#3, October 2022

Annual Progress Report

for

Project for Promoting Minamata Convention on Mercury by making the most of Japan's Knowledge and Experiences

(Reporting Period: July 2021 – June 2022)

Approved by Regional Director	Dechen Tsering	Date:	21 October 2022
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1 Project Information

Project title	Promoting Minamata Convention on Mercury by making the most of Japan's Knowledge and Experiences
Participating countries	Indonesia, Japan, Malaysia, Maldives, Mongolia, Myanmar[1], Nepal, Palau, Philippines, Sri Lanka, Thailand, and Vietnam
Project outcome	Countries increasingly generate and apply information on how to monitor and reduce mercury emissions and releases in their legislations, policies or action plans.
Executing agency	UNEP Regional Office for Asia and the Pacific
Project period	July 2019 – June 2024 (60 months)
Reporting period	July 2021 – June 2022
Total budget	US$3,000,000 pledged (US$2,999,990 received as of June 2022)

[1] The participation to the project activities has been suspended since February 2021.

2 Summary

Project for 'Promoting Minamata Convention on Mercury by making the most of Japan's knowledge and experiences' has made significant progress in implementing activities under all three (3) Outputs. Capacity building programmes are focused on two (2) key areas, namely 'mercury flow analysis' and 'mercury monitoring'. Training packages on these topics, which provide practical and hand-on information with multimedia files (video) to facilitate local trainings to be organized by the project partner countries, are under development and will be made publicly available. Then, trainers' training programmes will be provided for key individuals who will be the facilitators and/or organizers of the local trainings.

Efforts have been made in this reporting period for strengthening the analytical capacity of mercury for the laboratories in the region. Assessment and assistance are the two main wheels to improve mercury monitoring performance. In principle, Assessment precedes further assistance to individual laboratories. Virtual capacity assessment missions were e-dispatched to the laboratories in Nepal and the Philippines, and another mission is under planning in Vietnam. Also, laboratory proficiency testing (PT) for evaluating the performance of mercury analyses was conducted in collaboration with National Institute for Minamata Disease (NIMD). 34 public laboratories and laboratories in universities that undertake mercury analysis for monitoring, survey or research purposes were participated and 26 of them successfully delivered the results. The second round will start in next reporting period and a call for participation will be disseminated to the laboratories.

Collaboration and joint efforts have been progressed in this period with new and existing stakeholders/partners to increase the project impacts beyond the project partner countries. The Project organized and implemented global webinars in collaboration with Minamata Secretariat and UNEP Global Mercury Partnership (GMP). United Nations Industrial Development Organization (UNIDO), United Nations Institute for Training and Research (UNITAR), and Ministry of the Environment, Japan (MoEJ) also co-organized online trainings with the Project. Asia Pacific Mercury Monitoring Network (APMMN) and the Project participated in each activity as the reciprocal representations.

Compilation and dissemination of project-generated data is another important component of the Project. The Project has established a dedicated website and email address to accumulate and disseminate the Project results and other information for project partners and other stakeholders beyond the region. County-level activities, which have been long delayed due to COVI-19 pandemic, will be resumed, depending on the improvement of the local situation.

In terms of the result framework, the Project has already achieved some output indicators while some other indicators need further assessment. Although it is still premature to assess the outcome level indicators, the mid-term review will be conducted to provide good insights to the expected overall project impacts. The Project has initiated the internal review, which to analyse whether the project is on-track, what problems or challenges the project is encountering, and what corrective actions are required. Along with the mid-term review, annual follow-up of the training results will be conducted to obtain a project output indicator.

Project Management Unit (PMU) completed its recruitment, and all positions has been filled. The project advisory function is also being active, so that the project implementation structure is now fully furnished.

Year 2022 is the transitional period for the Project to new UNEP Medium-term strategy where the Project falls under 'Chemicals and pollution' sub-programme. Under the new sub-programme,

project has explored and extended the collaboration with other institutions, which is mutually beneficial and enhances the impact of the Project.

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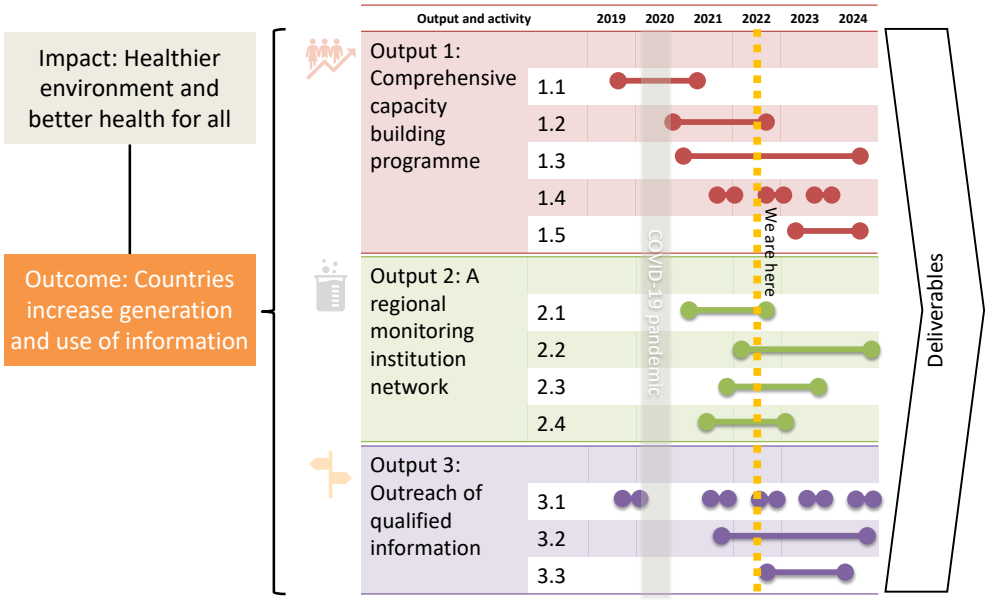
3.1 Overall progress

The Project has entered the latter half of the implementation period. It has made significant progress in implementing the activities under all three (3) Outputs. Particularly, the Output 1 (training component) is advancing faster than the other 2 outputs and some key deliverables are close to completion. The main efforts in this reporting period were in Output 2 (monitoring component) where all 4 activities were implemented. As the Project has gradually accumulated results and data, disseminating the information under Output 3 becomes more important to increase the Project visibility. Key achievements have extracted and delivered them effectively using existing platforms and events.



Overall Project Workplan and Theory of Change

Capacity building programmes are focused on two key areas, namely 'mercury flow analysis' and 'mercury monitoring'. The project is preparing training packages for these two topics, which provide practical and hand-on information with multimedia files (video) to enable their self-study in online setting even under the travel restriction such as COVID-19 pandemic. The draft was prepared and will be published as UNEP publication and publicly available.

Strengthening the analytical capacity of mercury laboratories in the region was the key effort of this reporting period. A virtual capacity assessment mission, an innovative approach developed under COVID-19 setting, was applied for laboratory assessment in Nepal and the Philippines. Another key activity is the laboratory proficiency testing (PT) for evaluating the performance of mercury analyses conducted by the laboratories. Laboratories responded UNEP's call for expression of interest and participated in the PT. A total of 26 laboratories delivered the results to the Project and the assessment report is under preparation.

Compilation and dissemination of project-generated data is another component of the Project. The Project held webinars in October 2021 and June 2022 in collaboration with the Minamata Secretariat and UNEP Global Mercury Partnership. The Project has established a dedicated website

and email address to accumulate and disseminate the project results and other information for project partners and other stakeholders beyond the region.

Year 2022 is the transitional period for the Project to new UNEP Medium-term strategy where the Project falls under 'Chemicals and pollution' sub-programme. Under the new sub-programme, project has explored and extended the collaboration with other institutions such as UNIDO, UNITAR, etc. which is mutually beneficial and enhances the impact of the Project. The Project has initiated the mid-term review, which is undertaken approximately half-way through project implementation, to analyse whether the project is on-track, what problems or challenges the project is encountering, and what corrective actions are required.

In terms of the result framework, the Project has already achieved some output indicators while some other indicators need further assessment. It is still premature to assess the outcome indicators, but the mid-term review will provide good insight to the expected overall project impacts.

3.2 Activity implemented

(Activity 1.2.1) Develop standard training materials for training courses, and (Activity 1.2.2) Develop data books or technical handbooks that compile assessed information for government officers and practitioners.

Progress: 80%

The project is preparing two (2) training packages on 'mercury monitoring' and 'mercury flow analysis'. A training package is composed of multimedia files, i.e., videos, which provide substantive information when organizing a training programme. The video material is prepared using Microsoft PowerPoint with pre-recorded narration embedded in each slide, then grouped by decks in each topic/subject. The 'Users' Manual' provides a sample course with full scope that uses materials in one consistent programme. The PowerPoint slide decks are developed, and the Users' Manuals are drafted.

The project has developed following training packages:

Training package for mercury monitoring to enhance national capacity to generate scientific data that meets international standards

This training package addresses specific skills for laboratory managers and technicians to produce reliable data. It enhances national capacity to generate scientific data from focus of multi-media and from focus of different applications that meets international standards. The material provides not only manual skills to use devices and instruments, but also the principles of quality assurance and quality control to address comparability issues as 'quality' is value of produced data. Practical examples to reduce data bias and uncertainty are also provided.

Training package for mercury flow analysis to identify and monitor national mercury situation in its entire lifecycle

This training package addresses particularly the economic activities such as mercury trade, production, use (sales), manufacturing, etc. in addition to emissions and releases to the environment. It introduces a comprehensive mass flow concept to outline the national mercury situation throughout its life cycle. It supports the improvement of national mercury inventories by compiling various types of information. UNEP has developed Mercury Inventory Toolkit level 1 and

2, which have been used by many countries and stakeholders for developing their emission/release inventories.

Scientists and practitioners of mercury management at national level is the primary target audiences for this material. The training programme can be organized in face-to-face setting, online setting, or hybrid of the two. In each case, the facilitator(s) will run the programme and bring the audiences / participants to certain direction. Advantage and limitation of online and face-to-face programmes setting are described in this material. It will be published as UNEP publication and internal peer-review is ongoing.

(Activity 1.3.1) Formulate and implement skill up training programmes

Progress: 60%

The project held the third online training programme on 'Laboratory management for mercury survey and monitoring' on 7 – 9 December March 2021. (see Annex 5.1) The programme aimed to provide support for enabling efforts of laboratories wishing to participate in the proficiency testing (PT) for their readiness to the proficiency testing, which is a part of continual improvement of quality data collection and analysis. Public laboratories and laboratories in universities that undertake mercury analysis (or will undertake near future) for monitoring, survey or research purposes are invited.

The training programme is composed of 3 sessions (3 hours each including opening, brief note, etc.).

- Session 1: Atmospheric sampling analysis
- Session 2: Multimedia sampling analysis
- Session 3: Advancement to qualified laboratory

The session 1 of the atmospheric sampling analysis is focused on the manual gold trap method recently included in the draft monitoring guidance document if the Minamata Convention. It was co-organized by United Nations Industrial Development Organization (UNIDO) to extending the individual participants beyond Asia and the Pacific region. It was also integrated in the annual workshop of South African Mercury Network (SAMNet) co-organized by Ministry of the Environment, Japan (MOEJ). MoEJ also co-organized the session 2 and 3 as a part of its collaboration with Asia Pacific Mercury Monitoring Network (APMMN) to strengthen the mercury monitoring capacity of the network members.

The training programme was attended by approx. 150 participants, resource persons, etc. The participants came from 33 countries/regions including 10 from project partners, 7 from Asia-Pacific other than project partners, 16 from other regions.

The project also held the fourth online training programme on 'Developing and updating mercury mass flow and inventory' on 19 – 20 January, 8 – 9, 17 February 2022 (see Annex 5.2). The programme aimed to support the improvement of national mercury inventories by compiling various types of information. It also introduces a comprehensive mass flow concept to outline the national mercury situation throughout its life cycle. National Focal Points of the Minamata Convention, ministry/agency responsible for monitoring/management of mercury emissions and releases to air, water and soil, and university, research institute or consulting company which is engaged in development of mercury inventory were invited.

The training programme was composed of 5 sessions (including opening, brief note, etc.) spread over 1 month.

- Session 1: Mercury issues and source categories
- Session 2: Principles and practice
- Session 3: Stepwise discovering of mercury mass flows, Part 1
- Session 4: Stepwise discovering of mercury mass flows, Part 2
- Session 5: Presentations of the initial mass balance setup

The training programme was attended by approx. 100 participants came from 6 countries/regions.

(Activity 1.3.2) Formulate and implement training/visit programmes upon the special requests from network partners

Progress: 30%

The project was requested by Environmental Monitoring Centre (EMC) of Ministry of Environment and Forestry, Indonesia to provide advice for their local lab proficiency testing on mercury. An online workshop for the proficiency testing in Indonesia was held on 5 – 6 April 2022 (See Annex 5.6). The Purpose of this online workshop is to provide hands-on lectures/online training support to the EMC in line with the process of the proficiency testing.

The workshop connected EMC participants who physically attended at EMC meeting room and international experts who joined the workshop virtually. It was composed of 2 sessions over 2 days. It was attended by 23 participants.

(Activity 2.1.1) Capacity assessment of existing monitoring laboratories

Progress: 50%

This work aims at evaluating the current mercury monitoring capacity of the analytical institutions that are monitoring (or will monitor in near future) mercury levels in the country. In this reporting period, laboratories in Nepal and the Philippines were assessed. In Nepal, the Laboratory in Department of Environment, in Ministry of Forests and Environment, and National Public Health Laboratory, in Ministry of Health and Population (see Annex 5.3), in the Philippines, the Environmental Research and Laboratory Services Division- Environmental Laboratory Services Section, Environmental Management Bureau, Department of Environment and Natural Resources of Philippines (ERLSD) were surveyed (see Annex 5.4), respectively.

Under the travel restriction, the assessment survey explored the possibility to obtain necessary data by a series of online hearings to the staff of the analytical institutions. Considering the rapid development of new online tools, surveys without physical travel could be a prospective future methodology, not just an ad hoc measure but more effective and efficient survey technique. But at the same time, such methodology cannot replace the traditional physical survey completely and still has some vulnerability that is beyond the control. Therefore, laboratory assessment needs not to be either actual visits or virtual, and both methods can be used to combine useful parts for assessment.

(Activity 2.2.1) Develop and/or harmonize methodologies and standard operating procedures

Progress: 30%

Comparable monitoring data is essential to enhance mercury management. It is beneficial to harmonize the methodologies in the region to make it comparable regionally. Asia Pacific Mercury

Monitoring Network (APMMN) is an existing platform for mercury monitoring where some of the project partner countries are participating. Currently, wet deposition (rainwater) is the monitoring media systematically collected in APMMN and the expansion of the scope is explored.

Selected APMMN countries and the Project met virtually on 24 February 2022 and discussed the development of a standard operation procedure (SOP) of ambient mercury monitoring for the network. It was agreed that the SOP will be drafted and discussed at APMMN annual workshop. Once it is approved, the Project will promote the use of this SOP for the project partner countries.

(Activity 2.2.2) Undertake continuous data collection and analysis

Progress: 20%

Continuous data collection and analysis is continuing at one dedicated site in Maki, Japan in order to evaluate the feasibility and challenges for introducing ambient mercury monitoring by gold trap method. More sites will be established in harmonization of methodologies, which will ensure the comparability of data collected at different locations.

(Activity 2.3.1) Establish a technical advisory body

Progress: 100%

The Technical Advisory is a pool of individual experts in the region who are individually and/or collaboratively contributing technical inputs to the project or partner countries as needed. The members are selected based on the technical competency relevant to the scope of the project. Five (5) members have been selected based on the technical competency relevant to the scope of the project:

Name	Title	Organization	Expertise
Bhupendra Devkota, Dr	Founder Principal	College of Applied Sciences, Nepal	Ecotoxicology
Koichi Haraguchi, Dr	Senior Researcher	National Institute for Minamata Disease (NIMD)	Analytical chemistry
Yasuhiro Ishibashi, Dr	Professor	Prefectural University of Kumamoto (PUK)	Environmental science
Minoru Koga, Dr	Director General	Minamata Environmental Academia	Analytical chemistry
Osamu Sakamoto, Mr.	Senior Consultant	EX Research Institute Ltd. (EXRI)	International relations

Technical advisors have contributed their expertise to specific activities. Dr Bhupendra Devkota facilitated technical discussions with Nepali government and laboratories to promote mercury management towards ratification of the Minamata Convention. Dr Koichi Haraguchi provided PT design and will assess the competency of the participating laboratories. Dr Yasuhiro Ishibashi advised the mercury survey and research programme for partner countries. Dr Minoru Koga has led the expert team of laboratory assessment missions and advised on the methodology for Minamata survey on co-benefit mercury management. Mr. Osamu Sakamoto has provided technical input on mercury inventory and flow analysis.

When specific expertise is required, supplementary members can be invited based on the specific knowledge to the subjected item.

(Activity 2.3.3) Undertake inter-laboratory data quality assessment for continual improvement

Progress: 40%

This activity aims at evaluating the performance of mercury analyses conducted by the laboratories in the region, which provides individual proficiency levels and collective mercury monitoring capacity in the region. 34 public laboratories and laboratories in universities that undertake mercury analysis (or will undertake near future) for monitoring, survey or research purposes expressed interest and participated in the proficiency testing (PT). It is the first PT in the region.

Sample for PT was shipped to the participating laboratories in February 2022. The return date was initially set on 25 March 2022 and then extended on 8 April 2022. Some laboratories withdrew the participation and finally a total of 26 laboratories sent the results back to the Project.

National Institute for Minamata Disease (NIMD) is currently assessing the results and will prepare the results to send back to the participating laboratories (see Annex 5.5).

(Activity 2.4.1) Collaborative activities with other programmes

Progress: 40%

Asia Pacific Mercury Monitoring Network (APMMN) is a US-led cooperative effort to systematically monitor mercury in air and rainwater throughout the Asia-Pacific Region. The project participated in the APMMN annual workshop to introduce the project outlines and invite APMMN members to laboratory proficiency testing (PT). As the results, many APMMN members enrolled the 1st round of laboratory PT in 2021-2022.

Project also established collaborative work with NIMD for the laboratory PT, where NIMD developed PT design and responsible for the results analysis and report preparation. UNEP provided overall supervision and dissemination of the results. The Project has discussed the second round of laboratory proficiency testing with NIMD and agreed that NIMD calls for the laboratory PT and UNEP provides dissemination of the analytical samples, which is expected in Q1 2023.

(Activity 3.1.2) Convene periodic stakeholders' meetings to share project results

Progress: 40%

The project held an annual webinar to disseminate the project results to the stakeholders and other audiences on 21 and 26 October 2021. It was convened virtually in collaboration with Minamata Secretariat, UNEP Global Mercury Partnership and Ministry of the Environment, Japan. The webinar reported the progress and workplan of the project and then presented four (4) key results.

- Virtual survey for mercury analytical laboratories (Activity 2.1.1),
- Comprehensive training package for mercury inventory including UNEP Toolkit (Activity 1.2.1),
- Laboratory proficiency testing on mercury analysis (Activity 2.3.3),
- Strategic partnership with Minamata City (Activity 3.2).

For better outreach to the other regions, the session is convened twice in different time. (See Annex 5.7)

The Project held another webinar on 'Strengthening mercury research capacity in developing countries for science-based policy making' in collaboration with the Minamata Secretariat under its Minamata Online platform on 30 June 2022. This webinar introduces ongoing activities implemented by the Project to assist scientists, researchers and policy makers towards science-based policy making. Four key topics (4) were results presented.

- Laboratory proficiency testing for mercury – strengthening mercury analytical capacity meeting international standard – (Activity 2.3.3),
- Virtual laboratory assessment methodology – Innovative approach under COVID-19 setting – (Activity 2.1.1),
- Mercury inventory and mass flow analysis – Improving national mercury inventory in Indonesia – (Activity 1.3.1),
- Comprehensive mercury survey for solid waste disposal facilities – Results and challenges – (Activity 3.2).

Minamata Secretariat provided a web platform and called for the participation via its communication channel. The webinar was attended by 80 participants excluding the organizers, secretariat and resource persons from 36 countries globally. Approx. 80% of the participants are working routinely on mercury issues more than 10% and 48% were involved in research planning and experiment. The topic and participants type are thus in good match. Approx. 54% of the participant were female, which is typical case for the Project activities attended by more female.

(Activity 3.2) Accumulate and compile technical data and make it publicly available online

Progress: 20%

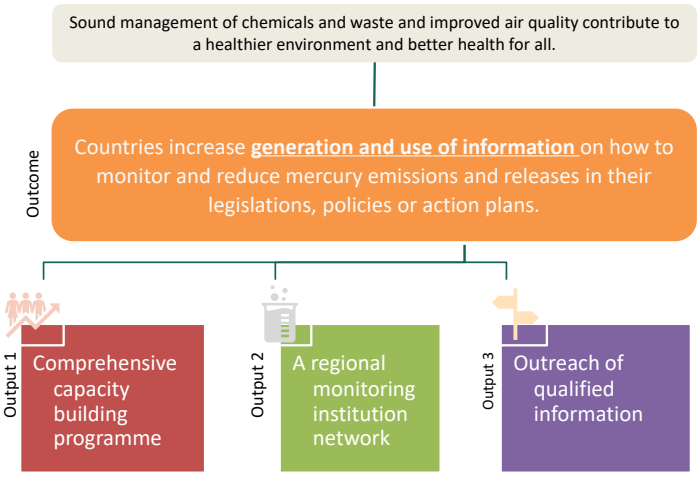
The project established a dedicated website (http://www.rrcap.ait.ac.th/Pages/japanmercuryproject.aspx) and email address (japanmercuryproject@un.org) to disseminate the project results and other information for project partners and other stakeholders beyond the region. At the same time, the project has prepared and uploaded technical and project information that can be downloaded from the website. The information includes, but not limited to, the project brochure, progress reports, technical information, event announcement, etc.

It is recognized that there are some activities and measures on sound mercury management that also bring other environmental benefits, or vice versa. A study on situation of environmental conservation means, which can also serve as the mercury management measures in Minamata area, was conducted to extract the evidence how seriously the city has addressed and culminated the historical lessons towards the one of the leading cities being showcased for others. This study explores the concrete examples of such co-benefits and quantifies these benefits as much as possible. (See Annex 5.8)

3.3 Results achieved

The Project has been operational for 3 years since its inception in July 2019. The Theory of Change (ToC) established in the project implementation plan states that the Project supports the participating countries to increase the generation and the use of information on how to monitor and reduce mercury emission and releases in their legislation, policies, or action plans. It will be

achieved with three interconnected outputs. The project results are evaluated against the established indicators and target values set out in the Result Framework (see 5.6).



Theory of Change in the Project Implementation Plan

(Output 1) Comprehensive capacity building programme based in Minamata developed and implemented.

Output 1 provides comprehensive capacity building programme to strengthen the capacity of participating countries to assess the national situation and develop their own policies on mercury management. Three output indicators are defined.

Indicator 1.1: Number of capacity building programme package for specific subjects developed and implemented.

Baseline: 0, Target: 2, Status: 0

Narrative note: in progress: Content of 2 training packages drafted, peer-review in-progress.

The lecture materials are developed using PowerPoint with pre-recorded narration. Users' Manuals are drafted for organizers and facilitators to formulate and implement their own training programmes. The draft is under review and will be published as UNEP publications.

Indicator 1.2: Local coordination structure in Minamata developed.

Baseline: 0, Target: 1, Status: 2

Narrative note: achieved: Local coordination structure with Minamata City and National Institute for Minamata Disease established.

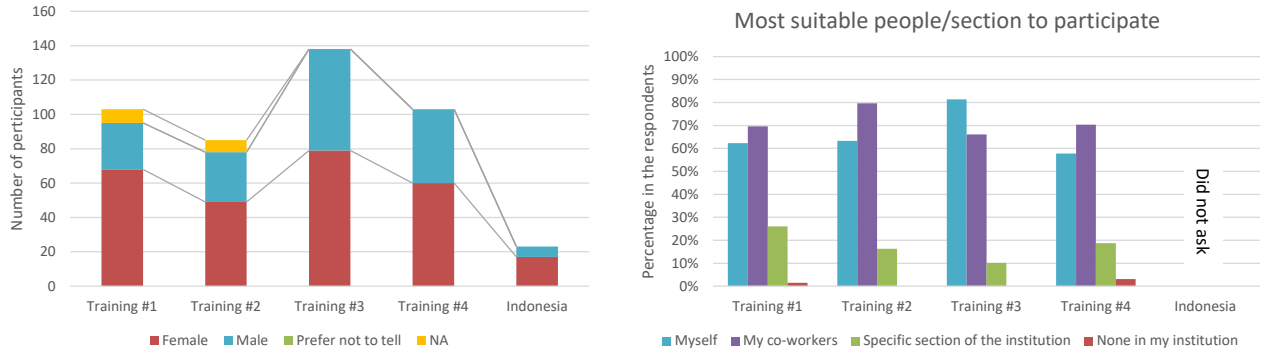
The Project has been benefitted from knowledge and experiences that Japan has accumulated in and around Minamata area. The institutions are engaged to provide technical information as well as learning opportunities of the experiences on Minamata disease.

Indicator 1.3: % of trained participants who successfully apply the knowledge and skills on mercury management in their work disaggregated by gender and age range.

Baseline: 0, Target: 50%, Status: Not available

Narrative note: preliminary: Baseline data collected and compiled. Follow up survey will be conducted in Q3 2022.

The Project has provided trainings on mercury mass flow and monitoring, whose attendances were collected and compiled. A questionnaire will be distributed to the participants and the information relevant to this indicator will be collected.



Number of Participants and Response to the Training Programmes

Overall, the Project has made a good progress on this output. For beneficiary side, project partners have continuously expressed its interest to the Project activities and sent the staff and stakeholders to the training programmes. The Project is now able to know their needs more clearly, and the activities and materials will be more aligned with them. For resource provider side, the institutions in Minamata are actively assisting the Project activities in line with the agreed partnership. Post training follow up will further enhance the effectiveness of the trainings that will improve the indicator values 1.3 mentioned above.

(Output 2) A regional monitoring institution network in Asia and the Pacific established.

Output 2 provides supports to the analytical institutions to generate internationally comparable scientific data. The activities are organized from two angles, i.e., assessment and assistance. The output indicators are set for each of them.

Indicator 2.1: Number of countries with national institutions on the network that meet international standards on mercury analysis.

Baseline: 0, Target: 3, Status: Not available

Narrative note: preliminary: The first laboratory proficiency testing to examine the analytical quality conducted.

The project called public laboratories and laboratories in universities that undertake mercury analysis for monitoring, survey or research purposes to participate in the proficiency testing, which assesses the competency of the laboratories in mercury monitoring. The analytical results have been compiled and statistically analysed, which will be publicly available by September 2022.

Indicator 2.2: Number of existing regional networks establishing partnership with this programme.

Baseline: 0, Target: 2, Status: 1

Narrative note: in progress: Collaboration with Asia Pacific Mercury Monitoring Network is undertaken.

The project is working with APMMN to promote atmospheric mercury monitoring among partner countries. The Project is also communicating with a few other existing programmes to explore the collaborative activities.

Overall, the mercury monitoring and analysis has just started in the region, and the capacity of the laboratories vary significantly. Methodologies introduced by the Project provide objective information to the laboratories and suggest the specific items that each laboratories needs to improve. Participation in existing fora and networks will increase the exposure to new knowledge that will also stimulate the motivation of further capacity development. The Project will connect laboratories in the region and create collaborative relations among them, e.g., more advanced laboratories assist the other laboratories with limited capacity.

(Output 3) Outreach of qualified information in support of early implementation of the Convention implemented.

Output 3 compiles information and made available via internet page managed by the project or one of participating institutions. It also promotes the visibility of the project by enhancing the outreach activities at local, regional, and global levels.

Indicator 3.1: Number of countries submitting information to the information portal

Baseline: 0, Target: 6, Status: 0

Narrative note: preliminary: Project's dedicated website has been established, where national data will be uploaded.

The project has established a dedicated website as a platform to receive and disseminate information from countries and other stakeholders. The information, once submitted, will be uploaded to the website.

Indicator 3.2: Number of countries outside of the project partners that received information through project activities.

Baseline: 0, Target: 30, Status: 35

Narrative note: achieved: Minamata Online session invited participants globally.

The Project collaborated with the Minamata Secretariat to convene a Minamata Online session to disseminate the project results. 35 countries participated in the dissemination events, which are more countries than the dissemination events in 2021 (24 countries).

The outreach target is achieved thanks to virtual platforms which are widely available. The Project should now consider more about the impacts to the participants as more in-person events will be resumed in coming years. Setting up exhibition displays and/or organizing side events in the margin of forthcoming conferences will be a good approach to improve its visibility. Technical information from each country will gradually coming in but it will depend on the internal process of each

country. Discussions continues to encourage the participating countries to generate relevant scientific data.

(Project outcome) Countries increasingly generate and apply information on how to monitor and reduce mercury emissions and releases in their legislations, policies, or action plans

Building on the three (3) outputs, overall goal of the Project is described in the ToC. The Project has set 3 outcome indicators to evaluate the achievement of the intended results.

Indicator 1: Number of countries that embed scientific data collection in their mercury management policies.

Baseline: 0, Target: 6, Status: Not available

Narrative note: preliminary: Participating countries needs firstly to improve the quality of relevant data collection system.

It is still preliminary, but the participating countries are engaged in the project activities to strengthen and improve the skills for mercury-related data collection/compilation. In the fourth online training programme in January – February 2022, 4 participating countries initiated the development and/or improvement of their mercury mass flow analysis.

Indicator 2: Number of Countries that regularly put information on mercury monitoring available via the information portal.

Baseline: 0, Target: 6, Status: 0

Narrative note: in progress: Project collaborating with regional mercury monitoring network to enhance monitoring data collection and sharing.

Atmospheric monitoring is undertaken at one station. More stations will be engaged in collaboration with APMMN. Harmonizing methodologies of mercury monitoring among network partners is under discussion.

Indicator 3: Number of new, adequate policies and legislation in effect on mercury management.

Baseline: 0, Target: 3, Status: Not available

Narrative note: preliminary: A survey to be conducted to collect national information on mercury policies and legislation.

The advancement of mercury policies and legislation in participating countries since the commencement of the Project in 2019 will be collected to evaluate the achievement.

Summary of the outcome and output indicators

The Project passed through the midpoint and entered the latter half of the implementation period. Some output indicators have already achieved, and some others are in good progress. It is still premature to judge the overall project level achievement. The mid-term review will provide good insights to the expected results of the Project and the recommended improvement of the Project result structure.

One concern is the situation of Myanmar that the Project is currently suspending the assistance due to the political situation. As it was one of the most active participating countries to the Project at the inception period, the absence of the results delivered from Myanmar overshadows the achievement of the Project targets, which should also be reconsidered in the mid-term review process.

Outcome	1	Preliminary	2	In progress	3	Preliminary
Output 1	1.1	In progress	2.1	Preliminary	3.1	Preliminary
Output 2	1.2	Achieved	2.2	In progress	3.2	Achieved
Output 3	1.3	Preliminary				

Colour codes	Achieved or good progress towards the achievement	Slow progress or insufficient data to assess the progress	Failed or difficult to be achieved

3.4 Risk management

(Risk log #2) Attention on chemicals and waste decreases.

The establishment of a science-policy panel on chemicals and waste was decided at UNEA 5.2. This will boost the awareness of the chemicals management issues.

(Risk log #5) COVID-19 pandemic situation

Security phase of UN office in Bangkok returned to Phase III (low risk) in June 2022 and some in-person activities has been resumed.

3.5 Lessons learned

(Lessons learned log #4) Enhanced collaboration and joint implementation

The project activities attracted more attention to agencies beyond Asia-Pacific region and collaboration extended to other regions, which increased the impacts of the project. Activity-based joint implementation and collaboration will be explored with organizations/agencies that interest the planned project activities. This approach is mutually beneficial and increase the visibility of the UNEP project.

(Lessons learned log #5) Benefits of different meeting format

Online, in-person, and hybrid modality are applied for various meetings these days. There are pros and cons of these formats, and the Project can examine the nature of the activities and consider the option that suits the purpose.

3.6 Financial status

The total amount of USD2,999,990 has already been transferred to UNEP, which is sufficient for all project activities in the implementation plan.

Preliminary sum of the total expenditures[2] were USD1,199,846, which is approx. 37.3% against total project budget of USD3,000,000 (see Annex 5.12).

Category	Income (USD)		Expenditure (USD)			Delivery Rate (%)
	Planned	Received	Committed	Actual	Total	
Project cost	2,980,198	2,980,188	295,850	804,006	1,099,856	36.9
Exchange loss/gain	-	-	-	124	124	-
UN Levy (1%)	19,802	19,802	0	19,802	19,802	100.0
TOTAL	3,000,000	2,999,990	295,850	823,932	1,119,782	37.3

The delivery was severely affected by the COVID-19 pandemic in 2019-20 period and continued at the Q3 2020, after that the Project activities resumed in Q4 2020 onward. The levels of activities are continuously growing.

Reporting period	2019-20	2020-21	2022-23
Annual expenditure (USD)	69,681	398,054	651,913
Cumulative (USD)	69,681	467,735	1,119,782
Delivery rate (%)	2.3	15.6	37.3

3.7 Management progress and results

Recruitment of PMU staff

Recruitment of Admin Assistant and Programme Assistant to the project has been completed as follows:

Programme Management Assistant (National UNV) took office on 22nd November 2021, who assists in managing the implementation of the project and ensures project monitoring & evaluation is properly conducted according to the workplan.

Admin Assistant (G-5) took office on 1st November 2021, who takes on logistical and financial functions of the project implementation. The position is initially shared with another UNEP project with 50% effort to be dedicated to the Japan Mercury Project.

Transition to UNEP new Medium-term Strategy 2022-25

New UNEP Medium-term strategy sets 'Chemicals and pollution' one of three inter-connected pillars to address triple-planetary crisis. The Project currently implemented under the global project titled 'Generating and sharing knowledge for influencing decision-making on sound management of chemicals and waste' that is linked to the UNEP Programme of Work 2020-2021.

In 2022 onward, new programme is to be developed and the result structure to be re-configured. Year 2022 is the transitional period for the Project to make itself ready to the new programme. The Project remains its operation as was developed initially and expect no major modification.

[2] Certified amount will be finalized by UNON.

Project steering committee

The Project Steering Committee (PSC) is composed of the representatives of UNEP ROAP, Minamata Secretariat, UNEP Chemicals & Health Branch and MOEJ with the ROAP to serve as the chair. PSC held the second and the third dialogue webinar on 16 September 2021 and 8 March 2022, respectively, for providing strategic direction to the project towards expected project outcome. It reviewed project progress and planned activities and confirmed that the project was active towards delivering expected results.

The PSC members provided the insights and advice to the project activities to better align with the programme under the Minamata Convention as well as the UNEP Global Mercury Partnership (GMP). The Project has also extended its collaboration with other institutions such as UNIDO, UNITAR, etc. which is mutually beneficial and enhances the impact of the Project as well.

Communications and visibility

The second segment of Minamata COP4 was convened in hybrid mode where UNEP participation was strictly minimised. The Project was not able to not send its team or expert to the conference venue and no exhibition was prepared. Instead, the Project worked collaboratively with the Minamata Secretariat and implemented a webinar under the Minamata Online organized by the Secretariat.

Monitoring, evaluation, and reporting

The project is continuously monitoring its progress and situations to ensure the targets being achieved in accordance with the approved work plan. The monitoring items are considered based on the reporting frequencies, i.e., quarterly, semi-annually, annually or once in the project lifetime.

On quarterly basis, the project monitors its financial status as an internal control and the Programme Management Officer examined and took appropriate measures to align it in accordance with the approved budget.

A semi-annual report was prepared in January 2022 that summarized the progress and results in July-December 2021. The adopted report was submitted to the PSC for their consideration.

The Project has initiated the mid-term review, which is undertaken approximately half-way through project implementation, to analyse whether the project is on-track, what problems or challenges the project is encountering, and what corrective actions are required. The review will be conducted internally by the Project team in line with the UNEP evaluation policy.

4 Workplan in July 2022 – June 2023

Based on the overall implementation plan approved for entire project period and following the project progress in July 2021 – June 2022, the workplan for July 2022 – June 2023 is presented. (see Annex 5.9)

In this implementation period, the focus is on the stocktaking of the progress to date and adjustment of the project direction, as necessary, towards the completion of the project with satisfactory outcome.

Activities under Output 1

Main efforts of this output are now moved to the follow up of the trainings provided, and further enhancement of the impacts of the training programmes using the materials developed under this output.

Activity 1.2 will complete the publication of 2 training packages (i.e., mercury mass flow and monitoring) for making them publicly available and for using in the other part of the project activities. This deliverable is the key resources for further enhancement of the national mercury management capacity. Thus, trainers' trainings for these training packages are planned for key partners and experts under Activities 1.3. The trainers' trainings will enable the participants to become organizers and/or facilitators for local trainings which will be supported under the Output 3.

Annual follow-up of the training results will be conducted under Activity 1.4, which answers the actual usefulness of the trainings provided by the Project. An online survey will be organized to assess the extent of the impacts of the training programmes to the participants. The finding and lessons will be the important input to the project mid-term review.

Activities under Output 2

Output 2 is now the main component of the project activities. All 4 activities under the output 4 will be undertaken to assess the capacity and to assist the efforts of the participating laboratories. Developing in-country capacity of mercury monitoring (Activity 2.1) will continue to conduct the capacity assessment of existing laboratories in virtual setting. Assessing a laboratory in Vietnam will be conducted in this period.

Continuous data collection and analysis (Activity 2.2) is undertaken at one dedicated site. Standard operating procedures (SOP) is currently discussed by Asia Pacific Mercury Monitoring Network (APMMN) and once agreed among the network partners, more sites will be established in the harmonization of methodologies. The Project will continue to liaise with the partner countries and encourage them to join the APMMN.

As for the Activity 2.3, the first round of laboratory proficiency testing (PT) has implemented successfully, and the results are currently under analysis by National Institute for Minamata Disease (NIMD). The second round will start and call for participation will be disseminated to the laboratories in the region. The group of laboratories who will receive advice and guidance from the first-round report in Q3 2022 will be assisted by the Project to improve their analytical capacity.

Activities under output 2 will be coordinated with APMMN to enhance regional cooperation (Activity 2.4). APMMN annual workshop is under development and cross-participation will be continuously practiced for enhancing the impact of the activities. Local research and or survey activities by

partner institutions will also be promoted, and the Project encourages them to develop proposals for mercury-related research/surveys.

Activities under Output 3

Dissemination of the project results are done with close collaboration with Minamata Secretariat and other organizations/programmes (Activity 3.1.2). The Project will organize a workshop in ICMGP conference, which takes place virtually in July 2022. In addition, the Project will keep its eyes on the forthcoming events that might suit for improving the Project visibility. Side-events and/or exhibitions will be explored if suitable events are identified.

Disseminating relevant information via internet is another means to improve the visibility. A dedicated project website is gradually populated with technical as well as project-related information (Activity 3.2). The information from project partners will also be uploaded and be made publicly available.

County-level activities has been long delayed due to COVI-19 pandemic. Depending on the improvement of the local situation, national technical workshops for scientists and practitioners will be resumed (Activity 3.3.2). The hybrid modality will be introduced, as appropriate, to facilitate the participation and minimise the risks.

Project coordination, monitoring for workplan July 2022-June 2023

The Project Steering Committee (PSC) meeting will be held in every 6 months to inform project the strategic direction towards expected project outcome. It could meet either physically or virtually. The meeting in Q3 2022 will be convened virtually.

PMU will continue to monitor the project progress, results, financial status, and risks. Prior to the PSC meetings, Semi-annual reports will be prepared and shared to the PSC members in Q3, 2022.

In addition, a mid-term project review (MTR) is planned in Q3-4, 2022 by PMU to analyse feedback from partner countries and other stakeholders against initial expectation to the project. The workplan of the review process will be developed with the interview and survey schedule.

Timeline for the MTR process

Milestone	Schedule
Online questionnaires	September – October 2022
Online interviews	September – October 2022
PowerPoint presentation on preliminary findings and recommendations (to be presented to PSC)	30 September 2022
Draft Mid Term Review Report shared with the stakeholders	15 November 2022
Final Mid Term Review Report for clearance	30 November 2022
Mid Term Review Report to the Project website	31 December 2022

5 Annex

5.1 Online training programme #3

Outlines of the online training programme

Date & venue	7 – 9 December 2021, virtual meeting
Title	Laboratory management for mercury survey and monitoring
Objective	To provide support for enabling efforts of laboratories wishing to participate in the proficiency testing (PT) for their readiness to the proficiency testing, which is a part of continual improvement of quality data collection and analysis.
Programme	The training programme is composed of 3 sessions (3 hours each including opening, brief note, etc.). Session 1: Atmospheric sampling analysis Session 2: Multimedia sampling analysis Session 3: Advancement to qualified laboratory
Participants	Public laboratories and laboratories in universities that undertake mercury analysis (or will undertake near future) for monitoring, survey or research purposes. The laboratories which are able to obtain analytical results by themselves without external resources/supports. The programme is co-organized by Ministry of the Environment, Japan which extended invitations in other groups and regions. Session 1 is also co-organized by United Nations Industrial Development Organization (UNIDO). Participants: 138 from 33 countries/regions (10 from project partners, 7 from Asia-Pacific other than project partners, 16 from other regions) Resource persons: 9 Organizers: 8 (UN and MOEJ) Secretariat: 4 from AIT RRCAP

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Summary of the results

The third online training programme on 'Laboratory management for mercury survey and monitoring', held on 7 – 9 December 2021, was attended by approx. 150 participants, resource persons, etc. The participants came from 33 countries/regions including 10 from project partners, 7

from Asia-Pacific other than project partners, 16 from other regions. There are continuous trends that more female (57%) is participating in the training programme, which suggests the project benefits more to female. More than half of the participants has been dedicated 10% or more of their time for mercury-related works and similar percentage of them felt that the programme fitted their level of competency.

The purpose of this training programme #3 is to provide enabling support to the efforts of laboratories wishing to participate in the forthcoming proficiency testing under the project and to strengthen their readiness to participate in the proficiency testing. The training programme however is part of a continual improvement of quality data collection and analysis on mercury. Due to COVID-19 challenges which restricts international movement for most countries, a series of trainings resources comprising series of lectures on various subtopics covered under laboratory management for mercury survey and monitoring have been programmed and is delivered virtually through internet communication tools to participants.

The training programme is composed of 3 sessions (3 hours each including opening, brief note, etc.).

Session 1: Atmospheric sampling analysis

- Lecture 1: Atmospheric survey and analysis (manual active sampling method) part 1: sample collection (Video)
- Lecture 2: Atmospheric survey and analysis (manual active sampling method) part 2: measurement, data processing and QA/QC (Video)
- Brief note 1: Possible application of manual active sampling method in SAMNet (Dr. Lynwill Martin, SAWS)

Session 2: Multimedia sampling analysis

- Brief note 2: Introduction of APMMN and its future (Dr. David Gay, NADP)
- Lecture 3: Solid sample (soil, sediment and biota) survey and analysis (Video)
- Lecture 4: Water sample survey and analysis (Video)
- Lecture 5: Human biological sample analysis (Video)

Session 3: Advancement to qualified laboratory

- Brief note 3: Readiness to laboratory proficiency testing (Mr. Tatsuya Hattori, IDEA)
- Lecture 6: Methylmercury analysis (Video)
- Lecture 7: Quality management (Video)
- Lecture 8: Laboratory safety / environmental management (Video)

The session 1 of the atmospheric sampling analysis is focused on the manual gold trap method recently included in the draft monitoring guidance document if the Minamata Convention. It was co-organized by United Nations Industrial Development Organization (UNIDO) to extending the individual participants beyond Asia and the Pacific region. It was also integrated in the annual workshop of South African Mercury Network (SAMNet) co-organized by Ministry of the Environment, Japan (MOEJ). MoEJ also co-organized the session 2 and 3 as a part of its collaboration with Asia Pacific Mercury Monitoring Network (APMMN) to strengthen the mercury monitoring capacity of the network members.

Lectures and exercises

Lectures 1 to 8 were presented in pre-recorded video form that included the exercises in the field or in the laboratory in order for the participants to imagine the actual procedures and handling.

Day 1 (Session 1)

Short opening remarks were presented by co-organizers of the online training programme.

On behalf of the UNEP ROAP, Dr. Mick Saito welcomed all participants from different parts of the world who joined the training programme. He noted that the training programme is part of the slated activities under the "Project for promoting Minamata Convention which is funded by the Government of Japan and Implemented by UNEP. He hinted that the programme has been able to establish agreements with many other international organizations and programmes on many collaborative actions that has brought more attention and participation to the programme. He expressed his profound gratitude to the Ministry of Environment, Japan, UNIDO, and APMMN for their support for utilizing their networks to extending participation in the programme.

Mr. Hitoshi Yoshizaki, Director of Office of Mercury Management, Ministry of Environment Japan noted that MOEJ launched the MOYAI Initiative upon the adoption of the Convention, which supports developing countries to share scientific knowledge and to disseminate mercury management technology. He hinted that the manual active sampling method for measuring atmospheric mercury concentration is officially adopted in Japan and the method, he believes, is applicable to many developing countries as well as information that would be presented in the training programme would be useful or all participants.

Ms. Rodica Ella Ivan, Department of Environment, United Nations Industrial Development Organization (UNIDO) thanked the Government of Japan and UNEP for the efforts to organize the training programme and also the providing the opportunity for UNIDO to take part in the programme. UNIDO is joining the global effort in training and capacity building in developing countries concerning appropriate mercury monitoring measurement, and control. She noted that UNIDO has a standing partnership with UNEP and the Government of Japan to provide substantive support to developing countries towards achieving the SDG's.

Lecture 1: Atmospheric survey and analysis (manual active sampling method) Part 1: Sample collection

Lecture 1 of session 1 focused on the sample collection for manual active sampling method of atmospheric mercury monitoring. A brief overview of the three methods often used in atmospheric mercury monitoring was presented. Further, subdivisions of atmospheric mercury survey methods involving the automated active sampling method, manual active sampling method, and the passive sampling method was briefly introduced. An explanation of how mercury is collected and measured, the advantages and disadvantages of each method was discussed. In addition, the outlines of the manual active sampling method, and the requisite equipment, tools and devices used in this method were explained in detail. These include the procedure for setting up the equipment for sample collection and duplicate sampling in atmospheric surveys.

An explanation of typical examples of survey or monitoring situations in non-general environment were discussed. Where high atmospheric mercury concentration is expected, survey should be conducted in order to protect the workers and residents, and emissions should be evaluated. Precautions for the survey at high atmospheric mercury concentration environment such as the gold mining workplace using mercury or accidental spill out or leakage site is explained. The lecture

concludes with explanations on interfering substances for instrumental measurement and results providing explanations on how to measure in environments of probable high interfering substances such as aerosols high humidity, high concentration ozone (in rare cases) and chemical substances such as halogenate gas such as chlorine or hydrochloride gas, nitrogen oxide and sulphur oxide, and gaseous organic compounds.

Q&A:

- Q: Does the kit come with a heating device, or any suitable heater can be used to clean the gold particles? A: Such types of heater and temperature-controlled devices are not available on the market. Mr. Hattori, member of the expert team from IDEA noted that relating to his experience in his laboratory, he intimated that they had tried to build such customized kit but could not use it because they could not use electrical power supply. The lab is currently building such type of temperature-controlled device, but he could not provide a complete answer on it yet.
- Q: Please provide more details regarding the particle filter; A: The particle filter uses 0.45 micrometre membrane filter which is useful and sufficient for sampling. The filter is not mostly required for the monitoring method for the general environment, however if specific situations require it then 0.45 micrometre may be used.
- Q: What about flow calibration? A: The details of the methods of flow calibration are explained in the next video with outline of the use of the traceable standard meter.
- Q: Should the toolbox be standard or equivalent device might work? A: Toolbox is not a standard device and can be built on individual devices (e.g., pumps, tubing, and thermometer) that may be obtained. However, the gold cartridge absorbent may be difficult to prepare. Hence obtaining an already prepared gold cartridge adsorbent from market is advisable.
- Q: How can we vary the sampling volume by simply flow rate change or any other means? A: Sampling flow volume may be informed or changed to suit the objective of the survey. For example, high concentration areas, 24 hrs. sampling, or issues of security for night sampling conditions may influence the choice of the flow rate. Japan manual prescribed flow rate between 0.1 - 0.5 L/min, however experiences from many other researchers has shown that flow rate could reach as high as 5 L/min.
- Q: I was wondering why Teflon cannot be used for the tubing; A: Teflon tube can be applicable. Tubes other than glass or Teflon can also be applicable.
- Q: What brand/purity of soda lime do you recommend? We use it when sampling with a Tekran analyser and sometimes see a spike in mercury - can you clean the soda lime by baking or purging? A: Mostly unclean soda lime trap has been used in the IDEA laboratories, but soda lime cleaning has also been done by baking.
- Q: According to the US EPA (chapter I0-5), we must use 2 traps to take vapour Hg. Can you share the difference between using 1 trap and 2 traps? A: In the US EPA method, it combines the sampling and measurement, as such the second cartridge is use for purifying such as collected gold cartridge which makes it almost same as this method presented in the video. Further explanation on this will be provided in the second lecture which focuses mostly on the laboratory analysis.
- Q: Is there any specified periodic flow rate duration for 24 hr. monitoring? A: There is no specific flow rate. However, the manual of Japan requires 0.1-0.5 L/min of flow rate and 24-hour sampling. To avoid the deviation from diurnal variation of survey site, 24-hour sampling is recommended to obtain the general situation of the site.
- Q: What is the detection limit of this manual method? A: It is due to the measuring equipment, but in our condition (0.5L/min and 24-hour sampling, CVAAS measurement), LOD is usually lower than 0.1ng/m^3.

Lecture 2: Atmospheric survey and analysis (manual active sampling method) Part 2: measurement, data processing and QA/QC

Training Lecture 2 describes the analysis of the gold cartridge mercury adsorbent, data processing, and quality control. An outline of the operation of the thermal desorption atomic absorption spectrophotometer, which is the analytical instrument was explained along with an overview of the standards for analysing mercury in the atmosphere. Explanations on the flow of analysis of mercury collected in a gold cartridge, the instrumental analysis and the key points for sample analysis and the analyses required for QA / QC were presented. The maintenance and calibration methods of two equipment for quality control was also discussed. Further, an overview of analysis with an atomic absorption spectrophotometer for gold cartridges and the preparation of the standard for atmospheric mercury analysis were given along with explanations on data processing and the items used for QA / QC were presented. Actual monitoring of the atmospheric environment by using the manual active sampling method in Japan was briefly introduced with highlights of the distribution of atmospheric mercury concentration in Japan in 2018 and the trend of average atmospheric mercury concentration from 1998 to 2018.

Q&A:

- Q: For duplicate or triplicate sampling, does each tube has its own pump or not? How do you trouble shoot pump problems? A: Usually, two pumps are used for duplicates or 3 pumps for triplicate, each pump connected to each tube. In the case of pump malfunction, pumps are normally replaced or fixed by manufacturers.
- Q: What is the relationship between the flow rate and mercury sampling at 0.5 L? A: There exists a linear relationship between flow rate and sampling or mercury concentration. It is better to restrict mercury level from instrument side rather than cartridge side.
- Q: According to the US EPA, you will have to use 2 traps to get Hg. Can you share the difference between getting 1 trap and 2 traps? A: The second trap is mostly used to remove the interfering substances from the collected gold trap. When a single trap method is used, it means the directly heat the sampling gold trap and measurement amount may be interfered by halogen gas or NOx.
- Q: Can someone use Barium hydroxide as a trap? A: The team has not had any prior experience using Barium Hydroxide trap.
- Q: Does the sampling method is traceable to other official standards like ISO? A: The sampling method explained in the video is from the manual of the Japanese method, which does not fall under or related to the ISO method, but it is not too different from the ISO method. The manual for the Japanese method is published in translated draft (English version) and is accessible via this link. Any traceability will be established for the standard method and any other recognized international method.
- Q: Can you use calibration mercury standard solution instead of standard mercury gas? A: Standard solutions may be used to calibrate for atmospheric mercury measurement using closed apparatus and SnCl2. Further explanation is provided in the subsequent lecture materials.
- Q: In the earliest schematic diagram, there is the use of $SnCl_2$, can Sodium Borohydrate be used instead? A: The team does not have prior experience in the use of $SnCl_2$ however Sodium Borohydrate may be used as reagent to digest solid samples.
- Q: What is the essence of soda lime in the sampler inlet? Is it not interfering with the mercury concentration? A: The soda lime is composed of lime and calcium carbonate and some alkali

such as sodium hydroxide. This component which does not vaporize and thus hardly affects measurement of mercury, notwithstanding detail method for removing interference is still unknown, however interfering substances such as hydrogen related gas, SOx, NOx and trapped moisture which are explained in subsequent lectures are effectively absorbed by the alkali trap, sodium carbonate.

- Q: In place of air pump to carry mercury vapour into AAS, can we use other inert gas? A: Yes, alternative inert gases such as nitrogen gas or air may be used if they contain no traces of mercury. Mercury free air is a probably the cheapest option.
- Q: Are LOQ and LOD QC measures adequate at all for QA/QC measures? A: Yes, LOD and LOQ estimation methods are sufficient and almost the same as estimation of the safety rate of about 1%. The LOD and LOQ are applicable for most of the QA/QC procedure.
- Q: In case of high Hg concentration, can we reduce sampling time or flow rate. Can you say more specifically how much can be reduced, can we take within 4 hours, and how much can be considered as high concentration? A: As of other answer to the question, LOD of the method is lower than 0.1ng/m3 for 24-hour sampling. So, we can obtain the concentration data from 4-hour sampling even the general situation. On the other hand, we should keep in mind that the extreme high condition exceeds the range of calibration curve.
- Q: It is better to quite JIS special code number as reference? A: The manual is published from Japan government, but it is not a series of JIS. The draft English translation of the manual is accessible in the web storage of MC.

Mr. Alvin Chua, Nippon Instruments Corporation (NIC) introduced and shared a brief information about the NIC Ambient Air Sampling Kit Model SK-100A. Highlighting the various components and functions of the sampling kit, Mr. Chua noted the Gold Amalgamation Trap cartridge of the kit can be used to effectively sample and concentrate mercury from ambient air. The Gold Amalgamation Trap cartridge is of 2 sizes/different models (N-65(65 mm) and N-160 (160 mm)) and both can be conveniently used on mercury analysers after sampling. Both N-65and N-160 have the same amounts of Gold coated materials, thus mercury amalgamation efficiency and capacity are the same. Further information on the procedure for analysis of N-160 mercury collector tube under different AAS configurations—NIC Mercury WA-5 series and with auto samplers, and NIC Mercury MA-3000 RHMA3—was explained. The use of the N-65 mercury collector tube under AAS configurations for NIC Mercury MA3-Solo was also explained by Mr. Chua.

<u>Brief Note 1: Possible applications of manual active sampling method in SAMNet</u>

Dr. Lynwill Martin, Senior Scientist, South African Weather Service (SWS) presented on the application of the manual active sampling method by the South African Mercury Network (SAMNet). Mercury monitoring in South Africa began in 1995 and SAMNet in 2020. SAMNet aims to expand ground-based stations and upgrade infrastructure while also becoming the link into Africa through AfriGEO. The objectives of SAMNet include:

- To develop a coordinated SA observation network for mercury to determine the status and trends in atmospheric mercury concentrations,
- Provide high quality data for the validation of local and regional model output,
- Assist partners in developing their mercury monitoring capacity (training),
- Give government and relevant stakeholders a firm basis for future policy developments in the in the implementation of the Minamata Convention,
- Support the GOS4M mandate (make EO data available) within GEO, and

- Establish a network in Africa through AfriGEO.

SAMNet has about 7 monitoring passive sampling monitoring sites across South Africa. SAMMnet intends to explore the application of the manual active sampling method in existing 4 passive sampling and wet deposition sampling locations two new sites (Witbank and Stellenbosch) where passive sampling is being done. Manual active sampling will be carried out in these two new sites from 2022. SAMNet is also considering installing the manual active sampling method at the Welgegund sampling site. On a regional scale, Dr. Lynwill hinted that the there is a huge data gap in Africa due to the small number of monitoring activities on the continent. He noted that out of about 37 African countries that are parties to the Minamata Convention, its only South Africa that is carrying out active mercury monitoring in the region. He noted that the manual active monitoring method is suitable for a region where prior mercury monitoring activities have been done.

Day 2 (Session 2)

Brief note 2: Introduction of APMMN and its future

Dr. David Gay, National Atmospheric Deposition Program (NADP) presented a brief introduction to mercury deposition and monitoring activities of Asia Pacific Mercury Monitoring Network (APMMN) and its future. The APMMN's goal is to systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region. The APMMN's objective is to determine the status and trends in concentrations of ambient mercury, wet, dry, and total atmospheric deposition of mercury, develop a robust dataset for regional and global modelling and assist partner countries in developing monitoring and assessment data, and share data and information. The timeline of APMMN activities between 2012 to 2018 was presented along with the various milestones achieved. Sharing brief information on how the precipitation measurements are collected, APMMN uses the automated wet only precipitation collection sampling systems that use the NCON Model MDN 00-125-2, NADP-style Aerochem 301 and Taiwan-style MIC Collector samplers at regionally representative sites located in rural, urban and suburban areas with estimated high levels of mercury emissions and depositions. Dr. Gay also explained the various functions and use of the components of the Taiwan-style MIC Collector. Regarding atmospheric mercury monitoring, the gold amalgamation trap method, which is a straightforward and simple design, are to be used in all APMMMN networks.

Future plans of APMMN are focused on adding additional wet deposition sites in/around Asia and in the Pacific region. The network is also aiming to improve their network of atmospheric samples by adding more sites to gaseous monitoring and organising monitoring on specific days. Other planned future endeavours include setting up a passive measurement of mercury in Network and continuing close working collaborations with the Ministry of Environment Japan.

Lecture 3: Solid sample (soil, sediment, and biota) survey and analysis

Lecture 3 mainly explains sampling and analysis of solid samples, such as soil, sediment, and biota. An overview of the characteristics of mercury in soil and sediment, the collection and characteristics of soil and sediment samples was discussed. The key considerations for undertaking mercury surveys in such media and the sampling procedures involved were discussed under lecture 3. The actual analysis operation of total mercury in the laboratory is explained. The operational flow of the acid digestion-reduction aeration CVAAS analysis method described in the "Mercury Analysis Manual" in Japan was also explained. The cold vapor atomic absorption spectrometry, CVAAS in which samples are digested with acid, and then mercury in the solution is

purged out by reduction aeration was explored by the lecture. Further, the analysis, data processing, and QA/QC of the samples after acid digestion by a reduction aeration CVAAS were explained. The important items for quality control of analysis were also highlighted while further discussions on QA/QC, limit of detection, LOD and limit of quantification, LOQ and thermal decomposition CVAAS were introduced. Explanations on the screening of samples that may contain very high concentrations, products using mercury, mercury-contaminated waste or soil that may be contaminated with high concentrations of mercury in facilities, etc. were also given.

Q&A:

- Q: Is there any potential risk of bias when using metal tools during field sampling? A: Strictly speaking, metal sampling tool may affect the mercury concentration of the sample. However, considering of concentration level of the soil/sediment sample, area of contact between tool and sample, usually the effect of metal (steel) tools for solid sample is small. But the metals which create amalgam with mercury, such as copper or aluminum should be avoided. For the water sample, since of its low concentration, metal tools should be avoided.
- Q: Could we use other oxidizing agent for complete oxidation in addition to using the prescribed acid solutions? A: Yes, oxidizing agent can be used in addition to the prescribed acid solutions. However, from experience, most of solid samples or sediment samples can be easily digested by reagents such as hydrochloric acid and sulfuric acid as mentioned in the lecture.
- Q: In place of stannous chloride, is it preferable to use 0.1% sodium borohydrate? A: Yes, sodium borohydrate can be used to create mercury hydride. Some types of the CVAAS in the market uses this hydride generation system.
- Q: When the mercury vapour from the reaction chamber is purged into the absorption cell of the CVAAS assembly does it need to be dried or not? A: Reaction chamber should not be dried for each measurement.
- Q: Dealing with the XRF use for screening, can we use it to direct the sampling procedures, especially for soil sampling? A: Yes, XRF can measure the samples directly, hence XRF can be used for direct measurement of unprepared samples. However, mercury added products such as batteries need to be disassembled for a particular part to be measured since mercury is added for purpose. Specific pretreatment may be need for specific mercury added products.
- Q: How to digest if the sample in dental amalgam? A: Although the team has little experience in mercury analysis in dental amalgam, digestion/ dissolving in strong acid might be required. The objective for analysis of mercury in dental amalgam may inform the process that might be useful. Thus, the methodology may be pretty much different from the approaches shown in the lecture. To know the approximate concentration of mercury in a mercury added product, one of the easiest ways is to ask the vendor of the mercury concentration.
- Q: We can use inert gas like argon as carrier gas in place of air, is it correct? A: Yes, argon gas may be used as carrier gas. However, this may not be necessary for the CVAAS. Air is cheaper carrier gas and enough for the analysis.
- Q: Do you report wet-based Hg concentrations of soil and sediment samples or dry-based? A: The video explained the method assumed wet-based. The video does not say about the base of concentration for the report.
- Actually, it something new for us, we never analyse dental amalgam at all. but generally, dental amalgam contains about 40-50% Hg, so can we analyse it directly using XRF? A: Yes, I think XRF is better to analyse the dental amalgam. (I am sorry, but we have not been experienced. However probably XRF is suitable.) metal element in alloy needs some specific consideration. You may ask vendors on its operation condition.

Lecture 4: Water sample survey and analysis

The lecture 4 explored the collection and analysis of water samples, the meaning of the aquatic environment in mercury pollution and the characteristics of water samples in survey analysis. The importance of aquatic environment surveys in understanding mercury pollution was also considered. A description of the characteristics of water samples for mercury research and analysis and the actual collection of water samples was explained. An overview of the procedure for collecting water samples using a water sampler, the material of container bottle that can be used for mercury survey, the status of sampling and information record keeping was given. Also, the analysis of total mercury in water samples and the method of extracting and concentrating mercury as a dithizone complex and the reagent preparation for analysis were introduced. The standard solutions for preparing the calibration curve to calculate concentration are also extracted and digested in the same manner for the analysis method were provided.

Lecture 5: Human biological sample analysis

Lecture 5 focused on the analysis of hair, blood, and urine, which are the media related to human health. The unique characteristics of mercury in human body which are the key factors to consider in conducting mercury surveys in human body were explained thoroughly. Hair takes up methylmercury in it very much when it grows and thus, the hair often is one of the most typical monitoring media for mercury survey in human biological sample analysis for mercury. Analyzing mercury in hair from the root to the tip can inform the historical methylmercury exposure of the individual. Another typical media for mercury survey is the blood which also plays an important role in the metabolism of many chemical substances in human body including mercury in both organic and inorganic forms. Elemental or inorganic mercury taken into the body by inhalation of mercury vapor is not accumulated in the hair but mostly excreted as urine. Thus, urine is a very good indicator to survey the exposure to elemental or inorganic mercury.

The procedure for collecting the hair sample, urine and blood samples for mercury surveys was explained. The analysis of total mercury in biological samples using an acid digestion-reduced aeration atomic absorption spectrophotometer is explained. The analysis of total mercury in biological samples using an acid digestion-reduced aeration atomic absorption spectrophotometer is explained. The operation flow indicates the acid digestion-reduction aeration CVAAS analysis method described in the "Mercury Analysis Manual" in Japan. Explaining the collection of analytical samples, firstly, the hair sample for analysis is taken. The lecture discusses the external factors that affect mercury levels in hair both positively and negatively. Hair is a very good indicator for surveying people subject to the methylmercury exposure. In some cases, however, mercury may adhere to the outside of hair. The lecture concludes with explanation on the importance of infection prevention during handling human bio-samples is explained.

Q&A:

- Q: Normally what is the ratio of inorganic mercury to methylmercury in human body? Which species of mercury (inorganic or methyl) is more toxic? A: The people who is not living in high concentration of atmospheric mercury (such as ASGM), most of mercury exposure is methylmercury from the food, so most of mercury in the body of general population is methylmercury. For the biological half lie and toxicity, methylmercury is more serious. However, gaseous elemental mercury is inhaled from the lang in high ratio, and high concentration of GEM affects serious effects to the nervous system. So very high concentration of GEM is also very toxic. Methylmercury is gradually oxidized to inorganic mercury. So, some inorganic mercury exists in human body even though the exposure is very low.

- Q: When dealing with urine samples, we sometimes find it challenging especially with very low-level Hg urine sample. Should you give us any advice to ensure the dilution will not cause bias?
  A: Yes, analysis of low concentration urine samples using CVAAS will generally may not require dilution. Though the team has little experience using the CVAFS, causes of unstable analytical result from water may be because of volatisation of the mercury in the sample during handling and also reducing the amount of the blank water. Volatisation mercury from the sample may be reduced by keeping the sample in hydrochloric acid condition compared to keeping sample in normal state or nitric acid.

Dr. Mick Saito explained the exposure pathways, behaviour and fate, symptoms and treatments of elemental, inorganic and methylmercury in the human body. Elemental mercury, in unoxidized form mainly enters the human body majorly by inhalation (75-85% absorption rate) and passes through blood-brain barrier by diffusion. However, it gradually gets oxidized by the body to divalent inorganic mercury and excreted from the body with urine. In cases of acute exposure and chronic exposure of low concentrations, symptoms of exposure to elemental mercury are mostly evident in the presence respiratory distress (which is reversible). Relating the central nervous system, the exposed person may experience tremor, personality change, tooth pain and excessive salivation. The treatment patients mostly may be done by stimulating mercury excretion. Inorganic mercury enters the human body by ingestion (5-10% or less absorption rate), or dermal contact (in small amount absorbed) and is mostly excreted with urine. In cases of acute exposure and chronic exposure of low concentrations, symptoms of exposure are observed corrosion in the digestive tract accompanied with vomiting, chest pain, abdominal pain, bloody diarrhoea. Other symptoms may include kidney damage and renal insufficiency. Treatment options may include gastric lavage and excretion with chelating agent. Methylmercury enters the body by ingestion (90% or more absorption rate) and passes through blood-brain barrier via amino acid transportation and gradually oxidized by the body to divalent inorganic mercury to be excreted with urine from the human body. In cases of acute exposure and chronic exposure of low concentrations, symptoms of exposure to methylmercury include sensory nerve dysfunction, ataxia, and construction of the visual field of the central nervous system whereas symptoms such as non-specific cerebral palsy like features may be noticed in fetuses. There are no known effective treatments to methylmercury exposure yet.

Day 3 (Session3)

Brief note 3: Readiness to laboratory proficiency testing

Mr. Tatsuya Hattori, IDEA Consultants Inc. explained the outlines and precautions for the planned laboratory proficiency testing under the project. He hinted that, for the proficiency testing items, one bottle of fine shredded human hair, containing about 3 gramme of hair sterilised by gamma ray will be distributed. The testing parameter will be total mercury, but the moisture of the sample must be reported by participating laboratories. Any method may be used for analysis of the samples by participating laboratories but limit of detection of less than 0.1 mg/kg on 10 mg sample is applicable. Estimated concentrations of the samples are not high however, to ensure accurate performance evaluation of each participating laboratory, the method should be chosen that has such LOD. The method should be the laboratories usual analytical method that is often used to analyse mercury from human hair samples. Three (3) times of analysis should be conducted for each sample and results accurately reported. For moisture analysis, the procedure indicated in the presentation should be used. The same hair samples used for moisture analysis should not be used for total mercury analysis.

On reporting of the analytical results of the proficiency testing, the secretariat will provide a reporting format/template for use by all participating laboratories. Completed reports by

laboratories will then be required to send the results in the report format back to secretariat via e-mail. Participating elaborates are very much encouraged to not falsify results and to avoid collusion by keeping their individual results discreet. In the event where collusion or falsification of results are detected, the data of the affected laboratories would be excluded from the analysis of results and evaluation of performance and the affected laboratories would be excluded from participating in subsequent proficiency testing. Testing items will be distributed in February 2022 and reports from the laboratories expected by March 25, 2022. The presentation at International Conference of Mercury as Global Pollutant (ICMGP) and the results feedbacks will be provided in July 2022 and August 2022, respectively. Detail instruction and format of the reports would be shared with participating laboratories, Mr. Hattori hinted that that each participating laboratory would have a unique ID. The report of the proficiency test results for each laboratory will include results of testing of each laboratory, statistical analysis of the testing results and performance evaluation of participants would be provided in excel format.

Q&A:

- Q: Can we dry the sample more than 4 hours? A: To minimize the uncertainty for the moisture result, please do not dry longer than 4 hours.
- Q: Could you please highlight some statistical analysis tools for report quality? A: The statistical analysis and performance evaluation conducted in reference to the requirement of ISO 17043. We will publish the protocol of the testing and the way of the analysis is described in it.
- Q: How do you consider public universities for capacity building? A: Public universities can join our proficiency testing. In my personal view, the capacity of university is also important for the local/global environmental assessment. I expected to build the capacity of the university regarding the environmental research unite or cooperate with the institute of government.

Lecture 6: Methylmercury analysis

In this lecture, the analysis of methylmercury was explained. Though there are several methods for analysing methylmercury, the method described in the Mercury Analysis Manual in Japan was discussed. It involves decomposing the sample with an alkaline solution, then to extract with toluene as a dithizone complex, and finally to analyse it with Gas Chromatography GC / Electron Capture Detector ECD. Further, the effects of methylmercury and its typical characteristics were briefly addressed in lecture 6. In the lecture noted that, assessing methylmercury levels in food items is also relevant to evaluate the effect to humans accurately. The actual analysis procedure of methylmercury was discussed using fish as an example and a diagram of alkaline digestion-dithizone-toluene extraction and GC/ECD analysis, its actual operations, the analytical steps in the analytical operation were discussed. At the end of the lecture, the analysis of methylmercury in hair was explained and methylmercury extraction by hydrochloric acid without digestion. In addition, detail explanation on the actual analytical process for hair was presented.

Q&A:

- Q: We think that the solvent must be of GC grade; A: Precise comparisons have not been carried out by our lab, but toluene in GC grade has been used by our laboratory.
- Q: Does the concentration process is required for the extract prior to injection into GC? A: Under this method, most types of biota and hair sample can be analysed under the condition of sampling amount and final volume. Normally the mercury concentration on the hair is not that low but quite high.

- Q: Is there any provision to share JIS standard method of testing to trainee? A: The mercury analysis manual published by the Japanese government and published in English on the website of the National Institute of Minamata Disease. The manual has procedure for both procedures as solid sample and hair sample analysis are described.
- Q: How can you compare the results of mercury analysed as THg and those analysed as Me-Hg? Is there a common big difference in concentration? A: Total mercury analysis has been mostly conducted with methylmercury analysis by IDEA lab. Thus, based on the type of species, content of the survey or situation of the hair. In the case of fish of high trophic level such as tuna, it is almost same as concentration of total mercury or methylmercury. Lower trophic level fishes have considerable difference between total mercury and methyl mercury concentration. Also, for hair mercury analysis, mercury in hair is mostly methyl mercury because human body excretes mercury in hair as methylmercury. Elemental mercury in hair is found when survey is for exposure to gaseous mercury environment or mercury added products. Such cases have often been experienced by the IDEA Lab. The justification for using the total mercury analysis in addition to methylmercury analysis is because sometimes the common assumptions that methylmercury concentrations is equivalent to total mercury concentration may not be valid under certain conditions. Under such conditions, the analysis of methylmercury concentration becomes helpful. For biota samples, the muscles are sampled hence all mercury is methylmercury. However, in the organs such as the liver may have some deposition of inorganic mercury in such organs and thus, the choice of mercury to analyses may be dependent on the body part. This can be tricky.
- Q: What is the percent recovery for the long method? A: Though it is long procedure the recovery of mercury from this method becomes quite steady and 100% recovery of methyl mercury is possible.
- Q: Is the analytical method done parallel with the standards? What are the forms of standards? A: Yes, the analytical method is usually done with standard materials such as fish or hair CRM obtainable from the market.
- Q: How much percentage of methylmercury in total mercury? A: This has been answered in the previous questions. High trophic level fishes have almost the same amount total mercury and methyl mercury. However, this relation is not the same for low trophic fishes and hair samples.
- Q: Apart from hair, how do we dry other biota sample, like fish muscle-Oven or freeze dry? A: This method can be used for normal wet sample such as fish muscle tissue. However, high moisture content samples may require freeze drying. The team has little experience using oven for drying biota samples.
- Q: Does there any quick qualitative method for M-Hg in biological sample in spite of this? A: There are other alternative instruments for analysing the methylmercury that are available on the market.
- Q: Could it be possible to measure total mercury in hair sample by CVAAs? A: Yes, for obtaining qualitative information of total mercury concentration can be analysed by CVAAS. However, where separation procedure for measurement is required, it may not be advisable to use the CVAAS, instead DCACD may be applicable. Simple methods to obtain qualitative information on mercury CVAAS may be used.
- Q: How can we assure the representativeness of muscles sampling? A: In general, there isn't so large difference of mercury in body parts of the same creature/ for samples. To avoid relation from sample analysis is required a whole muscle sample for sufficient homogeneity. Some high trophic level species, there may be localized concentration.
- Q: Is there any differences in distribution of M -Hg on the basis of fish species? A: These features distribution of mercury shows distribution accumulated in muscle tissues and liver is

almost same in same species but may be slightly different in some species due to their fructose levels or metabolic systems in species.

- Q: Do you determine Me-Hg in seaweed products? A: The expert team has not had prior experience on seaweed analysis. But we have conduct analysis of rice sample slightly amended this method.
- Q: In case of human body, which body part is considered for sampling to identify the Hg contamination, is it hair, muscle (which part)? A: To evaluate the mercury exposure for general population (most of the source is food), hair is appropriate sample. On the other hand, the survey for the population who are under the high concentration of atmospheric mercury (such as gold mining, work environment), total mercury analysis of urine is appropriate.
- Q: Can we use polypropylene type centrifuge tubes, for the mentioned dithizone-extraction GC/ECD method? A: On the view of the blank of methylmercury, PP is no caused. However, toluene may dissolve the interfering organic substances from the tube, thus it is recommended to avoid the PP tube for dithizone extraction method.

Lecture 7: Quality management

The Lecture 7 explains quality management of analytical data by referring to the definition in ISO. A few terminologies about Total Quality Management, and Quality Assurance, QA and Quality Control, QC, which are often confused were explained. Subsequently, the overall concept of Total Quality Management including the seven principles of quality management defined in ISO 9000. Highlights of the key points in the quality management system of the organization was thoroughly discussed along with the items relevant to the quality control and how to ensure the quality of analytical data. The operation blanks, duplicate analysis, standard samples, etc. were explained for evaluating the validity of analytical data. Reference material and certified reference material were also explained. The lecture 7 also explained the limit of detection and the limit of quantification in relation to the QA QC sample and emphasized the most important factors for data quality are their errors, i.e. biases, and uncertainties. Biases and uncertainties of the data are described in relation to the traceability as a means of assessing data bias against standards. Then, the process to estimate the uncertainty was explained. The analytical operations were examined to extract possible factors affecting the data uncertainty for evaluation using Type A and Type B assessment approaches.

Q&A:

- Q: Good presentation regarding to uncertainty. Could you please elaborate rectangular and triangular distribution in type A and type B uncertainties? A: The slide explained the triangular and rectangular distribution for the estimation of type B. On the estimation of type A, uncertainty is estimated from the standard deviation of the multiple experiment of the measurement. In many cases of the Type B analysis, the actual uncertainty is unknown (e.g. the pipette, which is assigned only the guaranteed value, not the uncertainty). In such case, we should expect the probability distribution of the value and estimate the uncertainty. If the probability distribution seems like normal distribution, uncertainty can be estimated as triangular distribution. If the value seems be uniformly distributed in the range, rectangular distribution is suitable. If it is unknown, rectangular distribution is more "safe" estimation since the larger uncertainty is calculated than triangular distribution.
- Q: How often should you perform a reagent blank? I did not understand why the SOP said about it being minimal; A: We confirm reagent blank in prior of the first usage of the reagent. When we change the type of reagent (such as provider, or grade) we confirm its blank again. Even though we conduct operation blank on every analysis, the periodical test of reagent is not

conducted. When we found large operation blank, we also confirm the blank of each reagent to find the source of them.

- Q: Regarding to management system, it's better to aware about ISO 17025: 2017. Q: Yes. The description of management system is rather short. However, the policy of the QM is same between the other ISO system such as ISO 9000, so the description of ISO 9000 is also useful to the system of ISO 17025.
- Q: Can we consider control samples, retesting of samples including intra-laboratory and inter laboratory comparison A: Yes, remained interlaboratory testing sample is also a good reference material for QA/QC.
- Q: In reporting, which is better, Standard error of the mean or simply Standard deviation? A: In the report, uncertainty is also attached of the analysis result. If you conduct the multiple analysis and report its mean value. The estimated (expand) uncertainly with the result. Uncertainty can be estimated the standard deviation divided by the square root of the number of the testing, and also calculated the expanded uncertainty to multiply the uncertainty by covering factor (usually 2). When uncertainty is indicated as expanded uncertainty, this covering factor should be described.
- Q: In LOD and LOQ +3S and +10S are considered, what about -3S and -10S? A: If it is estimated that the result shapes the normal distribution, 3s covers about 99% range of the result. So, it is one indicator to assume the reliable detection level. Actually, it is difficult to consider the mean of LOQ, but it is one way to consider 10s is sufficient level of the concentration is statistically treating the result. LOD/LOQ of 3s and 10s is described in some manuals (not limited for mercury analysis) of Japan. There is an advantage that it can be easily calculated.
- Q: Could you highlight briefly on risk and opportunities of mercury testing laboratory? A: As of the last slide of QM, one opportunity of the laboratory is high value of the data. High quality data can find the new fact. On the other hand, risk of the laboratory is the misunderstanding of the survey/experiment by the bad quality data.
- Q: Very good presentations in all three days. Some countries don't conduct or even have proper setups for effective testing and monitoring of mercury therefore could the program organizer also provide us working samples showing and explaining the whole process from sample collection to processing (analysing data) and reporting for the air, soil, liquid & human biological samples along with the lecture videos after the training program? A: Due to COVID challenges, physical meetings are a challenge for everybody. And due to the uncertainty about when physical meetings may happen. The project team adopted the use of video presentation as alternative method to disseminate knowledge and strengthen capacity of participants. The project team would have loved to have physical and hands-on training with participants.
- Q: I think for laboratory The ISO 17025:2017 is best one rather than 90001 and 14001:2015. Why is it not necessary to have ISO 14001 accreditation? Will inspectors not ask? A: It is effective to have accreditation of ISO 14001 because auditing is done under the accreditation often which supports the laboratories total environmental management compliance. It is recommended to have ISO 14000 standards.
- Q: For laboratory the ISO 17025:2017 is best one rather than 90001 and 14001:2015? A: ISO 1725:2017 is focused on procedures for management system for testing laboratories. However, testing laboratories should also be managed under environmental management where ISO 14000 standards for environmental management and ISO 90001 for process management is also useful for quality management system.

<u>Lecture 8: Laboratory safety / environmental management</u>

Lecture 8 was not directly related to survey analysis, but the safety and environmental managements in the laboratory described here are important for all. These might be basic but important for workers' safety and reduction of environmental impacts, thus, it is relevant. Reagents often used in mercury analysis have their own unique properties, especially highly hazardous ones that require understanding and specially handling for safety. The lecture described the basic precautions when handling hazardous reagents such as acids. Often, despite putting safety measures in place, accidents can sometimes happen. Thus, the lecture explained how such accidents may be handled from the perspective of understanding of the properties of the reagents. Further, steps to address and manage accidents involving various harmful reagents such as concentrated hydrochloric acid and sulfuric acid, perchloric acid, nitric acid sodium hydroxide was comprehensively explained. The safety procedures for using apparatus and equipment, especially glassware and electric devices used in the laboratory were explained.

Wastewater and exhaust gas treatment in the laboratory as environmental considerations in the laboratory was explained. ISO14001, which is a standard for environmental management, is also introduced here. Analytical operations that generate harmful gases, such as acid decomposition, should be performed in an exhaust chamber. A standard for environmental management system, ISO14000 was introduced and benefits of introducing the ISO14001 system were also highlighted. The benefits particular to the analytical laboratory are discussed and explained here.

Q&A:

- Q: Preliminary treatment about Hg contaminated wastewater? Could you please specify about primarily treatment of laboratory wastewater contaminated with Hg? A: In the case where probably the wastewater has no other substances in addition to mercury, the wastewater can be treated in same manner as solid sample.
- Q: Given the time differences among countries please, let you conduct more training by videos; A: The project is considering this and has plans to compile and finalize the eight training videos, as these ones are drafts. The finalized materials to be shared, along with other instruction manuals and FAQs packaged for use as resource material for trainers training and also available to persons who may avail themselves as champions to train other laboratory staff in their respective countries. These packaged materials will be become a whole package for trainers within 2022. The participants may have to start with what is available in their laboratories and gradually improve quality. Where analytical instruments are not available, perhaps those laboratories may just focus on sampling procedures and do inhouse training to improve their performance. Laboratories may be selective in their use of the training materials, focusing on the one that is suitable to them.

Wrap up and Closing

In closing, Dr Mick Saito thanked all participants for their active participation in the 3-day training programme and summarily highlighted the key features of the training programme. He noted that the first 2 days was focused on exposition on the sampling and analytical method in air, solid and water given mercury's special properties in these media when monitoring, and human sampling that requires special care. Mercury monitoring is not only limited to the areas covered under the training. Mercury monitoring is mostly dependent on the media of which monitoring is done. For example, mercury in mercury added products, solid waste or stack exhaust gas has different way of monitoring. As such, there still exists need to build capacity and train, albeit couldn't be covered in one go under the training programme. In these other areas, which are equally useful, gradual provision of training and capacity building might also be dependent on what governments, laboratories and research topics consider as priority needs. Methylmercury is useful in addition to

analysing total mercury because it may provide unique information. Simplified method proposed in this training which you might consider using in mercury monitoring especially in hairs. Emerging mercury monitoring opportunities in the world are evolving more and more with researchers are even investigating stable isotopes and deep ocean water sampling being undertaken for global scale modelling of ocean mercury.

Mercury, a chemical element does not disappear and once released, it circulates globally until it is deposited into deep underground strata. Thus, scientist must be equipped with the right message to the right people to enable them to take the right decisions. Instead of using scary terms, there need not be a fear of mercury but the understanding that mercury has been on the Earth since its creation, and with our ancestors from the very beginning. How to live with it in a safe manner must be understood to drive sound policy making. He thanked participant, expert team once again for their participation.

Time zone management

The time difference among participating countries is wide as the co-organizers invited participants from different regions. For example, the focus of UNIDO was mostly African countries while APMMN is mainly organized by USA. In order to provide comfortable time slots to the participants as much as possible, a time zone table of the sessions was developed.

Session 1 was arranged in between 14:00 and 17:00 in Bangkok, Thailand (UTC+7), which covered Africa to the Pacific. Session 2 and 3 were arranged in between 8:00 and 11:00, which covered South Asia to America. It enabled the participants and lecturers attending the session in between 6:00 and 22:00.

Location	Session 1	Session 2-3
Suva (UTC+12)	7pm – 10pm Tue. 7 Dec.	1pm – 4pm Wed.-Thu. 8-9 Dec..
Tokyo, Koror (UTC+9)	4pm – 7pm Tue. 7 Dec.	10am – 1pm Wed.-Thu. 8-9 Dec.
Manila, Kuala Lumpur, Ulaanbaatar (UTC+8)	3pm – 6pm Tue. 7 Dec.	9am – noon Wed.-Thu. 8-9 Dec.
Bangkok, Jakarta, Hanoi (UTC+7)	**2pm – 5pm Tue. 7 Dec.**	**8am – 11am Wed.-Thu. 8-9 Dec.**
Kathmandu (UTC+5:45)	12:45pm – 3:45pm Tue. 7 Dec.	6:45am – 9:45am Wed.-Thu. 8-9. Dec.
New Delhi, Colombo (UTC+530)	12:30pm – 3:30pm Tue. 7 Dec.	6:30am – 9:30am Wed.-Thu. 8-9. Dec.
Male (UTC+5)	Noon – 3pm Tue. 7 Dec.	6am – 9am Wed.-Thu. 8-9. Dec.
Nairobi (UTC+3)	10am – 1pm Tue. 7 Dec.	4am – 7am Wed.-Thu. 8-9 Dec.
Cape Town (UTC+2)	9am – noon Tue. 7 Dec.	3am – 6am Wed.-Thu. 8-9 Dec.
Vienna, Geneva (UTC+1)	8am – 11am Tue. 7 Dec.	2am – 5am Wed.-Thu. 8-9 Dec.
Sao Paulo (UTC-3)	4am – 7am Tue. 7 Dec.	10pm – 1am Tue.-Wed. 7-8 Dec.
Washington DC (UTC-5)	2am – 5am Tue. 7 Dec.	8pm – 11pm Tue.-Wed. 7-8 Dec.
Chicago (UTC-6)	1am – 4am Tue. 7 Dec.	7pm – 10pm Tue.-Wed. 7-8 Dec.
Los Angeles (UTC-8)	11pm – 2am Mon. 6 Dec.	5pm – 8pm Tue.-Wed. 7-8 Dec.
Honolulu (UTC-10)	9pm – 0am Mon. 6 Dec.	3pm – 6pm Tue.-Wed. 7-8 Dec.

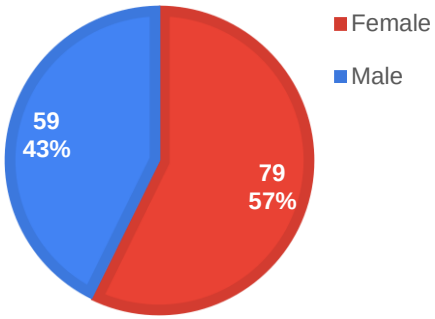
Results analysis

The training programme was attended by 138 participants, 9 resource persons, 8 organizers, and 4 secretariats. The participants came from 33 countries/regions including 10 from project partners, 7

from Asia-Pacific other than project partners, 16 from other regions. The invitation was initially sent to the laboratories participating in the proficiency testing (PT) for supporting their readiness, and then open to wider audience. Particularly, it was extended to APMMN participants, UNIDO partner countries, SAMNet participants (South Africa), and NIMD partners. Approx. 35% on the participants were from countries other than project partners.

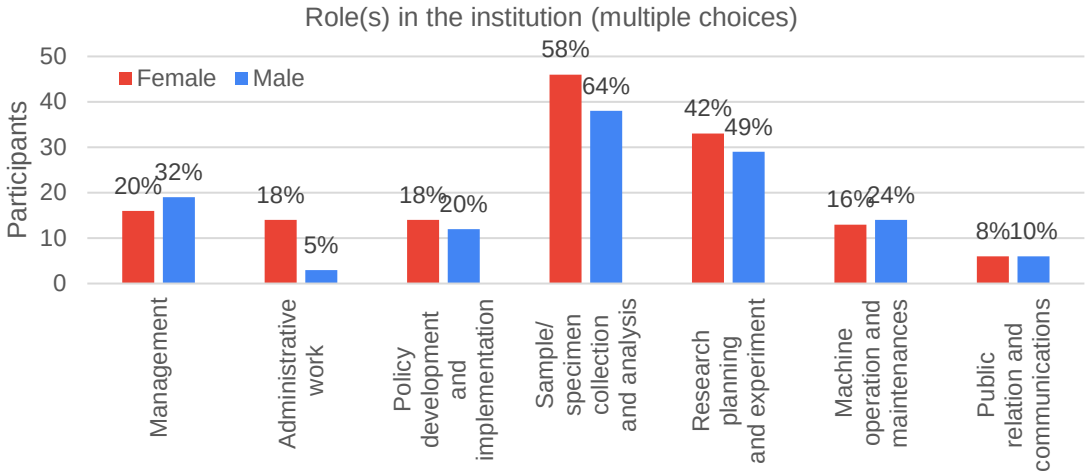
Project partners	Total	Remarks	Other types	Total	Remarks
Indonesia	30	10 from environment, 2 from trade, 8 from local government, 8 from academia, 2 from other	From Asia excluding partners	13	China, Korea, Singapore
Japan	4	3 from environment, 1 from academia	From Pacific	4	Australia, Fiji, Papua New Guinea
Malaysia	8	7 from environment, 1 from private	From Europe	1	Switzerland
Mongolia	2	2 from environment	From North America	1	USA
Myanmar	1	1 from UNEP	From Latin America	6	Antigua, Argentina, Nicaragua
Nepal	8	5 from environment, 1 from health, 1 from academia, 1 from private	From Africa	24	Botswana, Côte d'Ivoire, Ghana, Kenya, Namibia, Niger, Nigeria, Sénégal, South Africa, Tanzania, Zambia
Philippines	16	11 from environment, 5 from energy	Sub-total	49	23 countries/regions
Sri Lanka	1	1 from academia			
Thailand	2	2 from environment			
Vietnam	17	8 from environment, 9 from academia			
Sub-total	89	10 countries/regions	Total	138	33 countries/regions

Among the 138 participants, 79 (57%) were female and 59 (43%) were male. It is continuous trends that more female is participating in the training programme, which suggests the project benefits more to female.

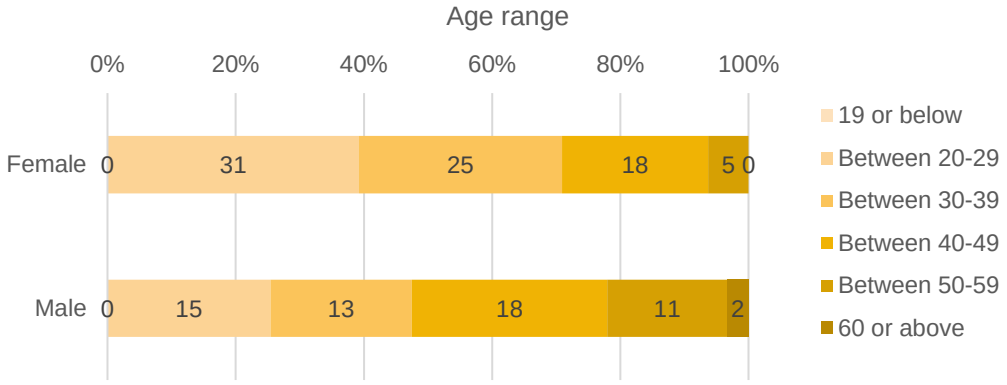


Gender distribution of the participants

The roles of the participants in the institutions were similar between female and male. This programme targets public laboratories and laboratories in universities that undertake mercury analysis. Thus, the role of sample/specimen collection analysis was the most frequently seen, followed by research planning and experiment.

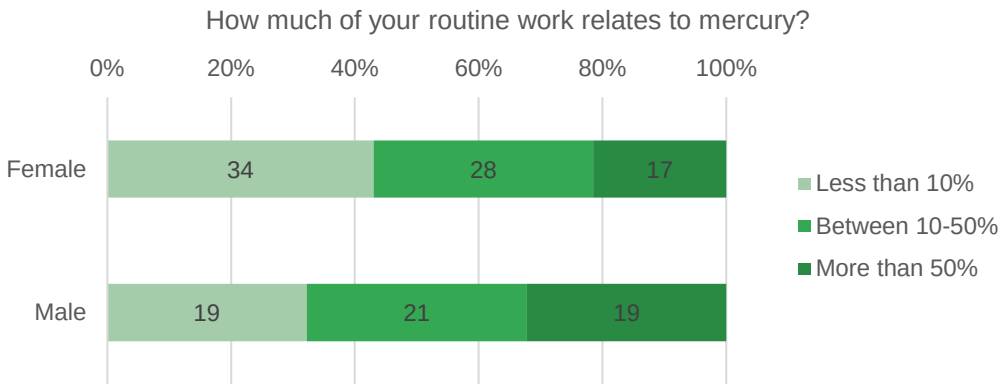


As for the age distribution, the female participants are younger than the male participants. Approx. 70% were 39 years old or below for the female participants while this age range was less than half for the male participants.

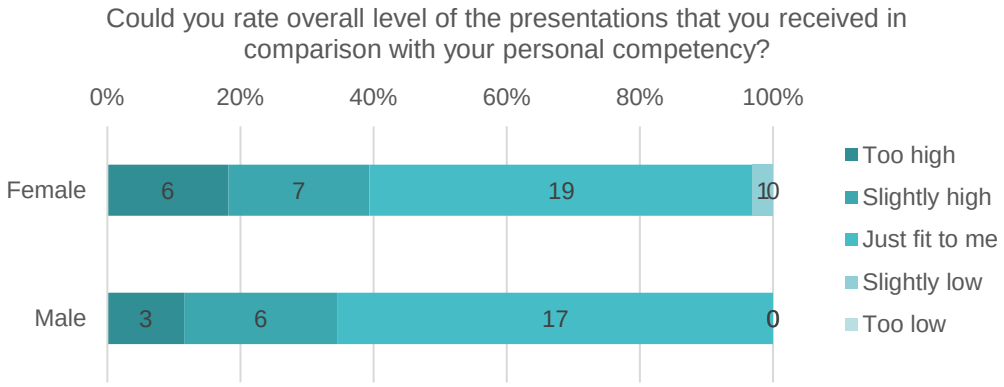


More than half of the participants has been dedicated 10% or more of their time for mercury-related works. The percentage shows more involvement of male participants but actual numbers of female and male participants are similar (45 female and 40 male). On the other hand, many of them are

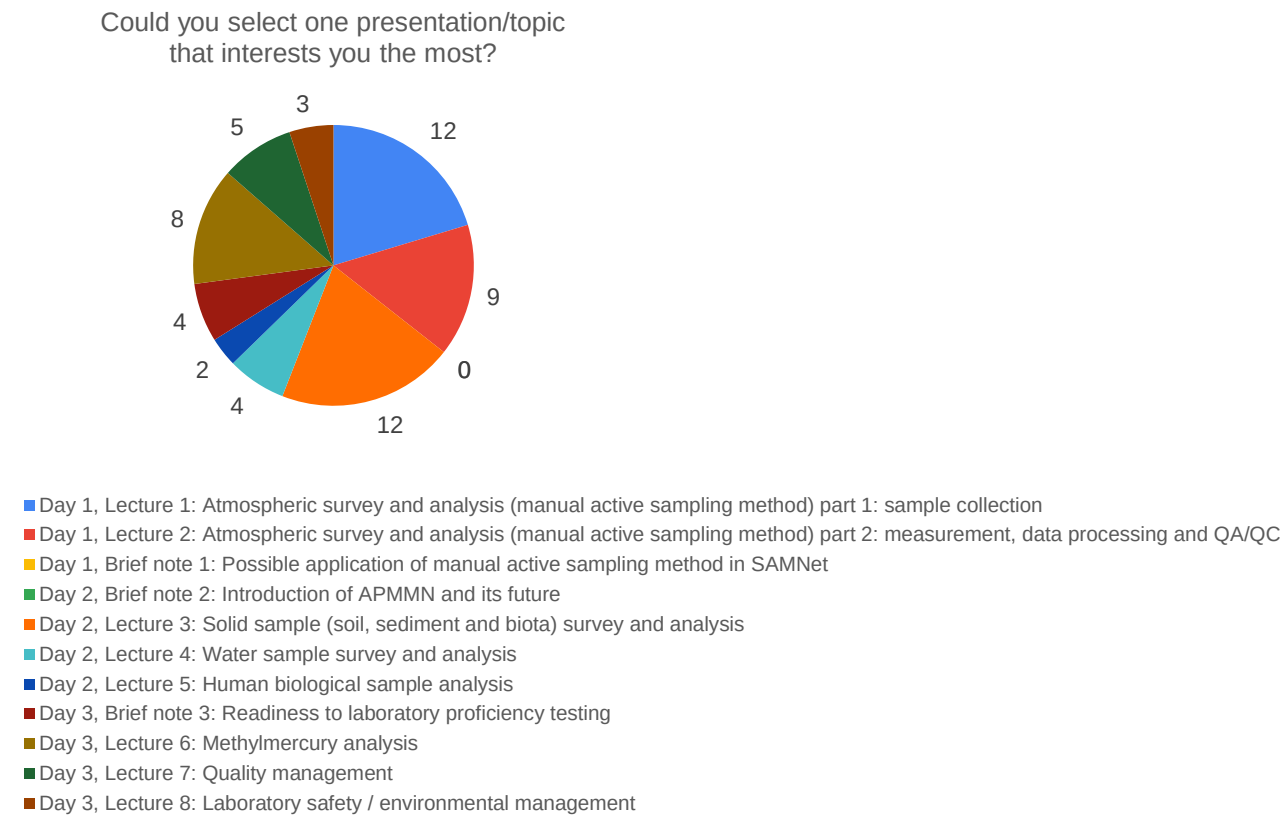
doing more works other than mercury. The participants with the mercury-related works less than 10% may have acquired knowledge that could enable them more works in future.



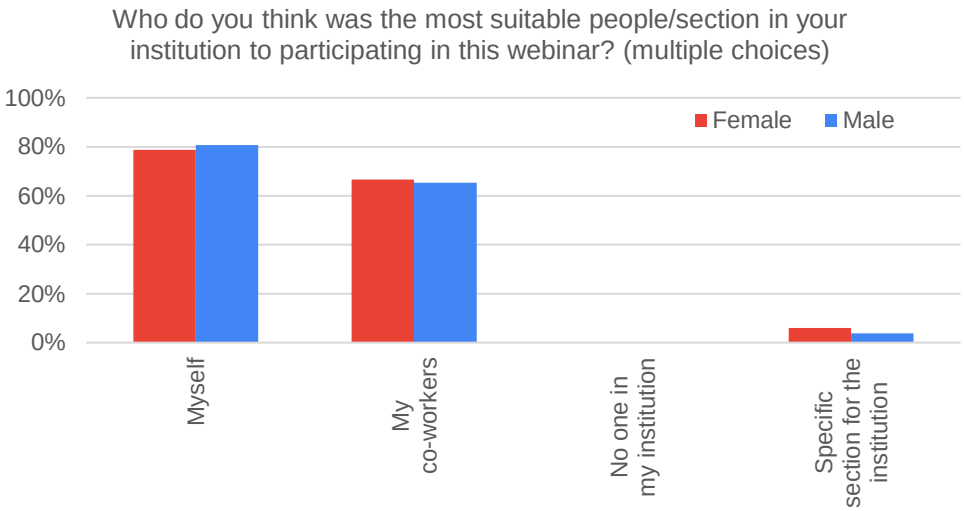
A post-training questionnaire was collected from participants to analyse the results of the programme. Total of 59 response was received. Participants had different level of understanding. More than 60% of the respondents felt that the programme fitted their level of competency. Approx. 40% felt that the programme provided lectures higher that the level of their personal competency. This is consistent with the previous results that similar percentage of participants are currently involved in mercury works less than 10%.



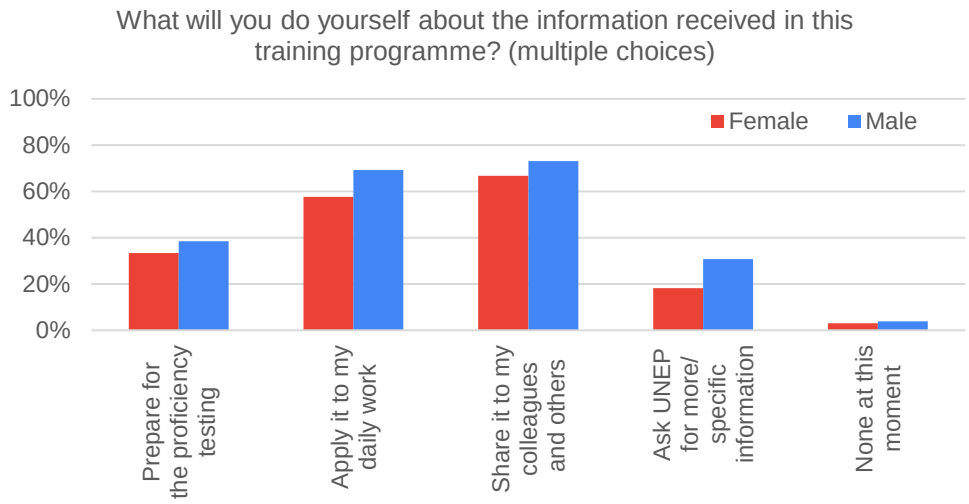
The respondents had different interest in the lectures provided in the programme. Lecture 1: Atmospheric survey and analysis (sample collection) and lecture 3: Solid sample survey and analysis were two most popular topics. These two activities are most likely practiced by the mercury laboratories in developing countries. Also, it is worth to be noted that many other lectures have also received the preferences by some of the respondents. It may come from the affinity to the individual jobs that they are performing on daily basis.



A question was asked about the suitability of the training programme. Approx. 80% of the respondents felt that the programme suited for themselves. More than 60% felt that it also suited for their co-workers.



The programme induced some motivation for the participants. Approx. 60% of the respondents indicated that the information obtained will be used for their own work and/or shared with their colleagues.



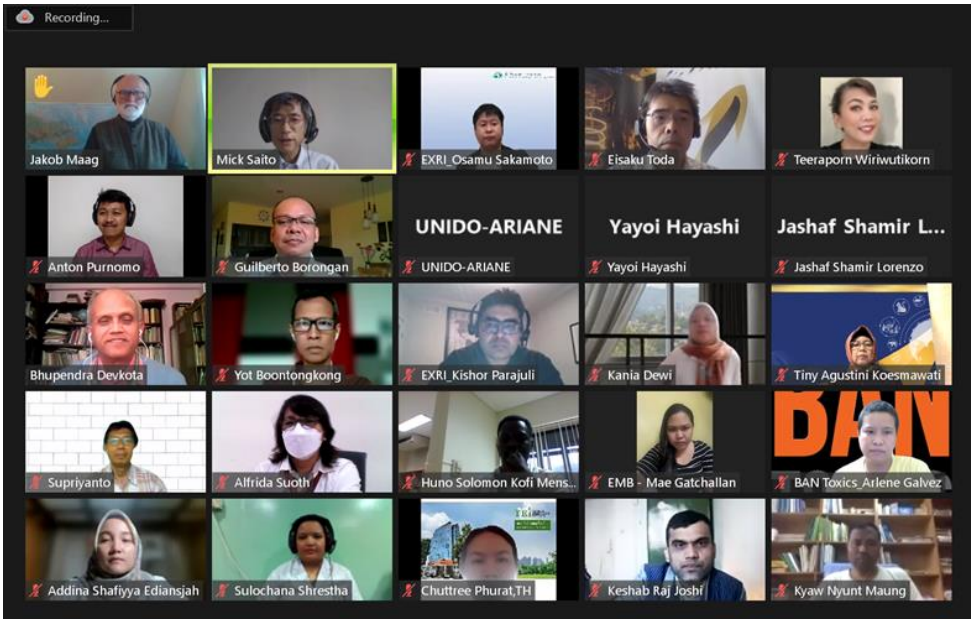
Follow-up actions

This training programme was specially dedicated for the readiness support to the laboratories participating in the PT. The information is made available for the participants who want to refer it for the PT preparation. The materials developed for the programme will be compiled and published for further use in various opportunities such as local trainings.

5.2 Online training programme #4

Outlines of the online training programme

Date & venue	19-20 January and 8-9 and 17 February 2022, virtual meeting
Title	Developing and updating mercury mass flow and inventory
Objective	To support the improvement of national mercury inventories by compiling various types of information. It also introduces a comprehensive mass flow concept to outline the national mercury situation throughout its life cycle. This is a part of continual improvement of national mercury mass flow and inventory for better science-based policy making and implementation.
Programme	The training programme is composed of 5 sessions in 5 days (3 hours each including opening, brief note, etc.). Session 1: Mercury issues and source categories Session 2: Principles and practice Session 3: Stepwise discovering of mercury mass flows, Part 1 Session 4: Stepwise discovering of mercury mass flows, Part 2 Session 5: Presentations of the internal mass balance setup
Participants	Ministry/agency responsible for monitoring/management of mercury emissions and releases to air, water, and soil. University, research institute or consulting company which is engaged in development of mercury inventory. National Focal Points of the Minamata Convention. In order to enhance the effectiveness of the training programme, participants from different sectors in each country were encourages to create teams for group exercises. This programme was jointly implemented by UNEP and MOEJ to enhance the effectiveness and impacts. Participants: 103 from 6 countries/regions (Indonesia: 27, Mongolia: 7, Nepal: 9, Philippines: 35, Thailand: 21, and Vietnam: 4) Observers: 4 Resource persons: 9 Organizers: 5 from UNEP and MOEJ Secretariat: 3 from UNITAR



Summary of the results

The fourth online training programme on 'Developing and updating mercury mass flow and inventory', held on 19, 20 January and 08, 09 and 17 February 2022, was attended by approx. 120 participants, observers, resource persons, etc. Their background is diverse from environmental to industrial while environmental ministries and NGOs took the largest portion. International and regional institutions based in the region also participated and provided substantive input to the programme.

The purpose of this workshop was to support the improvement of national mercury inventories by compiling various types of information. It also introduces a comprehensive mass flow concept to outline the national mercury situation throughout its life cycle.

The training programme was composed of 5 sessions (3 hours each) in 5 days spread over 1 month. The days 1-4 provided training and country experience with inventory and mass flow development and group work on mercury source identification and mass flow development. Day 5 was devoted to reporting of the progress in group work, including results, successes and challenges, and input to how mercury mass flows can be developed further in the participating countries.

Due to COVID-19 situation, the international movement for most of countries is severely restricted, thus, the training was programmed virtually through internet communication tool. One of new arrangement was to apply an online whiteboard 'Miro" to develop mercury flow diagrams.

The programme was opened with welcome remarks from UNEP ROAP, MOEJ and UNITAR.

Session 1: Mercury issues and source categories

- Lecture 1: Mercury issues and Minamata Convention and how mercury inventories and mercury mass flows can contribute.
- Lecture 2: Mercury source category.
- Group work 1: Identifying mercury source types and anticipated data availability in each country.
- Brief note 1: Mercury surveys to industries and knowledge centres. (Mr. Takashi Nishida, EXRI)

Session 2: Principles and practice

- Lecture 3: Mass balance principle and examples on process, sectoral and societal level.
- Country presentation: Experience with making mercury inventories in Nepal: Results, successes and challenges (Dr. Bhupendra Devkota)

Session 3: Stepwise discovering of mercury mass flows, Part 1

- Lecture 4: Steps in mercury mass flow development: Sector definitions, identifying individual flows, quantification of flows.
- Brief note 2: The Japanese mercury materials flow analysis; process and results. (Mr. Kishor Parajuli, EXRI)
- Group work 2: Identifying and quantifying flows.

Session 4: Stepwise discovering of mercury mass flows, Part 2

- Lecture 5: Steps in mercury mass flow development: Quantification of stocks, collection of supplementary data, working with intervals, available online tools and resources.
- Lecture 6: Steps in mercury mass flow development: Closing and calibrating the mass balance, identifying and reducing uncertainties, reporting and review.
- Group work 3: Improving and expanding the national mercury mass flow. Introduction + planning and starting the improvements.
- Brief note 3: Examples of mass flows for other chemicals and materials, and Danish experience with mass flow development. (Dr. Carsten Lassen, COWI)

Session 5: Stepwise discovering of mercury mass flows, Part 2

- Final presentation: Presentations of the initial mass balance setup and plans for future work on the mercury in the countries including Q&A and discussion.
- Brief note 4: Mercury flow analysis in solid waste management sector in Minamata area. (Ms. Yayoi Hayashi, OECC)
- Discussion: Advancing mercury mass flow and inventory development in each country.

A post-training questionnaire survey using the online meeting platform collected feedback from the participants.

Lectures and exercises

The time difference among participating countries is within plus/minus 2 hours from Thai central time (GMT+7), which was one of the considerations to develop time arrangement of the sessions. The training sessions were taking place in the afternoons, Thai time.

Day 1

Short opening remarks were presented by co-organizers of the online training programme.

Dr. Mick Saito welcomed, on behalf of the UNEP-ROAP Director, Dr. Mushtaq Memon, all the participants to the 4th online training program entitled, ”Developing and updating mercury mass flow and inventory”, which was jointly organized by UNEP and the Ministry of the Environment, Japan (MOEJ) with the support of the United nations Institute for Training and Research (UNITAR) and EX Research Institute (EXRI), Japan. The aim of this workshop was to support the improvement of national mercury inventories by compiling various types of information. It also introduces a comprehensive mass flow concept to outline the national mercury situation throughout its life cycle.

Mr. Hitoshi Yoshizaki, MOEJ, highlighted the importance of mercury management, emphasized Japan's support for the implementation of the Minamata Convention in the region, and expressed the hope that this workshop could support the participating countries in developing inventories and mass flows that could provide a useful basis for efficient implementation of the Convention nationally.

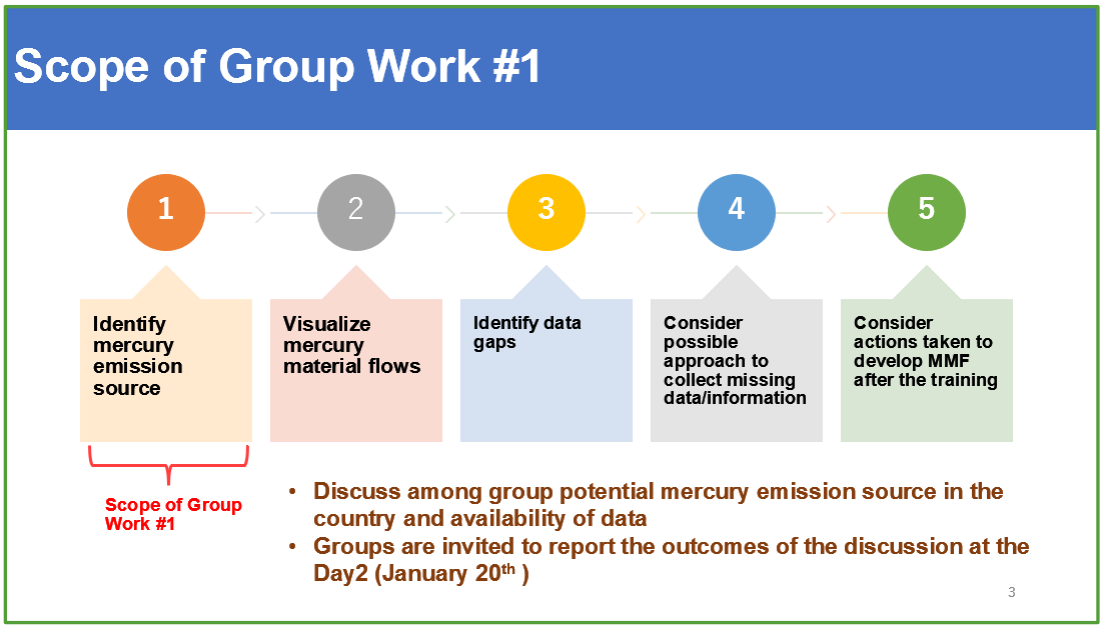
Mr. Jakob Maag welcomed the participants on behalf of UNITAR and expressed the hope that this training would be of benefit for all participants, and that the materials developed will be of use for trainer in the participating countries and beyond.

Dr. Saito, then in the form of a recorded video presentation, briefly explained the objectives, expected outcomes and schedule of the training programme, which aimed to support national mercury monitoring and management of the participating countries.

Session 1 started with Lecture 1 by Mr. Jakob Maag, mercury expert at UNITAR, describing the mercury issue and how mercury inventories and mass flows can contribute to countries implementation of the Minamata Convention. He stated that while this lecture would be well known information for most participants, it was needed to secure the necessary level for participating in the subsequent sessions for all.

Mr. Maag then continued with Lecture 2, focusing on the mercury source categories.

Day 1 was concluded with the first group work session, where countries were distributed into the virtual break-out rooms to work with the identification of mercury source categories in each country, and (if time allows) potential data sources for these categories. Four groups, Indonesia, Philippines, Thailand, Nepal (and others) were formed.



Dr. Saito concluded the workshop day and invited participants to take part in Day 2 scheduled for the next day.

Day 2

Day 2 started with brief reports back from Group work 1, which found challenging for most groups because of the limited time available.

Mr. Takashi Nishida, EXRI, then presented Brief note 1 outlining the methods used for data collection in Japan's mercury materials flow development, and the advantages and drawbacks of the individual data collection methods. The presentation was an illustrative example of a mercury mass flow development case. This concluded Session 1.

Session 2 was initiated by a presentation from Dr. Mick Saito on key features of the mercury problem and the wide application mercury has had and still have to a certain extent, as per the restrictions of its use stipulated by the Minamata Convention.

The followed Lecture 3 by Mr. Jakob Maag describing the mass balance principle and examples on process, sectoral and societal level. He also elucidated the relations between mercury mass flows, the UNEP Mercury Inventory Toolkit and other mercury inventory tools.

Then, Dr. Bhupendra Devkota presented the experience in the case of Nepal with making mercury inventories. He highlighted the results obtained as well as the successes and challenges met in the work. Major challenges were, as observed in many countries, lack of data for some mercury source sub-categories. He also highlighted a source sub-category that was seen to be important in the country but does not yet have an individual entry in the UNEP Mercury Inventory Toolkit because of lack of data. Dr. Devkota informed that a follow-up study is in progress in Nepal on this topic, which hopefully can inform the Toolkit in any future updates.

Dr. Saito concluded the workshop day and invited participants to take part in Day 3.

Day 3

Session 3 was briefly introduced by Dr. Saito.

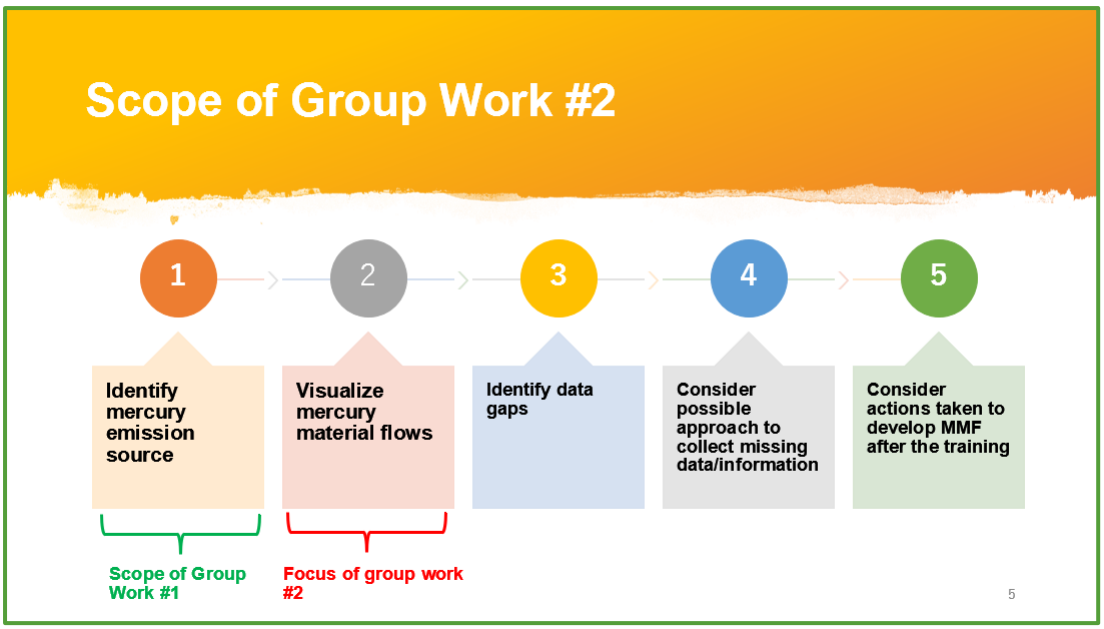
Mr. Jakob Maag then presented Lecture 4, explaining how mercury source categories can ideally be defined by using the definitions in the Toolkit. He also explained how the individual mercury flows can be identified and quantified.

In Brief note 2, Mr. Kishor Parajuli, EXRI, presented the process and results of the 2016 mercury materials (mass) flow of Japan. He gave further details of the illustrative example of Japan's efforts and highlighted the challenges and successes of the process. He explained how making materials flow assessments can be complicated and how – due to difficulties with getting response from all data owners – some data needed to be extrapolated to cover the full national situation. The example was seen as typical for developed countries and illustrative for developing countries.

Then, Group work 2 was introduced. It focused on the visualization of mercury flows in each country, based on the source identification of Group work 1 and the explanations given in Lectures 3 and 4. The group work was conducted in virtual breakout-rooms; this time in combination with pre-setup virtual MIRO white-boards specific to each group. The groups were as for Group work 1, except the observers from other countries than the four main countries this time joined the Philippines' group (this division was later used in Group 3 as well).

Since working in MIRO boards was new to some participants, careful instruction was given by Ms. Yuki Hashimoto, EXRI, on how to do indicate mercury source categories (sectors/processes), flow arrows, flow tonnages and comments in MIRO.

This was followed by a short animation video created in cooperation between EXRI and UNITAR, summarising the steps in developing mercury mass flows.



Dr Mick Saito concluded the workshop day and invited participants to take part in Day 4.

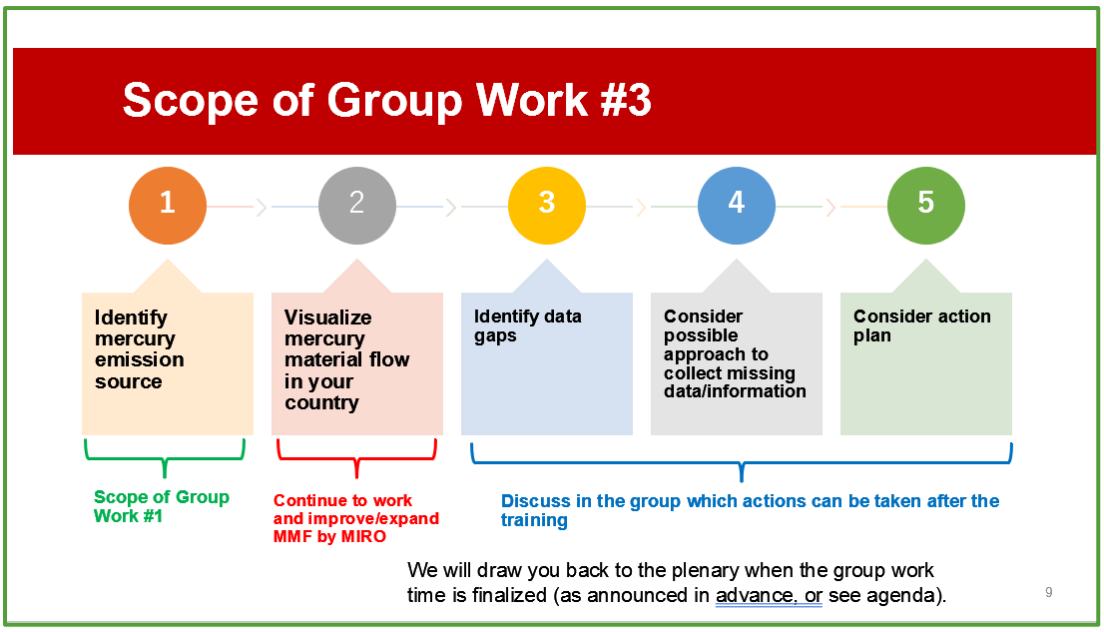
Day 4

Session 4 was briefly introduced by Dr. Saito.

Thereafter Mr. Jakob Maag presented Lecture 5 on continued steps in the development of mercury mass flows, explaining principles for quantification of mercury stocks on trade and in the general society, as well as possibilities for collection of supplementary data, the art of working with intervals (instead of one-number entry date and results), and available online tools and resources.

Mr. Maag continued with Lecture 6 on the principles for closing the national mass balance if adequate data are available, on identifying and reducing uncertainties in the mass flow quantifications, and on reporting principles and draft inventory reviewing. As part of this, he illustrated how diverging data can contribute to “assembling the puzzle” of making the best possible estimates, using an example from the Danish Paradigm for Substance Flow Assessments (SFA = mass flows).

Then, the group work continued with Group work 3 on improving and expanding the national mercury mass flow, as well as a discussion on how to proceed in each country with data collection and stakeholder involvement to make/finalise actual mercury mass flows.



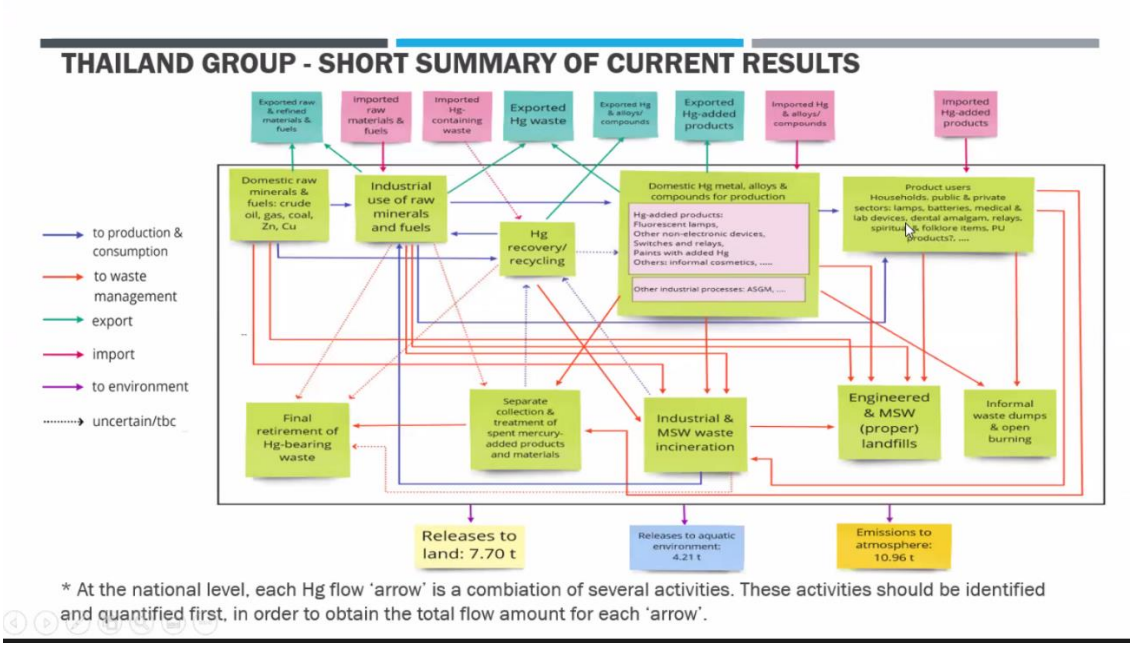
Dr. Saito concluded the workshop day and invited participants to take part in Day 5.

Day 5

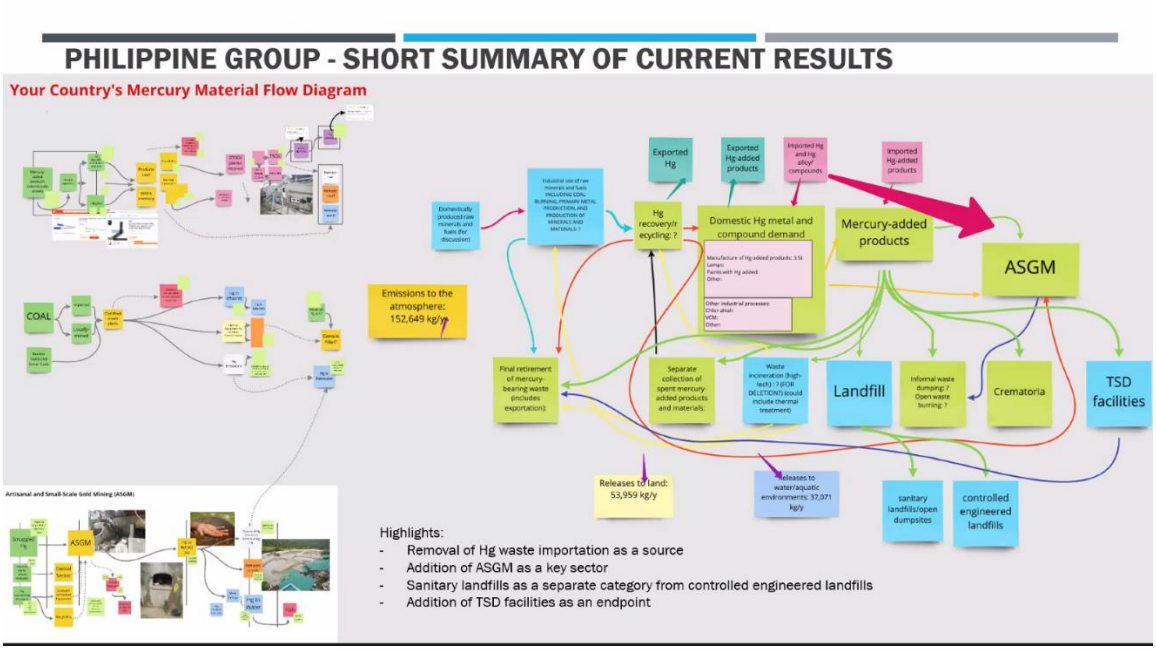
Day 5 started with Brief note 3, presented by Dr. Carsten Lassen, COWI, Denmark, on examples of mass flows for other chemicals and materials, and Danish experience with mass flow development. Dr. Lassen confirmed – through examples from Danish mass flow (also called SFA) work – the importance of many of the lessons from the training performed in this course, for example on handling uncertainties and the benefits of closing the mass balance when the required data are available. He also presented a list of mass flows (=SFAs) done in Denmark; many of them done by Dr Lassen, Jakob Maag and their colleagues.

Session 5 was thereafter introduced by Dr. Saito, after which the group facilitators presented the status of their results, process experience and discussion points. All four group focus countries had the advantage of having earlier Toolkit Level 2 mercury inventories at their disposal. Indonesia, Nepal, and Philippines worked on in their mass flow charts developed in the previous training workshop under this project (March 2021), while Thailand started from scratch with their mercury mass flow chart development.

Dr. Yot Boontongkong presented the work in the Thailand group. He explained the status of the mass flow chart and highlighted data gaps, data collection strategy suggestions and challenges/advantages of mass flows as summarised in the discussion topics.



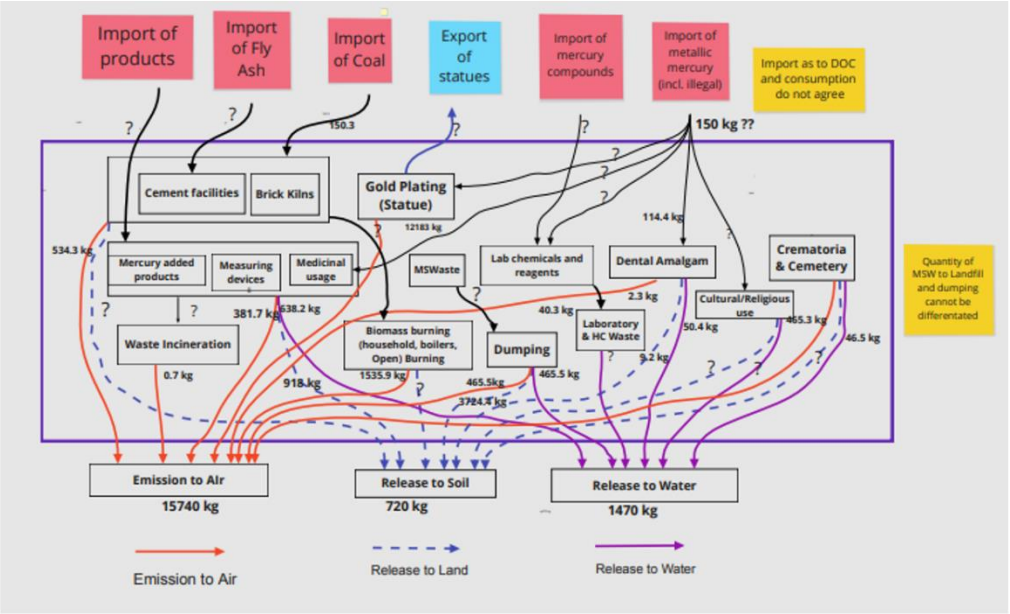
Dr. Jashaf Shamir Lorenzo presented the work in the Philippines group. He explained the status of the mass flow chart and highlighted data gaps, data collection strategy suggestions and challenges/advantages of mass flows.



Dr. Bhupendra Devkota presented the work in the Nepal group. He explained the status of the mass flow chart and highlighted data gaps, data collection strategy suggestions and challenges/advantages of mass flows.

[NEPAL] GROUP - SHORT SUMMARY OF CURRENT RESULTS

- [insert a screenshot of MIRO board at its present state]
- [insert short texts, as needed]



Dr. Kania Devi presented the work in the Indonesia group. She explained the status of the mass flow chart and highlighted data gaps, data collection strategy suggestions and challenges/advantages of mass flows.

Many similar data gaps, challenges and suggestions for solutions and follow-up actions were presented by the groups.

Analysis of group discussions

The below is a cross-cutting analysis and summary of points raised in the group discussions; some entries are joined here based on similar/related points made by groups in slides or.

Key data gaps highlighted	Key challenges highlighted	Suggestions for ways forward
Mercury (Hg) contents/concentration in waste (municipal, medical, etc.; IDN, NPL, PHL)	Information sharing among governmental institutions, lacking knowledge of the mercury problem (IDN, NPL)	Improve communication among GOV institutions, with local institutions, industry and NGOs/CSOs through awareness raising and improving/developing system(s) for data sharing (IDN, NPL, PHL, THA)
Hg in industrial inputs, production and emissions/releases (IDN, NPL)	Getting data from industry and informal sectors; “regulation phobia”, trade secrets, fear of prosecution (IDN, NPL, THA)	Approach stakeholders via trusted middle persons (associations, GOV, etc.), create incentives for data sharing (THA)
Hg in imported products (IDN)	Lack of specific customs codes for mercury-added products (IDN, NPL, THL)	Implement mercury-specific customs codes suggested under the Minamata Convention (THA, NPL, IDN)

Un-recorded/illegal imports (NPL)	Stakeholder engagement made difficult by COVID pandemic (PHL)	Increase awareness raising to create common motivation (NPL, THA)
Data from informal sectors (waste, ASGM; THA)	Lack of nationally specific input/output factors (meaning data related to estimation with inventory toolkit or similar; THA)	Prioritise further mercury flow analysis efforts to key Hg inputs/outputs (THA)
		Be open to international assistance (IDN)
		Improve laboratory capacity (IDN)

IDN: Indonesia; NPL: Nepal; PHL: Philippines; THA: Thailand.

Further in the programme, Brief note 4 entitled "Mercury flow analysis in solid waste management sector in Minamata area", was presented by Yayoi Hayashi, OECC. She gave an overview of the flow of mercury in the waste management conducted in Minamata and two adjacent cities using the same facilities, highlighted existing data and data gaps, and posed questions on suggested ways forward in their work with quantifying mercury outputs. The participants advised to apply mass balance principles to estimate the mercury inputs through interpolation from the national mercury demand/usage situation, and thereby get an impression of possible quantities of mercury entering the area in question. Such estimates could inform the strategy for any further data collection.

The next agenda point was a concluding brief plenary discussion on advancing mercury mass flow and inventory development in each country, facilitated by Dr Osamu Sakamoto, EXRI.

Ms. Suki Kuroda from the Ministry of Environment Japan (MOEJ) expressed the following:

As a sponsor of this 5-day seminar, MOEJ appreciated all the effort the experts made to make this seminar fruitful. MOEJ also thanked all the participants who shared the valuable time with us and the active interaction. MOEJ believed that the MMF training package that was developed by experts from UNEP/UNITAR/EXRI for this seminar was a living material which can be improved regularly by reflecting the feedbacks from those who actually used in their home countries. Sharing lessons and experiences were appreciated. MOEJ considered that developing MMF was very important for mercury policy development and evaluation. MOEJ started cooperation with Nepal and Philippines to provide technical support for the MMF development, which will be shared in future.

MOEJ also committed to assist other countries that were motivated to develop MMF. Similarly, MOEJ will actively collaborate with ongoing and future projects which are implemented with the GEF or other financial mechanism and appreciated updating the progress of those project to seek possible synergies with its support.

UNIDO, Mr Dave Ariane mentioned that they look forward to synergies between the MOEJ-supported project and a GEF funded project on mercury in the Philippines.

Nepal (Dr. Bhupendra) expressed his gratitude for having been involved in the work of this project and explained that the project will help fill some of the gaps that became evident during the course of their Minamata Initial Assessment work conducted in the country. The training supported this work, and he will use it further in the training of government officials and others in Nepal.

AIT, Mr. Guilberto Borongan, explained that they conducted the products on mercury usages in the health sector in Philippines and Indonesia, and the training conducted in March 2021 contributed to

their project. AIT is now identifying other countries for sharing of the experience made in the first two countries. He expressed his gratitude to MOEJ and the national partners for the cooperation.

Mr. Anton Purnomo, BCRC-SEA, thanked the organizers of this workshop for the useful training and looked forward to continuous cooperation in the work to implement the Minamata Convention to reduce mercury's impacts.

The Minamata Convention Secretariat, Mr. Eisaku Toda, was impressed by the work done, especially in the countries' mass flow exercises of this workshop, and that this supports the Convention's requirements for cooperation among parties (Article 19), and raised the questions of how we can share this work with other countries to improve the mercury inventories to be used in reporting to the Convention's Articles 8, 9, 3 [emission and release sources, resp.], but also to the effectiveness evaluation of Article 22 to be performed.

Mr. Osamu Sakamoto summed up the comments underlining the common understanding that the training package will be useful in the countries' implementation of the Minamata Convention. He expressed the hope that the work can be continued and that mutual updates on efforts can be shared on a regular basis.

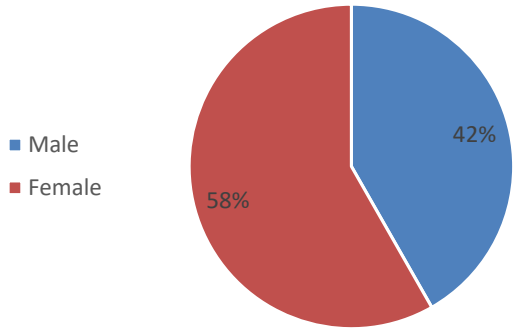
Dr. Saito wrapped up and closed the workshop, emphasising that while mercury is gradually being substituted, mercury waste must be managed for a long time still. The mass flow concept can help policy makers understand how they can target the mercury issue. We know that mercury is an element presents in nature, so we are not insisting on complete elimination of mercury in the environment, but we need to reach acceptable levels through science-based management of mercury. UNEP will publish the developed training materials for use in local training programmes. He emphasised that this is a starting point for countries making their mercury mass flows for their own purpose. The work and sharing will continue.

Results analysis

The training programme was attended by 103 participants, 4 observers, 8 resource persons, 5 organizers, and 3 secretariats. The participants came from 6 project partner countries. Majority of the participants came from environmental sector. One of the positive indications is that the programme was attended by private sector and academia, which fits the purpose of mercury mass flow development. The total number is more that the Online training programme #2 held in March 2021. Countries intending the development and/or improvement of the national mercury inventory registered more participants to this training.

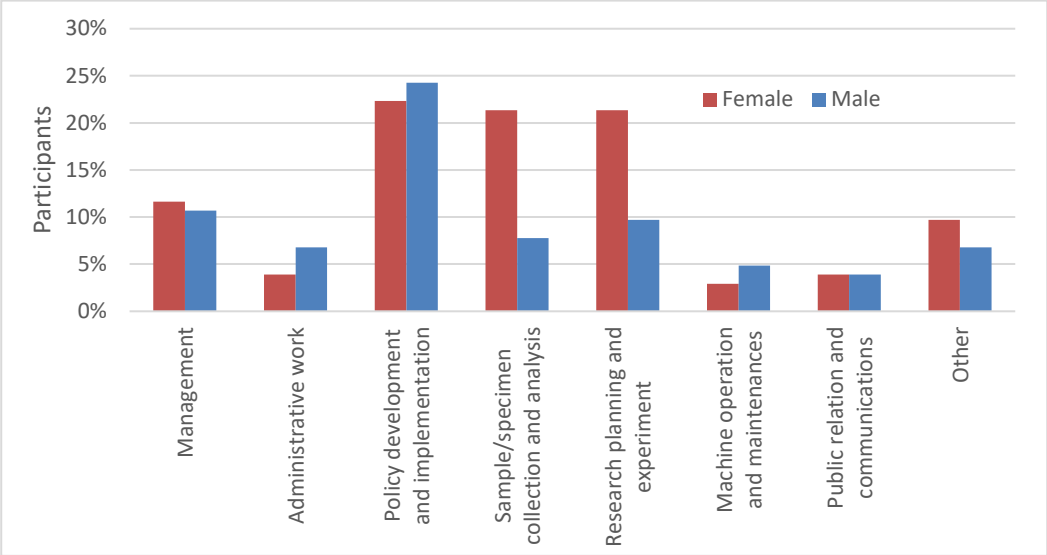
Project partners	Total	Remarks	Project partners	Total	Remarks
Indonesia	27	17 from environment, 1 from marine, 4 from academia, 4 from BCRC, 1 from private sector	Philippines	35	27 from environment, 8 from private sector and NGO
Mongolia	7	7 from environment	Thailand	21	7 from environment, 5 from academia, 7 from research institute, 2 from AIT
Nepal	9	6 from environment, 3 from private sector	Vietnam	4	4 from environment

Among the 103 participants, 60 (59%) were female and 43 (42%) were male. It is continuous trends that more female is participating in the training programme, which suggests the project benefits more to female.

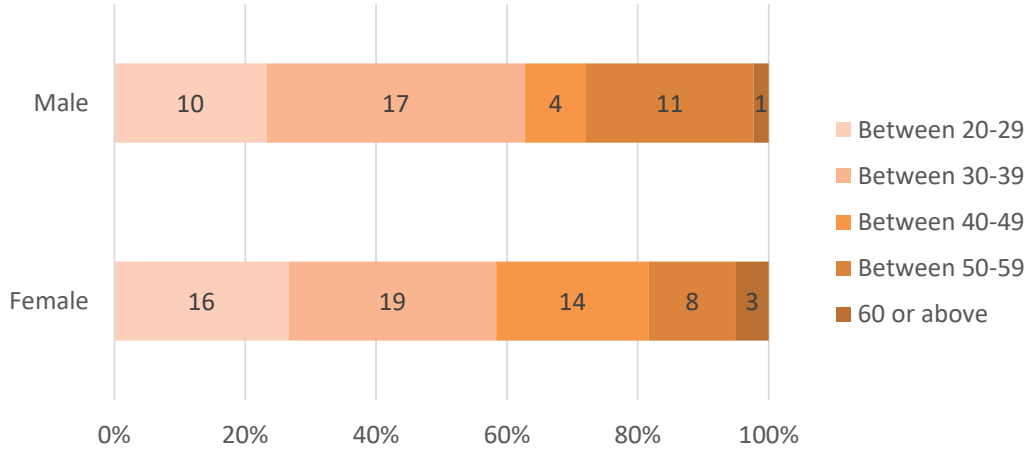


Gender distribution of the participants

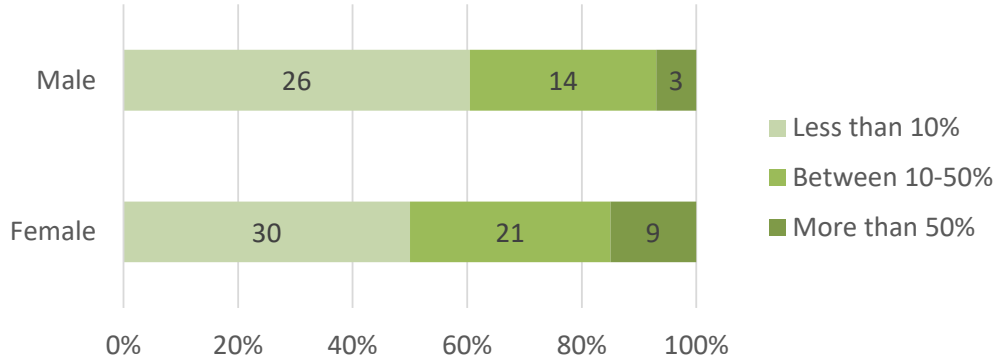
The roles of the participants in the institutions were significantly different between female and male in the area of research and laboratory analysis. This programme targets wider stakeholder groups but male participants were predominantly came from policy and management sectors.



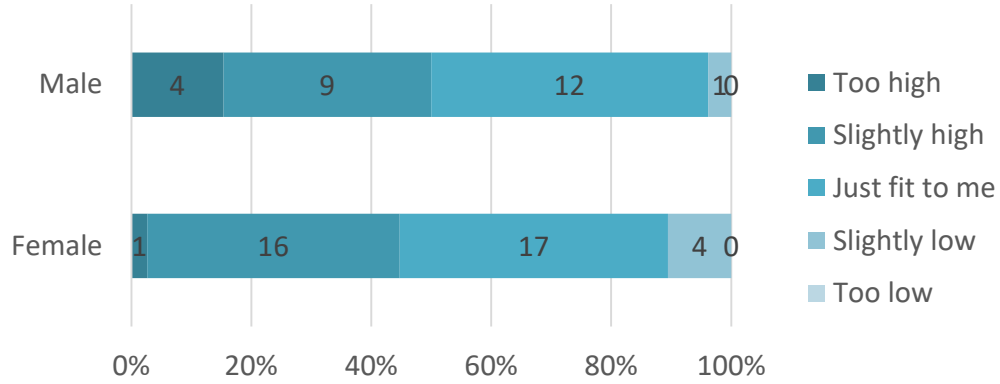
As for the age distribution, the female participants in age 40's are significantly outnumbered male participants. This middle-aged female participants might play important roles for the development and improvement of national mass flow and inventory. The future Project activities may consider this group to promote female capacity in this area.



More female participants have been dedicated their time for mercury-related works. The percentage shows more involvement of female participants particularly the people involved in more than 50 % are 3 times higher for female participants than for male participants. On the other hand, many of them are doing more works other than mercury. The participants with the mercury-related works less than 10% may have acquired knowledge that could enable them more works in future.

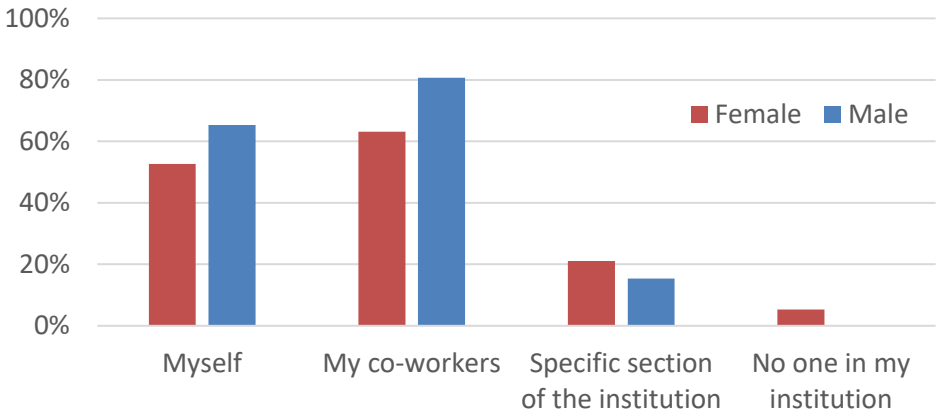


A post-training questionnaire was collected from participants to analyse the results of the programme. Total of 64 response was received. Participants had different level of understanding. Approx. half of the respondents felt that the programme fitted their level of competency. Approx. 40% felt that the programme provided lectures higher that the level of their personal competency. This is consistent with the previous results that similar percentage of participants are currently involved in mercury works less than 10%.

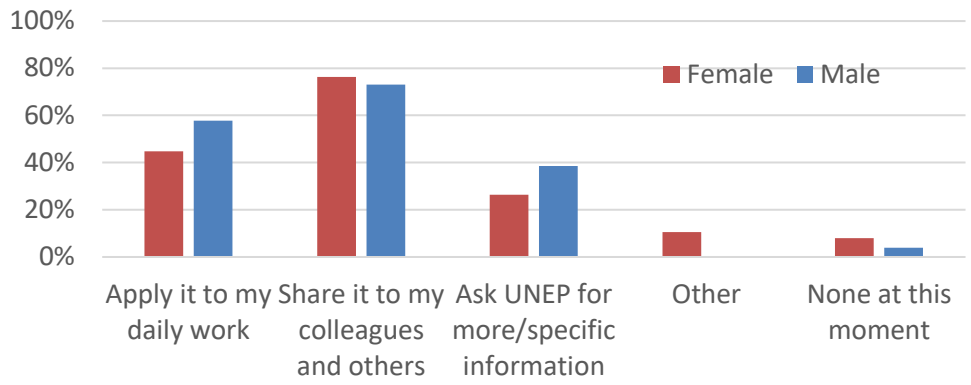


The respondents had different interest in the lectures provided in the programme. Lecture 3: Mass balance principle and examples on process, sectoral and societal level and lecture 1: Mercury issues and Minamata Convention and how mercury inventories and mercury mass flows can contribute were two most popular topics. Also, it is worth to be noted that many other lectures have also received the preferences by some of the respondents. It may come from the affinity to the individual jobs and the topics in the lecture.

A question was asked about the suitability of the training programme. Approx. 60% of the respondents felt that the programme suited for themselves. More respondents 60% felt that it suited more for their co-workers.



The programme induced some motivation for the participants. Approx. 60% of the respondents indicated that the information obtained will be used for their own work and/or shared with their colleagues.



Follow-up actions

This training programme was organized to initiate the development of national mercury mass flow development. Four countries have conducted the exercise for the development, which will deepen the understanding of the mass flow concept. The materials developed for the programme will be compiled and published for further use in various opportunities such as local trainings.

5.3 Capacity assessment of existing monitoring laboratories: Nepal

Objective of the assessment

This work aims at evaluating the current mercury monitoring capacity of the analytical institutions that are monitoring (or will monitor in near future) mercury levels in the country in order to clarify the areas in need of intensive assistance in the coming years to set clear direction for future assistance. The identified needs and gaps will serve the basis of technical assistances under the project.

Laboratories subject to assessment

Nepal was selected as the first survey country and the Laboratory in Department of Environment, in Ministry of Forests and Environment, and National Public Health Laboratory, in Ministry of Health and Population were identified as the analytical laboratories. As the official visits were not possible due to recent COVID-19 situation, a local coordinator was engaged to communicate with the stakeholders for survey planning.

Country	Monitoring facility	Organization
Nepal	Laboratory in Department of Environment	Ministry of Forests and Environment
Nepal	National Public Health Laboratory	Ministry of Health and Population

Survey methods

Under the travel restriction, the assessment survey explored the possibility to obtain necessary data by a series of online hearings to the staff of the analytical institutions. New and emerging online technologies that enables real-time two-way communications were considered as the means of this virtual survey.

The survey team, which composes of four international experts (team leader, project management, assessment of lab instrumental analysis, and assessment of lab quality management) and a national coordinator, exchanges information and discusses with managers/staff/technicians of those monitoring facilities on the issues regarding the research and monitoring activities taking into account the national status. The international experts are the knowledgeable in lab operation and chemical analysis particularly on mercury. They collaboratively assess the local settings and consolidate their views in the assessment report. The national coordinator works with international experts and establishes relation to the laboratories subject to the survey.

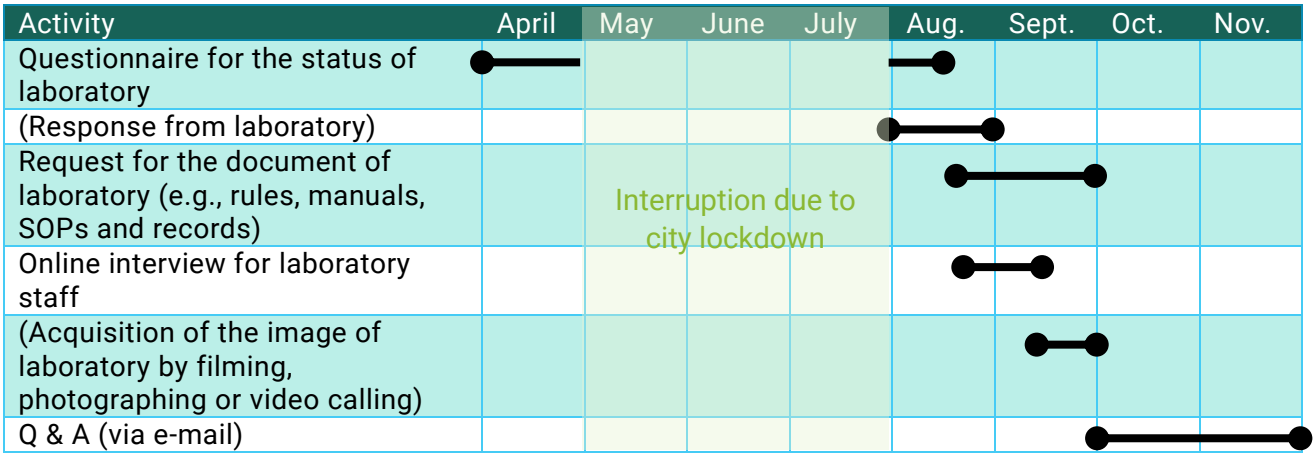
The current situation of laboratories was assessed from following perspectives:

- Media subject to survey and analysis
- Forms of mercury surveyed and analysed
- Personnel and organisational structure
- Method and procedures for survey (sampling) and analysis
- ISO accreditation and quality management system, etc.
- Sample handling

- Facilities, apparatus, reagents, and measuring instruments
- Exhaust and water discharge

Workplan and progress

The survey involves 4 steps starting from questionnaire survey, which laboratory staff filled the form as much as possible. Then, two-way real-time communication was conducted together with the collection existing lab management documents. Some follow up Q & A were also conducted. Assessment report of the laboratory situation captures the issues and challenges and include suggestions for the laboratory advancement and its support.



There was one thing unfortunate for the project. As Nepal shares long land border with India and suffered from the inflow of the Indian (Delta) variant of COVID-19 that resulted in the rapid increase of new cases since late April 2021. The Government of Nepal imposed strict control measures to limit people's movement and access to offices, which forced the project activity put on hold for a couple of months. The actual survey was resumed in August.

Questionnaire for laboratory situation

The questionnaire to the laboratories was created to facilitate the survey by knowing the current situation of the laboratories prior to the online survey. This questionnaire included the items regarding such as current survey and analysis activities, personnel, facility and equipment, quality management, laboratory safety and environmental management. The questionnaire was sent to target laboratories, and answers were sent back prior to the online laboratory survey.

Online laboratory survey

Two types of online lab surveys were conducted: interviews with laboratory staff using a web meeting system and a virtual laboratory video surveys using a web meeting system with video. The online survey of the target laboratories was conducted at the following schedule:

National Public Health Laboratory (NPHL)

- Online interview: 25 August 2021
- Virtual laboratory video survey: 13 September 2021

Department of Environment (DoE) laboratory

- Online interview: 7 September 2021
- Virtual laboratory video survey: 27 September 2021

National Public Health Laboratory (NPHL)

Current situation of the laboratory

1 Media of surveyed and analyse

NPHL has not performed mercury analysis yet. The main focus of the laboratory is diagnostic tests (haematology, biochemistry, immunology), and other medical and public health and surveillance related test such as COVID, Influenza, JE, Measles etc. Some environmental (water environment or wastewater) monitoring is being conducted at present (e.g. Environmental polio surveillance) and some planned in near future.

2 Forms of mercury surveyed and analysed

Currently any chemical form of mercury survey or analysis has not been conducted yet.

3 Personnel and organization

Currently (September 2021), there are around 100 staff in the institute. Out of these, around 70% or above are technical staff with varied educational background, ranging from diploma level to post graduate. However, the number of the staff who is experienced environmental survey and analysis is few, approximately 5 staff.

4 Methods and procedures for the survey (sampling)

The survey and analysis for heavy metals including mercury or other trace elements has not been conducted in NPHL yet. However, the staff have experienced environmental water sample collection for biological survey. SOP for the sample collection is prepared.

5 Methods and procedures for the analysis

Currently any chemical analysis for environmental parameter including mercury have not been conducted yet.

6 ISO accreditation, etc.

NPHL has obtained ISO15189:2012 accreditation, which is a medical laboratory accreditation standard.

7 Quality management system

Even it is different from the testing laboratory standard ISO/IEC17025, both are focused on quality management so many systems are applicable for 17025 system, and experience of the staff for quality management is also useful.

For the management of analytical results, Bidirectional laboratory information management system (LIMS) is in place for most of the equipment.

8 Samples

Collected water samples (for the analysis of polio) are primarily stored in refrigerator (2-4 degree C), after pre-treatment (concentration), samples are stored in freezer (-80 degree C) until the shipment to analytical institute. The samples are labelled with their unique ID to avoid the confusing of similar sample.

9 Facilities

Since the chemical analysis has not been conducted yet, there are no room for chemical analysis including mercury. However, there is a spare room, which can be used for future mercury analysis (not yet refurbished for analysis).

On the status of the facility, the supply of power, water and so forth are stable and reliable.

10 Apparatus

Since the chemical analysis has not been conducted yet, there are no apparatus for chemical analysis including mercury.

11 Reagents

Since the chemical analysis has not been conducted yet, no reagents for apparatus for chemical analysis including mercury are stored yet. From the information of other chemical analysis laboratory in Kathmandu, there are probably not major troubles for purchasing such reagents when the mercury analysis will be started.

Even though the reagent is for clinical test, not for chemical analysis, there is the management system including SOPs are organized. Most of this system are applicable for the future reagent management for chemical analysis.

12 Measuring instruments

The measuring instruments for chemical analysis have not been installed so far. (For bacterial and other microbial identification, MALDI-TOF-MS from bioMerieux, VITEK, has just been installed).

The many instruments, although not for chemical analysis, are operated under the quality management system, also the SOPs for the operation and maintenance are prepared and implemented. Many of them are under the maintenance contract with provider, so most of them are well supported condition (however, some issues relating delayed response occurred in some equipment are reported). From the information of other chemical analysis laboratory in Kathmandu, most of the measuring instruments for mercury analysis seems to be able to install without problems. Since most part of the management system for medical equipment can be applicable, there are lesser works to build a management (operation and maintenance) system for such instruments.

13 Exhaust and water discharge

The room for chemical analysis has not been equipped, thus no protection or treatment system for toxic gas, water and solid waste, etc. The biosafety cabinets are in lab rooms where needed, for protection from biohazard, and wastewater after clinical test is treated as necessary and released

into municipal wastewater. Fume hood is placed in tissue grossing station for protection from formaldehyde gas during grossing. However, most of the equipment and treatment procedure may not be applicable for toxic chemical conditions such as strong acid, so new equipment for the environmental control become necessary when the chemical analysis is started.

Even the environmental management system such as ISO14001 is not implemented, SOPs for laboratory safety management and solid waste management are prepared and operated.

Discussion for future support for establishment or advance of mercury survey and monitoring

1. Summary of the current situation of mercury or other chemical substances survey/monitoring

1-a) Media and parameters

At present, testing activity in NPHL focuses on clinical and public health related test, and so far, analysis of organic and inorganic chemical substances including mercury in the environment and human organisms has not been conducted. Thus, there is no or very few equipment for chemical analysis including mercury such as measuring instruments, reagents for analysis pre-treatment (strong acids, etc.), glassware and safety equipment (exhaust chamber for handling toxic gas, etc.) yet. When NPHL begins mercury analysis, such equipment for chemical analysis will be required in addition to the measuring instrument, in particular, a room for sample preparation where strong acid treatment etc. are applicable. The cost of such equipment and the space for analytical pre-treatment and safety operation may not be small, thus it should be considered the necessity and priority of the chemical analysis in line with the mandate of the institution. Once such needs are identified and recognized, then the installation cost and floor plan for the analytical pre-treatment and safety operation. (When targeting mercury analysis only, there is an option to use a thermal decomposition type cold vapour atomic absorption spectrometer (CVAAS) that requires little reagents and sample preparation and can be measured with a relatively simple exhaust facility. It is possible to measure total mercury in human hair, urine and blood that are probably the subject of the NPHL.

However, the analysis of heavy metals other than mercury may be required in near future, thus the installation of the room for the chemical analysis could be considered from the beginning. It is expected that reagent storage for chemical analysis will need to be newly installed or expanded because they are not common to biochemical tests. On the other hand, the samples for chemical analysis (assuming human related samples such as hair, urine, blood, etc.) are similar to the one for biochemical analysis, therefore, it is considered that most of the equipment can be shared.

The equipment currently in NPHL is in good condition, and there is no major issue with the power supply. From the information from this laboratory and the DoE laboratory, it is expected that there will be no major obstacles in the installation of the instruments and the purchase of the necessary reagents for mercury analysis.

1-b) Sample collection

Regarding sample collection, there seems to be no problem because it is almost the same as the method and technique for the general clinical testing for human samples. Perhaps the laboratory staff has no experience in collecting hair sample, but mercury in hair is stable and easy to handle, so that it will be easy to carry out. On the other hand, mercury in urine samples, which is not stable, requires sufficient instruction and training for sample transportation and storage. Similarly,

sufficient instruction and training is required when drinking water is targeted for the survey and analysis.

1-c) Laboratory staff

NPHL has focused on clinical test for their testing operation so far, thus there are very few personnel who have experience in chemical analysis. Training and experience are required for actual analysis operation, and also, laboratory management including quality assurance / quality control requires the high knowledge and experience of the chemical analysis. Thus, it should be considered the plan such as the participation of new staff or support of external institute for smooth laboratory start-up.

1-d) Measuring instruments

Reduction aeration type cold vapour atomic absorption spectrometer (CVAAS) or thermal decomposition type CVAAS those which are commonly used for mercury measurement are suitable for total mercury analysis. Each device has its own strengths and weaknesses, but both can handle the analysis of human biological samples. They can be used for the measurement of drinking water sample when the purpose of the analysis is the judgment of health effects (relating with such as the standards or criteria), However, when the precise quantification of concentration in the background level ambient water is required (in many case, it is around 1 ng/L order of concentration), procedure of sample concentration, or measurement by the high sensitivity instrument such as cold vapour atomic fluorescence spectrometer (CVAFS) is required. In any way, stricter quality control procedure is necessary for such low-level concentration sample analysis.

In the future, the laboratory may require the analysis of methylmercury in food or human organisms to obtain the information of methylmercury exposure of human. Methylmercury analysis requires a different measuring instrument from total mercury analysis, and there are many challenges if the system of methylmercury analysis is established because of some technical requirements. However, it may also be useful to design of the laboratory room including the procedure of methylmercury analysis at the beginning.

Also, inductively coupled plasma optical emission spectrometer (ICP-OES) or inductively coupled plasma mass spectrometer (ICP-MS) may be options when planning for trace element analysis both mercury and other elements. Although, they are useful instruments because of their high sensitivity and performance of multi element measurement, mercury measurement by ICP-OES or ICP-MS is often problematic, and there are cases where data with many errors is shown. Therefore, it should be noted that there are challenges when mercury measurement by ICP-OES or ICP-MS is planned. (There are many laboratories that heavy metals other than mercury are measured by ICP-OES or ICP-MS, and mercury is measured.by dedicated instruments such as CVAAS.)

1-e) Quality management

NPHL is obtained of ISO15189;2012 accreditation for quality management system for clinical laboratories. When chemical analysis is started, ISO/IEC17025 is the appropriate quality management standard. It is effective to plan the construction of a laboratory management system with the requirements of ISO/IEC17025 in mind from the beginning to maintain and improve the quality of the laboratory continuously and keep the comparability of data with external institutes. Although it is a system related to the same quality management, the current (ISO15189) system may not be used for chemical analysis laboratory based on ISO/IEC17025 quality management system directly because of the difference in the properties of clinical examination and chemical analysis. It should also be noted that the basic idea regarding quality management is same. In

addition, as the personnel have basic training and experience in system operation, it is expected that the creation and operation of the quality management system can be easier than usual.

1-f) Safety and environmental management

In chemical analysis procedure such as mercury, harmful substances such as acid gas, wastewater or solid waste are generated due to the reagent usage. There are no laboratory room or facility for chemical analysis in NPHL yet, but when such laboratory is set up, an exhaust chamber (and gas treatment equipment) for handling harmful gases is required. Currently NPHL is taking a room for future mercury analysis including pre-treatment, however there may be a challenge for arranging the facility and equipment for toxic gas treatment. (There is not the case if only thermal decomposition CVAAS described above is used, but it should also be considered that some combustion gas is generated even in this option). It is also necessary to understand the wastewater and solid waste generated by the analysis operation and prepare a contract with an appropriate treatment company. (Although it is possible to install treatment equipment and treat it within the laboratory, in any case, it seems that waste that cannot be detoxified in the laboratory will remain, so the treatment company should be engaged, and a contract should be made in advance.

2. Suggestions for establishment of mercury survey and analysis

The following items are suggested as the NPHL begins the survey and analysis on mercury.

2-a) Formulation of medium- to long-term future plans

When starting chemical analysis, not only the installation of the equipment for direct operation and measurement for the analysis is important but also the improvement of the laboratory environment and related necessary infrastructure. In the case of NPHL, it is expected that the analysis of many sorts of chemical substances other than mercury could be launched in parallel, so the development plans for the capacity of such other parameters of chemical analysis than mercury should also keep in mind.

Following are example of the items to be considered:

- What is the target medium, and what is the target medium in the near future?
- What is the expected number of samples to be conduct analysis?
- If other heavy metals analysis to be started at the same time?
- If the methylmercury analysis to be started in the near future?

The above contents may require large-scale facility expansion or infrastructure expansion (electric power, etc.) at the time of start-up, and if not planned at the time of laboratory installation, the situation that higher renovation cost may be required. It does not require a definitive and detailed plan, but it may be possible to reduce costs by planning as much as possible for content that requires related facilities.

2-b) Plans for facility and equipment for analysis

Plan of equipment and facility that will be installed immediately or installed near future based on the future plans should be considered. As described above, some equipment has requirements for its installation (installation space, electrical power, exhaust gas treatment, air conditioning for exhaust heat, etc.), so it is important to consider such necessary requirements in advance.

As described in 1-d), if the initial plan of chemical analysis is focused on survey and analysis of total mercury in human organisms (hair, blood, urine, etc.), a reduction aeration CVAAS or thermal

decomposition CVAAS and necessary facility and equipment of analytical pre-treatment (for the measurement of reduction aeration CVAAS, such as the equipment for acid decomposition with heating and gas ventilation and treatment equipment, facility for wastewater treatment) is required. The NPHL may have plans of survey and analysis (which may include parameters other than mercury), thus the laboratory design should be considered including overall plans of the survey and analysis in NPHL. However, as far as analysis using by CVAAS is concerned, it is expected that the size of the room or power requirement is not too high. In addition, there are no expensive reagents or consumable parts for CVAAS. But also, there may be a challenge the facility and equipment for toxic chemicals handling such as acidic gas.

2-c) Securing and training of personnel

There are only few personnel with experience in chemical analysis at the NPHL, so it may need to secure new personnel with experience or provide sufficient training to the current personnel when launching mercury analysis. Since many of the instruments used in chemical analysis and clinical tests are different, also the dangers of reagents are very different, sufficient instruction and training from the basics should be provided for proper analytical operation and safety. In the case of instruction and training, a periodical documented training program (preferably created with around a year) will be created along with the quality management system of 2-d) described later, and systematic and continuous training is desired to maintain and improve the ability of personnel.

2-d) Development of quality management system

Data quality management enhances the value of the obtained survey and analysis result and it is very important factor in comparison with the data of other institutions. At the beginning of chemical analysis, pilot survey may be the focus, but in order to secure a sufficient time for personnel to get used to the system, it is desirable that a quality management system based on the requirements of ISO/IEC17025 will be established from the earliest possible stage. (Whether to obtain ISO/IEC17025 accreditation for each type of chemical analysis can be planned according to the needs of the institution, but it is very effective to prepare a quality management system for any analysis, even if not complete.)

Especially for measuring instruments, it is useful to maintain its performance and manage the data, it is desirable to give priority to the earlier establishment of systemized maintenance system, if possible.

Laboratory of Department of Environment, Ministry of Forests and Environment

Current Situation of the laboratory

1 Media of mercury surveyed and analysed

DoE laboratory conducts mercury monitoring for atmosphere and rainwater. Sample collection is conducted by its own, but laboratory analysis has not been done yet. Even mercury analysis has not been conducted, analysis of other heavy metal parameter such as copper, iron, cadmium, zinc, nickel, cobalt, lead and chromium in wastewater are conducted. Also, lead analysis of the paint sample is conducted.

2 Forms of mercury surveyed and analysed

Any chemical form of mercury analysis has not been conducted yet. Mercury monitoring for atmosphere and rainwater are continuing, whose monitoring is focused on total mercury.

3 Personnel and organization

Currently (September 2021), five persons (1 Senior Divisional Chemist, 3 Chemist, 1 Assistant Chemist) are in the laboratory. Senior Divisional Chemist is 16 years of experience of chemical analysis, and Chemists-are about 5 years of experiences. The periodical training program for laboratory staff is prepared.

4 Methods and procedures for the survey (sampling)

Documented SOPs for survey / sampling are prepared.

5 Methods and procedures for the analysis

Even though mercury analysis has not been conducted yet, other parameters including heavy metals are conducted based on the methods of APHA. For analysis operations, the standard operating procedures (SOPs) are prepared.

6 ISO accreditation, etc.

DoE laboratory has not obtained the ISO/IEC17025 accreditation, it is under the process of preparation.

7 Quality management system

Quality management systems in the laboratory is prepared based on ISO/IEC17025 requirement. To ensure analysis accuracy, this laboratory performs operation blank, tests, duplicate analysis on the same sample, and analysis of reference material (RM) (8 metals solution) for each analysis batch cycle. They have not participated in inter-laboratory comparison such as inter-calibration or proficiency test, yet.

For the management of sample and analysis, the Laboratory Information Management System (LIMS) is used in the laboratory.

8 Samples

Collected samples (used for analysis other than mercury) stored in refrigerator (below 4 degree C). The samples are labelled with their unique ID and managed by a quality system following (but not accredited yet) with ISO17025. SOPs for sample management and storage are prepared.

9 Facilities

Laboratory room for heavy metal analysis is approximately 40 m^2, which is separated from other analytical parameters which may interfere the trace element analysis.

There is not an issue on the supply of electrical power. Fluctuation of voltage sometimes occurs, which may cause damage to measuring instruments. DoE laboratory used the batteries for compensation for voltage drop, however it may not be able to cover all sensitive instruments in the

facility. In the DoE laboratory, large development plan is undertaken, and building of power stabilization facility is in this plan. Thus, it is expected this issue regarding of power supply will be resolved in the near future.

Distilled water is used for analysis, and there are no problems for current heavy metal analysis (from operation blank test).

10 Apparatus

Apparatus used for heavy metal analysis and mercury analysis are cleaned by water and stored. Number of apparatuses used for heavy metal analysis is ready to analyse about 20-30 samples.

In DoE laboratory, microwave digestion device is equipped, and most digestion preparation for heavy metal analysis are shifted from open digestion by hotplate. Measuring balance are calibrated by an external agency (Nepal Bureau of Standards and Metrology).

11 Reagents

No difficulties in obtaining the reagents used for the analysis of trace elements. Thus, probably most of the reagents using for mercury analysis can also be easily obtained.

Trace element analysis grade reagents are used for trace elements analysis. SOPs for reagent management have not been prepared, but reagents are stored in locked cabinet, and standard solutions are stored in refrigerator. Records of usage of reagents have been kept.

Gas cylinders for measuring instruments were placed in the laboratory rooms in unfixed state. As this situation is dangerous in the event of such as earthquake or contact with laboratory workers, in the development plan of the facility, gas using in laboratory will be centralized in gas storage room and provided into each laboratory room. However, since earthquakes or contact with workers can still occur anytime, it is required to take immediate safety measures such as fixing the cylinder to the wall even if it is temporary location.

12 Measuring instruments

The following instruments are used for trace element analysis:

- Agilent Technologies 200 series (Agilent Technologies): Atomic Absorption Spectrometer

This AAS is also equipped with Vapour Generation Accessory, thus this instrument can measure the mercury in the prepared (acid decomposition) samples with minor investment. The instrument maintenance and the operation status are satisfactory. The status of the support of instrument provider is good. The estimated lead time needs for supply parts and maintenance service is short, so estimated downtime when the instruments have mechanical trouble is also insignificant.

13 Exhaust and water discharge

Analysis is process that emits acid gas is performed in equipment that has an exhaust draft system to minimize impacts on the operators and the facilities. However, recovery system for toxic gas (gas scrubber) have not been attached and exhaust gas is released to air directly. There are no SOPs for safety management.

Wastewater from the laboratory is discharged to municipal wastewater. Since the amount of wastewater from the analytical operation is small, this wastewater is diluted by miscellaneous wastewater and discharged with them. Solid waste is collected by municipal or private waste collectors for each type of waste.

Discussion of future support for establishment or advance of mercury survey and monitoring

1 Summary of the current situation of mercury or other chemical substances survey/monitoring

1-a) Media and parameters

Mercury analysis has not been conducted at DoE laboratory, but for heavy metal analysis other than mercury (cadmium, lead, chromium, nickel, iron, cobalt, copper, zinc, calcium) of water sample is conducted using the atomic absorption spectrometer (AAS). Considering total mercury analysis for wastewater and common environmental media (sediment, soil, etc.), most of the equipment and related analysis operation can be used for mercury analysis, so it can decrease investment cost. (Of course, there are cases that specific procedure for mercury analysis is required to maintain sufficient quality, but in most case, there is no need to introduce new expensive instrument or equipment). The vapour generation accessory has already been added to the AAS, also the hollow cathode lamp for mercury measurement is already purchased. Thus, the mercury measurement can be set up simply by purchasing a mercury measurement cell. However, when quantifying the background level ambient water sample (on the concentration order of 1 ng/L), or conducting analysis of the rainwater samples currently sample collection is performed (high-sensitivity analysis is required due to the low mercury level), or conducting measurement of atmospheric sample (collected by gold cartridges), a new measuring instrument is required. In addition, a new instrument apparatus for analytical pre-treatment is required when conducting methylmercury analysis.

Regarding the acid digestion process in most analysis of heavy metals, currently DoE laboratory shifts to use microwave digestion device from open digestion by hotplate. There are many advantages on microwave digestion in the view of its effectiveness, work environment, and environmental management, however, it often causes troubles on digestion on mercury analysis (these troubles are due to the characteristic of mercury which is easily volatized.) Before the mercury analysis using by microwave, examinations of the condition of digestion, such as reagent and temperature may be required. Unless this condition of digestion is determined, open digestion process should also be considered.

The equipment currently in the DoE laboratory is in good condition. Regarding the facility, there is an issue with the supply of electricity. However, this issue is expected to be resolved by the installation of power stabilization facility planned in near future.

It is expected that the reagents used for mercury analysis will not cause any major obstacles in purchasing.

1-b) Sample collection

In sample collection, DoE laboratory is already conducting sample collection and analysis including heavy metals for ambient water and wastewater. Also, sample collection for mercury is conducting for atmosphere (manual sampling with a gold cartridge) even though their analysis has not been conducted in DoE laboratory. Mercury and other heavy metals have some different characteristics, thus there are special precautions for sample transportation and storage. However, it is considered the newly training to laboratory staff for the transportation and storage of water sample for mercury analysis may not be difficult. Since DoE laboratory has no experience with other environmental media such as soil and sediment, capacity building including survey design will be required when starting the survey.

1-c) Laboratory staff

As for the personnel, it is expected that they will have no difficulty in acquiring techniques for mercury (total mercury) analysis since they have a sufficient experience of chemical analysis, in particular, they are already conducting heavy metal analysis other than mercury. Since the laboratory quality management system is built based on the requirements of ISO/IEC17025 and there is also a training program, it is desirable a systematic training program for the acquisition of mercury analysis technique.

Since the DoE laboratory has little experience of analysis of organic chemical substances, it is considered that sufficient capacity building will be required if analysis of methylmercury is considered.

1-d) Measuring instruments

As already described in 1-a), total mercury measurement of (prepared) ambient water and wastewater sample is possible with the AAS and vapour generation accessory which is already in the DoE laboratory (although a lamp for mercury measurement is necessary). It is possible to measure by the same instrument when measuring samples of soil, sediment, biota, etc. in the future, but when measuring the atmosphere sample (collected gold cartridge), installation of the dedicated measuring instrument is required. (It is also possible to create and add an introduction device using heaters for cartridges, air pumps, etc. to the current AAS, but in this case, it may be necessary to modify the software of the instrument.) In addition, as described above 1-a), when the laboratory will conduct the quantitation of background level mercury in ambient water (it means that the analysis result is not “not detectable”, but actual concentration can be measured), or analysis of rainwater sample will be conducted, additional development will be required such as the installation of higher sensitivity instrument. When performing methylmercury analysis, which cannot be measured by AAS, another instrument is required as described in 1-a) above.

Compared to mass spectrometer, the equipment introduced above is not so difficult requirement for their installation in terms of its size, power consumption, exhaust, etc. However, it is important that the requirements such as power supply, exhaust gas arrangement (to protect to workers and other equipment) is sufficiently researched and considered in advance of the installation.

1-e) Quality management

DoE laboratory has not obtained ISO/IEC17025 accreditation for any of its work yet, but preparations are currently underway for accreditation. Initially, it will be a trial operation for mercury survey and analysis, but it is hoped that a quality management system that complies with the requirements of ISO/IEC17025 will also be developed in mercury analysis from the earliest possible stage in terms of accumulating highly comparable data.

1-f) Safety and environmental management

Toxic exhaust gas, wastewater and hazardous waste is generated due to the operation of mercury analysis. These wastes are generally similar to those generated in other heavy metal analysis, and it can be managed with almost similar treatment system and recovery company. The analysis process for generating harmful gas is carried out in the exhaust chamber, but currently the chamber is not equipped with a harmful gas treatment device and is directly discharged to the outside air. As the amount of treatment increases, the impact on the peripheral equipment and the environmental load increase, so it is desirable to introduce a treatment equipment for exhaust gas. In addition, even though currently DoE laboratory discharges the wastewater from chemical analysis diluting miscellaneous wastewater due to the small amount of analysis wastewater, it is desirable to consider a treatment process of wastewater as soon as possible in the view of protection of the facility and environmental management. Some sort of wastewater can be treated by laboratory staff

without treatment facility (e.g. neutralization, sedimentation). It was explained that a large-scale development plan is currently underway at DoE laboratory, so it is expected to the development of environmental management.

Currently, gas cylinders are placed in the laboratory rooms in unfixed state. Even though these gas cylinders will be relocated into the centralized room, it is required to take safety measures such as fixing the cylinder to the wall.

2 Suggestions for establishment of mercury survey and analysis

The following items are suggested as the DoE laboratory begins its survey and analysis on mercury.

2-a) Formulation of future plans of the survey, and procurement of necessary equipment and facility

It may not be difficult to initiate mercury analysis of wastewater and ambient water in DoE laboratory, but it is desirable to prepare the future expansion plans for mercury and other parameters which are considered for future plan, to the extent possible; whether to expand the medium (air, soil, sediment, etc.); whether to conduct survey and analysis of methylmercury; what is the expected number of samples for annual survey, etc. These matters are not only for measuring instruments and personnel, but also for the wide range of conditions such as workspace, waste management, and sample storage space. Therefore, unplanned expansion of target media, parameter, and number of survey samples, etc. may lead to high introduction costs. It is considered that there are many uncertainties in the future plan, but it is desirable to design the laboratory so that future expansion can be facilitated within the range that can be expected.

2-b) Formulation of a quality management system

The DoE laboratory is currently preparing for ISO/IEC17025 accreditation. As mentioned above 1-e), it is desirable to introduce a quality management system conforming to ISO/IEC17025 for mercury analysis at an early stage if possible. The actual application for ISO/IEC17025 accreditation should be decided according to the business operation in the laboratory, and the acquisition of the accreditation is not always essential. But the assurance of quality of the analytical data (ensuring traceability and estimating uncertainty), it will be the best to operate a system that complies with ISO/IEC17025. In addition, a continuous training program linked with a quality management system is influential in maintaining and improving the capabilities of personnel, and a systemized maintenance system of the equipment keeps the performance of equipment and it is useful for using equipment for a long time.

2-c) Participation for inter-laboratory comparison (e.g. proficiency testing), information exchange with other institutions

As related to 2-b) above, inter-laboratory comparisons (proficiency tests, etc.) are important for objectively confirming the quality of laboratory data. At present, DoE laboratory have not participated in inter-laboratory comparisons for each item, but it is desirable for the periodical participation plan.

In addition, it is important to collect information in order to maintain and improve the quality of survey and analysis and the ability of personnel. Both experience and information of the latest technology are very useful, but what can be collected within the lab staff alone is limited. Regarding mercury survey and analysis, it is expected that the opportunities for information exchange and discussion between researchers and monitoring operators will expand in the future as the implementation of the Minamata Convention including its effectiveness evaluation. Active participation in these opportunities will be meaningful.

Conclusion of virtual capacity assessment by online (Internet) communication technology

Advantages of virtual capacity assessment

First of all, cost is one of the great benefits of virtual assessment. In most case, there are few or no experts near the laboratory, thus the survey expert(s) needs to travel long distances (most often abroad). It needs expensive travel cost and long time. Virtual meeting and video survey can be conducted through the mediation of the local coordinator in the area, so that travel cost and time can be significantly reduced. (Of course, local coordinator requires the cost for transportation, and communication infrastructure is necessary. However, these costs are smaller than international travel cost.) In the case of actual visit of through the international travel, it is difficult to add the number of experts because of the travel cost. But online survey, participation of more experts may be easier.

On the actual visit of the laboratory, all survey procedures such as documents confirmation, interview for laboratory staff and laboratory observation should be completed in short staying time of experts. By contrast, online survey and assessment can spare a long time for this information gathering. In this project, more than one month could be taken to total laboratory survey from the questionnaire for the general situation of the laboratory to virtual laboratory observation.

Even it is not an advantage for virtual assessment, there are many advantages that the expert can use the information devices. In actual visit, there are often the case that the expert cannot use PC at the observation venue because of the restriction of the space or power supply. Using by information device, experts can refer relative information and conduct observation more effective. Also, it is another advantage that the recording of observation is very easy, and experts can see it after the video survey.

Challenges and suggestions for virtual capacity assessment

Communication infrastructure is one of the major challenges of virtual survey and assessment. In this survey, there were a number of interruptions of communication during the virtual video survey. The performance and stability of communication is different by the countries or cities (if the facility LAN is used for communication, its performance varies by the facilities.) Even though there were no underground laboratory room in this survey, it is considered the condition of cell phone communication may get worse if the target laboratory room is located underground. In this survey, rehearsal of video survey was performed in advance of actual survey, and it provided valuable

information. To ensure the video survey, the condition of communication should be confirmed in advance.

Another technical challenge is the difficulty of having multiple laboratory staff involved. Since the number of communication devices is limited, in most cases it is not possible to distribute communication devices to each participating staff, and it is difficult to reuse equipment such as headsets from the viewpoint of infection prevention. Thus, it is difficult to create a format in which a number of laboratory staff can always participate in conversations. (Even if all participating technicians can use their own communication device, there is a challenge in communicating while avoiding the echo of conversation.) The role of the local coordinator who mediates between experts and laboratory staff and helps mutual understanding is very important. (As other issue, it is more difficult to take a long conversation with the laboratory staff than actual visit to the laboratory. If the expert already knows the target laboratory and staff well, the inquiry and information exchange can be progressed smoothly from the beginning, however it is not, may need more time for experts and lab staff to get to know each other. In such case, the role of local coordinator may become more important.)

Time difference is inevitable issue on the virtual survey. In this project, there was 3 hours and 15 minutes of time difference between the target laboratory (Nepal) and experts' location (Japan). The time difference limits the available opportunity for online interview or video survey, so it may be more difficult when the time difference is larger. In such case, further utilization of asynchronous means of communication such as e-mail, online chat or exchange of recorded video may be used.

Conclusion and future direction

Considering the rapid development of new online tools, surveys without physical travel could be a prospective future methodology, not just an ad hoc measure but more effective and efficient survey technique. Especially the opportunity of the communication between laboratory staff and expert is drastically increased by the online infrastructure.

But at the same time, such methodology cannot replace the traditional physical survey completely and still has some vulnerability that is beyond the control. At this moment, it still is a better option to dispatch engineers/technicians who are experts in mercury monitoring physically on site in some case. Therefore, laboratory assessment needs not to be either actual visits or virtual, and both methods can be used to combine useful parts for assessment.

Nepal was selected as the first countries as a trial basis to accumulate knowledge and explore the feasibility. The survey items and the methodologies applied for Nepal will be adjusted based on the results and will be applied for assessing laboratories in other countries with less COVID-19 restriction.

The virtual assessment is not a simply substitutional means of actual visit due to COVID-19 situation that restrict international travel, but there are many advantages even if the actual visit can be applicable. This way of virtual communication is recommended to use not only for future capacity assessment but also building or strengthening of laboratory capacity.

5.4 Capacity assessment of existing monitoring laboratories: Philippines

Objective of the assessment

This work aims at evaluating the current mercury monitoring capacity of the analytical institutions that are monitoring mercury levels in the country in order to clarify the areas in need of intensive assistance in the coming years to set clear direction for future assistance. The identified needs and gaps will serve the basis of technical assistances under the project.

Laboratories subject to assessment

Philippines was selected as the second survey country and the Environmental Research and Laboratory Services Division (EMB Central Office Laboratory), in Department of Environment and Natural Resources was identified as the analytical laboratory for this assessment. As the official visits were not possible due to recent COVID-19 situation, the assessment was conducted virtually.

Country	Monitoring facility	Organization
Philippines	Environmental Research and Laboratory Services Division (EMB Central Office Laboratory)	Environmental Management Bureau, Department of Environment and Natural Resources

Survey methods

Virtual survey method was developed and tested by the Project. As the travel restriction continues, the assessment survey applied the same virtual format to obtain necessary data by a series of online hearings to the staff of the analytical institutions.

The survey team, which composes of four international experts (team leader, project management, assessment of lab quality management, and assessment of lab instrumental analysis) and a coordinator, exchanges information and discusses with managers/staff/technicians of the facility on the issues regarding the research and monitoring activities taking into account the national status. The international experts are the knowledgeable in lab operation and chemical analysis particularly on mercury. They collaboratively assessed the local settings and consolidate their views in the assessment report. The coordinator worked with international experts and established relation to the laboratories subject to the survey.

The current situation of laboratories was assessed from following perspectives:

- Media subject to survey and analysis
- Forms of mercury surveyed and analysed
- Personnel and organization
- Methods and procedures for survey (sampling)
- Methods and procedures for analysis
- ISO accreditation, etc.
- Quality management system
- Samples
- Facilities

- Apparatus
- Reagents
- Measuring instruments
- Exhaust and water discharge

Workplan and progress

The survey involves 4 steps starting from questionnaire survey, which laboratory staff filled the form as much as possible. Then, two-way real-time communication was conducted together with the collection existing lab management documents. Some follow up Q & A were also conducted. Assessment report of the laboratory situation captures the issues and challenges and include suggestions for the laboratory advancement and its support.

Activity	Aug.	Sept.	Oct..	Nov.	Dec.	Jan.	Feb.	Mar.
Questionnaire for the status of laboratory								
(Response from laboratory)								
Request for the document of laboratory (e.g., rules, manuals, SOPs and records)								
Online interview for laboratory staff								
(Acquisition of the image of laboratory by filming, photographing or video calling)								
Q & A (via email)								
Drafting assessment report								

Due to the year-end holidays and other commitment of the laboratory, video shooting was postponed to early January.

Questionnaire for laboratory situation

The questionnaire to the laboratories was created to facilitate the survey by knowing the current situation of the laboratories prior to the online survey. This questionnaire included the items regarding current survey and analysis activities, personnel, facility and equipment, quality management, laboratory safety and environmental management. The questionnaire was sent to target laboratories, and answers were sent back prior to the online laboratory survey.

Online laboratory survey

Two types of online lab surveys were conducted: interviews with laboratory staff using a web meeting system and a virtual laboratory video surveys using a web meeting system with video. The online survey of the target laboratories was conducted at the following schedule:

- Online interview: 1 October 2021
- Virtual laboratory video survey: 12 January 2022

Survey results

Current situation of the laboratory

1 Media of surveyed and analyse

ERLSD laboratory has conducted mercury survey and monitoring for water (ambient water and wastewater), sediment, and particulate matter in the atmosphere. The laboratory conducts sample collection for some sort of the media (rainwater and atmosphere, however, mercury survey has not been conducted for the rainwater) by themselves, but other section of the institution conducts sample collection of some other media. Other than mercury, ERLSD laboratory also conducts the survey and monitoring for targets such as the general parameter, nutrients and heavy metals in water (ambient water, rainwater and wastewater), soil, sediment, and particulate matter in the atmosphere.

2 Forms of mercury surveyed and analysed

ERLSD laboratory conducts total mercury analysis. Analyses for certain chemical forms of mercury such as methylmercury have not been conducted.

3 Personnel and organization

At the time of the survey (January 2022), 18 staff (including maintenance engineers) and 5 project-based staff are in the laboratory. Division Chief has more than 25 years of experience of chemical analysis. Although the experience of the other laboratory staff is varying, average of their experience is around 3 years.

4 Methods and procedures for the survey (sampling)

The laboratory section of ERLSD that was surveyed in this project has not conducted collection of the samples. (Sample collection is usually conducted by another section of the institution.)

5 Methods and procedures for the analysis

Mercury analyses are conducted based on the methods of USEPA, and Standard Methods for Examination of Water and Wastewater (SMEWW). Analysis of the particulate matter in the atmosphere is conducted based on “Methods for Air Sampling and Analysis: 3rd edition” (James P. Lodge, 1988 Routledge/ 2020 CRC Press). For the analytical operations, the standard operating procedures (SOPs) are prepared.

6 ISO accreditation, etc.

At the time of the survey (January 2022), ERLSD laboratory is preparing to obtain the certification of the ISO/IEC 17025 accreditation.

7 Quality management system

Quality management system of the laboratory is prepared based on ISO/IEC 17025 requirement. To ensure analysis accuracy, this laboratory performs analyses of operation blank, laboratory fortified blank (2 concentrations), and reference material (laboratory fortified matrix) for each analysis batch cycle (20 samples). Analysis of certified reference material (CRM) is conducted by annual basis. ERLSD laboratory participates interlaboratory study or proficiency test around once in a year or more, however, these interlaboratory study or proficiency test do not always include mercury analysis.

For the management of sample and analysis, the Laboratory Information Management System (LIMS) is used in the laboratory.

8 Samples

Collected water samples are stored in refrigerators (4 degree C), and solid (e.g. soil, sediment) samples are stored in freezers (-20 degree C). The samples are labelled with their unique ID and managed by a quality system following (but not accredited yet) with ISO/IEC17025. SOPs for sample management and storage are prepared.

9 Facilities

Laboratory room for heavy metal analysis including mercury is approximately 500 m2, which is separated from other analytical parameters which may interfere the trace element analysis.

There is not an issue on the supply of electrical power. To protect the damage from the fluctuation of voltage of power supply source, uninterruptible power supplies (UPS) are connected to the vulnerable instruments. Also, emergency power generator is installed in the facility.

Deionized water is used for analysis, and there are no problems for mercury (and other heavy metal) analysis (it is confirmed by the routine operation blank test).

10 Apparatus

Apparatus used for heavy metal analysis and mercury analysis are cleaned by water and stored soaking in the nitric acid. Number of apparatuses used for heavy metal analysis is ready to analyse about 20 samples (excluding the required apparatus for calibration and QA/QC).

11 Reagents

Currently there are no difficulty to purchase most of the reagents used for mercury analysis. To purchase nitric acid, a permission is required according to the Philippines law, however it can be purchased without problem via that permission procedure. Regarding mercury for calibration standard, there are no local supplier and there is an issue to purchase.

AR grade reagents are mainly used for mercury analysis. Also, trace element analysis grade reagents are used as needed. Reagents are stored in locked cabinets, and standard solutions are stored in a refrigerator. Reagent management procedure is described in the SOPs for sample analysis, and records of usage of reagents have been kept.

Gases (fuel and reagent) for analysis are centralized in the gas storage located out of the facility, and they are provided into the laboratory rooms.

12 Measuring instruments

The following measuring instruments are used for mercury analysis:

- RA-4300 (Nippon Instruments): Reduction Aeration Cold Vapour Atomic Absorption Spectrometer
- MA-3000 (Nippon Instruments): Thermal Decomposition Cold Vapour Atomic Absorption Spectrometer
- Mercur Duo Plus (AnalytiK Jena): Reduction Aeration Cold Vapour Atomic Fluorescence Spectrometer
- Nex CG (Rigaku): X-Ray Fluorescence Spectrometer

The instrument maintenance and the operation status are well organized. The status of the support of instrument provider is good, and annual maintenance is conducted by the local service provider. However, there is a case that it takes a long time to repair the instrument because of the lack of the parts in country when it is broken.

13 Exhaust and water discharge

Analytical procedure that emits acid gas is performed in a fume hood to minimize impacts on the operators and the facility. Drafted air is treated by acid scrubber to remove acid from the air. The procedures for safety managements are described in the analysis SOPs.

Wastewater from the laboratory is separated from the general wastewater of the facility and pooled in the wastewater tank in the facility. Analysis of hazardous substances in pooled wastewater is conducted every three months by the third-party institution and collected by the accredited waste disposer. Solid waste from the laboratory is also collected by the accredited waste disposer. ERLSD is obtained the certification of ISO14001 accreditation, and environmental management including these waste management is implemented under the system of ISO14001.

Discussion for future support for establishment or advance of mercury survey and monitoring

1. Summary of the current situation of mercury survey/monitoring

1-a) Media and parameters

ERLSD laboratory conducts mercury analysis for water and sediment samples. Also, mercury in particulate matter in atmosphere is analysed by x-ray fluorescence spectrometry (XRF) with other elements although the survey of gaseous mercury which makes up the majority of atmospheric mercury have not been conducted. Regarding water sample, ERLSD conducts analysis both of ambient water and wastewater samples. Biota sample analysis is not conducted in ERLSD laboratory at this moment. Also, the human biological samples such as hair are not handled because these are out of the scope of the laboratory. However, analytical method and measuring instruments are almost the same as for the solid samples that the analysis is performed in ERLSD such as sediment, thus it seems to be easy to obtain the capability of the analysis for biota or human hair sample when it is required. However, handling of other media of human biological samples such as blood and urine will require training and experience because of the hygienic issues and characteristics of the samples when the analysis is required. ERLSD laboratory also conduct analyses of other parameters than mercury in the water, soil, sediment and atmosphere (particulate matter) samples (e.g., general parameters, nutrients and heavy metals), therefore the relative information of the samples can be obtained.

ERLSD laboratory conducts analysis of total amount of mercury. Mercury analyses by its chemical forms such as methylmercury have not been conducted.

1-b) Sample collection

Because there is a section for field survey and sample collection in the institution, the laboratory section surveyed in this project usually do not collect samples.

1-c) Laboratory staff

It is considered that there are enough number of laboratory staff to maintain the activity of mercury (and other environmental parameter) analysis. Even though there is a wide range of experience of the analysis among the laboratory staff, education for inexperienced staff seems to proceed without hindrance since administrative person has long experience and documented training and education program is prepared.

1-d) Measuring instruments

For mercury analysis, reduction aeration cold vapor atomic absorption spectrometer (CVAAS) and thermal decomposition CVAAS are equipped. In addition, cold vapour atomic fluorescence

spectrometer (CVAFS) which has higher sensitivity than CVAAS is equipped. It makes the analysis of low mercury concentration sample such as ambient water easier. To analyse the particulate matter in atmosphere, x-ray fluorescent spectrometer (XRF) is used. XRF can measure the sample without pre-treatment, and it can be used for the screening analysis for such as highly contaminated sample or mercury added product.

The conditions of the instruments are good, and they can be kept the condition by the operation under the documented SOPs and service provider support including annual maintenance.

1-e) Quality management

At the time of the survey (January 2022), ERLSD laboratory is preparing to obtain the certification of ISO/IEC 17025 accreditation, and the quality management system abide by the requirement of ISO/IEC 17025 is almost completed. Documents for quality management such as quality manual, rules and SOPs for analytical operation are prepared. Analysis is performed under the QM system and evidence (records) of the procedure are complied. Quality assurance samples such as operation blank, reference material and certified reference material (CRM) analysis are periodically conducted to ensure the result of analysis.

SOPs for analysis are stored in data processing room, and copies are not distributed in the laboratory rooms. Since it is good that the SOPs is easy to refer during the analytical operation, it is recommended that the copies of the SOPs are distributed in the laboratory rooms where the relative analytical operations are performed. (When distribution of the copies of SOPs, there is a case that the previous version of SOP is remained in the laboratory room and analysis is performed under the old SOP. To avoid such mistake, number and distributed place of the copies should be managed and older version SOP should be rapidly recovered when it is revised.)

1-f) Safety and environmental management

Safety managements for analytical operations are described in the SOPs of analysis. To protect the health of staff (and facility), analytical operations that generates toxic (acid) gases are performed in a fume food. To deal with the accident in the laboratory, emergency shower and eye washer are equipped in the laboratory room.

Institution of ERLSD laboratory obtain the certification of ISO 14001 accreditation, which is the standard of environmental management. Environmental management of ERLSD laboratory is properly implemented under this environmental management system. Exhaust gas from the fume hood is treated by the gas scrubber and released into the ambient air after detoxified. Wastewater and solid waste are properly collected and handed over to the disposer.

2. Suggestions for the future development of the laboratory

The following items are suggested for the future improvement of the ERLSD laboratory.

2-a) Enhancement of the training program for analysis

Analytical activities of the ERLSD laboratory are well implemented. There is a properly systemised quality management, and staff are trained by the programmed training of the laboratory. On the other hand, ERLSD is the national central laboratory for environmental monitoring, thus it is expected to lead the local and private laboratories in the country. Continuous education of the laboratory staff is one of the important keys for the laboratory development. By enhancing the training materials used in the laboratory, effective training programs for the staff of local and private laboratory sectors can be conducted. Especially, the training for quality management (QM) is

important. Early establishment of QM system and education of the staff make smooth development of the well qualified analysis structure.

2-b) Studying of the data format and required parameter for national monitoring

As the structure of national environmental monitoring is developed, monitoring data obtained from many laboratories will be gathered and compiled. To ensure the reliability of the data, and compare them each other, QA/QC data related to the analysis result are necessary. To obtain the sufficient information without excessive work of the data providers, required QA/QC parameter should be selected properly. The ERLSD laboratory may not compile the national monitoring data, but in any case, data analysis requires the opinion of technical experts. Studying of required QA/QC parameter and data report format can help the data compilation and analysis of future national monitoring. (Actually, it is considered not easy to plan a scheme of QA/QC for national monitoring, as even such quality assurance procedure for global monitoring data used to the effectiveness evaluation of the Minamata Convention is also still under discussion. However, because of its difficulty, it is considered to be worth to study from an early stage.)

2-c) Maintenance the analytical technique other than routine (automated) procedure

ERLSD laboratory has the thermal decomposition CVAAS (MA-3000). This instrument is well automated, and operators need very little work for sample preparation. It is advantage for the routine analytical work, thus most solid samples may be (or will be) analysed by this instrument. On the other hand, when the anomaly data is obtained, it is difficult to understand its cause since the operators cannot confirm most part of the procedure. Automated measuring instrument is not necessarily perfect. Even though the instrument is under the good maintenance, there is a case of unpredictable trouble. When the instrument is in trouble, the data may be incorrect. Also, if the characteristics of the sample are significantly different from the normal sample, there is a case that the sample preparation procedure of the instrument is not applicable for such a “special” sample and incorrect analytical data might be obtained. Verification by another analytical method is a good way to crosscheck the result. ERLSD laboratory has apparatus used for the mercury analysis by acid digestion method, so it is recommended that the staff keep the techniques of mercury analysis by acid digestion method and conduct analysis for the samples such as reference material (or it is also effective the sample conducted analysis by routine method) periodically.

2-d) Acquiring experience in mercury analysis for other media (biota and human hair)

Currently, ERLSD laboratory conduct analyses of environmental samples such as water, soil, sediment, and atmosphere. However, biota is also important for environmental survey and its assessment, so there may be opportunities of biota sample analysis in the future. Whether or not to analyse biota depends on the scope of the laboratory, but it is also valuable to enable biota analysis for the purpose of verifying data from other environmental media. Except for such as CRM, ERLSD has all the equipment needed for mercury analysis in biota sample, so it is suggested to try biota sample analysis and learn the techniques.

Similarly, ERLSD equipment can be used for mercury analysis of human hair. Human biomonitoring is out of the scope of ERLSD, but it may be useful to be able to analyse hair to obtain information on the effects of biota to the human mercury exposure. In addition, when the survey collaborated with the laboratory of health sector will be conducted (such as the case that ERLSD conducts an environmental sample analysis and a health sector conducts a human sample analysis), experience of the analysis can be useful for comparing analytical data.

3. Suggestions for the future support for the laboratory

3-a) Establishment of the on-line community for monitoring laboratories

National central laboratories such as ERLSD laboratory are very important for not only the national monitoring, but also the global monitoring structure. There are many laboratories (including ERLSD) that implement sufficient quality management system and be able to provide the comparable data. However, there is a case that it is difficult to obtain the information of newly established technology, situation of other countries (such as concentration level) because of less opportunity to communicate with the researchers / technicians of the other countries. (In the case of the researchers in research institute, they have more opportunities such as academic meetings. However, the staff of the monitoring institute have less opportunity for some reasons.) On-line communication platform, which provides the opportunity for the technicians of monitoring institutions to exchange the information, can strengthen the global monitoring capacity well. It may be also applicable for the place for the discussion about the analysis and quality assurance of the global monitoring. On the establishment of such community, it is preferable rather easy-to-enter than the solid style such as an association. However, in the case such community will be begun as informal style, it is effective the collaboration with the existing network. ERLSD has already participated with the Acid Deposition Monitoring Network in East Asia, (EANET), also another section of EMB-DENR has participated with the Asia-Pacific Mercury Monitoring Network (APMMN). Making the communication with the member staff of the institutions of participating countries easier can also be a great help for laboratory staff.

5.5 Laboratory proficiency testing (intermediate results)

Objective of the laboratory proficiency testing (PT)

This activity aims at evaluating the performance of mercury analyses conducted by the laboratories in the region, which provides individual proficiency levels and collective mercury monitoring capacity in the region. This is a part of continual improvement of quality data collection and analysis. The overall result is shared among participating countries and individual laboratories will receive some advisory that may include supporting options.

PT is conducted to confirm the laboratories' competency by an inter-laboratory comparison using a sub-sample from a homogenized material. Participating laboratories will receive the samples simultaneously and undertake the analysis in accordance with the provided SOP (standard operating procedures). The results from the laboratories are compiles to assess the performance trend, which will be informed to the laboratories so that its own result can be compared with other laboratories. Unsatisfactory results will trigger the corrective actions and regular participation to PT will provide the evidence of ongoing improvement towards satisfactory performance of the laboratories.

Laboratories subject to the proficiency testing

Public laboratories and laboratories in universities that undertake mercury analysis (or will undertake near future) for monitoring, survey or research purposes are welcomed to participate in the proficiency testing. The laboratories should be able to obtain analytical results by themselves without external resources/supports. Requirements for the analytical qualification is the limit of detection (LOD) below 1 ng-Hg (corresponding to 0.1 ng-Hg/mg relative to a 10 mg sample).

Institutional arrangement

The activity is jointly implemented with National Institute for Minamata Disease (NIMD). NIMD developed PT design and responsible for the results analysis and report preparation. UNEP provides overall supervision and dissemination of the results. It also engages AIT RRCAP (Asian Institute of Technology, Regional Resource Centre for Asia and the Pacific) to implement the activities such as laboratory engagement and sample distribution, etc. The homogenised sample was prepared by IDEA Consultants, Inc.

Progress and preliminary results

Workplan

The call for expression of interest started in September 2021 via various channels including project annual webinar on mercury science, Global Mercury Partnership, NIMD website, etc. The distribution of test samples started in February 2022.Participating laboratories analysed the mercury concentration of distributed samples three (3) times and reported back the result by 25 March 2022, which was then extended by 7 April 2022 due to the shipping delay by the pandemic. The feedback on the statistical results of the PT will be given to the participating laboratories in August 2022.

Activity	Q2/21	Q3	Q4	Q1/22	Q2	Q3
Literature and web search						
Call for expression of interest						

Activity	Q2/21	Q3	Q4	Q1/22	Q2	Q3
Survey for capacity assessment						
Online training #3 for participants*						
Sample preparation		Homogeneity test		Stability test		
Sample shipping						
Reporting results						
Statistical analysis of testing results						
Feedback report preparation						

*: Participation to online training programme #3 is optional.

Progress and results

1) Capacity assessment of existing laboratories in the region

Literature and web search were conducted to identify possible candidates to participate in the proficiency testing. A list of laboratories in the region that have experience on mercury research were prepared, which serves as the distribution list of call for expression of interest. An invitation is distributed widely in the region and beyond. The flyer calling for the interesting laboratories are uploaded on the websites of NIMD and UNEP Global Mercury Partnership. A survey form (questionnaire) is prepared to collect current/past mercury analytical activities, challenges encountered, and future plan or expectation on mercury analysis.

2) Support enabling efforts of the participating laboratories

Collective and individual capacity development needs are extracted from survey results. Support for enabling efforts of laboratories wishing to participate in the proficiency testing is provided depending on the nature of needs. An online training programme (#3: Laboratory management for mercury survey and monitoring) are provided to the participating laboratories for their readiness to the proficiency testing (optional). Provisions of Certified Reference Material (CRM) developed by NIMD is freely distributed to analyse mercury.

3) Sample preparation

The media for the proficiency testing is decided to be 'human hair'. The preparation of sufficient quantity of the samples included homogeneity test and stability test to ensure that the participating laboratories will receive the same samples for analysis. Human hair was collected from ordinary Japanese citizens. It was washed by detergent and then sterilised by γ (gamma)-ray. The sample was cut finely and mixed to ensure the sufficient homogeneity, which was confirmed by assessing the values from one hundred bottles selected randomly. After the completion of the testing period, stability testing was done by using the remaining stock samples.

4) Sample shipping

The samples were properly packed and shipped out with proper conditions. An instruction for participants was prepared and enclosed together with the shipping samples for proper sample handling, analysis and reporting.

5) Participants' profiles

34 laboratories were registered to the PT to which the samples were shipped out. Logistical delay and tight border control of human biological samples due to COVID-19 prevented 3 laboratories from receiving the test items. Finally, 26 laboratories delivered the results of the PT, which accounts for approx. three-quarters of the registered laboratories. Out of 26, 21 laboratories are located in

Asia and the Pacific region followed by 2 from Africa, 2 from Latin America and the Caribbean (LAC), and 1 from Western Europe and other groups (WEOG).

6) Preliminary results

The assigned value of the analysed samples was 1.46 mg/kg, which was obtained from median value of the participants' values. The uncertainty of 0.122 mg/kg was obtained from normalised interquartile range (NIQR).

The Z-score for each participant's result was used as the performance evaluation data, which tells the proportion to the standard deviation above or below from the assigned value.

$$Z - score = (xi - xpt)/\sigma pt$$

where:

xi: report value of each participant (average)

xpt: assigned value of test item

σpt: standard deviation of proficiency evaluation

The Z-scores in between -2 and +2 is regarded as satisfactory. The score above +3 or below -3 is regarded as unsatisfactory, which triggers action signal. The scores between satisfactory and unsatisfactory provide caution signal as the performance is questionable. 19 out of 26 laboratories (69%) are regarded 'satisfactory'.

Four (4) methods were employed by the participating laboratories for analysing the test items. The most frequently used method was thermal decomposition amalgamation – atomic absorption spectrophotometry (TDA-AAS), also known as 'direct mercury analyser', for 15 laboratories followed by cold vapour – atomic absorption spectrophotometry (CV-AAS) for 7 laboratories. Both cold vapour – atomic fluorescence spectrophotometry (CV-AFS) and inductively coupled plasma – mass spectrometry (ICP-MS) was used by 2 laboratories each.

13 out of 15 laboratories using TDA-AAS derived satisfactory results while 3 out of 7, 1 out of 2 and 1 out of 2 laboratories derived satisfactory results using CV-AAS, CV-AFS and ICP-MS, respectively.

7) Opportunity for corrective actions

In order to provide comparable monitoring data for strengthening the scientific evidence, regular participation to external quality control is part of activities to trigger corrective actions as appropriate. In addition, each laboratory needs its own SOP and ongoing internal quality control. SOP should be easy to understand by the laboratory staff including the criteria for determining the measurement is ongoing successfully. Illustrated instruction can provide how to complete the analysis step-by-step. Each step has the acceptance criteria such as blank, slope, precision and recovery sample. In addition, instructions to record outputs in the logbook is included.

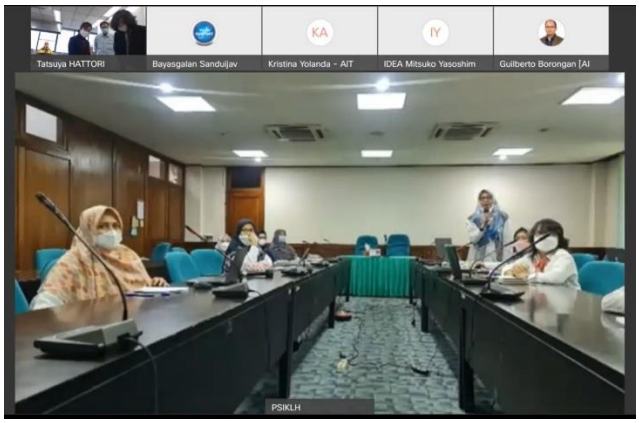
Planned activities

The analytical results and other information are compiled and statistically analysed, which will be publicly available. Individual laboratories will receive advisory notes, which will not be publicized, for further improving their analytical skills and encouraging the mercury-related activities. Some part of the results will be used for academic study.

5.6 Online workshop for the proficiency testing in Indonesia

Outlines of the online workshop

Date & venue	5-6 April 2022, virtual meeting
Title	Proficiency Testing Training in Indonesia
Objective	To provide hands-on lectures/online training support to the EMC in line with the process of proficiency testing. In addition, this training is a part of the continual improvement of quality data collection and analysis.
Programme	The training programme is composed of 2 sessions with 3 presentations and following discussions across two days (2:30h and 2h). The session on the third day was reserved if needed, but the participants did complete the discussions within two days. Presentation 1: 1st round of mercury laboratory proficiency testing – Asia and the Pacific Presentation 2: Experiment for storage of water sample for mercury analysis Presentation 3: Implementation of environmental laboratory proficiency test
Participants	Technical laboratory staff and analysts of the Centre for Standardization of Environmental Quality Instrument, Ministry of Environment and Forestry. Participants: 23 Resource persons: 4 Organizers: 3 Secretariat: 5



Summary of the results

The workshop is organized in the response to the request by Indonesia to undertake its own laboratory proficiency testing (PT) in line with national programme. Centre for Standardization of Environmental Quality Instrument, Ministry of Environment and Forestry has been conducting the PT for various parameters in water media. As dissolved mercury in water is unstable, it is difficult to prepare the PT sample. The Project examined the feasible options and shared with the Indonesian counterpart.

The workshop aims to provide hands-on lectures/online training support to the EMC in line with the process of proficiency testing, which is a part of the continual improvement of quality data collection and analysis. Two presentations were given from the Project and to describe the qualification of PT, and one presentation from EMC illustrated the ongoing lab PT in Indonesia and future direction.

Presentations and Q&A

Opening remarks

Dr. Naoya Tsukamoto (RRCAP) acknowledged the EMC, UNEP, and IDEA Consultants for making this workshop a reality. He noted that relevant monitoring organizations concerned with data and information generation on mercury must demonstrate high proficiency levels in mercury measuring and monitoring. AIT RRCAP is playing a significant role in implementing mercury-related activities in the region, which is aimed at enhancing capacities for mercury monitoring.

Dr. Mick Saito expressed UNEP ROAP's appreciation to the Indonesian Government for taking the leadership role in environmentally sound mercury management in compliance with the Minamata Convention on Mercury. He further congratulated the Indonesian Government on successfully completing the Minamata Convention COP 4.2 held in Bali. He stressed that accurate scientific data is the fundamental building block for mercury policy making, implementation and evaluation. Proficiency testing provides the opportunity for participating laboratories to compare their competencies and motivate continuous improvement.

Ms. Eva Bety Sinaga, Acting Head of the Centre for Standardization of Environmental Quality Instrument, MOEF, outlined the legal basis of the function of the Centre to lead the standardisation of the environmental instruments. Proficiency testing (PT) is a form for the development of methodology to establish the traceability of measurement. A proficiency testing programme is conducted every year with the scope of environmental quality standards in accordance with environmental laws and regulations. One of the parameters that were held in 2021 was total mercury, especially for mercury parameters testing to support the Presidential Regulation Concerning the National Action Plan for Mercury Reduction and Elimination. The organizers encountered problems relating to the preparation of mercury test samples. These constraints are related to unstable test samples. Several measures have been taken, including replacing the test sample containers with glass containers, but the problem has not been solved. As a result, the proficiency test was carried out without the mercury parameter. She hoped, by holding this workshop, the problems relating to mercury parameters testing can be solved so that the plan for mercury analysis/ testing in water can be carried out smoothly in the future.

Presentation 1: 1st round of mercury laboratory proficiency testing – Asia and the Pacific

Mr. Tatsuya Hattori (IDEA) led the presentation on Mercury Laboratory Proficiency Testing. He noted that the testing items should be homogenous and stable. Japan. He presented a brief outline of the training material, highlighting the key focus areas for discussion. These include quality of analysis data, how to evaluate biases, intercomparison study/proficiency testing, and a short information about the 1st Round of UNEP Proficiency Testing as well as Prohibition of Collusion/Falsification. Presenting on ensuring quality of analysis data, Mr. Hattori noted that the key question that must guide the process reducing biases is how different the data is from the true value and for ensuring data precision, the analyser must ask in respect to reducing uncertainties, how much does the data vary from analysis to analysis. Uncertainty or precision can be estimated

by the lab itself. However, bias (accuracy) is not possible to be assessed by laboratories on their own analytical data alone.

Mr. Hattori clarified that the Analysis of Certified Reference Material (CRM) by comparison with the certified value of CRM is one way of evaluating biases. Another way biases can be evaluated is by Intercomparison/Proficiency testing. This is achieved by comparing with the assigned value of the testing item via SI traceable analysis result by reference laboratories and calculations from proficiency testing participants' data or agreement value. Intercomparison / proficiency testing information is useful not only for participants but also for analysing data from surveys and monitoring conducted by many institutions. In conducting an intercomparison study or proficiency testing, participants must be aware to ensure accuracy and comparability of their analysis data, while the organizers must be aware of data quality overview across participating institutions in terms of data variation and bias analysis methods.

Drawing from the 1st round of the UNEP Proficiency Testing, Mr. Hattori shared with participants the procedure and specifics of preparing test samples used in the proficiency testing. He noted that the testing items should be homogenous and stable. Testing item homogeneity / stability affects results analysis and performance evaluation. Unlike the reference materials, it is sufficient for the stability of test items to ensure only during the testing period. He clarified the criteria for assessing homogeneity testing and stability testing.

The average or median of the participants is not always the closest to the true value. In the analysis of the results, it is important to note that the assigned value (agreement value), which often reflects the median of the result of participants, should be determined considering the purpose and procedure of the test, and the test method of the participants, etc. Analysis by the median and Normalized Inter-Quartile Range (NIQR) is more robust than the one by the average and standard deviation. However, in the case that the distribution of the results is much different from the normal distribution, it is inappropriate and thus, another analysis is required. Regarding performance evaluation, if the uncertainty of the participant's analysis result is expected to have a large effect, it is desirable to evaluate the performance of the participant by ζ score or *En* score instead of z score. He clarified that the idea of ζ score and *En* score is pretty much the same. The only difference is whether to use uncertainty or expanded uncertainty. In dealing with the case of biases, the cause of the bias must be investigated. It is also noteworthy to understand while the result analysis by the group of distribution provides valuable information for the bias between the analysis situations, the performance evaluation of each participant should be carefully considered.

Presentation 2: Experiment for storage of water sample for mercury analysis

Mr. Tatsuya Hattori explained the mercury state in water and the stabilisation of mercury in water. The presentation explored the behaviour of dissolved gaseous mercury (DGM), oxidized mercury, and organic mercury in water. Gaseous mercury originally has a very low solubility in water. If it exists in the surface of water, it often volatilises into the atmosphere. Oxidized mercury has high water solubility and is the main form/component of mercury in water. Organic mercury on the other hand has low volatilisation and low concentration in ambient water. Mr. Hattori clarified that mercury should be stable in water if the oxidized state is maintained. However, even in acidic and oxidized state (such as acidic by HNO3), mercury concentration in water often decreases rapidly, volatises into air or penetrates the container wall. Discussing the sufficiency of HNO3 acidic conditions of sampling and stabilising mercury in water, Mr. Hattori noted that mercury in water may decrease even under higher concentrations of HNO3. The coexistence of halogens (such as chloride ions) is effectively stabilized mercury, hence, HCl acidity is preferred. The addition of

bromine monochloride (BrCl) is very effective to stabilize mercury in water. BrCl is prepared at time of use, and this must be performed in the fume hood. Mr. Hattori further explained that Bromine Monochloride (BrCl) is a hazardous reagent and its use in the field should be avoided as much as possible. Mr. Hattori presented the step-by-step procedure of preparing of the BrCl solution. He mentioned that regarding containers of mercury in water samples, mercury in water penetrates polyethylene (PE) or polypropylene (PP) containers. Thus, PP, PE containers should be avoided for mercury analysis sample. Glass and fluoropolymer containers are good for mercury samples in water.

The experiment demonstrated the water sampling and dispensing process, Hydrochloric acid or BrCl addition, storing, and analysis. Observations from the experiment showed that the rate of decrease of mercury tended to be high at high temperatures (with exceptions). There was no noticeable tendency for mercury concentration and a rate of decrease between 0.1 mg/L and 1 mg/L. There was no noticeable tendency for hydrochloric acid concentration and rate of decrease between 0.1% and 1%. The decrease tended to be smaller with the addition of hydrochloric acid than the untreated case (with exceptions). The addition of BrCl drastically prevented the decrease of mercury. However, for long-term stability during the proficiency test, say about 1 month, stabilisation with HCl might not be sufficient. The addition of BrCl can stabilise mercury in water for about a month. Mr. Hattori noted that BrCl does not affect most total mercury analysis methods. However, there are still many unclear points on the behaviour at low concentration or other water characteristics such as seawater or sewage, etc.

Q&A:

- Q: What equipment was used for the shredding of hair samples used in the proficiency testing? A: A special cutter is normally used for the preparation; however, the IDEA laboratory does not have a special shredder. Most often, the lab outsources this task, but also, scissors may be used to shred the hair samples. For proficiency testing, a very fine homogeneity is required thus, the team got a finely shredded samples under 1 mm.
- Q: Has the expert team had any experience with the use of L-cysteine for mercury solution and standard solution preservation? This is used in the EMC laboratory to preserve mercury standard solutions. A: Yes, the stabilisation by L-cysteine is effective for the preparation of standard solutions for mercury. However, this has not been used for the PT. The expert team does not solely recommend its use because in the chemical shape of ambient water, the free ion or compound of oxidized mercury does not form a complex of L-cysteine. Because PT samples are required to be similar to actual samples as much as possible, it is not so preferred to have a water sample that makes a complex of L-cysteine. On the other hand, using BrCl or HCl is the actual way of stabilising the water sample. When these are used, it is assumed the participants collected stabilised water samples. This is recommended notwithstanding the little decrease in the mercury content in water with BrCl and HCl stabilized sample.
- Q: Should only borosilicate glass be used as the container for mercury sample, or any container will do? A: Yes, borosilicate glass or fluoropolymer container can be used for mercury sample.
- Q: How much of the HCl/BrCl should be added per sample and for PT water sample 50 litter glass bottle is normally used, is this acceptable? A: About 0.5 % prepared BrCl solution is added which means 5 ml for 1 L sample. In the experiment, 100 ml samples were distributed for 0.5% of BrCl solutions.
- Q: During the preparation of 50 L solution, polypropylene container was used and after homogenization, smaller containers which are not polyethylene were used although they aren’t

borosilicate or fluoropolymer container. Is the use of different material containers okay or acceptable? A: Normal glass or fluoropolymer container has been used by the team. Attention should be paid to the material of cap of the container also to avoid penetration of the samples. Large amounts of the sample can be prepared in the large polypropylene containers if it is quickly dispensed into other smaller glass or fluoropolymer containers.

- Q: We use glass container with1.3% nitric acid and L-cysteine preservative which is very good to preserve 1 ppm standard and above, but the challenges arise when there is the need to preserve a solution under the ppb. BrCl appears promising enough for preservation of mercury standard at lower concentration. Can BrCl be mixed with another type of preservative such as HNO3, HCl and KCr2 to avoid mercury loss in solution? A: HCl and BrCl can be mixed. BrCl contains HCl, however mixing with HNO3 and KCr2O6 as reagent should be avoided because mixing with deoxidizers may generate toxic gases such as Br2 or Cl2. Another way to stabilise low concentration of mercury in standard solution is using nitric acid and perchloric acid which is described in the Mercury Analysis Manual published by Ministry of Environment, Japan which describes similar method of acid reagent digestion of mercury sample on the coexistence of nitric acid, perchloric acid, and sulfuric acid. Mostly the best way to stabilise low concentration of mercury sample depends on the state of the methylmercury. This is also described in the Mercury Analysis Manual published by Ministry of Environment, Japan. Methylmercury in organic solvent such as toluene is very stable and can even be stored for one year. However, the challenge is how to obtain the reagent of methylmercury.
- Q: To prepare mercury solution of concentration of about 1 ppm, is it necessary to prepare from the standard solution or a dilution to the 1 ppm can be made? A: Even 1 ppm solution should be prepared from the standard solution. 1 standard solution (0.1% standard solution) can be diluted in stages.
- Q: In the slide the addition of BrCl is done after dispensing, however, our PT participants are more than 100, thus it appears difficult to add BrCl after dispensing. Is it okay to add BrCl before dispensing? A: BrCl may be added before the dispensing into each container, but caution must be taken when adding the BrCl because it is a strong oxidizing agent and when added in large amounts should be done under very good ventilation or under draft chamber. In other words, the safety protocols must be strongly adhered to.

Presentation 3: Implementation of environmental laboratory proficiency test

Ms. Rina Aprishanty, Environmental Specialist from the EMC, MOEF presented on the implementation of the PT in Indonesia.

PT implementation started in Indonesia in 2001 with about 200 participants across Indonesia at the start. However, the programme has experienced a decline in participation to about 50 (lowest number so far) participants as of 2019. She noted that the various parameters investigated in the PT were in water media. They emphasized that the country's primary purpose for PT is to provide tools for laboratory performance evaluation in laboratory development in Indonesia, and the traceability of testing or measurement. The laboratories involved in the PT must have accreditation by the National Accreditation Body of Indonesia (KAN, Komite Akreditasi Nasional). They must also be competent in conducting proficiency tests (SNI ISO/IEC 17043:2010). She outlined the various stages of organizing the PT. Ms. Rina elaborated on the various stages, which include the documentation, preparation, distribution, and follow up action processes.

On the assessment of PT, Ms. Rina provided the range of parameters for freshwater and their concentration range and assigned values. She also clarified that processing the PT results evaluates the data based on SNI ISO 13528 and assigned values obtained from CRM. Standard

deviation (SD) of PT is obtained from the SD of the assigned value derived from Horwitz's CV and SD formulas, as well as the SD reproducibility and repeatability methods. The determination of the performance of PT of participants are based on SNI 13528:2016 using Z-score values. Ms. Rina shared a summary of the 2020 evaluation results of PT, and the recommendations provided by the participating laboratories based on their results. Laboratories with satisfactory performance test results are requested to improve their competence in the testing of the environmental quality parameters, while unsatisfactory performances or outliers are advised to investigate or identify discrepancies and implement corrective measures along with reports to organizers.

Laboratories with unsatisfactory results or less are recommended to enrol in the coaching programme provided with such categories to find and rectify the causes of the irregularities. On the next steps of the PT Programme, Ms. Rina intimated that EMC is preparing the quality system documents for accreditation as a proficiency testing organizer as well as preparation for the PT implementation for COD, Cu, Cd, Fe, Mn, and Hg parameters. She hinted that there is a need for training for the preparation PT samples in the form of an environmental matrix as well as a long-term plan for developing the Centre's competencies as Reference Material Produced for the environmental matrix.

Q&A:

- Mr. Hattori commended the EMC for having high participation of their structured PT programme and sought clarification on whether the quality parameters monitored are from fresh water from river or ambient water or wastewater from facilities. Ms. Rina noted that the parameter monitoring is done for effluent from facilities. However, the PT samples are prepared from fresh water for mercury which is a challenge now. EMC hopes after training; they will be able to use fresh water and wastewater effluents.
- EMC has function or task to guide the local participating laboratories. The proficiency test serves as a tool to access the proficiency of the laboratories, however limited budget allocations prohibit the inclusion of as many laboratories as possible. Participation is free of charge and covered from the allocated national budget. For this year, there are about 29 laboratories shortlisted this year, but the available budget can only accommodate 20 laboratories.

<u>Live video demonstration of bromine monochloride (BrCl) preparation procedure</u>

Led by Mr. Hattori, the IDEA team demonstrated and explained the step-by-step procedure for the preparation of bromine monochloride solution via a live video feed. He clarified that in Japan, a special grade of potassium bromide and bromoxide which is equivalent to the reagent grade is used. Mr Hattori hinted that the procedure for the preparation of BrCl is described in the USEPA Method 1631 for the Determination of Low-Level Mercury. However, the volume preparation described in the USEPA Method 1631 is quite a large volume of about 2.5 l. Since only 0.5% of BrCl is added sample, it is usually excessive for the reagent preparation. In the demonstration, 1/50th scale of the method described in USEPA Method 1631 is prepared. The measurement of the various reagents was demonstrated, followed by a step-by-step preparation of the BrCl solution. Subsequently, the procedure for the preparation of the water testing was also demonstrated. Mr. Hattori clarified that the testing sample is manually prepared and homogenized by shaking without the use of any special equipment.

Q&A:

- Q: EMC team would like to understand the procedure for washing of the bottle used for cleaning the stock sample bottle and test sample bottles. Is it okay to dry the bottle in ambient environment under conditions where there is no special dryer or it's a must to use dryers? A: Regarding washing the sample bottles, mild detergent and water are used by the laboratory followed by cleaning with potassium permanganate solution. Small amount of the potassium permanganate solution is used to rinse the bottle by vigorous shaking. After washing, it is also sufficient to store the washed bottles in a normal clean laboratory room at ambient temperature. It is also okay to stabilize samples with BrCl at room temperature.
- Q: After rinsing with potassium permanganate should the bottles be rinsed with distilled water? The practice in the EMC laboratory is to rinse with hydroxylamine and distilled water after the potassium permanganate rinsing. Is this practice acceptable? A: That process is pretty much the same. The only difference from the practice in the IDEA laboratory is that deionized water is used instead of distilled water.
- Q: Is the above-described cleaning step applicable to the borosilicate sample bottles also? A: Yes, the stock reagent bottles, and small sample bottles are washed in the same manner.
- Q: What alternative analytical instruments would the expert team suggest for laboratories that do not have specialized analytical instruments for analysing mercury in water sample? Would you recommend other instruments such as AAS or ICP-MS? Is there any special method that you would suggest, particularly for ICP-MS, to deal with the chloride content which might bring interferences? A: Regarding the chemical analysis of mercury, it is best to use acid digestion, and reducing aeration cold vapour atomic absorption spectrophotometer (CVAAS) or cold vapour atomic fluorescence spectrophotometer (CVAFS) method. Other methods such as thermal decomposition CVAAS which is simple and applicable for water sample analysis around ppb scale. However, from our experience, the results of the mercury analysis by thermal decomposition CVAAS have rather larger deviation compared to manual acid digestion or reduction aeration CVAAS. Also, there is a challenge for measurement of mercury by ICP instruments such as ICP-AES and ICP MS. Countermeasures are provided however by some instrument manufacturers but from experience there can be challenges in achieving accurate results, notwithstanding.

Wrap up and closing

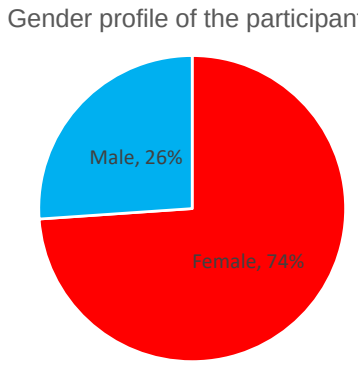
Ms. Rina, on behalf of EMC, expressed her thanks to the team and noted that together with her colleagues, the EMC laboratory team would like to try out the sample preparation procedure following the method discussed by Mr. Hattori and relay the results to the team. She hinted the team suspects they might have missed or paid attention to certain aspects of the sample preparation procedure. As such, they will try to rectify such in line with the discussions from the training. Ms. Rina further expressed her gratitude to the entire team from IDEA Consultants, UNEP and AIT RRC.AP for a very fruitful collaboration and discussions and hopes that knowledge sharing, and capacity building efforts fostered by the collaboration continue.

Mr. Guilberto Borongan, AIT RRC.AP, thanked the team from EMC and expressed his pleasure about the fruitful engagement and interaction with the EMC colleagues. Furthermore, he expressed gratitude to Mr. Hattori and the team from IDEA Consultants for leading the training and providing very insightful content to meet the objectives of the training workshop.

Results analysis

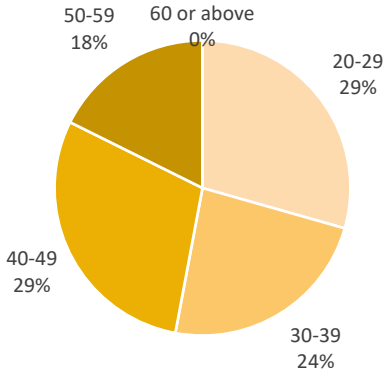
The two-day online workshop was attended by 23 participants from EMC and other agencies. Post survey questionnaire was conducted for them and a total of 17 participants provided the response.

Among the respondents, approx. 70% were female. It is because more females are employed by the analytical laboratory in EMC.



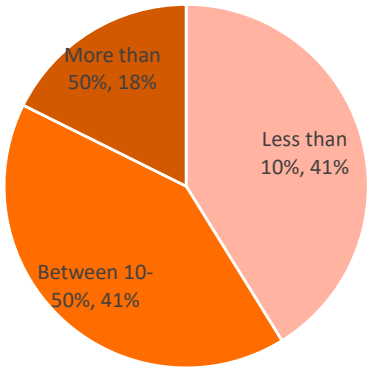
Gender profile of participants

Participants represent a broad spectrum of young and old technical staff with an aged range between 20 years to beyond 60 years, with the dominant an age range between 20 to 49 years, representing approx. 80% of the registered participants. The age groups were relatively distributed equally among 20-29, 30-39, 40-49, and 50-59. Among them younger generation (in 20s) and upper middle generation (in 40s) have relatively higher numbers of the participants to the workshop who work hands-on in the laboratory with good probability of applying the knowledge transferred over a longer service period in the EMC laboratories.



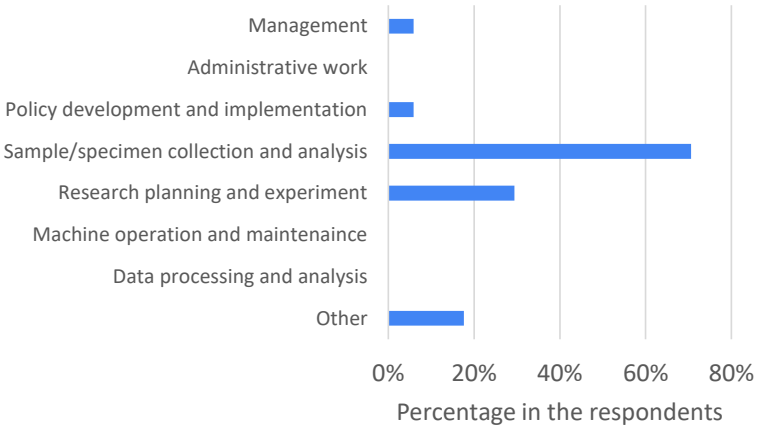
Age range

Responding to the question on how much of the routine work relates to mercury, approx. 60% of the participants has some (more than 10%) time being involved in mercury-related subject. This means that the mercury is not necessarily their principal work, but they are routinely involved in mercury-related issues. It is more or less similar tendency for the other Project activities. For majority of the participants, mercury monitoring is one of several duties they are routinely conducting.



Routine work related to mercury

For the question of the roles of the participants in their institutions, they could choose more than one that applied to their roles (multiple answers). As the purpose of the workshop was on the laboratory proficiency testing, the answers showed that 'sample/specimen collection and analysis' was the highest role followed by 'research planning and experiment'. The participants were brought by EMC by itself and most of them were relevant for the purpose.



Participants' roles in the institutions (multiple choice)

Follow-up actions

This workshop was formulated upon the special requests from partner countries. The analysis of the feedback received from participants via the survey question and during the workshop, it can be deduced that the objectives of the training workshop have been achieved. The target participants of the required knowledge base and skill sets were present. EMC will take necessary measures to undertake its own lab PT for mercury analysis and will come back to the Project if further assistance is needed.

5.7 Asia-Pacific annual webinar on mercury science 2021

Outlines of the annual webinar

Date & venue	21 and 26 October 2021 (each session has the same content), virtual event
Title	Asia-Pacific annual webinar on mercury science 2021
Objective	Dissemination of the information developed by Project for Promoting Minamata Convention on Mercury by making the most of Japan's knowledge and experiences. The meeting is open to non-partners countries especially peers in other regions as much as possible to provide replicative information.
Programme	The webinar presents the project results and planning. For better outreach to the other regions, the session is convened twice in different time (Session 1 at 6pm, Session 2 at 8am in UTC+7). The second session uses recorded presentation as much as possible to reduce the burden of the presenters. Project progress and workplan reported by Project Management Unit Four key achievements of the project activities presented by relevant experts and implementing partners.
Participants	Ministries/agencies responsible for mercury, National Focal Points of the Minamata Convention, universities, research institutes, and other interested stakeholders and individuals. Participants: 112 (61 in Session 1, 51 in Session 2) from 32 countries/regions (7 from project partners, 8 from Asia-Pacific other than project partners, 17 from other regions) Resource persons: 7 Organizers: 3 (UN and MOEJ) Secretariat: 2 from OECC

Summary of the results

The project is creating qualified information in support of early implementation of the Convention. The dissemination of such information is beneficial not only for the participating countries but also many others beyond the region. Periodical meetings that inform project planning and results will be convened during the implementation period of the project.

The webinar was organized twice (sessions 1 and 2) with the same contents but at different time schedules so that participants worldwide would be able to join at their preferred time. Each participant was requested to register a set of data such as country, age, gender, etc. before joining the webinar, and asked to answer the questionnaire after the webinar. The registration data and the questionnaire's answers were analysed for the evaluation purposes.

The opening remarks were given by Dr. Isabelle Louis from UNEP ROAP, Ms. Itsuki Kuroda from MOE, Japan, and Mr. Eisaku Toda from Minamata Convention Secretariat. The webinar began with an explanation of the outline of the project and its progress. Followed by key results of four individual projects:

1. Virtual survey for mercury analytical laboratories.

2. Comprehensive training package for mercury inventory, including UNEP toolkit.

3. Laboratory proficiency testing on mercury analysis.

4. Strategic partnership with Minamata City

Presentations and Q&A

Project profile and progress for promoting the Minamata Convention in Asia and the Pacific

The project "Promoting the Minamata Convention on Mercury by making the most of Japan's Knowledge and Experience" is the 5-year project sponsored by Ministry of the Environment, Japan and implemented by UNEP ROAP. Mr. Mick Saito, UNEP ROAP provided outlines of the project and progress that has been made so far.

The key features of the project are to contribute to early implementation of the Minamata Convention, connecting Minamata Convention and Minamata city, and networking analytical institutions.

Expected outcomes include that the countries increase generation and use of information on how to monitor and reduce mercury emissions and releases in their legislations, policies or actions plans. The output is expected in three-folds.

- Output 1. Comprehensive capacity building programme based in Minamata is developed and implemented,
- Output 2. A regional monitoring institution network in Asia and the Pacific is established, and
- Output 3. Outreach of qualified information in support of early implementation of the Convention is implemented.

This webinar itself was a part of the project. The progress of each project will be explained during the following presentations.

Key result 1: Virtual survey for mercury analytical laboratories

Concept, objective, outlines, and expected results were presented by Dr. Minoru Koga (Minamata Environmental Academia) who lead the survey team. The objective of the survey is to evaluate the

laboratories in Nepal. Due to the COVID-19 pandemic, laboratory capability had to be examined by online video conferences.

Two laboratories in Nepal were selected as the target for the first survey. Procedures for the survey included the questionnaire to understand current capacities of the laboratories. Web meetings included the real time video shooting at the laboratory. Discussions among the expert team were conducted by emails, before the final survey report was submitted.

Advantages of the online survey for the laboratory assessment were cost efficiency, time saving, and availability of spending more time on discussions. Challenges were the Internet environment, which was often unstable, time differences, and the need for well-organized preparation (local coordinator, rehearsals, background information on the target laboratory and countries, etc.).

Dr. Bhupendra Devkota, Local coordinator in Nepal described the background of mercury issues in Nepal and local coordination for virtual assessment of two laboratories for mercury analysis.

Nepal has signed the Minamata Convention in 2013 and is in the process of ratifying. Ministry of Forests and Environment (MOFE) prepared the Minamata Convention Initial Assessment (MIA) in 2019, with UNIDO as an implementing agency and financial support of GEF.

The two targeted laboratories were the National Public Health Laboratory (NPHL) under the Ministry of Health and Population (MOHP) and the Laboratory of Department of Environment (DoEnv), MOFE. Primary online meetings with NPHL, MOEF and DoEnv included clarifications on survey questions, additional questions on the capacity of Nepali laboratories, arrangement and schedule of virtual assessment using real time video shooting.

Online assessment was conducted separately for NPHL and DoEnv. NPHL is established primarily for samples related to communicable diseases, including vector born disease and histopathological services. Facilities for mercury determination need to be established, and being a well-established and accredited laboratory, it can provide high level of mercury determination/analysis in human samples, once such facility is established. Also, code of practice and protocol specific to hazardous and toxic waste need to be developed at the time of establishment of mercury analysis facilities.

DoEnv was established in 2014 and is growing within the limits of its resources made available through the annual budget. The laboratory has the plan to develop the facilities to analyze environmental samples from different media and continuously monitor the environmental quality of the country. Being a member of the Asia Pacific Mercury Monitoring Network and having some technical staff trained for the purpose of mercury monitoring, the Department has developed a work plan to establish mercury monitoring facilities in parallel to other environmental parameters.

Then, two laboratories provided short comments on this virtual assessment:

Comments from Dr. Runa Jha, NPHL

- We are aware of the adverse effect of mercury to human health. Soon with technical assistance we will be able to start mercury testing services at our facility, which will help us to upgrade and contribute more to our role as a National Public Health Laboratory.
- I understand how technically demanding this virtual assessment was, and I really appreciate the patience of the Japanese colleagues as well as Nepal team, for taking the time for the virtual assessment and especially Dr. Bhupendra for organize all of this project. I look forward to the project.

Comments from Mr. Indu Joshi, Laboratory of Department of Environment

- Our lab is in its early stage, and we are planning to strengthen our lab with support from the government. Further support for joining the PT and CRM projects, we will be able to assure our quality.

Q&A:

- Q: Will the project help to strengthen the capacity of analytical institutions to conduct human biomonitoring? A: Yes. This monitoring project is about multimedia monitoring exercise, including environmental media and bio media. This may be an opportunity for environmental laboratories and help laboratories to participate into the exercise. Some activities are still open, which means you can still enrol to some of the activities.
- Q: Will the project assess countries' capacity to sustain laboratory capacity over the long term, including hardware, software and HR capacity? A: Assessment is the first activity. Once the result is available, we will discuss further steps.
- Q: Are there any biomonitoring projects related to the current mercury project? A: Laboratory training program includes both environmental and bio media so some health laboratories are participating.
- Q: Can you explain the follow up assessments? How will they be conducted? A: Laboratory capacity assessment is implemented virtually using web conference application.
- Q: When do you expect the data from the gold-plating project to be published? A: Some data are already in MIA report (estimated), but for other data form analysis we will have to wait for a couple of months.

<u>Key result 2: Comprehensive training package for mercury inventory including UNEP Toolkit</u>

The objectives of the activity are to provide training that can help countries raise their mercury inventories into higher level of accuracy and to develop mercury material flow analysis. Concept, outlines, and overall design were presented by Mr. Jakob Maag, UNITAR.

The project will support to improve national mercury inventories. It will train participating countries in lifting the inventories to actual mercury mass flows analyses, emphasizing the links between mercury inputs, flow with uses and wastes through society, the fate, or recycling of the mercury in the economy. Furthermore, mass flows analyses enable effective and efficient policy measures to be developed and monitored later. The training materials will be prepared and published to enable trainers to subsequently train colleagues in the mentioned topics. Thus, the key target of this project are the trainers.

Mercury mass flows and toolkit inventories provide information that can be utilized for national reporting to the Minamata Convention COP. Also, the toolkit is one of the recommended tools under the Minamata Convention to develop mercury emission inventory. Developing inventories for releases to water is also currently under the consideration.

The toolkit is designed based on mass balance with a few exceptions to make it simple for the countries not yet familiar with the exercise. Also, its mercury inventories are based on the in-country data to know the activity levels of each country. The inventory gives estimated emissions and releases to all environmental media.

Mass flow shows mercury’s way through the economy and the biosphere, and at the different levels of scope from process, sector, national or even global. It is important to identify the most effective and efficient target point for mercury reduction efforts.

The Danish national mass balance of mercury shows a negative accumulation which means that the amounts of mercury are being depleted as it has been regulated over the time. There, mercury is hardly emitted to the environment, but mostly to landfills and exports as hazardous waste. As Denmark does not have any facility dedicated for final mercury storage, it engaged with Germany and Norway for this purpose for different types of waste.

Another example of mercury material flow from Nepal shows mercury inputs from various sources, noting that there is mercury present naturally in raw materials, and so on. It also shows how mercury goes through the waste sector, and then migrates through different sectors, till ends up in air, water and soil and waste treatment. This Nepali example was produced in the training exercise, and we are expecting to make it available online so that other people can receive the same training. Development of mass flow will be the first improvement of inventories towards level two or higher level, because a lot of countries have difficulties of getting a good data set.

Then, Ms. Teeraporn Wiriwutikorn (MNRE, Thailand) presented the national inventory developed in 2010, which will be a possible user for this new training material.

A preliminary mercury emission inventory was estimated for the year 2010 in Thailand, under the project “Development of Approach and Measures to Efficiently and Appropriately Manage Mercury in Thailand”, where the team applied the UNEP toolkit.

Overall distribution of mercury released to the environment in Thailand in 2010 shows 34.2% to air, 13.2% to water, 24.1% to soil, 6.8% to products, 16.6% to waste stream, and 5.1% to specific treatment/disposal. The source categories of mercury release to the environment and the associated amounts released in Thailand in 2010 shows that the biggest source category was extraction and use of fuels/energy sources, followed by waste disposal/landfilling and waste water treatment, then by waste incineration.

Based on the results from the preliminary inventory of the mercury release to the environment in Thailand, the data will to be updated with new activity information, more representative views and up to date advanced system or mercury management in Thailand.

Q&A:

- Q: Referring to the Thai mass flow study, is there any literature quantifying the flow of mercury from oil and gas sector? A: The program mentioned in the presentation (“Development of Approach and Measures to Efficiently and Appropriately Manage Mercury in Thailand”) was reported in Thai, including the references. Therefore, it is difficult to share the detailed information of the literatures.

Key result 3: Laboratory proficiency testing on mercury analysis

Dr. Koichi Haraguchi (NIMD) introduced the concept, objective, outlines, and expected results of the laboratory proficiency testing (PT).

The purpose of PT is to evaluate the laboratories’ performance. Comparing data with other laboratories provides more reproducible and reliable results. Also, participating in PT is a requirement for ISO/IEC17025 accreditation. PT gives educational opportunities for analytical staff, such as looking at anonymously published analytical results from participants, a trend in their testing performance and comparing with other laboratories and recognizing their contribution to the output quality of the laboratory.

One of the unique features of PT Asia and Pacific is open entry. Pilot program for PT in 2018 was conducted only by invitation. The targeted participants were 50 laboratories worldwide from the UN

databank of Laboratories analysing mercury. However, this time, it is the first PT that any public laboratories including Universities and NGOs can participate. PT uses hair powder as a testing item, due to its stability under the curtain condition, and its easy handling to transport and store.

UNEP will organize an online training program to improve analytical performance. The topic of the program will be mercury monitoring and analysis in the environmental and biomonitoring samples. The analytical results (anonymous) will be compiled, statistically analysed, and made publicly available. Also, individual laboratories will receive advisory notes to improve their skills, which will not go public.

The result is expected to use a reporting format. The total mercury concentration must be analysed three times using the same method by the usual staff. It will be compared with wet base, but the water content in the sample is needed to be checked for moisture changes during the transport and storage. Also, the moisture should be measured by percentage of weight decreased after drying.

Then, Mr. Guilberto Borongan (AIT RRCAP) provided the implementation arrangement, schedule, progress, and coordination.

AIT RRCAP arranges and coordinates the implementation of PT. There are some steps, work plan and schedule, starting with capacity assessment of existing laboratories in the region. This includes identifying possible candidates to participate in the PT, distributing invitation widely in the region, calling for the expression of interest from participating laboratories, and distributing survey questionnaires to collect information on current situation and future expectation.

Next step is to support enabling effort of the participating laboratories. Collective and individual capacity development needs are expected to be identified from the survey results. Then a training package for the participants will be developed. After that, online training will be conducted to the laboratories participating in the PT.

For sample preparation and shipping, firstly the PT samples are prepared. Their homogeneity and stability have to be insured so that the participants will receive the same samples. Then participating laboratories will be provided with the testing protocols.

Finally, analytical results are compiled, statistically analysed, and shared to the public. Individual laboratories will also receive advisory notes from this exercise, to improve their analytical skills and encourage them for mercury related activities.

Q&A:

- Q: Regarding the lab PT, is it limited to the Asia and Pacific countries to participate, or can other countries participate? (Similar questions were raised asking the availability and showing the interest for participating in the PT from Mauritius, Tanzania, Malaysia, Libya, etc.) A: We are calling for the expression of interest from laboratories, mainly in the Asia-Pacific region, but we can also accept a few laboratories outside of the region to assess the competency of the Asian laboratories to compare with other regions. The laboratories outside of the region will be compiled and analysed separately. They can receive some advisory, too.
- Q: Any possibility for collaboration with our local universities? A: Laboratories from public universities can participate in the proficiency testing.
- Q: Is this work part of the National Action Plan? A: The project focuses on Article 17, 18 and 19 of the Minamata Convention. ASGM-NAP is under Article 7 of the Convention which is not directly related to this Project. But if you are interested in the Project, you are welcome to join this webinar.
- Q: We are monitoring mercury in our groundwater (Malaysia groundwater). Is there any country in the Asia Pacific region which has robust experiences in monitoring and treating groundwater

with mercury? A: About 30% of water for urban activities comes from groundwater in Japan. The total number of regularly monitoring wells is about 6,400 nationwide. In addition, surveys are conducted every 4-5 years at 1-2 km and 4-5 km intervals in urban and its surrounding areas to detect contamination. If pollution is detected, the local government will survey within 500 m to confirm the direction of groundwater contamination.

- Q: What is the difficult point when we are preparing material PT for T-Hg in water? A: It is difficult to handle low concentration water samples because they are not stable for a long time. Changes may be acceptable at higher concentrations. There is a tap water CRM developed by Zhu (2017). The concentration of Hg is 0.38 µg/L, which seems to be a good indication of the concentration of Hg to maintain its stability. Incidentally, Hg concentration was given as an information value, not certified, since a loss of the water sample was observed when the sample was stored at room temperature and exposed to light.

Key result 4: Situation analysis of environmental conservation means, which can also serve as mercury management measures in Minamata area

Ms. Yayoi Hayashi (OECC) provided a concrete example of the strategic partnership with Minamata City.

Certain activities and policy measures on mercury management, which could bring other environmental benefits (co-benefit). Minamata city was selected as one of the SDGs Future Cities in Japan in 2020 for its policies and activities of environmental management, through learning from the historical lessons and turning into one of the leading cities being showcased for others.

Historical background dates back to the industrialization of Minamata area in early 20 centuries. The ancestor company of JNC initially developed hydropower plants in the region, but one of their carbide plants released methylmercury into Minamata bay, which caused Minamata disease. However, since the early years of Minamata area, hydropower has been one of the major products, and today the company owns 13 hydropower plans and their total capacity is approximately 96.9 megawatts.

This study focuses on the energy profile in and around Minamata area. Also, it examines the co-benefit effect of promoting renewable energy.

The first finding is about the high proportion of renewable energy used in the industry sector of Minamata area. Approximately 50% of public electricity in Minamata area is supplied by local providers using renewable energy resources, namely, hydropower. In the industry sector, JNC's electricity is 100% hydropower, and its excess electricity is provided to its surrounding business partners.

Another finding is the energy sources of the electricity used by the Minamata municipal facilities. More and more municipal facilities use renewable electricity and both the absolute amount and share in the energy mix are growing in recent years, while the electricity use has gradually decreased owing to the energy saving efforts.

The third finding is about the co-benefit effect of reducing CO2 and mercury emission from the use of renewable energy. Minamata area's public electricity supply has a high proportion of renewable energy, achieving a low GHG emission and theoretical prevention of mercury emission from the coalfired plants.

Time zone management

One of the challenges of online event is how to cope with the time difference where target audiences reside. When planning a global event, at least two identical session should be organized to provide the same information to the participants. At the same time, the convenience of the presenters and the organizers should also be considered. In this project with its PMU in Bangkok, Thailand (UTC+7), a morning and an evening time slots fulfils this requirement.

Location	Session 1	Session 2
Suva (UTC+12)	11pm – 1am Thu. 21 Oct.	1pm – 3pm Tue. 26 Oct.
Tokyo (UTC+9)	8pm – 10pm Thu. 21 Oct.	10am – 12pm Tue. 26 Oct.
Bangkok, Jakarta (UTC+7)	6pm – 8pm Thu. 21 Oct.	8am – 10am Tue. 26 Oct.
New Delhi, Colombo (UTC+530)	4:30pm – 6:30pm Thu. 21 Oct.	6:30am – 8:30am Tue. 26 Oct.
Nairobi (UTC+3)	2pm – 4pm Thu. 21 Oct.	4am – 6am Tue. 26 Oct.
Geneva (UTC+2)	1pm – 3pm Thu. 21 Oct.	3am – 5am Tue. 26 Oct.
Sao Paulo (UTC-3)	8am – 10am Thu. 21 Oct.	10pm – 0am Mon. 25 Oct.
Washington DC (UTC-4)	7am – 9am Thu. 21 Oct.	9pm – 11pm Mon. 25 Oct.
Los Angeles (UTC-7)	4am – 6am Thu. 21 Oct.	6pm – 8pm Mon. 25 Oct.
Honolulu (UTC-10)	1am – 3am Thu. 21 Oct.	3pm – 5pm Mon. 25 Oct.

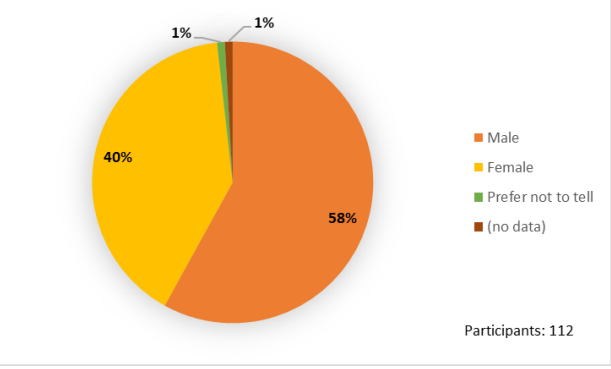
Results analysis

The webinar required registration for all the participants, and questionnaire was conducted after the webinar, which 51 participants (46%) answered. Analysing the registration data found that there were 112 participants in total for the sessions 1 and 2 from 32 countries/regions in 7 regions of the world. More than 70% (83) of the entire participants were from Asian region, followed by Africa (9%, 10) and North America (7%, 8). Approx. 60% (67) of participants came from project partner countries and remaining 40% from non-partner in Asia-Pacific (15%, 17) or other regions (25%, 28).

Region	Total	Remarks
Asia	83	
Pacific	2	
Middle east	2	Incl. North Africa
Africa	10	
Europe	3	
North America	8	
Latin America	4	
Total	112	

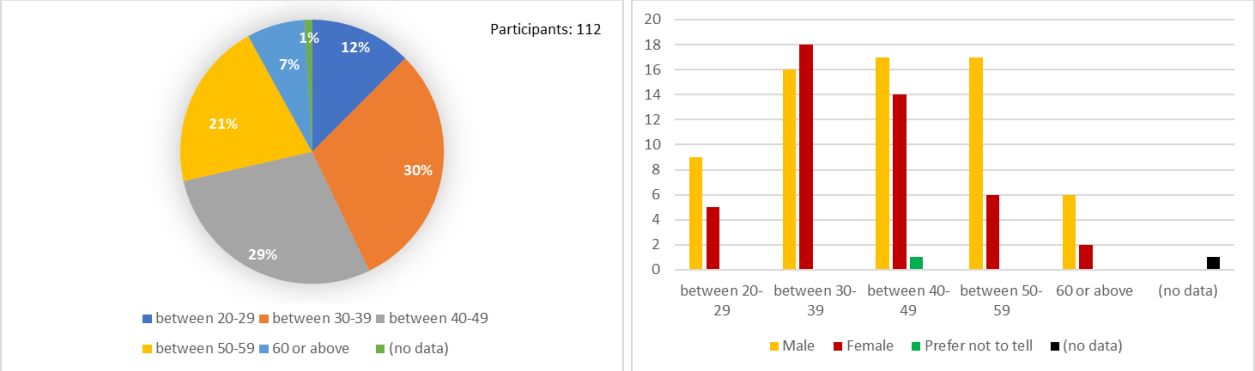
Type	Total	Remarks
Project partner	67	
Non-partner	17	Asia-Pacific
Non-partner	28	Other regions
Total	112	

Regarding the gender proportions, 58% was male and 40% was female among the entire participants.



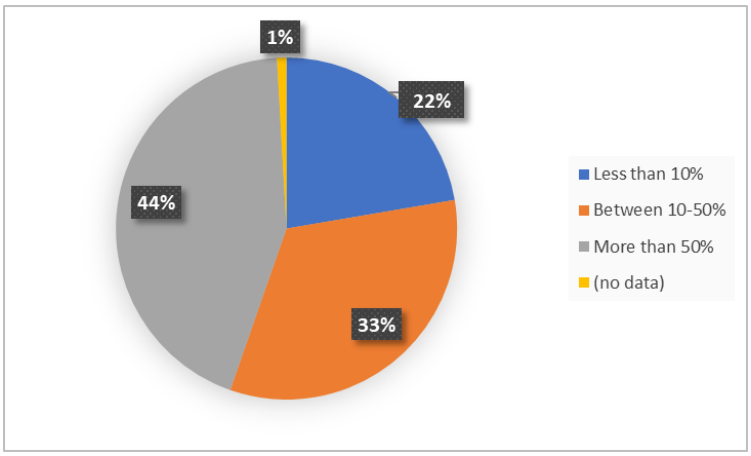
Gender profile of participants

The largest age group of the participants was between 30-39 (30%), followed by the age group 40-49 (29%). The age group breakdown of the female participants indicated an increasing attendance of younger population especially the age groups of 30-39 and 40-49, while over 50 are male-predominant age groups.



Age range disaggregated by gender

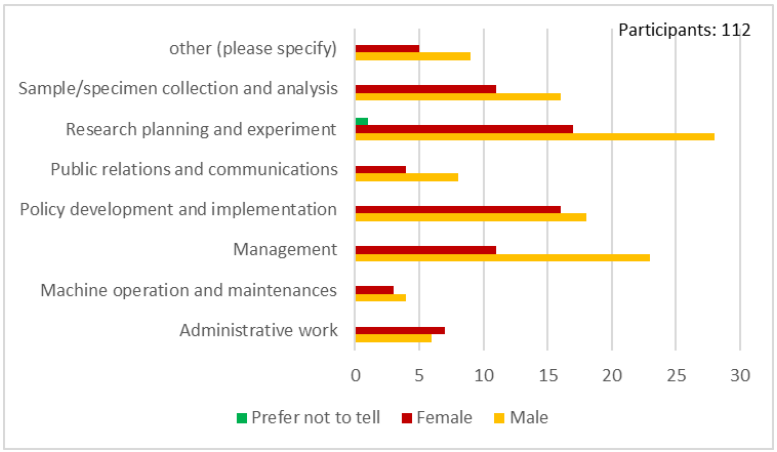
Responding to the question on how much of the routine work relates to mercury, the three-fourth of the participants has some (more than 10%) time being involved in mercury-related subject. It indicated that the webinar was reached out the appropriate audiences who might have received relevant information for their routine works.



Routine work related to mercury

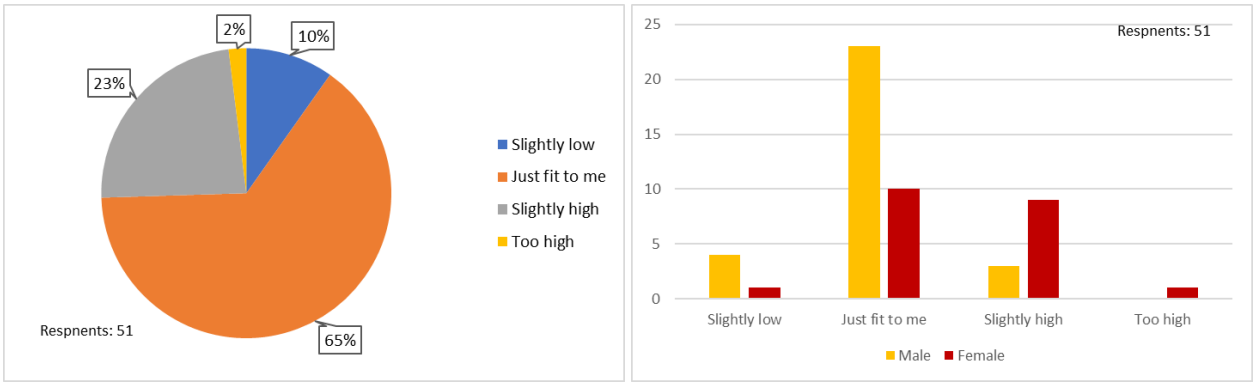
For the question of the roles of the participants in their institutions, they could choose more than one that applied to their roles (multiple answers). The answers showed that ‘research planning and experiment’ was the highest role for both female and male followed by ‘policy development & implementation’ for female and ‘management’ for male participants, respectively.

Participants who answered “others” included advocacy, lecturer, mercury analyser distributer, mercury network coordinator, student, etc.



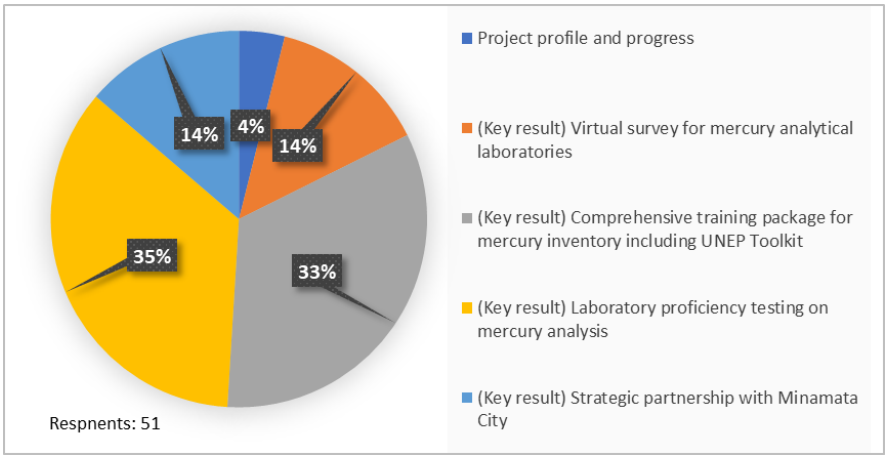
Participants' roles in the institutions (multiple choice)

The questionnaire asked the participants to rate the overall level of the presentations in comparison with their personal competency. Amongst the 51 respondents, approx. two-third felt that the level of presentations just fitted to them. However, the impression of the webinar was slightly different between male and female. Among the female participants, those who answered the level as "just fit" and the others as "slightly high" were almost the same numbers, in addition to the fact that those who answered "too high" were only females. This may suggest the gender discrepancies in access to human resource development. It could be also the case that there were younger participants among the female group, and they were more motivated to learn new knowledge with fewer experiences compared to male group.



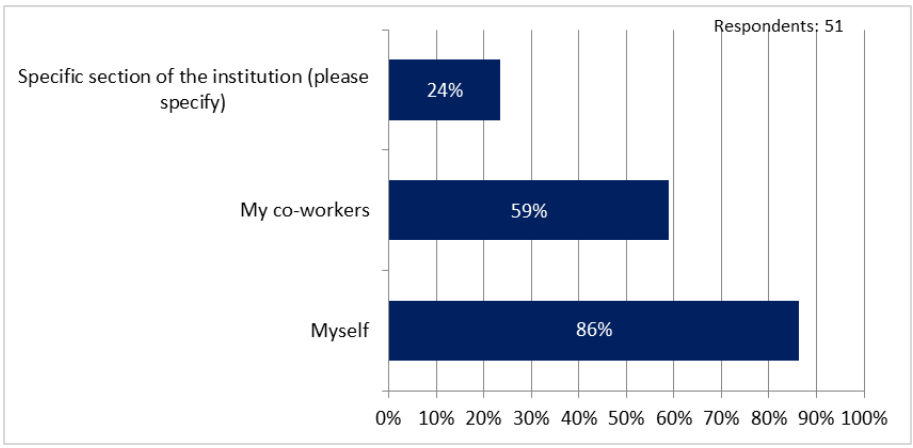
Level of presentations in comparison with the competency

The topic on laboratory proficiency testing on mercury analysis drew the most interest of the participants, closely followed by the topic on comprehensive training package for mercury inventory including UNEP toolkit. These results may reflect the participants' interests in joining any of those UN programs.



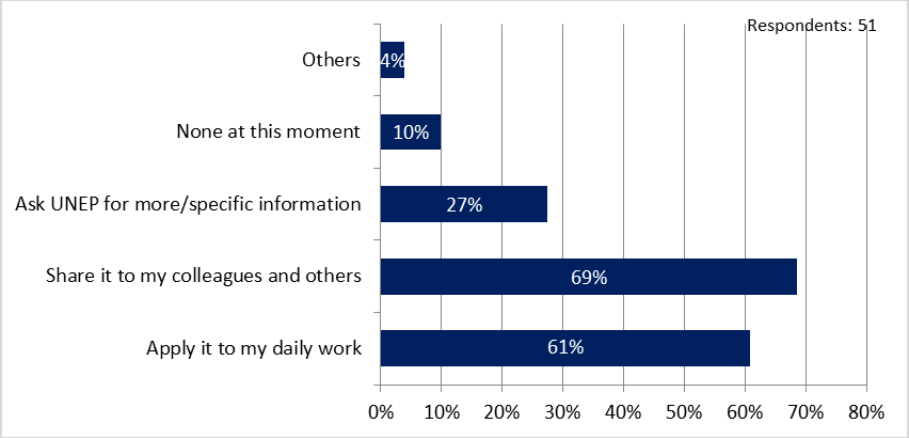
The most interesting topic in the webinar

The question about the most suitable people/ section in participants' institution to participate in this webinar could be answered more than once (multiple answers). More than 80% of the respondents believed that the webinar was suitable for themselves, and almost 60% recommended to their co-workers. Other specific section of the institution includes technical services, research, chemicals management, laboratory analysis, etc.



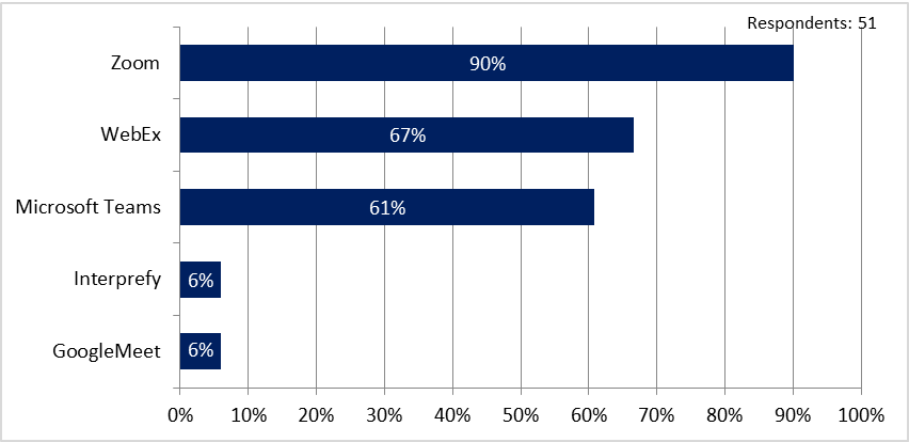
Suitability of the webinar (multiple choice)

The question about what the participants would do themselves about the information received at this webinar could be answered from multiple choices. Almost 70% of the respondents answered that they would share it to their colleagues and others, whereas about 60% would apply it to their daily work. This result concurs to the answers to the previous question about the webinar's suitable participants as mostly one-self and co-workers.



Intention of personal actions after the webinar (multiple choice)

This webinar used the WebEx-events as the online platform. The questionnaire asked about the webinar platforms which the webinar participants were familiar with (multiple answers). Out of 51 respondents, 90% were familiar with Zoom and 60% with WebEx and Microsoft Teams.



Familiarity to the webinar platforms (multiple choice)

Follow-up actions

The online format of webinar is one of the good means to disseminate the project results to wider audience. Especially, the outreach to the possible stakeholders who are not identified by the project needs external support to announce the event. Minamata Secretariat, Global Mercury Partnership and other organizations that have their own networks should be asked for disseminating the announcement.

On the other hand, disseminating project information to more focused audiences, face-to-face and/or hybrid arrangement might be effective. Side events or exhibitions in the existing/planned conferences will also be utilized for the dissemination more effectively and efficiently.

5.8 Minamata study to quantify environmental status relevant to SDGs

Background and objectives

The City of Minamata and its surrounding area (hereafter "Minamata area") has accumulated rich and valuable experiences of coping with Minamata disease and developing advanced policies for environmental conservation.

Such resourceful Minamata area has shared its historical efforts of turning the past tragedy of Minamata disease into an environmental capital in many occasions during the Diplomatic Conference of the Minamata Convention held in Kumamoto and Minamata in 2013 and the first meeting of the Conference of the Parties to the Minamata Convention on Mercury (COP1) held in Geneva in 2017 among others. There is also abundant literature of policy analyses and scientific research papers which document the achievement of Minamata area and provide qualitative analyses.

The "Minamata study to quantify environmental status relevant to SDGs" (hereafter "the study") attempted to develop the methodologies to estimate the environmental status in Minamata area in a quantitative manner.

The City of Minamata has been promoting the community development to achieve a future city built upon a virtuous cycle of economy, society and environment. The City's contributions include comprehensive waste management, circular economy, energy efficiency/climate actions, citizen's actions to conserve marine and land ecosystems, to name a few. Such efforts made by the City of Minamata were recognized to earn the title of "SDGs Future City" in Japan in July 2020.

Scope

The study focused on the policies and initiatives of mercury management, which can also address other environmental issues at the same time. Not only the administrative policies and regulations, but also community initiatives were studied in the exercise, so that an integrated status of Minamata area could be illustrated.

The initial interviews were made with the stakeholders in Minamata area, including the local government, academia, and private sector, in parallel to the literature study on the environmental policy documents and related data which were available from the City of Minamata website. The public electricity supply area was selected to evaluate the current situation quantitatively.

It was initially examined the available data, and then, more detailed data were collected from the tailor-made surveys for the electricity consumption at municipal in Minamata.

Methodologies and data obtained in the study for CO_2 emission

In Minamata area, the industrialization started as early as 1908 when JNC (or Chisso Corporation) was established. It initially developed hydropower plants in the surrounding region to supply electricity to their industrial and mining activities in the vicinity. One of them was the carbide plant in Minamata, which released methylmercury into Minamata Bay, the cause of Minamata disease.

Meanwhile, hydropower was and has been one of the major products of the region. Today, JCN owns 13 hydropower plants with a total capacity of approximately 96.9 MW [3]. Since 2020, its surplus hydropower is supplied to the municipal buildings of the City of Minamata [4].

Renewable energy can achieve co-benefits of CO_2 and mercury reduction from coalfired power plants. Both benefits can be estimated using emission factors and activity data.

Estimation of CO_2 emission factor for the public electricity grid in Minamata area

It is established that the proportion of hydropower in the public electricity grid in Minamata area is distinctively high [5]. Consequently, the CO_2 emission factor for the local grid is considerably low.

The study attempted to evaluate such advanced status of renewable energy penetration in the public electricity grid in Minamata area.

Figure 1 illustrates the scope of local electricity grid which is the scope of estimation. There are three sources of public electricity supply in Minamata area, they are: JNC, the conventional electricity company Kyushu Electric Power Co., Inc. (Kyuden) and new electricity companies (such as power purchase arrangement (PPA), power producer and supplier (PPS), etc.).

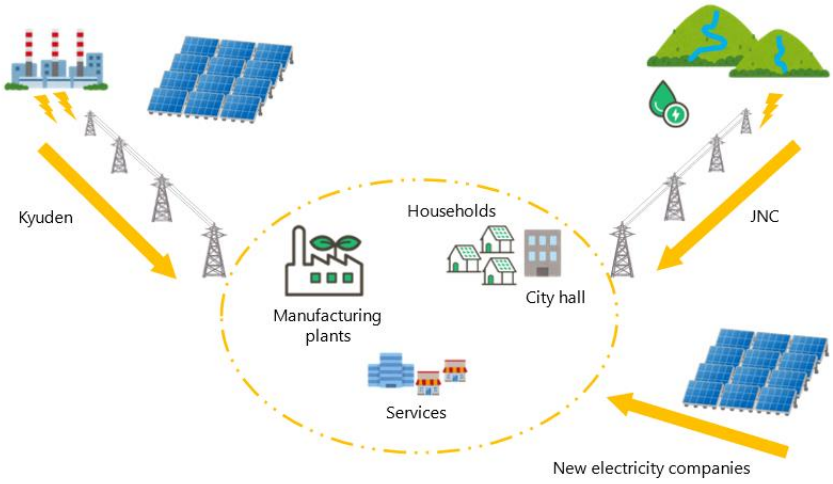


Figure 1 The scope of local electricity grid in Minamata area

The latest field data [6] of electricity consumptions by these three electricity suppliers shows that nearly a half of the local electricity grid in Minamata area is supplied by the JNC hydropower alone. The same contribution becomes overwhelming (70%) in the industry sector, where the JNC is entirely supplied by its own hydropower and the surplus hydropower is shared to its neighbouring plants.

[3] JNC Corporation < https://jnc-eng.co.jp/business/energy/electricity/>
[4] JNC Corporation < https://www.jnc-corp.co.jp/news/2020/sdgsco2.html >
[5] Tanaka and Ishihara, 2009 "Estimation on Greenhouse Gas Emission in Environmental City Minamata," Energy and Resources Vol.30 No.5 (2009), pp 261-264 (Japanese only)
[6] Professor Akio Tanaka, Prefectural University of Kumamoto. Unpublished data.

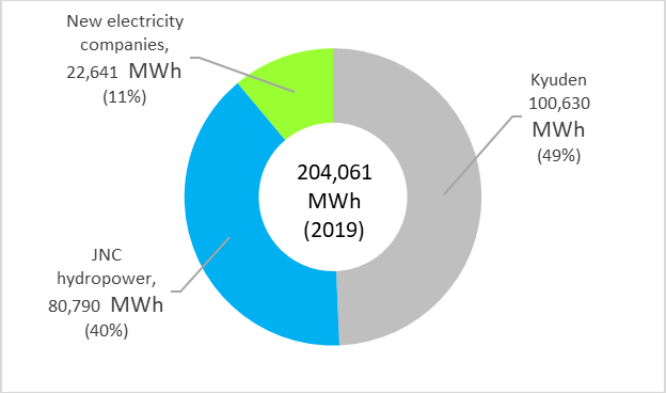


Figure 2 Electricity consumptions by electricity suppliers in Minamata area, 2019

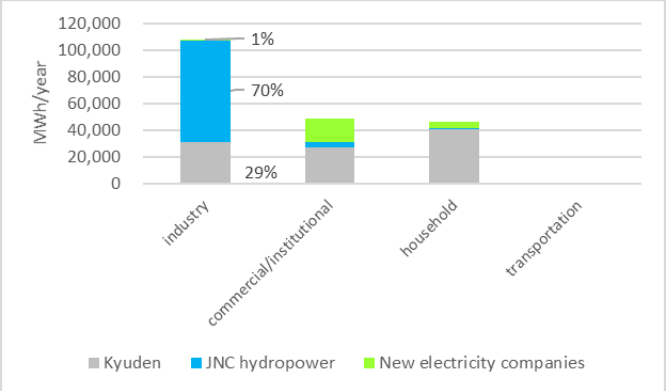


Figure 3 Electricity consumptions by electricity suppliers by sector in Minamata area, 2019

The CO_2 emission factor of the local electricity grid in 2019 in Minamata area was estimated to be 0.2218 t-CO_2/MWh as a weight mean average of the three emission factors from the three electricity supply sources.

$$EFco_2(m) = \{Eco_2(j)+Eco_2(k)+Eco_2(n)\} / \{C(j)+C(k)+C(n)\}$$

Whereas:

- EFco2(m) means CO2 emission factor of local electricity grid in Minamata area,
- Eco2(j) means CO2 emission from the consumption of electricity supplied by JNC (estimated as the said electricity consumption in Minamata area multiplied by its CO2 emission factor),
- Eco2(k) means CO2 emission from the consumption of electricity supplied by Kyuden (estimated as the said electricity consumption in Minamata area multiplied by its CO2 emission factor),
- Eco2(n) means CO2 emission from the consumption of electricity supplied by new electricity companies (estimated as the said electricity consumption in Minamata area multiplied by its CO2 emission factor)
- C(j) means the consumption of electricity supplied by JNC in Minamata area,
- C(k) means the consumption of electricity supplied by Kyuden in Minamata area, and
- C(n) means the consumption of electricity supplied by new electricity companies in Minamata area.

The sources for these data are provided in Table 1.

Table 1. Sources for the data used for estimating the CO2 emission factor in Minamata area

Data	Value and unit	Data year	Source
Electricity consumption in Minamata area by supplier			
Electricity supplied by JNC	80,790 MWh/year	2019	Professor Akio Tanaka, Prefectural University of Kumamoto [7]
Electricity supplied by Kyuden	100,630 MWh/year	2019	
Electricity supplied by new electricity companies	22,641 MWh/year	2019	
CO2 emission factors			
Electricity supplied by JNC	0 t-CO2/MWh	2019	Ministry of the Environment (MOEJ) [8]
Electricity supplied by Kyuden	0.000344 t-CO2/MWh	2019	
Electricity supplied by new electricity companies	0.000470 t-CO2/MWh	2019	

Estimation of CO_2 emission per person in Minamata area, in Japan and in the world

The study then considered to make a comparative analysis among the CO_2 emissions in Minamata area, in Japan and in the world, so that the status of CO_2 emission in Minamata area can be subjectively evaluated. For such analysis a candidate index of CO_2 emission per person was identified and relevant information was collected from the existing resources, as following.

For the CO_2 emission per person in Minamata area, the population data was obtained from the statistical data published in the City of Minamata website (24,275, as of December 2019) [9]. The CO_2 emission per person from the consumption of public electricity was estimated to be 1.86 t-CO_2/year in Minamata area (2019).

For the CO_2 emissions from the public electricity sector at the national and global levels, the suitable data set is found in the United Nations Framework Convention on Climate Change (UNFCCC) database [10]. To note, the breakdown of CO_2 emissions by detailed subsectors is only available for the Annex I parties (developed countries) since developing countries (non-Annex I parties) can submit to the UNFCCC secretariat their national GHG emission inventories without detailed breakdown of source subsectors.

Meanwhile, the population data for most of the developed countries are published by the Organisation for Economic Co-operation and Development (OECD) in its website [11]. Then study screened 32 countries which are members of both OECD and the Annex I of the UNFCCC (OECD & UNFCCC Annex I countries). Hence the CO_2 emissions per person in Japan and in the OECD & UNFCCC Annex I countries were estimated as 3.15 t-CO_2/year and 2.86 t-CO_2/year respectively in 2019.

Preliminary results of CO_2 emissions per person

[7] Professor Akio Tanaka, Prefectural University of Kumamoto. Unpublished data.
[8] MOEJ, 2021, Emission factors for electric power generation sector for estimating GHG emissions from specified emitters on 2019 basis, published on 7 January 2021 by Ministry of the Environment and Ministry of Economy, Trade and Industry, amended on 19 July 2021, < https://ghg-santeikohyo.env.go.jp/files/calc/r03_coefficient_rev.pdf > Japanese only.
[9] City of Minamata website < https://www.city.minamata.lg.jp/dynamic/statistics/pub/default.aspx?c_id=25&y_mst=2&a_mst=2 >
[10] UNFCCC website < https://di.unfccc.int/detailed_data_by_party >
[11] OECD website < https://data.oecd.org/pop/population.htm >

A comparison of CO_2 emissions per person among Minamata area, Japan and developed countries (OECD & UNFCCC Annex I countries) illustrates that CO_2 emission from the public electricity supply in Japan was higher of the three. It is generally explained that Japan increased its dependence on coal and other fossil fuels due to the Great Earthquake, which caused the nuclear accident in 2011 (put aside the modest decarbonization efforts in Japan at that time).

Meanwhile, Minamata area has historically used its local hydropower, to go far ahead of the national decarbonization in the 2010s. Moreover, it is suggested that Minamata area was even greener than the average developed countries to a considerable extent in 2019, as far as the public electricity supply was concerned. This is one of the important findings, which became possible through the quantification exercise of the study.

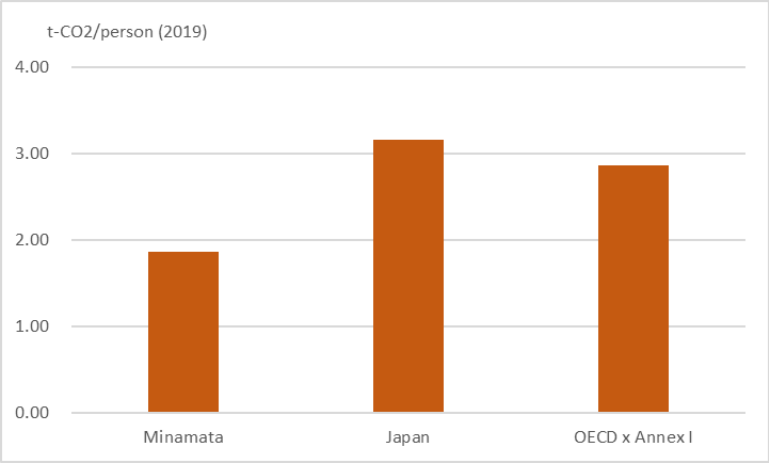
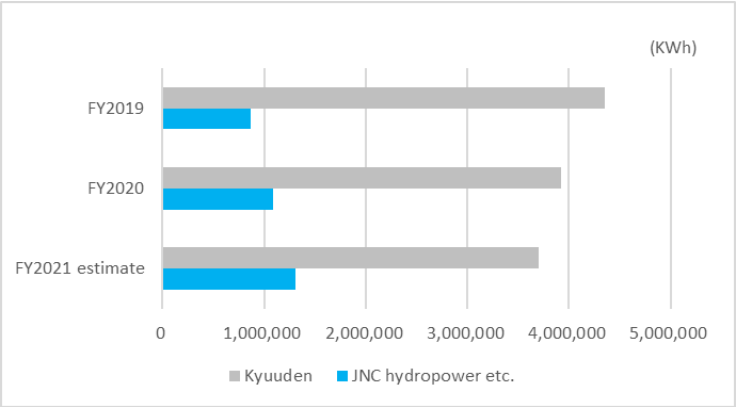


Figure 5 Comparison of CO_2 emissions per person among Minamata area, Japan and developed countries (2019)

Study on the penetration of renewable energy electricity sources in the municipal facilities of the City of Minamata

As mentioned earlier, JNC supplies its surplus hydropower electricity to the neighbouring communities. In 2020, The City administration concluded a contract with JNC for using JNC's surplus hydropower electricity in the municipal buildings. The study obtained a data set of the electricity consumption at each municipal building through the City of Minamata. The data are showing some buildings switched from Kyuden to JNC hydropower and other renewable electricity (Kyuden hydropower etc.) around summer of 2020. Consequently, the renewable energy's contribution increased from 2019, and it was expected to increase more in 2021 (Figure 6).



(Note)

- To estimate FY2021, three assumptions were made:
- A building's total electricity consumption for FY2021 was assumed to be the same as FY2020
- If a building's electricity is 100% from Kyuden in March 2021, the FY2021 electricity consumption is assumed to be 100% from Kyuden;
- If a building's electricity is 100% from the JCN hydropower or any other renewable sources in March 2021, the FY 2021 electricity consumption is assumed to be 100% renewable, and
- If a building's electricity is mixed with both Kyuden and JCN hydropower in March 2021, the FY2021 is assumed as identical with the FY2020, both in total and the breakdown.

Figure 6 Proportion of renewable electricity supplies in the municipal buildings of the City of Minamata.

Methodologies and data obtained in the study for mercury emission

Estimation of mercury emission factor for the public electricity grid in Minamata area

The mercury emission factor of the electricity grid in Minamata area was estimated to be 0.000117 t-Hg/year, based on the theoretical consumption of coal fired for the equivalent amount of electricity consumed in Minamata area.

$$EFhg(m) = \{B(m) \times EFhg(jp)\}$$

Whereas:

- EFhg(m) means mercury emission factor of local electricity grid in Minamata area per year,
- B(m) means the amount of theoretical consumption of coal equivalent to the consumption of local electricity grid in Minamata area (estimated from the contribution of the consumption of local electricity grid in Minamata area out of the total amount of electricity generated by Kyuden per year, multiplied by the amount of coal used by Kyuden to generate its total electricity), and
- EFhg(jp) means national mercury emission factor per ton of coal fed at coal-fired power plants in Japan.

The sources for these data are provided in Table 4. The data year is between 2016 and 2018, taking into account that the latest national mercury emission factor is for 2016. Although it would be accurate to use the data from the same year for all the parameters such as coal and electricity consumptions, they are rapidly changing in the recent years. Thus, the year 2018 was compromised as not too far from 2016 but closer to the current situations in Minamata area.

Table 4 Sources for the data used for estimating the mercury emission factor in Minamata area

Data	Value and unit	Data year	Source
Total electricity generated by JNC	72,200,000 MWh	2018	Kyuden website [12]
Electricity supplied by Kyuden etc. (note)	145,944.47 MWh	2018	Prof. Tanaka [13]
Amount of coal used by Kyuden to generate the total electricity	4,930,000 t-Coal	2018	Kyuden website [14]

[12] Kyuden Group Databook, 2020 < http://www.kyuden.co.jp/var/rev0/0308/2733/data_book_2020_all_b.pdf > Japanese only
[13] Professor Akio Tanaka, Prefectural University of Kumamoto. Unpublished data.
[14] Kyuden Group Databook, 2020 < http://www.kyuden.co.jp/var/rev0/0308/2733/data_book_2020_all_b.pdf > Japanese only

National mercury emission factor of coal-fired power plants in Japan	11,726.50μg-Hg / ton-Coal	2016	MOEJ [15]

(Note) The amount includes the electricity supplied by Kyuden and also the new electricity companies for staying on the conservative side, since the details of the new electricity companies were not available as to estimate the coal consumption.

Estimation of mercury emission per person in Minamata area, in Japan, and in the world

Similar to the analyses of CO_2 emission from the local electricity grid in Minamata area, a comparison of mercury emissions among Minamata area, in Japan and in the world was considered.

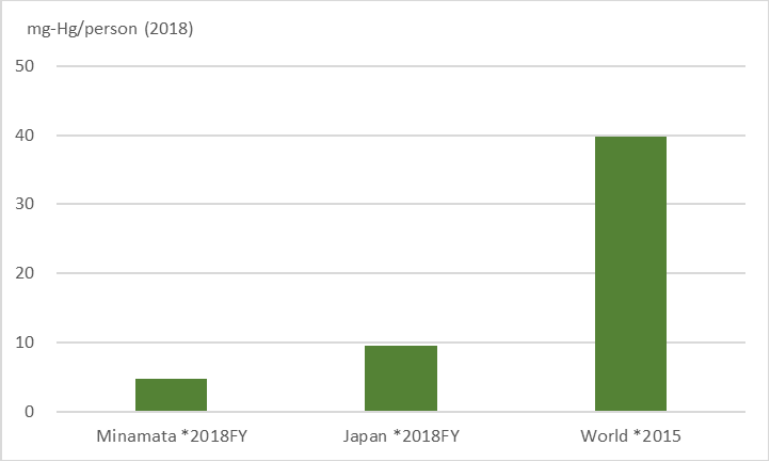
The data sources are summarized as follows.

- For the mercury emission per person in Minamata area, the same population data as the CO2 was applied (24,769 persons, as of December 2018). The mercury emission per person was estimated to be 4.72 mg-Hg/year in Minamata area in 2018.
- The mercury emission from the public electricity sector in Japan was identified as 1.20 t-Hg/year according to the national mercury emission inventory [16]. Also, the mercury emission from the stationary combustion of coal (power plants) was found to be 292 t-Hg/year in 2015 [17].
- The World Bank [18] makes the population data available in its website, to obtain the populations of 126,529,100 and 7,339,000,000 for Japan (FY 2018) and the world (2015) respectively.
- Per-person mercury emission in Japan was then estimated as 9.48 mg-Hg/year in 2018. The same for the world was estimated as 39.79 mg-Hg/year in 2015.
- It is worth mentioning that the GMA found the emission factors from the public electricity sector with not only coal but also oil and gas. However, national data on the amount of oil and gas used for the public electricity in Japan could not be identified. This topic remains to be explored in the future.

Preliminary results of mercury emissions per person

A comparison of mercury emissions per person among Minamata area, Japan and the world illustrates that, the mercury emission from the coalfired power plants in Japan is better-managed than the world-level mercury emission by approximately one-fourth, and furthermore that, the same mercury emission in Minamata area was smaller than the already-exemplar control of mercury emission at the national level. Thus, the analysis shows a shape of the efforts for shifting to renewable energy in a verifiable manner.

[15] MOEJ, no date, Results of mercury material flow study on 2016 basis, < http://www.env.go.jp/chemi/materialflow/materialflow_2016-2.pdf > Japanese only
[16] MOEJ, no date “Mercury emission inventory” < http://www.env.go.jp/air/suigin/2018inventry.pdf > Japanese only
[17] UNEP 2018, “Global Mercury Assessment 2018”, < https://www.unep.org/resources/publication/global-mercury-assessment-2018 >
[18] World Bank Data, “Population, total” < https://data.worldbank.org/indicator/SP.POP.TOTL >



(Note) Only the coal-related mercury emissions are considered, i.e., mercury emission from oil and gas at the public electricity power plants are not included in the estimation.

Figure 7 Comparison of mercury emissions per person among Minamata area, in Japan and in the world (2015, 2018).

Conclusions and future challenges

The study developed the methodologies to quantify the status of environmental policies in favour of mercury management and other co-benefits relevant to the SDGs, through a good practice example of Minamata area.

The methodology could identify the quantitatively measurable indices such as CO_2 and mercury emissions per person from the use of the public electricity, as there are comparable indices available at the national and global levels.

The results could provide an example of quantitative evaluation on the status of environmental efforts undertaken in Minamata area, supported by new data sets which the study was able to collect through the exercise. One of such data sets was the thorough field survey data on electricity consumption collected by Prof. Tanaka, Prefectural University of Kumamoto, who generously offered his research data to the study. Other examples are the electricity consumption data by power supplier at each municipal building which the City of Minamata kindly compiled particularly for the study. It goes without saying that the environmental efforts are undertaken in all aspects in Minamata area and thus important data have been accumulated, waiting to be introduced in public fora.

Furthermore, the quantitative evaluation results shed light to the significance of renewable energy use in Minamata area, which might have been either not well-known or underestimated before the study. Once spotlighted, the results of quantitative evaluation could be capitalized by the various stakeholders in Minamata area, be it academic communities, private sector, local government and citizens, to demonstrate as a reference to their fellows.

The methodologies developed by the study may be applied to different communities and countries, to respond to any potential needs of making similar evaluation of environmental conservation status. Meanwhile looking at the developing countries, these methodologies may need to be simplified so that the communities/countries with fewer available data could be quantitatively studied.

5.9 Annual workplan

Output	Activity	Sub activity	Timeline[19] 2021 3	2021 4	2022 1	2022 2	2022 3	2022 4	2023 1	2023 2	Deliverables	Progress and Planning
1	1.1 Assess and compile available resources and facilities in and around Minamata and establish partnerships to implement project activities.	Planned									A list of local partners in Minamata, Japan providing support for the project.	2 Local coordination structure established.
		1.1.1 Assess local human resources, facilities, programmes, and activities that may benefit the project implementation.		Completed								
		1.1.2 Establish partnership/collaboration for implementing project activities.		Completed								
1	1.2 Develop relevant capacity building programmes under the Minamata Convention.	Planned									Sets of training materials (agenda, presentations, reference materials), data books, and technical handbooks, etc.	Two training modules to be developed by Q4 2022.
		1.2.1 Develop standard training materials and menus for scientists and technicians that are available for training courses and self-studying.	———	———	———	———	- - -	- - -				
		1.2.2 Develop data books or technical handbooks that compile assessed information for government officers and practitioners.			———	———	- - -	- - -				
1	1.3 Formulate and implement trainings based on regional priorities and identified needs.	Planned									2 face-to-face trainings and series of online trainings implemented per year[20].	2 online trainings in Q4 2021 and Q1 2022. 1 special training for Indonesia in Q2 2022. 2 Trainers' training to be held in Q4 2022.
		1.3.1 Formulate and implement skill up training/visit programmes based on the needs and regional priorities.	———	———	———	———	- - -	- - -	- - -	- - - >		
		1.3.2 Formulate and implement training/visit programmes upon the special requests from network partners.				———						
1	1.4 Undertake follow-up assessment of the effectiveness of the training programmes and publish annual reports.	Planned									Annual reports published.	Progress by mid-2022 to be assessed against 2021 baseline results.
								- - -	- - -			
1	1.5 Develop institutional coordination structure to sustain capacity building programme based in Minamata.	Planned									Agreement on local coordinating structure beyond the project implementation.	Not started

[19] Solid lines are implemented, dotted lines are planned timelines.
[20] Frequency will be adjusted depending on the COVID-19 situation.

Output	Activity	Sub activity	Timeline[19]								Deliverables	Progress and Planning
			2021		2022				2023			
			3	4	1	2	3	4	1	2		
2	2.1 Develop in-country capacity for sampling and analysing mercury and mercury compounds from multiple media.	Planned									Laboratory assessment reports for all partner countries.	Two virtual lab assessment conducted by Q1 2022. Another assessment to be conducted by Q4 2022.
		2.1.1 Capacity assessment of existing laboratories in the region on the basis of technical assistance menus.										
		2.1.2 Provide advice to improve sampling design and field sample collection capacities and skills.										
		2.1.3 Provide advice to improve sample handling, pre-treatment and instrumental analysis capacities and skills.										
2	2.2 Undertake continuous data collection and analysis based on national/regional monitoring plans.	Planned									Mercury monitoring plans in participating partners that are harmonized.	A continuous data collection site developed in accordance with regional methodologies.
		2.2.1 Develop and/or harmonize methodologies and standard operating procedures of mercury monitoring among network partners.										
		2.2.2 Undertake continuous data collection and analysis based on national/regional monitoring plans.										
2	2.3 Provide technical advice and tools to strengthen a harmonized system for data processing and quality assurance for the regional institution network.	Planned									A QC/QA guidebook published; inter-laboratory quality assessment conducted.	1st round laboratory proficiency testing implemented. 2nd round to be implemented in 2023
		2.3.1 Establish a technical advisory body for backstopping the regional institution network partners.		Completed								
		2.3.2 Develop a QC/QA guidebook for mercury monitoring customized for the network.										
		2.3.3 Undertake inter-laboratory data quality assessment for continual improvement among network partners.										
		2.3.4 Develop a start-up assistance menu for inviting new network partners for its expansion.										
2	2.4 Undertake partnership activities/ collaborations with other monitoring programmes to promote science-based policy making.	Planned									Collaborative activities with other monitoring networks.	Collaborative activities with APMMN implemented and with other organizations explored.
		2.4.1 Participate in the activities of other programmes and invite other programme parties for collaborative activities.										
		2.4.2 Conduct mathematical modelling, research, and environmental studies for enhancing science-policy interaction.										
3	3.1 Convene stakeholders' meetings on project planning and result dissemination.	Planned									Meeting reports; increasing list of partners joining.	Online seminars and workshops held in Q4 2021 and Q2 2022. More dissemination activities to be
		3.1.1 Convene an inception workshop for project launch.		Completed								
		3.1.2 Convene periodic stakeholders' meeting to share project results.										

Output	Activity	Sub activity	Timeline[19]								Deliverables	Progress and Planning
			2021		2022				2023			
			3	4	1	2	3	4	1	2		
												implemented using existing platforms.
3	3.2 Accumulate and compile technical data and make it publicly available online.	Planned									A dedicated web page of the project serving as an information portal.	A project dedicated website established by Q4 2021. Technical information to be collected and uploaded.
3	3.3 Strengthen national capacities to utilize mercury data for risk assessment and policy development through the provision of technical advice and knowledge exchange.	Planned									List of services provided, web stories on impact.	Local workshops and seminars to be held in Q4 2022 onward by responding the requests by partner countries.
		3.3.1 Provide technical advice to partners to include national mercury monitoring plan into national development plans.										
		3.3.2 Conduct country level technical workshops for scientists and practitioners.										
		3.3.3 Prepare national inventories and national report with the mercury data obtained by national monitoring plan.										

5.10 Result framework

Intended Project Outcome *(linked to UNEP POW 522.3 Outcome and Output 8[21])*: Countries increasingly generate and apply information on how to monitor and reduce mercury emissions and releases in their legislations, policies or action plans.		
Outcome indicators, including baseline and targets:		**Updated Result Status**
Indicator 1: Number of countries that embed scientific data collection in their mercury management policies.	Baseline: 0, Target: 6	Status: Not available Preliminary: Participating countries needs firstly to improve the quality of relevant data collection system.
Indicator 2: Number of Countries that regularly put information on mercury monitoring available via the information portal.	Baseline: 0, Target: 6	Status: 0 In progress: Project collaborating with regional mercury monitoring network to enhance monitoring data collection and sharing.
Indicator 3: Number of new, adequate policies and legislation in effect on mercury management.	Baseline: 0, Target: 3	Status: Not available Preliminary: A survey to be conducted to collect national information on mercury policies and legislation.

Results	**Results (Output) Indicators**	**Baselines and Targets**	**Updated Result Status**
Output 1: Comprehensive capacity building programme based in	Number of capacity building programme package for specific subjects developed and implemented.	Baseline: 0 Targets: 2	Status: 0 In progress: Content of 2 training packages drafted, peer-review in-progress.

[21] UNEP PoW 522.3 Outcome: Countries address priority chemicals and waste issues using information, assessments, guidance and tools provided by UN Environment. Outcome indicator: (iii) Increased number of civil society organizations addressing priority chemicals and waste issues under the chemicals multilateral environmental agreements through the use of knowledge and tools provided by UNEP, baseline 0 target 6. Output 8: Generation and use of information for science-based policy development on mercury management are enhanced at regional level. Output indicator: Number of Countries that regularly put information on mercury monitoring available via the information portal, baseline: 0, target: 2, Number of countries with national institutions that meet international standards on mercury analysis, baseline: 0; target: 2. Milestones to the PoW 522.3: by Dec. 2021, Annual seminar to disseminate the progress and results of the activities to wider audiences convened and reported, by Jun. 2022, Capacity building programme packages to strengthen science-based information collection are developed and available, by Dec. 2022, Analytical proficiency for mercury laboratories is assessed and documented.

Minamata developed and implemented.	Local coordination structure in Minamata developed.	Baseline: 0 Target: 1	Status: 2 Achieved: Local coordination structure with Minamata City and National Institute for Minamata Disease established.
	% of trained participants who successfully apply the knowledge and skills on mercury management in their work disaggregated by gender and age range.	Baseline: 0 Target: 50%	Status: Not available Preliminary: Baseline data collected and compiled. Follow up survey will be conducted in Q3 2022.
Output 2: A regional monitoring institution network in Asia and the Pacific established.	Number of countries with national institutions on the network that meet international standards on mercury analysis.	Baseline: 0 Targets: 3	Status: Not available Preliminary: The first laboratory proficiency testing to examine the analytical quality conducted.
	Number of existing regional networks establishing partnership with this programme.	Baseline: 0 Target: 2	Status: 1 In progress: Collaboration with Asia Pacific Mercury Monitoring Network is undertaken.
Output 3: Outreach of qualified information in support of early implementation of the Convention implemented.	Number of countries submitting information to the information portal.	Baseline: 0 Targets: 6	Status: 0 Preliminary: Project's dedicated website has been established, where national data will be uploaded.
	Number of countries outside of the project partners that received information through project activities.	Baseline: 0 Target: 30	Status: 35 Achieved: Minamata Online session invited participants globally.

5.11 Project budget

Item		Budget (USD)
Output 1: Comprehensive capacity building programme based in Minamata developed and implemented.		545,000
1.1 Assess and compile available resources and facilities in and around Minamata and establish partnerships to implement project activities.	5,000	
1.2 Develop relevant capacity building programmes under the Minamata Convention.	110,000	
1.3 Formulate and implement training based on regional priorities and identified needs.	400,000	
1.4 Undertake follow-up assessment of the effectiveness of the training programmes and publish annual reports.	-	
1.5 Develop institutional coordination structure to sustain capacity building programme based in Minamata.	30,000	
Output 2: A regional monitoring institution network in Asia and the Pacific established.		477,000
2.1 Develop in-country capacity for sampling and analysing mercury and mercury compounds from multiple media.	261,000	
2.2 Undertake continuous data collection and analysis based on national/regional monitoring plans.	158,000	
2.3 Provide technical advice and tools to strengthen a harmonized system for data processing and quality assurance for the regional institution network.	50,000	
2.4 Undertake partnership activities/ collaborations with other monitoring programmes to promote science-based policy making.	8,000	
Output 3: Outreach of qualified information in support of early implementation of the Convention implemented.		463,244
3.1 Convene stakeholders' meetings on project planning and result dissemination.	258,244	
3.2 Accumulate and compile technical data and make it publicly available online.	85,000	
3.3 Strengthen national capacities to utilize mercury data for risk assessment and policy development through the provision of technical advice and knowledge exchange.	120,000	
Project Coordination		1,152,099
Project staff personnel	1,039,425	

Item		Budget (USD)
Project M&E	30,636	
Office rent and common costs	82,038	
Sub-Total Project Cost		**2,637,285**
PSC (13%)		342,855
UN Levy (1%)		19,802
TOTAL		**3,000,000**

5.12 Financial report (preliminary sum[22])

Income Category	Pledged (USD)	Received (USD)	Status
2019 Contribution	1,000,000	1,000,000	Received
2020 Contribution	1,000,000	1,000,000	Received
2021 Contribution	1,000,000	999,990	Received
TOTAL	3,000,000	2,999,990	

Expenditure Category	Budget[23] (USD)	Expenditure (USD)			Delivery Rate (%)
		Committed	Actual	Total	
010 Staff Personnel	1,119,425	16,971	411,639	428,610	38.3
160 Travel	269,474	0	30,570	30,570	11.3
120 Contractual Service	190,186	0	12,623	12,623	6.6
135 Equipment and Furniture	15,518	0	6,256	6,256	40.3
125 Operational Costs	107,740	0	21,498	21,498	20.4
and 130 Supplies		0	462	462	
140 Grant to IP	935,000	278,879	194,426	473,305	50.6
Sub-Total Project Cost	2,637,343	295,850	677,474	973,324	37.0
155 UN PSC (13%)	342,855	0	123,915	123,915	36.9
and 150 IP PSC		0	2,617	2,617	
Total Project Cost	2,980,198	295,850	804,006	1,099,856	36.9
Exchange loss/gain	-	0	124	124	-
UN Levy (1%)	19,802	0	19,802	19,802	100.0
TOTAL	3,000,000	295,850	823,932	1,119,782	37.3

Note: Amounts are rounded at one dollar.

[22] Certified financial statement is issued separately by UNON.
[23] Budget after the revision done in February 2022.

5.13 Risk log

	Risk Description/ Analysis	Category	(I) Impact Severity 1-5	(L) Likely-hood 1-5	I x L Overall Risk rating	Risk Management Strategy & Actions	By When/ Whom?
1	Insufficient funding and human resources.	Economic	4	1	4	As this project is formulated under the contribution agreement already signed, the shortcoming of fund is unlikely. 22 March 2021 The third instalment (USD999,990) posted, which account for the total amount of the project budget. The funding enables proceeding the activities, so this risk has been resolved.	Closed
2	Attention on chemicals and waste decreases.	Political	4	2	8	The engagement with partner countries through this project and other opportunities to show the relevance of the issue. New UNEP Medium-term Strategy 2022-25 highlighted the 'chemicals and pollution' as one of 3 pillars. UNEA5 also discusses the needs to strengthen science-policy interface on chemicals sector. Such global trends should be promoted at regional and national levels. The establishment of a science-policy panel on chemicals and waste decided at UNEA 5.2. This will boost the awareness of the chemicals management issues.	On regular basis/ Programme Officer, ROAP SP5

	Risk Description/ Analysis	Category	(I) Impact Severity 1-5	(L) Likely-hood 1-5	I x L Overall Risk rating	Risk Management Strategy & Actions	By When/ Whom?
3	The supporting group do not provide quality input or sufficient support.	Organization	4	2	8	Cooperation and engagement of local partner in Minamata will be confirmed at the initiation stage of project implementation.	On regular basis/ Programme Officer
4	Low interest from decision makers at national level.	Organization	4	1	4	All partner countries are ratified or implemented MIA projects towards ratification, which indicates high interest at national level.	On regular basis/ Programme Officer, ROAP SP5
5	Covid-19 pandemic persists for many years.	Social	4	4	16	UN policy to cope with COVID-19 pandemic is still active. Implementation modality without international travel is prepared as an alternative plan, which can be switch to normal mode when travel restriction is lifted. Project will monitor the resumption of physical/face-to-face activities accordingly. Minamata COP4 is divided into 2 parts and the face-to-face segment also limits physical representation at the venue, which reduces the opportunity to disseminate project information. Security phase of UN office in Bangkok returned to Phase III (low risk) in June 2022 and some in-person activities has resumed.	On regular basis/ ROAP senior management

	Risk Description/ Analysis	Category	(I) Impact Severity 1-5	(L) Likely-hood 1-5	I x L Overall Risk rating	Risk Management Strategy & Actions	By When/ Whom?
6	Pro-democracy protest in Thailand leads social unrest.	Social	3	2	6	Pro-democracy protest against current military regime is put on pause. Local security situation is carefully assessed to evade demonstration campaign.	On regular basis/ ROAP senior management
7	Political instability in Myanmar continues.	Political	3	4	12	Political instability in Myanmar limits the engagement of the project. The Project Management Unit will continue to monitor the situation as well as guidance provided by the UN for engagement with the Government of Myanmar.	On regular basis/ Programme Officer, ROAP SP5
8	Cooperation from Minamata City reduces when focal persons of Minamata are replaced.	Organization	2	3	6	Partnership between Minamata City and UNEP is maintained basically by the mutual trust at individual level. There is uncertainty if such trust is maintained when the Director General is replaced. The project sent a letter as the tangible evidence to demonstrate the benefit of this partnership. Thus, this risk has been resolved.	Closed.
9	State bankruptcy in Sri Lanka slows down the implementation of mercury policy	Political	2	3	6	Unprecedented economic crisis in Sri Lanka forces the country reshuffle the government. The mercury policy under new administration will be closely monitored.	On regular basis/ Programme Officer, ROAP SP5

5.14 Lessons learned log

	Date	Description	Recommendation/ Action
1	2 September 2019	Local media (in Minamata and Kumamoto) valued this mercury project and published news articles in local newspapers. They asked more information on the project and requested participation to the workshop.	The project implemented by international organization such as UNEP has high news value to the local media so that it could increase visibility of the project. Press releases or other information may help more media coverage on this project.
2	2-4 December 2020	Online activities have limitation but could also provide opportunities to make tangible contribution to the project. Online programmes are open to more participants than that of face-to-face ones.	Online meeting tools such as WebEx, Microsoft Team, etc. are versatile applications, thus maximising their utility should be explored.
3	29 April 2021	Considering rapid development of new and emerging online technologies that enables real-time two-way communications, surveys without physical travel could be a prospective future methodology, not just an ad hoc measure but more effective and efficient survey technique.	But at the same time, such methodology cannot replace the traditional physical survey completely and still has some vulnerability in severe COVID settings that is beyond the control. Finding capable local coordinators and securing Internet connection are the key for such remote operation.
4	7-9 December 2021	Project activities attracted more attention to agencies beyond Asia-Pacific region and collaboration extended to other regions, which increased the impacts of the project.	Activity-based joint implementation and collaboration will be explored with organizations/agencies that interest the planned project activities. This approach is mutually beneficial and increase the visibility of the UNEP project.
5	21-25 March 2022	The second segment of Minamata COP4 completed successfully in hybrid modality. Good web platform is available to formulate events that involves both in-person and online participants. One disadvantage of online participation, however, is unavailability of side meetings with project partners participated in the COP on project-related discussions.	In-person meeting will be held more regularly to benefit the effectiveness of face-to-face communications. Online platform supplements and adds value of the meeting that can invite more participants and contributors who are not able to travel.