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Matters related to the establishment of arrangements in regard to effectiveness evaluation as referred to in paragraph 2 of article 22

Report by UN Environment, the World Health Organization and Italian National Research Council – Institute of Atmospheric Pollution Research regarding the activities of the Global Environment Facility Project: Development of a Plan for Global Monitoring of Human Exposure to and Environmental Concentrations of Mercury

Note by the Secretariat

As referred to in the note by the Secretariat on Mercury (UNEP/MC/COP.1/INF/15), the annex I to the present note contains a report by UN Environment, in close cooperation with the World Health Organization (WHO), and the Italian National Research Council - Institute of Atmospheric Pollution Research (CNR-IIA) regarding the activities and preliminary results of the UNEP/GEF project “Development of a Plan for Global Monitoring of Human Exposure to and Environmental Concentrations of Mercury”, including an overview of issues that need considered by the conference of the Parties, and highlight and conclusions.

* UNEP/MC/COP.1/1.

Annex I

Report by UN Environment, the World Health Organization and Italian National Research Council - Institute of Atmospheric Pollution Research regarding the activities of the Global Environment Facility Project: Development of a Plan for Global Monitoring of Human Exposure to and Environmental Concentrations of Mercury

Document prepared by:

UN Environment, Economy Division
Chemicals and Health Branch, Science and Knowledge Unit
International Environment House 1
11-13 Chemin des Anémones
CH-1219 Châtelaine, Geneva
Switzerland
Email: science.chemicals@unep.org

World Health Organization (WHO)
European Centre for Environmental and Health
Platz der Vereinten Nationen 1, 53113
Bonn, Germany

Italian National Research Council - Institute of Atmospheric Pollution Research (CNR-IIA)
Via Salaria km 29,300
00016 Monterotondo (RM), Italy

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Acronyms and Abbreviations

ASGM	Artisanal Small-Scale Gold Mining
COP	Conference of the Parties
CNR-IIA	National Research Council of Italy - Institute of Atmospheric Pollution Research
CVAFS	Cold Vapor Atomic Fluorescence Spectrometry
GEF	Global Environment Facility
GEM	Gaseous Elemental Mercury
GEO/GEOSS	Group on Earth Observations/Global Earth Observation System of System
GOM	Gaseous Oxidized Mercury
GMP	Global Monitoring Programme
GMOS	Global Mercury Observation System
GBMS	Global Biotic Mercury Synthesis
GCG	Global Coordinating Group
HBM	Human biomonitoring
Hg	Mercury
PBM	Particle-Bound Mercury
QC/QA	Quality Control/Quality Assurance
RGM	Reactive Gaseous Mercury
RIG	Regional Implementation Groups
POPs	Persistent Organic Pollutants
SC	Stockholm Convention
SOP	Standard Operation Procedure
TGM	Total Gaseous Mercury
TWO	Technical Working Group
UN Environment	United Nations Environment
UNEP	United Nations Environment Programme
UNECE-TF HTAP	United Nations Economic Commission for Europe – Task Force on Hemispheric Transport on Air Pollution
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UTLS	Upper Troposphere/Lower Stratosphere
WHO	World Health Organization

Executive summary

In 2013, the Minamata Convention on Mercury was adopted by governments and recognized mercury as a "chemical of global concern owing to its long-range atmospheric transport, its persistence in the environment once anthropogenically introduced, its ability to bioaccumulate in ecosystems and its significant negative effects on human health and the environment". After reaching the 50^{th} ratification the convention entered into force on 16 August 2017. According to the Article 22, the Conference of the Parties should establish 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 on the basis of available scientific, environmental, technical, financial and economic information.

Although guidelines or protocols have been developed by governmental or academic institutions, the existing approach to mercury monitoring does not provide sufficient and specific guidance to countries in order to establish a monitoring system at a global level. In anticipation of needs for technical assistance, countries will have to fulfil their new obligations for mercury monitoring in vulnerable population and the environment and the harmonization of the existing guidance documents is needed.

UN Environment in close collaboration with WHO and CNR-IIA are executing the Global Environmental Facility (GEF) project entitled "Develop a plan for global monitoring of Human exposure to and environmental concentration of Mercury". The main aims of the projects are to provide elements towards harmonized approaches for mercury monitoring, and to strengthen the capacity for mercury analyses in humans and in the environment. The project contributes to scientific knowledge for development of effectiveness evaluation mechanism as required by Article 22.

Building on the existing experiences in mercury monitoring and analysis of the new research, the project has created the scientific bases for monitoring of mercury in air and in humans at global, regional and local levels. A harmonized approach to mercury monitoring, including standards operation procedures for sampling and analysis of mercury in environmental media (air) and human biological material (human scalp hair, cord blood, and urine), and survey protocols have been developed to enable collecting of reliable and comparable data. The applicability of the proposed techniques has been pilot tested in 10 sampling sites for air pollution monitoring, and in 7 countries for human biomonitoring (HBM) surveys, globally. The pilot surveys were preceded by the training of core staff, as a main component of the national capacity building. The data on baseline concentrations of mercury in the air and in human biological matrices, gathered in the project framework, will be available by the end of 2017. To facilitate building of national and regional analytical capacities, the laboratories' network, which currently includes 188 laboratories globally, is under development. An inter-laboratory assessment to confirm credibility of the participating laboratories is in progress and results will be available by end of 2017.

Furthermore the experience made within the project suggests that there is an urgent need to coordinate the global effort in mercury monitoring and to this end to consider building on regional and global existing monitoring programs in cooperation with other on-going programs such as for example the GEO (Group on Earth Observation, www.earthobservations.org) Strategic Plan (2016-2025) and to its Flagship "Global Observation System for Mercury (GOS^4M)", which is aimed to contribute to the implementation of the Minamata Convention.

The experiences from the project implementation support the feasibility of a global plan of mercury monitoring in the environment and in humans to underpin an assessment of the effectiveness of the Minamata Convention implementation, at the same time pointing out the critical needs for building and strengthening capacities to establish and sustain such a monitoring system.

1. Introduction

Mercury (Hg) has been recognised as a chemical of concern due to its "long-range atmospheric transport, its high persistence, its ability to bio accumulate in ecosystems and its significant negative effects on human health and the environment". Mercury is a persistent and toxic element that, through anthropogenic activities or natural processes, can be mobilized from natural deposits into the biosphere. It can travel long distances within air masses and water currents, undergo methylation into methylmercury (MeHg; CH3Hg+), and biomagnify and bioaccumulate in food chains to levels that can be dangerous to humans. Because of this concern, in 2013, the Minamata convention for Mercury was signed. The primary objective of the convention is to protect human health and the environment from anthropogenic emission and releases of mercury and mercury compounds.

This international treaty stresses the importance of mercury monitoring by asking Parties to develop and improve monitoring tools and methods in its Article 19, called "Research, development and monitoring" (http://www.mercuryconvention.org/) and by expecting an **effectiveness evaluation of the Convention** to be conducted no later than six years after its entry into force and periodically afterwards (Article 22) and in order to facilitate this evaluation the Conference of the Parties at is first meeting should start with the arrangements for providing itself with comparable monitoring data on the presence, trends and movement of mercury and its compounds.

This document refers to the results of the Global Environment Facility project named "Develop a plan for global monitoring of Human exposure to and environmental concentration of Mercury". This project aims to provide elements towards a harmonized approach for mercury monitoring, and to strengthen the capacity for mercury analyses in humans and in the environment.

2. Review of existing information on human exposure to and environmental concentration of mercury

The Global Environment Facility project named "Develop a plan for global monitoring of Human exposure to and environmental concentration of Mercury" targeted to review existing information on human exposure to and environmental concentration of mercury, to draw the elements of a monitoring plan on the presence of mercury in ambient air and the elements of a monitoring plan on human exposure to mercury.

UN Environment's Chemical and Health Branch has prepared the following reports:

- *Global Review of Mercury Monitoring Networks – November 2016*
  This review compiles and synthesizes available information on existing mercury monitoring networks, including (i) air monitoring, (ii) human biomonitoring, and (iii) biota monitoring. It also seeks to highlight gaps in the coverage and scope of the monitoring networks, in particular in terms of geographical distribution and institutional organization (global, regional, national and local studies). The report also aims to provide a basis to consider further coordination and cooperation between the various networks and it seeks to also highlight gaps in the coverage and scope of the monitoring networks, in particular in terms of geographical distribution and institutional organization (global, regional, national and local studies).

- *Worldwide capacity to analyze mercury: an overview – June 2016*
  The document compiles a list of laboratories from all UN regions that have answered an initial survey and have indicated their capacity to identify and quantify mercury species in biotic and abiotic samples.

More information can be found at: http://www.unep.org/chemicalsandwaste/what-we-do/science-and-knowledge/issues-concern/mercury-waste-management-and-monitoring/un

2.1. Global Review of Mercury Monitoring Networks

An overview of the compiled information is presented hereby in Figure 1: *Location of atmospheric mercury monitoring stations from the networks identified in the report*, Figure 2: *Distribution of the regional (international) and national human biomonitoring surveys and studies* and in Figure 3: *Distribution of the regional (international), and national biota monitoring surveys and studies.*

The summary results of the global review of the mercury monitoring networks show that some regions with the highest mercury emissions into the atmosphere (i.e. Asia, Latin America, and Africa) are also those regions where atmospheric monitoring stations are scarce or information on existing monitoring initiatives is not well documented publicly and therefore the information or data is not easily available. There is a particularly global lack of monitoring mercury levels in humans and seafood. However, there are efforts to enhance monitoring networks at global (e.g. Global Mercury Observation System - GMOS), regional and local (e.g. the GBMS database or Consortium to Perform Human Biomonitoring on European Scale - COPHES, DEMO-COPHES) levels.

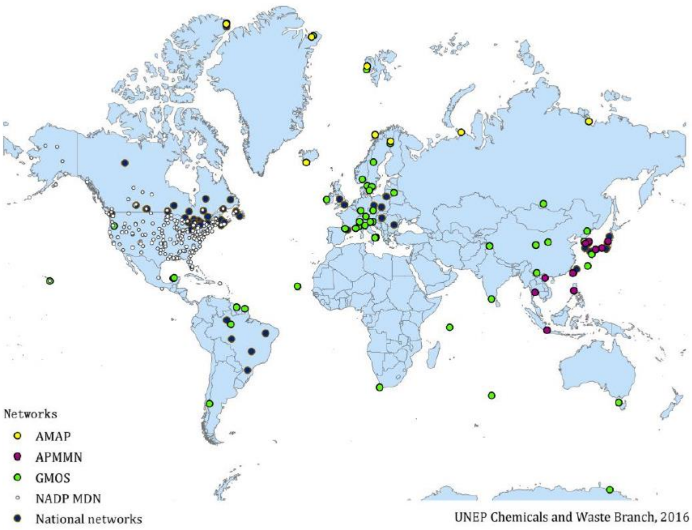

Figure 1. Location of atmospheric mercury monitoring stations from the networks identified in the report

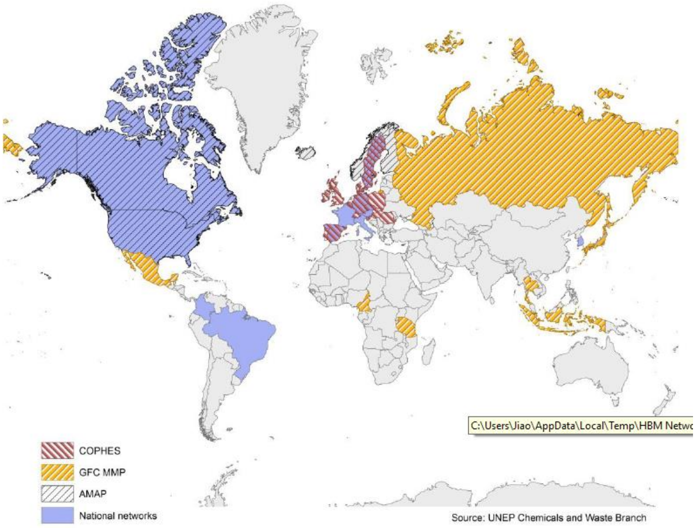

Figure 2. Distribution of the regional (international) and national human biomonitoring surveys and studies

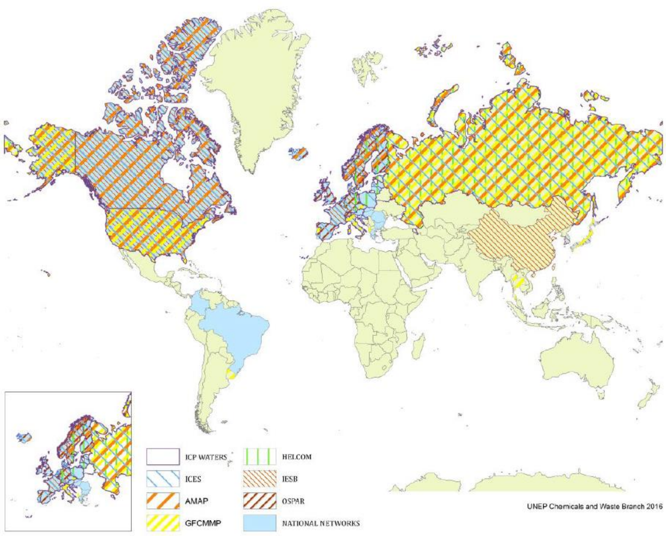

Figure 3. Distribution of the regional (international), and national biota monitoring surveys and studies

The full report is available at: http://www.unep.org/chemicalsandwaste/what-we-do/science-and-knowledge/issues-concern/mercury-waste-management-and-monitoring/un and also at: http://mercuryconvention.org/Negotiations/submissionsforCOP1/tabid/5535/Default.aspx.

2.2. Worldwide capacity to analyse mercury: an overview

The report provides a first overview of the laboratories contributions to a survey undertaken by UN Environment with the objective of developing a Mercury Laboratory Databank. From the 1st of August 2016 to 15th October 2016, invitations to submit information towards developing a Databank was open. Through an online questionnaire, a total of 188 laboratories provided information on their sampling and analytical capacities.

The overview report:

1) Provides information on the number of laboratories and countries that have submitted information through the survey, including their geographical distribution among UN Regions;
2) Describes capacities of these laboratories in terms of status (public, private, research centre), number of staff, and services to external clients;
3) Gives an insight on the sampling capacities of these laboratories and to find out which matrices are mostly sampled or ignored;
4) Shows how experience with mercury analysis is distributed between them, as follows:
    a. Number of years of experience with total mercury and/or methylmercury, analysis in abiotic and/or biotic matrices
    b. The typical sample preparation procedures
    c. Analytical techniques and the relative number of samples analyse per year per matrices, quality control systems, quality assurance programs and accreditation

The whole rapport can be found at: http://www.unep.org/chemicalsandwaste/what-we-do/science-and-risk/issues-concern/mercury-monitoring

2.3 Inter-laboratory Assessment

Through an interlaboratory assessment, laboratories will be invited to participate and analyse the same sample within a limited time frame for previously determined analytes and report the results to the coordinator of the intercalibration assessment. All results will be assessed according to international standards. Laboratories should be capable – at any time – of analysing samples for mercury within a variation to be fixed. The statistical model proposed to be used provide z-scores based on which the performance of each laboratory for each analyte in each matrix can be assessed. Successful analysis results based in a z-score will also be determined.

3. Elements to consider when designing a monitoring plan on presence of mercury in ambient air

3.1. Air as a matrix to consider: Importance and relevance of mercury presence in air

Mercury (Hg) is emitted to the atmosphere mainly as Gaseous Elemental Mercury, Hg0 (g) (GEM), and due to its long atmospheric lifetime (0.5 - 1 year) it is defined as a “global pollutant” and has an impact on ecosystems very distant from the places from where it is emitted.

The atmospheric transport and deposition patterns of mercury emissions depend on various factors including the chemical form of mercury present, stack height, characteristics of the area surrounding the emitting site, topography, and meteorology. Mercury is emitted to the air from various types of sources is transported through the atmosphere and eventually deposits onto land or water bodies. The chemical and physical properties of the different mercury forms determine their behaviour in the environment and the pattern of deposition.

Atmospheric Hg0(g) can be oxidized to form Hg(II) compounds (e.g. HgCl2), which is readily removed from the atmosphere by both wet (precipitation) and dry deposition (settling). A part of the Hg(II) that is deposited may be methylated within ecosystems and it is this form of mercury which can enter the food web and is particularly toxic to living organisms.

Mercury in the air is measured as three operationally defined forms:

- Gaseous Elemental Mercury (GEM)
- Reactive Gaseous or Gaseous Oxidized Mercury (RGM or GOM),

- and Particle-Bound Mercury (PBM).

Where it is not possible to perform speciation analyse, atmospheric mercury is measured as:

- Total Gaseous Mercury (TGM) consisting in the sum of GEM and GOM

The CNR-IIA (www.iia.cnr.it), in cooperation with partners and other research and university institutions around the world has lead a 5 year project "Global Mercury Observation System - GMOS, (www.gmos.eu)" (2010-2015), funded by the European Union's Seventh Programme for research, technological development and demonstration.

GMOS is a worldwide observation system of mercury contamination integrating ground-based monitoring sites, ad-hoc oceanographic cruise campaigns and lower stratospheric and tropospheric observations (Upper Troposphere / Lower Stratosphere UTLS), which can provide concentration data for mercury and its compounds in air and precipitation, as well as in marine ecosystems. The ground-based observational network has been established worldwide by including > 40 sites, with > 10 sites established in the Southern Hemisphere.

Within the GMOS network, stations are classified as Master Stations where GEM, GOM and fine particulate-bound mercury (PBM2.5) as well as mercury in precipitation are continuously measured, and as Secondary Stations where only TGM or GEM, and mercury in precipitation are continuously measured.

All of them are rural or remote stations in order to study the long-range transport of mercury, for understanding mercury dynamics and to analyse trends over long periods.

3.2. Experience gained and available guidance

The CNR-IIA has a big experience gained through the GMOS project, that provides consistent and high-quality mercury measurements worldwide and validate models for policy scenarios analysis.

GMOS has established a strong cooperation with on-going regional programs in the United State (USA), Canada, Japan and China as well as with international programs i.e., UN Environment, UNECE-TF HTAP, GEO/GEOSS. GMOS is involving nowadays more than forty institutions from Europe, North and South America, Asia and Africa.

Major recent GMOS outcomes include:

- Oceanographic campaigns have been carried out to better understand the cycle of mercury species in the ocean and between ocean and the atmosphere;
- Knowledge gaps on the vertical distribution of mercury species in the Upper Troposphere and Lower Stratosphere (UTLS) has been partly filled through aircraft intercontinental and regional aircraft campaigns;
- A Task Force on regional and global scale modelling has been established by involving major modelling groups worldwide, models will be validated for different scenarios of emission reduction strategies.
- A centralized repository archive and advanced web services has been developed (GMOS Spatial Data Infrastructure –SDI) in order to assure a timely and up-to-date sharing of information on mercury in the environment, including humans.
- Harmonization of Monitoring Procedures.

During the planning and implementation stage of GMOS, particular attention was paid to set the protocols governing measurement and sampling techniques and harmonization.

Harmonized Standard Operating Procedures (SOPs) were developed and adopted by the GMOS partners, and common Quality Assurance/Quality Control (QA/QC) protocols designed and implemented at all sites. The SOPs and QA/QC protocols have been based on current SOPs adopted in other regions/networks, on most recent literature as well as on the experience gathered from continuous measurement programs in Europe, United State (USA), and elsewhere.

Within the Global Environmental Facility (GEF) project "Develop a plan for global monitoring of Human exposure to and environmental concentration of Mercury" CNR-IIA has proposed a selection of "Master" and "Secondary" monitoring stations established within the GMOS network, mostly background sites, to undertake passive sampling and analysis of mercury in ambient air in order to strengthen capacity to provide globally comparable data.

The list of the sites of the pilot survey, including also those highly impacted where ambient and biomonitoring measurements are being performed in collaboration with the World Health Organization, and UN Environment. The sites agreed by the three institutions are reported in Figure 4.

For the past 10 years, semi-continuous measurements of atmospheric mercury have been possible using automated analyzers that collect mercury in a gold trap and analyze using cold vapor atomic fluorescence spectrometry (CVAFS). The costs (investment and running costs) associated to the use of automated analyzers are substantial higher compared to passive or diffusive samplers.

Furthermore passive or diffusive samplers are an economical alternative to active analyzers, since they require no electric power (expensive pumps), tend to be simpler (no pump operation or calibration), cheaper to deploy than automated analyzers, and can be deployed in background and remote sites were no electric power is available.

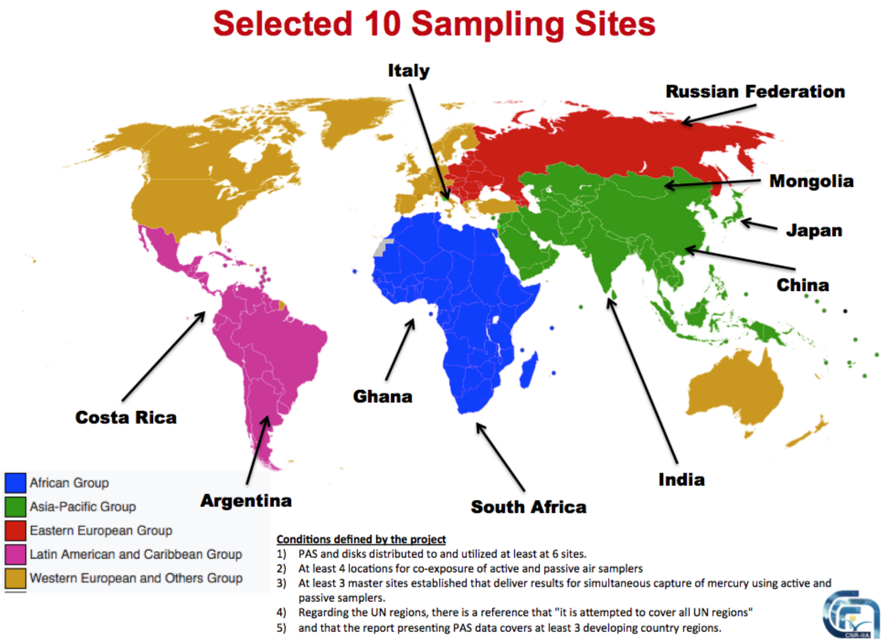

Figure 1. Pilot study of Passive air sampling of mercury showing the selected sampling sites

However, they require longer minimum sampling times (hours to months, depending on the gas of interest) and often have poorer precision. Therefore, the advantage of using an automated analyzer is that provide quasi-real time concentrations of total gaseous mercury in ambient air, on the contrary passive samplers need an exposition time of hours to several days, depending on the average concentrations of mercury in ambient air to be sampled.

The advantage of passive sampler is that does not require electrical power, that in many places can be a limiting factor, due to their very low cost, passive samplers can be placed at many points in a given area allowing a spatial mapping of mercury concentrations (not just in one point as it is with an automated analyzer) and does not require experts for their deployment, analysis can be performed at centralized specialized laboratories where passive samplers can be easily shipped.

Several strategies were planned by CNR-IIA, in the last months, to get novel mercury passive sampling systems based on nanostructured materials and keeping in mind the main features of a passive sampler which relies on the unassisted molecular diffusion of gaseous agents (i.e. volatile gaseous elemental mercury) through a diffusive surface onto an adsorbent scaffolding.

The pilot survey within the GEF project is aimed to perform a global scale validation of the Passive Air Samplers (PAS) for mercury and gather ambient mercury data for exposure assessment along with WHO biomonitoring campaigns.

Samplers were co-located (with active air samplers, only at chosen GMOS sites) and have been exposing with different exposure periods in parallel (both at World Health Organization polluted sites and GMOS remote sites); this would allow us to cross check key QA/QC parameters such as linearity over time, reproducibility and behaviour of samplers at different climate conditions. The gathered data would be representative of seasonal mercury concentration levels at all site.

The pilot survey of the GEF project is still running and will provide its final results at a later stage.

3.3. Existing gaps

Although mercury monitoring networks exist (Europe, Canada, USA and Asia), many regions still have scarce or no data on atmospheric mercury, particularly in the southern hemisphere.

Furthermore, existing gaps are related to a simultaneous and multiple approach to air monitoring concentrations of mercury in its gaseous and particulate forms, as well in wet depositions. A significant effort to overcome this gap involves the coordination of many partners capable of monitoring, assessing, and reporting different aspects of the mercury cycle over time and space, encouraging scientists to both collect mercury data and share information about their work by identifying on the map what they are collecting and the places they are doing it and the meteorological variables. Monitoring stations have to carefully follow standard operational procedures, based on methods developed from GMOS and other Regional programs and on guidance and/or recommendations provided by the GEF project for a global mercury monitoring approach.

An existing gap is related to the need of an improved transfer of knowledge and a capacity-building support for enhancing the competencies of all interested parties in the effective use of Quality Assurance / Quality Controls QA/QC criteria/methods for monitoring mercury (Hg) in ambient air at local level.

4. Element to consider when designing a monitoring plan on human exposure to mercury

Human biomonitoring (HBM) is an effective and reliable tool to assess cumulative exposure to pollutants, such as mercury. HBM data reflect the total body burden resulting from all sources and routes of exposure, and inter-individual variability in exposure levels, metabolism and excretion rates. Besides assessing exposure, in some cases HBM can be used to assess susceptibility or biological effects of exposure to specific pollutants,

Determination of mercury levels in human tissues, such as scalp hair, (venous or cord) blood, urine, nails, and milk is recommended for assessing population exposure to mercury and its compounds. HBM results can be used not only to assess the magnitude and distribution of exposure to mercury in a population, but also to plan and assess the effectiveness of risk prevention measures.

Given the toxicity of mercury and its compounds, environmental and occupational exposure can lead to adverse health effects, affecting mainly nervous system and kidneys. In case of non-occupational exposure in general population, neurotoxic and neurodevelopmental effects of mercury in children at the very early life stages, during prenatal development and in early childhood, are of main concern.

4.1. Importance and relevance of mercury presence in different human matrixes

Identifying appropriate biomarkers is critically important to ensure reliability of assessment of environmental and occupational exposure to mercury. The selection of biological matrices for assessing human exposure depends on the mercury compounds (metallic mercury, organic or inorganic mercury compounds), exposure pattern (chronic or acute) and time of sampling after the exposure. Two main matrices were identified as most relevant for assessment of prenatal exposure to different types of mercury: scalp hair and cord blood. In addition, mercury in urine has been suggested as an indicator of exposure to metallic/inorganic mercury in occupational settings and highly contaminated sites. The relevant Standard Operating Procedures (SOPs) for sampling and analysis of mercury in scalp hair, cord blood and urine have been developed to facilitate the implementation of mercury HBM at national, regional and global level.

The level of mercury in scalp hair is a good marker of long-term exposure to methylmercury. Mercury in maternal hair (close to the scalp) is a proxy of foetal mercury exposure and a predictor of long-term neurotoxic effects in children.

Short-term exposure to organic and inorganic mercury can be evaluated by measurement of mercury concentrations in blood. Mercury in cord blood is a biomarker of prenatal exposure to mercury and provides information on both the exposure of mothers and their children. Mercury in cord blood has a stronger association with neurobehavioral deficits in a child as compared to other matrices.

For assessment of recent exposure to inorganic and elemental mercury, particularly in occupational settings, urine is a preferable matrix. Due to wide variability in of urinary excretion rates among individuals, as well as the temporal variability in urine composition within individuals, the results should be expressed per gram of creatinine or adjusted for the specific gravity.

Meconium, placenta and foetal membranes, fingernails and toenails are less investigated as matrices and more research is needed to allow standardization of mercury analysis in these matrices.

4.2. Experience gained and available guidance

Most people are exposed to low levels of mercury, often through chronic exposure. General populations in many countries are exposed mainly to methylmercury from fish and other products. Complex exposure to mercury is characteristic for populations in hot spots such as former and current Artisanal Small-Scale Gold Mining (ASGM) activities, e-wastes management, chloralkali batteries production, etc. The period of in-utero development is the most vulnerable stage, in terms of long-term adverse neurodevelopmental effects of mercury and characterization of prenatal exposure is critical for evaluating its public health impact as well as for assessing the public health benefits of reducing exposure. The template Survey Protocol has been designed to enable assessment of prenatal exposure to mercury in the general population and in exposure hotspots.

Given the generally low exposure levels, analytical methods to determine mercury in biological matrices need to be sensitive enough and validated. Two methods are recommended: (1) methods based on acid digestion followed by cold vapour atomic absorption technique (CV AAS), cold vapour atomic fluorescence (CV AFS) and/or inductively coupled plasma mass spectrometry (ICP MS) detection; it is suitable for the determination of total mercury in human urine and cord blood and can cover all the ranges normally reported in general population as well as in the high exposure settings; and (2) methods based on thermal decomposition and CV AAS detection principle; it permits reliable and accurate determination of total mercury in blood and hair samples at the typical concentration ranges for environmental and occupational exposure but is not appropriate for determination of total mercury in urine samples. SOPs for mercury analysis in scalp hair, cord blood and urine include detailed description of mercury analysis in bio-matrices.

Recommendations on establishing a Quality Assurance/Quality Control (QA/QC) program at all steps of mercury HBM including mercury analysis to ensure the reliability and comparability of results are prepared. Such programs should cover both the basic QA/QC measures routinely applied in analytical labs as well as external actions to ensure the comparability and quality of the results.

The Pilot surveys in seven countries has contributed to gathering knowledge on level of exposure to mercury in pilot countries but also has allowed to identify the main element for planning of mercury Human Biomonitoring (HBM) at a global and national level.

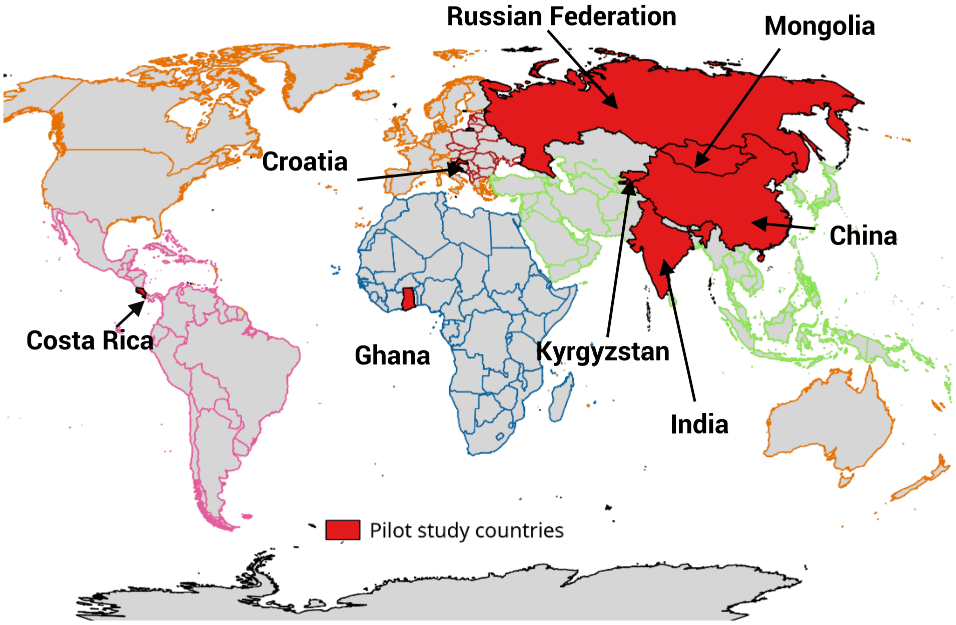

Figure 2. Pilot countries for mercury human biomonitoring (HBM)

4.3. Existing gaps

The WHO Survey Protocol on assessment of prenatal exposure to mercury is adopter to the needs of evaluation of exposure to mercury and its compounds in general population as well as in highly exposed population groups. HBM approach should be choosing (general population or highly exposed groups) to recommend indicator for evaluation of effectiveness of the implementation of the Minamata Convention.

It is envisioned that this survey will be repeated at regular intervals to monitor trends in exposure. Combining data from several data collection rounds would also increase the power of the statistical analysis of exposure determinants. Time period between surveys should be set up based on assessment of existing experience and results of existing national monitoring programs.

A sample size of 250 women can be assumed to be large enough to demonstrate a 27% change in the geometric mean mercury level between a baseline survey and follow-up cross-sectional surveys in the same country, at the conventional level of statistical significance and with 80% study power, as determined in previous studies (e.g. Flanders). In small contaminated areas with a small number of annual births, a survey involving women just delivered a child may require a longer enrolment period or decrease of sampling size. The minimum sampling size providing reliable data on population exposure to mercury needs to be agreed.

5. Overview of issues that need consideration by the Conference of the Parties

The purpose of the Minamata Convention is to protect human health and the environment from negative impact of mercury and its compounds. Decreasing of mercury level in humans is an objective indicator of the effectiveness of protective measures taken in the Convention framework. Mercury concentration in humans evaluated by using harmonized approach can provide this information at global level. Parties to the Convention can consider mercury Human Biomonitoring a scan to provide this data at global level and serve as an indicator for evaluation of effectiveness of the Minamata Convention.

Ambient air is an important matrix because it has a very short response time to changes in atmospheric emissions and is a relatively well-mixed environmental medium. It is also an entry point into food chains and a global transport medium. Mercury ambient air sampling is an instrument for assessing time trends and the regional and global transport of mercury.

The following project outputs can contribute to establishing national, regional and global monitoring programs:

- Global Review of Mercury Monitoring Networks;
- Worldwide capacity to analyse mercury: an overview;
- Standard operation procedures (SOPs) on sampling and analysis of mercury in human scalp hair, cord blood and urine, and in the ambient air using passive air sampling (PAS);
- Recommendations on quality control of mercury human biomonitoring and passive air sampling;
- Template Survey Protocol for assessment of prenatal exposure to mercury using biomarkers in cord blood, maternal urine and hair;
- Template for Human biomonitoring and air sampling results statistical analysis and assessment.
- Sample frequency and timing should be harmonized between matrices as much as possible.

6. Limitations of this report

The report presents information regarding the activities of the GEF project “Development of a Plan for Global Monitoring of Human Exposure to and Environmental Concentrations of Mercury”. Several challenges were encountered in gathering, compiling and analysing this information, resulting in some limitations to the report. Some specific gaps and limitations related with the presence of mercury in ambient air and human biomonitoring are already mentioned in the chapters 3 and 4 and in the specific sections 3.3 and 4.4.

- The project have centered the attention on the monitoring of Mercury concentration on ambient air and human biomonitoring, however other media could be considered as important media toward a Global monitoring plan for mercury, for instance, marine monitoring, food-feed-fish, biota monitoring (biomonitoring) and others.

- The implementation of a Global Monitoring Plan (GMP) toward the establishment of a global network of mercury monitoring on air and human biomonitoring the issue, have not covered the cost of the implementation however it will need to be considered.

Other gaps and limitations are covered in each of the reports and reviews prepared.

7. Highlights and conclusions

To support the effectiveness evaluation of Minamata Convention, UN Environment's Chemicals and Health Branch in close collaboration with WHO and CNR-IIA have initiated and successfully implemented an activity that aims to harmonize approaches for monitoring mercury in humans and environment, and to strengthen the capacity for mercury analysis in humans and the environment to accurately determining mercury concentrations globally. Providing the tools and methods for countries and regions where mercury monitoring programmes are poorly developed or non-existing to develop such programmes in a consistent and cost-effective way, thus promoting comparability of the monitoring data and contributing substantially to the development of a global picture of mercury. For an overall assessment of the effectiveness of the Minamata Convention, it is important to include data form all regions including quantitative and representative data with quality assurance and quality control procedures.

The sustainability of the mercury monitoring networks is an important factor affecting the effectiveness of the monitoring efforts. Data comparability, data reliability and accessibility, and quality assurance are key aspects when determining its relevance for a global effectiveness evaluation scheme. A reliable funding source is a key factor when establishing a monitoring system under the Minamata Convention in order to ensure generation of the relevant information in the long-term. Global and regional initiatives are built on previously established national monitoring network. In other cases, when developing an international or regional network, additional monitoring efforts or sites may be considered based on short-term support to fill gaps. Strengthening or creating the national capacity is therefore highlighted as an essential step towards more unified and successful mercury monitoring efforts globally.

Based on the experience of the GEF project "Development of a Plan for Global Monitoring of Human Exposure to and Environmental Concentrations of Mercury", the need to consider existing regional, national and global initiatives/networks is highly recommended in order to ensure the following key outcomes:

a) A sustainable long-term monitoring program for the Minamata Convention considering needs, expertise and existing capacities
b) Relevant spatial coverage – to the purpose looked for, including e.g. research, evaluation of trends at a particular point in time, assessment of effectiveness of measures taken
c) Comparability among different monitoring data sets, the adoption of common standard operating procedures (SOPs) and Quality assurance/Quality Control (QA/QC) criteria/methods for monitoring Hg and precipitation from different monitoring networks should be pursued.

Furthermore it is important to highlight the need to ensure a long-term capacity-building support and a transfer of technical knowledge to all interested parties, with particular regard to developing countries, aiming to support the full implementation of the Minamata Convention.

Mercury Human Biomonitoring (HBM) and passive air sampling (PAS) of mercury are well-established instruments to assess human exposure to mercury, including exposure of vulnerable population groups and environmental concentrations of mercury.

Harmonized approach and main elements for the development of a global monitoring scheme for assessment of exposure to mercury are developed based on available scientific data. Collection of comparable data – meaning following a similar protocol, and of good quality – as this is necessary for international comparison. Concentration of mercury in human biological matrices Proposed Human Biomonitoring indicators and assessing the air concentrations using passive air sampling can serve as an indicators to monitor geographical and temporal trends and contribute significantly to the assessment of the effectiveness of the Minamata Convention implementation.

Experiences of the pilot survey allowed assessing the need for building capacities for the implementation of mercury Human Biomonitoring (HBM) and passive air sampling networks (PAS) in countries and globally.

The project provided experience and good scientific basis for harmonised collection of data on exposure to mercury and confirms feasibility of using proposed biomarkers for the development of a global plan for mercury Human Biomonitoring (HBM) and the use of passive air sampling as a reliable methodology to assess the background concentrations with a high potential for comparability.