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Matters for consideration or action by the Conference of the Parties: effectiveness evaluation

Giving effect to article 22 of the Minamata Convention on Mercury: effectiveness evaluation

Addendum

Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention: executive summary

Note by the secretariat

I. Introduction

1. In paragraph 2 (a) of decision MC-3/10, on the arrangements for the first effectiveness evaluation, the Conference of the Parties to the Minamata Convention on Mercury requested the secretariat to advance the work on the effectiveness evaluation by securing services for drafting guidance on monitoring to maintain harmonized, comparable information on mercury levels in the environment.

2. Through the process described in section II below, draft guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention has been developed and made available as document UNEP/MC/COP.4/INF/12, along with supplementary material made available as document UNEP/MC/COP.4/INF/25.

3. The executive summary of the guidance is set out in annex I to the present note for consideration by the Conference of the Parties at its fourth meeting.

* The resumed fourth meeting of the Conference of the Parties to the Minamata Convention on Mercury is to convene in person in Bali, Indonesia, and is tentatively scheduled for the first quarter of 2022.

** UNEP/MC/COP.4/1.

II. Development of the monitoring guidance

4. In response to decision MC-3/10, the secretariat, in consultation with the Bureau of the fourth meeting of the Conference of the Parties, prepared a roadmap[1] outlining an iterative and participatory process for the development of guidance on monitoring in the context of the effectiveness evaluation.

5. In line with the roadmap, the secretariat developed a draft annotated outline of the monitoring guidance and held open online information sessions in June 2020 to discuss the development of the guidance. Subsequently, parties and organizations were invited to identify experts to contribute to the drafting of the guidance,[2] and three consultants were engaged by the secretariat to draft chapters on mercury monitoring in air, biota and humans.

6. The first webinar among the identified experts and consultants was held on 15 September 2020, and the final annotated outline of the guidance was developed taking into account the comments received. Further thematic online meetings were convened from September 2020 to March 2021 to develop the guidance.

7. As a result of the process, the secretariat, working with the consultants and supported by the experts identified by parties and organizations, developed a first draft of the guidance, which was made available for comments by parties and relevant stakeholders on 15 April 2021. A total of 14 submissions were received, from 8 countries and 6 organizations.

8. After further consultations with experts, a second draft of the guidance, along with supplementary material, was developed and was made available for review by parties and organizations on 15 July 2021. A total of 15 submissions were received during the commenting period, of which 10 were from parties and 5 were from organizations.

9. Throughout the development of the guidance, an attempt was made to address all comments and suggested amendments. Several bilateral discussions took place between countries or organizations and the secretariat or consultants in an attempt to fully address the comments and suggested amendments. Parties and organizations were also invited to submit additional information on existing monitoring programmes and available standard operating procedures. In spite of all efforts, some comments and suggestions could not be reflected in the guidance, in particular those that requested the removal of text that had received support from other reviewers. To support transparency and maintain open communication, parties and organizations were invited to contact the secretariat to discuss questions and comments related to the development of the guidance, including when they felt that their comments had not been fully reflected in the revisions.

10. The resulting "Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention" (UNEP/MC/COP.4/INF/12) is presented in six chapters: (1) introduction and objectives, (2) comparable monitoring data and the effectiveness evaluation, (3) atmospheric mercury monitoring, (4) biota mercury monitoring, (5) human biomonitoring and (6) cross-media data management, monitoring and analysis. It also has an executive summary, a list of references to the cited publications and an annex containing an overview of a tiered approach to monitoring mercury in the environment and humans. A supplement to the main guidance document, entitled "Supplementary material – guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention" (UNEP/MC/COP.4/INF/25), has two parts: part A, containing an overview of existing monitoring programmes organized by matrix (air, biota and human biomonitoring), an overview of existing gaps and a non-exhaustive list of standard operating procedures; and part B, which contains an overview of quality assurance and quality control procedures in laboratory analysis and data management and a draft template for the submission of monitoring data.

11. In addition to the above, the secretariat is developing separate guidance on monitoring of mercury in and around artisanal and small-scale gold mining sites.

[1] The documents and submissions mentioned in the present note are available online at https://www.mercuryconvention.org/en/meetings/cop4#sec971.

[2] At the time of drafting of the present note, 37 experts had been identified by 16 parties and 42 by organizations to contribute to the development of the guidance.

Annex I

Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention: executive summary

1. In paragraph 2 of article 22, on effectiveness evaluation, the Minamata Convention on Mercury requires the Conference of the Parties to make "arrangements for providing itself with comparable monitoring data on the presence and movement of mercury and mercury compounds in the environment as well as trends in levels of mercury and mercury compounds observed in biotic media and vulnerable populations".

2. The "Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention"[1] (hereinafter the "monitoring guidance") provides scientific and technical guidance to support the Conference of the Parties in obtaining comparable monitoring data for the effectiveness evaluation. The overall aim of the monitoring guidance is to (i) explain the role of monitoring in the effectiveness evaluation and set realistic expectations about what can be learned over time; (ii) provide guidance to parties and organizations that are currently conducting monitoring programmes on what data and accompanying information would inform the effectiveness evaluation; and (iii) provide guidance to parties and organizations who wish to develop new monitoring programmes or improve existing ones, with a view to contributing to the effectiveness evaluation.

3. The monitoring guidance is designed around the following four overarching policy questions:[2]

(a) Have the parties taken actions to implement the Minamata Convention?

(b) Have the actions taken resulted in changes in mercury supply, use, emissions and releases into the environment?

(c) Have those changes resulted in changes in levels of mercury in the environment, biotic media and vulnerable populations that can be attributed to the Minamata Convention?

(d) To what extent are existing measures under the Minamata Convention meeting the objective of protecting human health and the environment from mercury?

4. The monitoring guidance describes the scientific and technical processes and guiding principles for compiling and/or generating comparable monitoring data. It also suggests methods that can be used for understanding the presence, movements and trends of mercury in the environment and humans based on monitoring data, in order to inform the effectiveness evaluation. Throughout the guidance, monitoring activities have been grouped to achieve six objectives:

(a) Estimation of mercury concentrations for areas without (i.e., background sites) or with (i.e., affected sites) local anthropogenic sources;

(b) Identification of temporal trends;

(c) Characterization of spatial patterns;

(d) Estimation of source attribution of anthropogenic mercury;

(e) Estimation of exposure and adverse impacts;

(f) Quantification of key environmental processes to improve understanding of cause-effect relationships.

5. For each of these six monitoring objectives, questions have been formulated to guide the collection and analysis of the relevant monitoring data and to inform the effectiveness evaluation in complementary ways. These guiding questions are set out in chapter 2 of the monitoring guidance.[3] Answers to the guiding questions provide several lines of evidence with different strengths and challenges. Together, they form a range of scientific weight of evidence that can give evidence-based support to the effectiveness evaluation.

[1] Document UNEP/MC/COP.4/INF/12.

[2] Document UNEP/MC/COP.3/14.

[3] For ease of reference, the guiding questions in table 2.1 of the guidance are reproduced in annex II to the present note.

6. To strengthen the scientific evidence for the effectiveness evaluation, comparable and high-quality monitoring data should be used. The quality assurance and quality control (QA/QC) protocols employed by existing monitoring programmes will provide a basis to inform the development of comparable data of high quality. Data generated from different monitoring programmes may be supplemented, as appropriate, with comparable and high-quality data from academia and research. This may be accomplished through a well-documented and transparent set of "data flags" that will enable the use of data from different sources with different levels of QA/QC.

7. Air, biota and humans were identified as key matrices for monitoring trends in the movement of mercury from its sources to the environment and into human populations. A tiered approach to monitor trends in these different matrices is presented in the monitoring guidance, with a view to supporting parties and organizations who wish to develop new monitoring programmes or improve existing ones.

8. The tiered approach for the three matrices can differ in terms of which monitoring objectives are primarily being targeted; however, for the most part, tier 1 aims to provide evidence to support the achievement of objectives 1, 2 and partially 5; tier 2 aims to provide information that supports objectives 3, 4, and 5; and tier 3 aims to support objective 6, which in turn will improve the scientific strength of the data for the achievement of the other five objectives. Each tier builds upon the former tier to provide a better overall weight of evidence. Overall, the tiered approach is as follows:

(a) **Tier 1** is intended to provide guidance on baseline mercury monitoring under a limited set of parameters for circumstances where available resources are limited. The methods in tier 1 are cost-effective, practical, feasible and sustainable.[4] The tier 1 methods are intended to provide information that is useful in identifying and characterizing gaps and needs of national, regional or local interest and to provide information that is useful to the collective effort for the effectiveness evaluation. While the implementation of tier 1 actions may not fully address the monitoring objectives, it will contribute valuable information and create a foundation for tier 2 monitoring.

(b) **Tier 2** is intended to build upon tier 1 methods and create a basis for assessing source attribution at the local, national and global scales. The methods and approaches in this tier may be more expensive or complex than those under tier 1. Although implementation of tier 2 is not required by all parties, the more tier 2 approaches that are implemented, the better the weight of evidence for the effectiveness evaluation will be.

(c) **Tier 3** identifies research methods and approaches that may play a vital role in supporting the tier 1 and tier 2 programmes and the effectiveness evaluation, primarily by improving understanding of key processes that link sources to environmental concentrations and exposures (objective 6). Tier 3 focuses on processes; thus, the results would likely yield insights that are broadly applicable and strengthen the weight of scientific evidence used to support the other monitoring objectives. Tier 3 information should therefore be taken into consideration in the effectiveness evaluation where available.

9. The tiered recommendations are further elaborated for each of the key matrices in chapters 3 (air), 4 (biota) and 5 (humans). While the overall tier principles are similar in each of the matrices, there are some differences in the recommended approaches. For example, in the approaches to monitor mercury in air, the primary differences between the tiers are the methods employed to collect data. In the biota chapter, the main differences between the tiers reflect how sites are selected and sampled, as well as what ancillary measurements are collected. In the human biomonitoring chapter, the three tiers are primarily differentiated by the target human population and how they are sampled. The annex to the monitoring guidance presents a tabular summary of the recommended data to be collected under each tier, for each of the three matrices. Chapter 6 discusses how single- and cross-matrix analyses of the observations can be performed using various mechanistic and statistical models to support the monitoring objectives and inform the effectiveness evaluation.

A. Atmospheric mercury monitoring

10. Mercury levels in the atmosphere are linked to mercury emissions from natural, geogenic and anthropogenic sources. Key anthropogenic sources of atmospheric mercury influenced by the Convention include the point sources listed in annex D to the Convention and the intentional use of mercury in artisanal and small-scale gold mining (ASGM) and other industrial products and processes. In the context of the effectiveness evaluation, it will be relevant to estimate how significant the contribution of sources influenced by the Convention are compared to total anthropogenic emissions,

[4] In decision MC-1/9, the Conference of the Parties noted that the monitoring arrangements should take into consideration cost-effectiveness, practicality, feasibility and sustainability.

as well as legacy and natural emission, and how these emissions travel and impact the receiving environment. Many of the Convention measures to control mercury supply, use, emissions, releases, storage and disposal are expected to reduce levels of mercury in the atmosphere.

11. Chapter 3 identifies different methods parties and organizations can use to monitor atmospheric mercury and generate comparable data to support the effectiveness evaluation. Atmospheric mercury has been successfully monitored for decades but not all regions have been covered equally, with the biggest data gaps occurring in the southern hemisphere. The suggested tiers for air monitoring gives parties and organizations an opportunity to start, expand or improve their monitoring programmes in a manner such that comparable data can be generated to support the effectiveness evaluation.

12. Air monitoring is well established in many areas. The guidance offers the opportunity of joining or employing one of the several existing monitoring programmes or networks to draw from the experience and information that these established networks can provide. Automated atmospheric mercury data collection is the predominant method within existing monitoring networks; however, passive and manual sampling of atmospheric mercury are two other options also presented for consideration. The advantages and disadvantages of employing each method are presented in chapter 3.

13. Depending on the specific needs of the monitoring initiative, the monitoring guidance puts forward different methods at tier 1 as the minimum step to start generating comparable atmospheric mercury data of high quality. The objective of tier 1 air monitoring is to provide comparable data to identify temporal trends and characterize spatial patterns to gain an understanding of the changes in the distribution of mercury over time around the world. Wet deposition of mercury from the atmosphere, one of the methods included at the tier 1 level, is a well-understood method that provides comparable results helpful for understanding part of the atmospheric deposition of mercury to a receiving environment. Therefore, the tier 1 recommendations offer scientifically sound and cost-effective means of acquiring comparable and high-quality data on mercury concentrations in air.

14. It is important for each monitoring initiative to identify sites that can provide insights into the guiding questions. Thus, recommendations are provided on where to monitoring mercury in the air in order to best observe changes from emissions, inform atmospheric model capabilities and fill data gaps. A variety of site locations should be considered, including background/remote, rural, urban and contaminated/industrial sites. Each site type addresses a different monitoring requirement and should be carefully chosen to focus on the appropriate question. To the extent possible, the air monitoring sites should be coordinated with sites (or vulnerable populations) in which mercury is monitored in biota or humans.

15. A wealth of experience on key elements and processes related to good QA/QC of the data is available from existing atmospheric mercury monitoring programmes and networks. Details on how best to implement good QA/QC programmes are identified both in the main guidance document and the supplementary material.[5]

16. Overall, the elements put forward in chapter 3 will help answer the different monitoring guiding questions for the effectiveness evaluation with regard to atmospheric mercury monitoring. Furthermore, chapter 3 provides parties and relevant organizations with the means of starting, improving or expanding on their initiatives for monitoring atmospheric mercury to enable them to deliver comparable data for the effectiveness evaluation.

B. Biota mercury monitoring

17. The approach to monitoring mercury in biota in support of the effectiveness evaluation takes into account: (a) the monitoring objectives described above and the guiding questions identified in chapter 2; (b) the current scientific understanding of mercury's biogeochemical cycle, including its transport, transformation and bioaccumulation, as well as atmospheric deposition, local pressures and large -scale drivers that affect these processes; and (c) the tiered approach presented to expand and develop monitoring programmes with available resources.

18. Mercury transport, transformation and bioaccumulation in the marine and continental environment is known to be influenced by a number of competing processes that ultimately determine how much mercury is found in a given biotic sample. The biomagnification and bioaccumulation of mercury in the food chain will depend on both the bioavailability of methylmercury and the food-web dynamics. While many of these processes are known, their relative strength and complexity is site- and

[5] The "Supplementary material – Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention" is available as document UNEP/MC/COP.4/INF/25.

location-dependent. This complexity makes site classification according to land use, habitat and ecosystem characteristics critical in data collection. When assessing biotic results, external pressures such as atmospheric deposition, industrial/agricultural or ASGM activity and large-scale drivers (for example, climate change) that can influence the system should be taken into account. Choice of bioindicators and related types of tissue are also critical decision points, as biotic methylmercury concentrations can vary significantly by trophic level and are often impacted by life history and ecological factors. Thus, the recommended tiers in the biota chapter reflect these and other considerations in its design. The necessary elements of monitoring mercury in biota have been arranged into tiers to include the selection of monitoring sites, bioindicators, tissue type and ancillary measurements.

19. For tier 1, it is recommended that the chosen sites represent a mixture of (a) remote sites, with little local anthropogenic input that will be representative of background conditions and (b) sites with well-known anthropogenic impacts. As several routinely used methods for analysing mercury concentrations in biota exist, it is important to consistently use the same method over time in the chosen sites and to sample the sites annually to inform robust trend analysis. Sites that are governed by well-known biogeochemical processes and co-located with monitoring efforts in air or human biomonitoring should be prioritized. All these sites should be classified according to their land-use, habitat and ecosystem characteristics. Trophic level 4 species are recommended because this trophic level is the most commonly measured and used as food by humans; choosing bioindicators at this trophic level is particularly suitable for ensuring consistency with ongoing monitoring efforts and for estimating exposure and adverse effects in humans. Ancillary measurements should be taken based on known (or suspected) co-variates of interest to normalize mercury concentrations for trend analysis. Where little or no prior information exists, experience with the use of geographic information system (GIS) maps gained during the Minamata Initial Assessments might also be helpful in choosing sites.

20. The tier-2-level recommendations include the addition of more locations that represent different site characteristics than those chosen at the tier 1 level and/or that are particularly suited to understanding the impact of a specific input, pressure or driver. Where beneficial, measurements can be collected at the additional locations on a rotational basis, resulting in every site being monitored every few years. It is recommended that, during the rotation, the same species be sampled in all sites. If that is not possible, sampling all the species used in the programme at least at some sites is recommended, to establish statistical relationships between the expected mercury levels. The tier 2 recommendations are aimed at the collection of additional ancillary measurements known to impact the inputs, pressures and drivers of interest at all sites. For example, carbon (^{13}C) and nitrogen (^{15}N) stable isotope measurements help assess changes in the food-web or organic matter sources. Further, water chemistry parameters such as dissolved organic matter and carbon, suspended solids, pH, dissolved oxygen and salinity can, in turn, give an indication of the impact from local pressures and large-scale drivers. Mercury measurements in the underlying sediments can be useful for tracking changes in a local inputs or pressures. These ancillary measurements, together with the site classification system introduced in tier 1, will also help to establish how widely the biogeochemical processes governing a particular site can be generalized with models. More details on the recommended ancillary measurements can be found in the annexed tiered approach table in the guidance document (UNEP/MC/COP.4/INF/12).

21. Tier 3 recommendations build on tiers 1 and 2. Site selection and bioindicator sampling are the same, but lower trophic-level species are suggested to be added to the data collection. Tier 3 recommendations also include the introduction of “supersites”, where a specific catchment or area of specific interest is monitored intensively, and “satellite sites” (sites with supporting data) in the vicinity of the supersite, by which the representativeness of the observed biogeochemical relationships can be established. Additional ancillary measurements, particularly of stable mercury isotopes, are also recommended to establish cause-effect relationships between mercury levels in biota and the inputs, pressures and drivers that influence them. All the elements in this tier will therefore help to quantify the key environmental processes that govern mercury levels in biota and strengthen the weight of evidence that biota monitoring adds to the effectiveness evaluation.

C. Human biomonitoring

22. Human health may be negatively impacted by mercury exposure. Human populations may be exposed to elemental and inorganic mercury in occupational settings (for example, in ASGM and dentistry), from contact with certain products (for example, dental amalgams, some skin-lightening creams, broken fluorescent bulbs and other waste products) and from environmental contamination and dietary sources, including but not limited to shellfish, fish and marine mammals contaminated with methylmercury. Measuring mercury levels in the blood, hair and/or urine of individuals from

target populations provides direct information on human exposures to mercury, from which risks to human health can be assessed.

23. Article 22 of the Convention requires the Conference of the Parties to establish arrangements to provide monitoring data on the trend in mercury levels in vulnerable human populations. This human biomonitoring data will help address the six monitoring objectives and support the effectiveness evaluation. Chapter 5 provides essential guidance and links to key resources, for parties and relevant organizations to consider in terms of using existing, and generating new, human biomonitoring data for the effectiveness evaluation.

24. There are several databases of human biomonitoring information and resources that can be used to help understand human exposures to mercury before the Minamata Convention's entry into force. This information helps to establish a baseline for the effectiveness evaluation. In terms of data to be collected in the future, there are two sources to consider. First, there is the biomonitoring data generated by existing government-led national biomonitoring programmes, regional initiatives and/or academic-led studies. Second, parties and relevant organizations can further support the effectiveness evaluation by implementing new biomonitoring studies in a harmonized way so that they are purposefully designed to fill data gaps and build capacity.

25. Human biomonitoring data can be designed as part of a tiered approach to inform new monitoring programmes or improve existing ones. The recommended activities in tier 1 are geared towards initiatives seeking to create a human biomonitoring programme or expand a minimal programme with modest resources. The goal of tier 1 is to focus on a vulnerable subpopulation and take total mercury measurements in blood, urine or hair. This activity should ideally be repeated in the same population every 2 to 5 years. A good starting point for tier 1 is the recent guidance from the World Health Organization for characterizing prenatal mercury exposure.[6] The tier 2 recommendations are aimed at the collection of data to inform all monitoring objectives and call for more in-depth analysis of the tier 1 subpopulation groups or incorporation of mercury biomonitoring into other, in-depth health surveys or cohort studies. Tier 3 aims to increase understanding of key processes that link mercury sources to human exposures, and thus resource-intensive research methods and approaches are required. These include national human biomonitoring programmes and surveys for comparison to vulnerable subpopulations, and coordination of human biomonitoring activities with air and biota monitoring where relevant.

26. Key elements of all human biomonitoring studies that need to be considered include: (a) defining the target and sample population (which usually focus on groups vulnerable to mercury, i.e., those in early life stages or those with relatively high exposures); (b) selecting and measuring the appropriate biomarkers to help define exposure to different sources and forms of mercury (with total mercury measurements in hair, urine, blood and cord blood being most commonly used and accepted); (c) administering surveys to gather supportive information (e.g., on sociodemographics, occupational practices, dietary habits) to deepen understanding and assist in interpretation; and (d) managing and analysing data as per the guiding policy question. All these elements must be performed in a responsible and ethical manner.

D. Cross-media data management, modelling and analysis

27. From primary release to human exposure, mercury can undergo many physical and (bio-)chemical changes that interact with each other over a large range of timescales and can be influenced by human behaviour. Attribution of observed trends to specific drivers such as direct anthropogenic mercury releases, legacy mercury, process-driven releases of natural or anthropogenic influence and non-mercury environmental or behavioural drivers requires the use of models that resolve the intervening processes, supplemented or calibrated by empirical statistical approaches. Separating the relative magnitude of the inputs, pressures and drivers influenced by the Convention from those that are not will be key to assessing the effectiveness of already implemented policies. This makes cross-media analysis involving both mechanistic and statistical modelling in all relevant media a vital part of the scientific weight of evidence used to evaluate the effectiveness of the Convention.

28. By analysing monitoring data, temporal and spatial trends in the levels of mercury in specific environmental media or human matrices can be derived. These trends provide a first-level indication of whether the Convention may be contributing to protecting human health and the environment from the adverse effects of mercury by assessing whether levels in the environment and humans are changing. Analyses of the monitoring data collected in each matrix separately will be informative, but this monitoring data can also be used in an integrated manner, where multiple complementary analysis

[6] https://apps.who.int/iris/handle/10665/334181.

approaches are combined to answer the same question. This will improve robustness and increase the scientific weight of evidence. As more comparable and high-quality monitoring data becomes available and our understanding of the intervening processes improves, more detailed questions can be answered with a higher level of confidence.

29. To estimate levels of mercury in locations with or without known anthropogenic mercury sources, simple analyses can be conducted on monitoring data at sites chosen for this purpose. These observations, together with suitable models, can be used to conduct trend analysis that gives a transparent presentation of the confidence with which a trend has been detected, as well as its magnitude.

30. To characterize spatial patterns, several atmospheric chemical transport models can be used, supplemented with statistical models where beneficial to quantify the representativeness of the observed levels and trends in air and to extrapolate ambient air concentrations and wet deposition to areas with sparse monitoring data. Spatially resolved models in air and other media can be used to interpolate levels and trends of mercury while accounting for the drivers of spatial and temporal differences.

31. Two types of analyses can be employed when using models to estimate source attribution and exposure for the effectiveness evaluation: a “bottom-up” or process-based analysis that estimates effects of drivers on observable quantities, and a “top-down” or observation-based analysis that identifies drivers. Bottom-up analyses can be used whenever suitable input parameters and a sufficient process-level understanding of the relevant system exists. Top-down analyses can be used whenever sufficient ancillary data and/or measurements are available (or suitable surveys, in case of human biomonitoring). These two approaches can be used separately, but the strongest weight of evidence is obtained when they are used together in a complementary manner. At intensively monitored sites, combined top-down and bottom-up analyses can be performed for air, biota and human biomarkers.

32. Finally, the quantification of key environmental processes can improve our understanding of cause-effect relationships, which in turn will improve the confidence with which models can be used to answer the guiding questions. An increased understanding of mercury processes can be obtained through the comparable and high-quality monitoring data compiled for the effectiveness evaluation, as well as through other experimental, monitoring, computational and modelling studies made available for the evaluation. The strength of the scientific weight of evidence available for the effectiveness evaluation will therefore improve in an iterative manner from one evaluation cycle to the next.

33. To improve transparency, understanding and legitimacy of the models used for the effectiveness evaluation, models can be evaluated and inter-compared to give a clear understanding of the confidence of their outputs with respect to the question(s) being asked. Key assumptions, parameters and functions, and the consequences of these choices, can be presented to all stakeholders. Participatory processes can also be used for model selection and/or construction to improve ownership of the results among policymakers.

34. In addition to the main document, the monitoring guidance offers supplementary material[7] organized in two parts: part A, which contains an overview of existing monitoring programmes organized by matrix (air, biota and human biomonitoring), an overview of existing gaps and a non-exhaustive list of standard operating procedures; and part B, which contains an overview of quality assurance and quality control procedures in laboratory analysis and data management and a draft template for the submission of monitoring data.

[7] Document UNEP/MC/COP.4//INF/26.

Annex II

Guiding questions excerpted from the guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention[1]

Monitoring objectives and associated guiding questions

1. Estimation of mercury concentrations for areas without (i.e., background sites) or with (i.e., affected sites) local anthropogenic sources

(a) What are the levels and form of mercury found in sites that are considered to be remote from anthropogenic sources?

(b) What are the levels and form of mercury found in sites that are expected to be affected by local anthropogenic point sources?

2. Identification of temporal trends

(a) Do the levels and form of mercury in the observed matrix (air, biota, human) at a given location change over time – for example, in the short term (< 5 years), medium term (5 to 20 years) and long term (> 20 years)? Is there a long-term trend or trajectory (a signal) that can be separated from the temporal variability (noise)?

(b) How do observed temporal variations and trends differ spatially, and how do they differ among matrices?

(c) How do observed temporal variations and trends in mercury compare to, or co-vary with, variations and trends of:

(i) Mercury in different forms (chemical species) or within other matrices?

(ii) Mercury emissions and releases?

(iii) Related pollutants/emissions or environmental variables?

3. Characterization of spatial patterns

(a) What are the levels and form of mercury in the observed matrix (air, biota, human) at a given location and time?

(b) Taken together, what does the available data suggest about:

(i) Spatial variability in environmental mercury concentrations?

(ii) Variability in mercury concentrations within and among human populations, wildlife populations and their habitats, and ecosystems?

(c) Do the observed spatial variations and patterns differ among:

(i) Forms (chemical species) of mercury?

(ii) Air, biota and human matrices?

(d) How do the observed spatial variations and patterns or gradients compare to those of:

(i) Mercury emissions and releases?

(ii) Related pollutants/emissions or environmental variables?

4. Estimation of source attribution of anthropogenic mercury

(a) Using models and statistical analyses consistent with observational data, how can the observed levels, spatial patterns, temporal trends and adverse impacts on species, ecosystem services, biodiversity and human populations be attributed to changes:

(i) In anthropogenic, natural and legacy mercury?

(ii) In anthropogenic sources (local, regional, global) of mercury?

[1] Shown as of 15 July 2021. A slightly revised version of the guiding questions will be available in document UNEP/MC/COP.4/INF/12.

(iii) Influenced by the Convention?

(iv) Not influenced by the Convention?

5. Estimation of exposure and adverse impacts

(a) How do the observed levels of mercury in air, biota and humans compare to established national and international benchmark levels associated with adverse effects on human health, wildlife and environmental sustainability?

(b) How significant are the observed changes in exposures for different types of impacts on humans and wildlife in regions that are remote from sources, as well as those that are locally impacted by anthropogenic sources?

(c) Are observed changes in exposure attributable to mitigation measures or changes influenced by the Convention?

6. Quantification of key environmental processes to improve understanding of cause-effect relationships

(a) How ancillary measurements contribute to establishing the level, spatial pattern or temporal trends of mercury and improve understanding about the relative importance of environmental processes and parameters driving transport and fate?

(b) How consistent are the observed levels, temporal trends and spatial patterns with the modelled estimates and what lessons can be learned from them to improve the existing models?