatial patterns and temporal trends in Hg observed in soils, sediments, surface and ocean waters consistent with trends in estimated releases to land and water?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- Are the spatial patterns and temporal trends in Hg observed in air, soils, sediments, surface and ocean waters consistent with trends in biota or humans?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have observed trends changed over the available record and how do those changes compare to the timeline of the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How do temporal trends of Hg levels observed in species that display different degrees of site fidelity (fish, invertebrates, plants, mammals, birds) vary with emissions/release data in impacted areas by point sources?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Process Understanding and Model Evaluation

What data are available?

Questions for Analysis

- How consistent are the observed levels, temporal trends and spatial patterns of Hg levels in air (TGM, GEM, Wet Dep, GOM, PBM) with estimates from current mechanistic models at the global scale?

- Information Used (including applicable indigenous and traditional knowledge)
- Methodology
- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- How consistent are the observed levels, temporal trends and spatial patterns of Hg levels in oceans with estimates from current mechanistic models at the global scale?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How sensitive are levels and trends of Hg in the air and ocean to various primary and secondary emissions and releases and environmental conditions across the globe?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How sensitive are levels and trends of Hg in the air and ocean to various Hg processes across the globe?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How consistent are the observed levels, temporal trends and spatial patterns of Hg levels in biota with estimates from current mechanistic models of biotic exposure?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How consistent are the observed levels, temporal trends and spatial patterns of Hg levels in humans with estimates from current mechanistic models of human exposure?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)

- Evaluation of Confidence
- Information and Capacity Needs
- How consistent are the observed levels, temporal trends and spatial patterns of Hg levels in air, water, soil with estimates from current multi-media mechanistic models?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Process and Source Attribution for Air and Oceans

What data are available?

Questions for Analysis

- What is the contribution of primary anthropogenic emissions and releases to Hg levels observed in the air (GEM, Wet Dep, Dry Dep)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are the contributions of changes in primary anthropogenic and natural emissions, and secondary emissions to changes in Hg levels observed in the air over the period circa [2010] to present?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are the fractional contributions of changes in anthropogenic Hg emissions and releases, and environmental conditions to changes in secondary emissions and releases of Hg over the period circa 2010 to present across the globe?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- In each world region, how much of the contribution of primary anthropogenic emissions to changes in Hg levels observed in air over the period circa [2010] to present are due to emissions within the region versus outside the region?
  - Information Used (including applicable indigenous and traditional knowledge)

- Methodology
- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- How are Hg levels in air expected to change in future under different scenarios of implementation of the Minamata and other Conventions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How are anthropogenic Hg emissions and releases expected to change in future under different scenarios of implementation of the Minamata and other Conventions across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How are secondary Hg emissions and releases from biomass burning, soils and ocean expected to change in future under changing anthropogenic Hg emissions and releases and environmental conditions across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are the fractional contributions of primary (anthropogenic and natural) and secondary Hg emissions and releases to current Hg levels observed in the air and ocean across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How have the fractional contributions of primary (anthropogenic and natural) and secondary Hg emissions and releases to levels of Hg observed in the air and ocean changed over the period circa 2010 to present across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response

- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- What is the fractional contribution of anthropogenic Hg emissions influenced by the Convention to current Hg levels observed in the air and ocean across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How has the fractional contribution of anthropogenic Hg emissions influenced by the Convention to Hg levels observed in the air and ocean changed over the period circa 2010 to present across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What are the fractional contributions of changes in primary anthropogenic and natural Hg emissions and releases, and environmental conditions to changes in Hg levels observed in the air and ocean over the period circa 2010 to present across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the fractional contribution of changes in anthropogenic Hg emissions influenced by the Convention to changes in Hg levels observed in the air and ocean over the period circa 2010 to present across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- In each world region, how much of the contribution of primary anthropogenic Hg emissions to changes in Hg levels observed in air over the period circa 2010 to present are due to emissions within the region versus outside the region?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response

- Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How are Hg levels in the air and ocean expected to change in future under different scenarios of implementation of the Minamata and other Conventions across global regions?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- [How are Hg levels in the air and ocean expected to change in future under changing environmental conditions across global regions? ]
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

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

What data are available?

Questions for Analysis

- What is the contribution of changes in primary anthropogenic emissions and releases to changes in Hg levels observed in biota over the period circa 2010 to present? (local environment, lower trophic levels, )
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of changes in anthropogenic , natural and legacy mercury in Hg levels observed in humans over the period circa 2010 to present?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of anthropogenic, natural, or legacy sources to the spatial and temporal trends in soil, sediments, surface and ocean waters?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology

- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- How can the spatial and temporal trends in soil, sediment, surface and ocean waters be attributed to changes in anthropogenic sources of mercury at the global, regional and local scale over the observed period?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of trends in drivers of human exposure related to implementation of the Convention to the trends observed in Hg levels in humans over the period circa 2010 to present?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of environmental processes and pressures (including climate, habitat changes) to the trends observed in Hg levels in biota over the period circa 2010 to present (does not include anthropogenic inputs)?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- What is the contribution of trends in drivers of human exposure unrelated to implementation of the Convention to the trends observed in Hg levels in humans over the period circa 2010 to present?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How can the spatial and temporal trends in soil concentrations be attributed to changes that are not influenced by the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology

- Answer/Response
- Consistency of Answer with Existing Literature (especially the 2018 GMA)
- Evaluation of Confidence
- Information and Capacity Needs
- How can the spatial and temporal trends in sediments concentrations be attributed to changes that are not influenced by the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs
- How can the spatial and temporal trends in surface concentrations be attributed to changes that are not influenced by the Convention?
  - Information Used (including applicable indigenous and traditional knowledge)
  - Methodology
  - Answer/Response
  - Consistency of Answer with Existing Literature (especially the 2018 GMA)
  - Evaluation of Confidence
  - Information and Capacity Needs

## Summary of Findings

*We propose to draft this section after we complete the analysis sections above. This section will summarize the main answers to the questions we are able to answer. We expect that the content provided in this section will be repeated in the Executive Summary (Official Report).*

# Recommendations for Future Effectiveness Evaluations

## Executive Summary

*Similar to the Scientific Report, we propose to draft this section after we complete the rest of the document below and to use this section as the official report under the Minamata Convention for the OESG's report on information gaps and lessons learned. It will be subject to length restrictions and will be translated into official languages. We propose to make the full document available as an informal document.*

## Introduction

## Emissions and Releases Quantification

## Air Monitoring

## Biota Monitoring

## Human Biomonitoring

## Other Media Monitoring

## Trend Analysis and Process Attribution

## Process Understanding and Mechanistic Model Development

## Data Reporting and Data Management