United Nations Environment Programme

Final report of periodic ambient mercury monitoring at Niigata-Maki Acid Deposition Monitoring station in Japan from 2021 to 2023 under the project of “Promoting Minamata Convention on Mercury by making the most of Japan’s knowledge and experiences”

December 2023

Asia Center for Air Pollution Research

Japan Environmental Sanitation Center

This project aims to evaluate the feasibility and challenges for introducing ambient mercury monitoring by gold trap method, which will be included in the monitoring guidance of Minamata Convention, to existing monitoring sites. First, we established a mercury monitoring system at the existing ambient monitoring site of Niigata-Maki Acid Deposition Monitoring station in Japan. Then, the pilot monitoring was conducted there from October 2021 to October 2023. The detailed activities are shown as below.

1. Establish and undertake continuous data collection and analysis based on consistent methodology in the region.

Activity 1.1: Evaluate the usefulness and value-add of the existing facilities and learning materials for establishing and implementing new ambient mercury monitoring.

- Examine the existing and available facilities and materials that will be used for ambient mercury monitoring.
- Evaluate the existing training materials and advise the improvement in more comprehensible ways.
- Evaluate the benefits and additional burden of existing monitoring sites in comparison with establishing independent monitoring sites.
- Prepare a project report.

Activity 1.2: Undertake continuous data collection based on methodology in the region.

- Set up a mercury monitoring system at an existing ambient monitoring site.
- Undertake continuous sample collection and analyze mercury levels in ambient air.
- Compile data set together with ancillary information including meteorological data.
- Assess and evaluate the effectiveness of the sampling methodology and amend it as necessary.

The activities in this report were implemented from 7 July 2021 to 30 November 2023.

Asia Center for Air Pollution Research, Japan Environmental Sanitation Center

4.1. Preparation for the pilot monitoring and development of the Standard Operating Procedures (SOPs)

The existing ambient monitoring site of Niigata-Maki national acid deposition monitoring station (N37°48’33”, E138°51’09”, 52 m altitude) was selected as the mercury pilot monitoring site. It is located at the foot of Mt. Kakuda (482 m a.s.l.), 1 km from the seashore, and 25 km southwest of the center of Niigata City, the capital of Niigata Prefecture, Japan, as shown in Fig. 1. This station was constructed by the Ministry of the Environment, Japan to monitor acid deposition and air pollutant concentration and to investigate acid deposition in rural areas on the coast of the Sea of Japan. There is no industrial source near the Niigata-Maki site, but a small community (approximately 1,300 population) is located 2 km northwest of the station, and thus it is classified as a rural station. Air masses reaching the station are dependent on seasonal wind patterns, which are affected by the monsoon circulation: in winter the northwest cold currents prevail, while in summer they are replaced by the hot and humid currents of the Pacific Ocean. At the station, gaseous pollutants such as SO_2, NO, NO_2, O_3, particulate matter concentrations of PM_{10}, $PM_{2.5}$, ionic and metallic components, water soluble organic carbon, and meteorological parameters of wind direction, wind speed, temperature, relative humidity, precipitation amount, solar radiation are monitored.

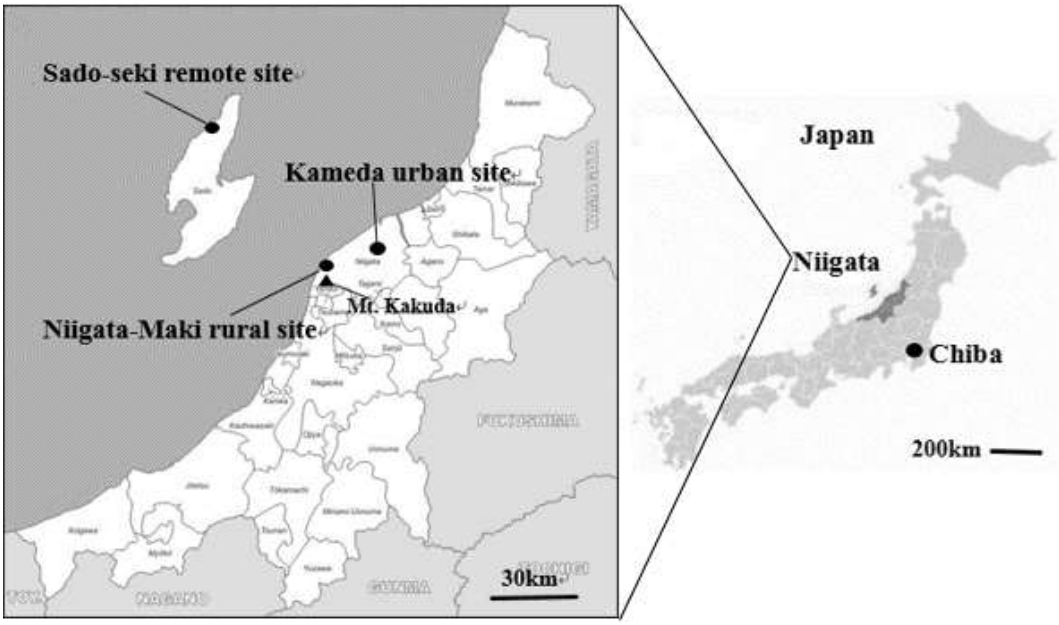


Fig. 1 Location of the Niigata-Maki national acid deposition monitoring station

For the preparation of pilot monitoring, the necessary equipment and analytical instruments for mercury monitoring were obtained, and the applications for use of the Niigata Maki station were submitted to the Ministry of the Environment and Niigata Prefecture, respectively, and were approved in September 2021. Then, the test measurements were conducted on September 21-22, 2021, and it was confirmed that the measurements could be made without any problems.

Fig. 2 Photo of the test measurements during September 21-22, 2021. The left one shows sampling through manifold, and the right one shows sampling without manifold.

As shown in Fig.2, the ambient air was sampled through manifold or without manifold. The

mercury concentrations for both sampling lines were compared. The results of Fig.3 show that there is no significant difference between the sampling line through manifold and one without manifold. Futhremore, there is good agreement between the mercury concentration at Niigata-Maki and those at near regular mercury monitoring stations in Niigata city. Therefore, we decided the mercury sampling is conducted through air sampling manifold considering the convenience of sampling operation and prevention from rain and snow. Then, we developed the Standard Operating Procedure (SOP) of ambient mercury sampling as shown in the Appendix 1.

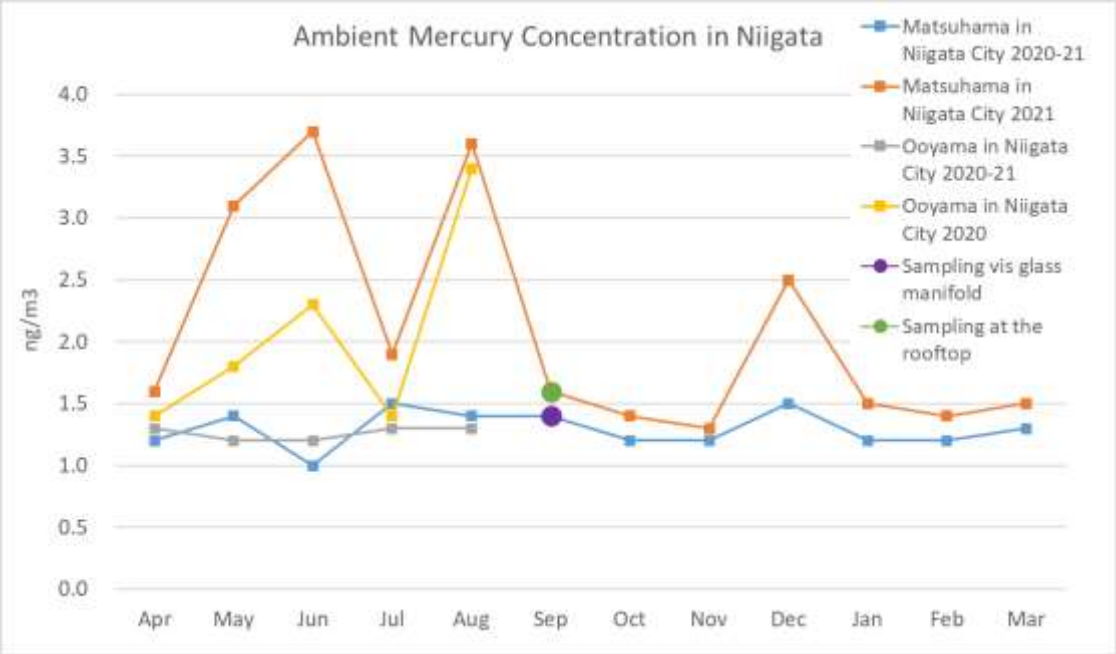
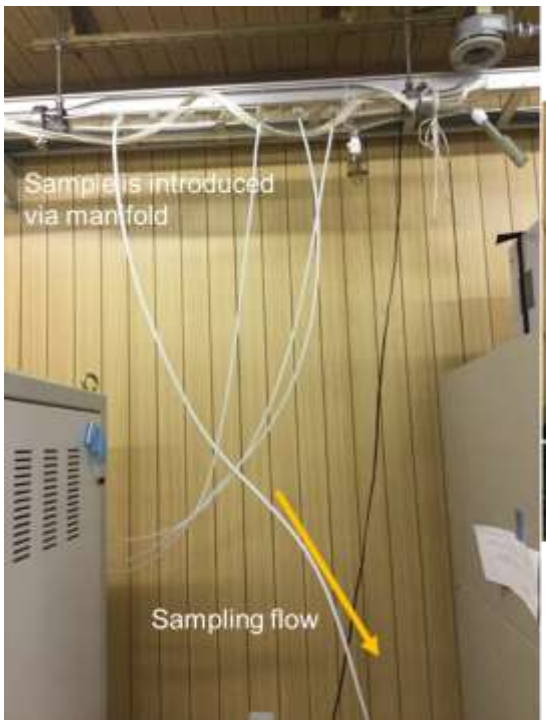


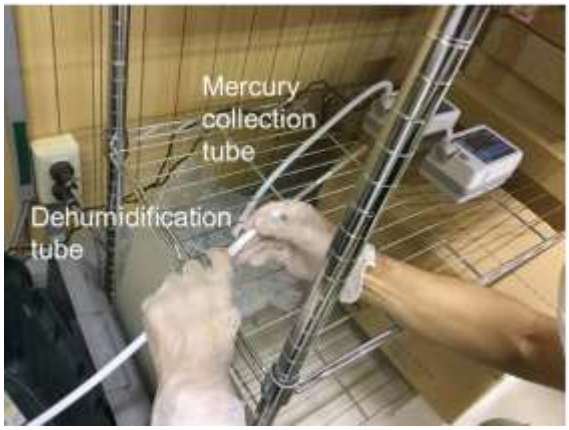
Fig. 3 Mercury concentrations obtained by the test measurements. The mercury concentrations are 24-hour average.

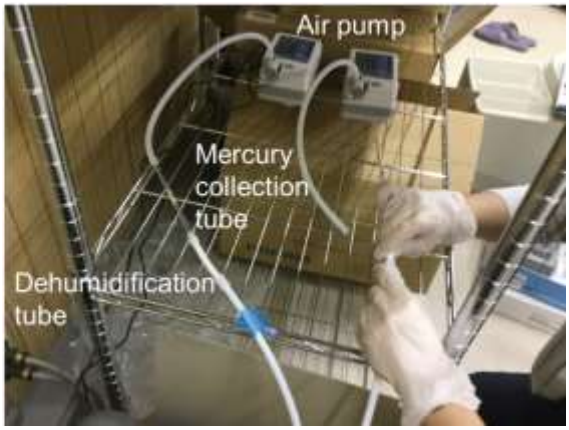
The first regular mercury measurement was conducted on October 11-12, 2021. The photos of regular mercury measurement are shown in pages 4 to 5. The sampling procedure was followed by the SOP shown in Appendix 1. The duration of each sampling is 24 hours, and the regular mercury measurement by using 2 sampling lines is conducted every two weeks until October 2023. During the regular measurement, the following issues are found.

- The quartz wool used to fill the soda lime may be shifted during sampling, and it may contaminate into the mercury collection tube. After this finding, the installation procedure of quartz wool was improved, and quartz wool was filled tightly so that it is not shifted.
- The Japanese guideline (Manual of measurement method of hazardous air pollutants-Monitoring of mercury in the Ambient Air) describes that the quartz wool should be treated with silane to prevent adsorption, but this process may be difficult to implement in developing countries because of treatment of hazardous chemical after use. The effect of adsoption on quartz wool was not examined, so it may cause underestimation of the measurement data.
- The mercury collection tubes are narrow in diameter, which may cause damaged during sampling procedure. The operator requires careful installation work.
- When power outage was occurred, the pump was stopped and then automatically resumed. The irregular event should be record in the field note.

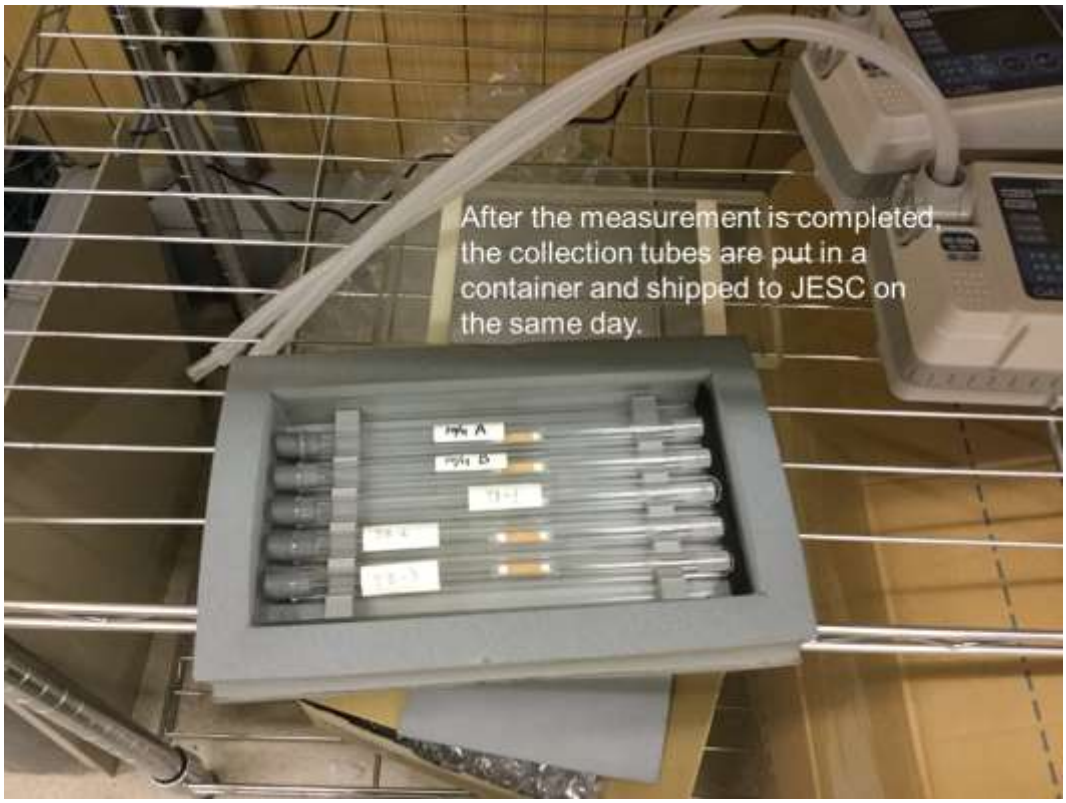
Photos of regular mercury measurement








Check the flow rate of 500 mL/min
before starting and ending the measurement


After the measurement is completed,
the collection tubes are put in a
container and shipped to JESC on
the same day.

After the sampling, the collection tubes are sent to Japan Environment Sanitation Center at Kawasaki, Japan for analysis. 2 mercury samples and 1 blank sample are analyzed at ever measurement followed by the Japanese guideline. This guideline adopts gold amalgamation trap, thermal desorption and cold vapor atomic absorption spectrometry. The quantity of mercury is measured by the atomic absorption at a wavelength of 253.7 nm. In order to avoid the contamination in ambient air, the shipment of the samples was conducted on the same day of end of each sampling, and the analysis was conducted within 1 or 2 days after receiving the samples. The analytical procedure was followed by the SOP shown in Appendix 2.

4.2. Time variations of mercury concentrations from October 2021 to October 2023

Figs. 4, 5 and 6 show time variations of mercury concentrations obtained by the regular measurements at Niigata-Maki and near regular mercury monitoring stations in Niigata city in 2021, 2022 and 2023, respectively. The numerical data of mercury concentrations obtained by the regular measurements at Niigata-Maki are shown in Appendix 3, and the metaata of the regular mercury measurements at Niigata-Maki are shown in Appndix 4. Providing ancillary information as well as periodical measurement data of ambient mercury, the monthly averages of meteorological parameters at Niigata-Maki in 2021, 2022 and 2023 are shown in Tables 1, 2 and 3, respectively.

Most of the mercury concentration data for the sampling line A were generally consistent with those for the sampling line B. These results suggest that the conducted sampling and analytical procedure well reproduced ambient mercury measurement. When the mercury concentration data at Niigata-Maki are compared with those at near regular mercury monitoring stations in Niigata city (Matsuhama and Ooyama, 30-35 km Northeast from the Niigata-Maki), the mercury concentrations at Matsuhama and Ooyama were relatibely higher in summer (July to September). Furthermore, high peaks of mercury concentration were observed at Ooyama in November 2022 and June and August 2023. These observation results suggest that there are local emission sources of mercury around the site. Around Matsuhama and Ooyama site, there are various kinds of factories and Niigata Thermal Power Station. Fossil fuel combustion from these insutry and power plant would be possible sources. On the other hand, there is no high concentration eposide in Niigata-Maki, and the site would be suitable to observe background level of mercury and transboundary air pollution episode.

The clear seasonal pattern of mercury concentration was observed throughout the observation period. The concentrations during winter (December to April) tend to be higher than those during summer (August to September). This pattern may be associated with long range transportation of mercury that may be contained in coal combustion particle. Tables 1, 2 and 3 show that the most frequent wind direction at Niigata-Maki is west-southwest in winter that is corresponded to the direction from the East Asian continent. On the other hand, the most frequent wind direction in summer is southeast that is s corresponded to the direction from the Pacific Ocean.

There is some previous studies of gaseous and particulate mercury and the mercury wet deposition flux measurement at the coastal site of the Sea of Japan. Marumoto and Sakata conducted periorical mercury monitoring at Matsue located in the Sea of Japan site from December 1998 to November 2001 (Marumoto and Sakata, 2007). The particulate mercury concentration and the mercury wet deposition flux during winter and spring were higher than those during summer. Especially during spring, their increase was accompanied with an increase in atmospheric concentrations and wet deposition fluxes of Al, Fe, non-sea-salt Ca and Mn, major components of soil. This suggests the large contribution of the yellow dust. During winter and the yellow dust periods, the Pb/Zn concentration ratio and Pb isotope ratios in air and precipitation observed in Matsue were close to those in the Asian continent. These results implied that during winter in Matsue, long-range transport of particulate mercury from the Asian continent contributes

primarily to the Hg wet deposition.

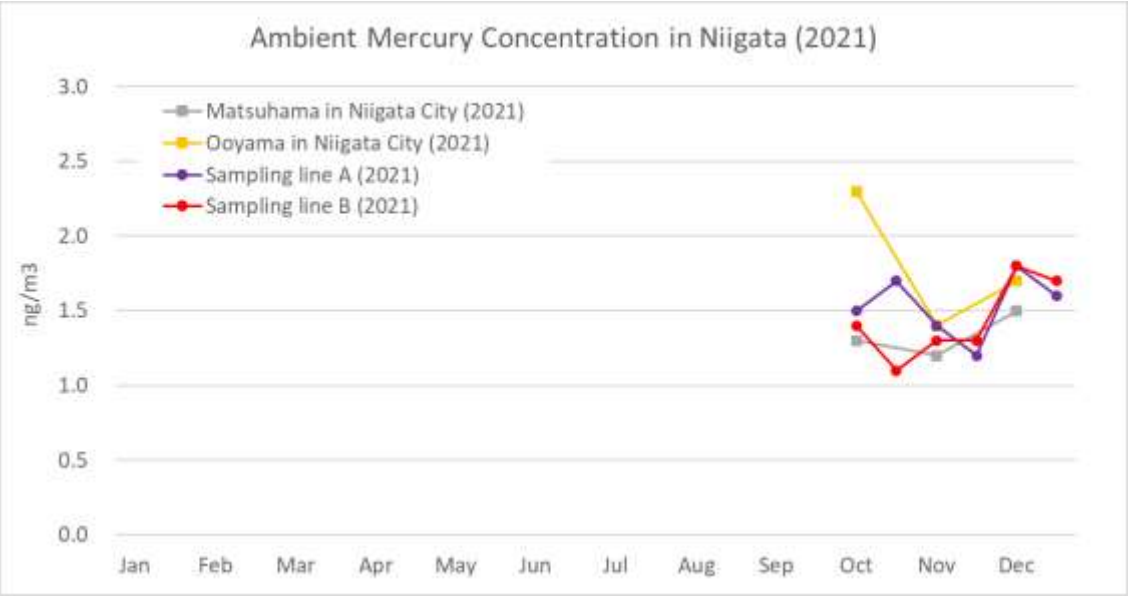


Fig. 4 Mercury concentrations obtained by the regular measurements at Niigata-Maki and near regular mercury monitoring stations in Niigata city in 2021. The mercury concentrations are 24-hour average.

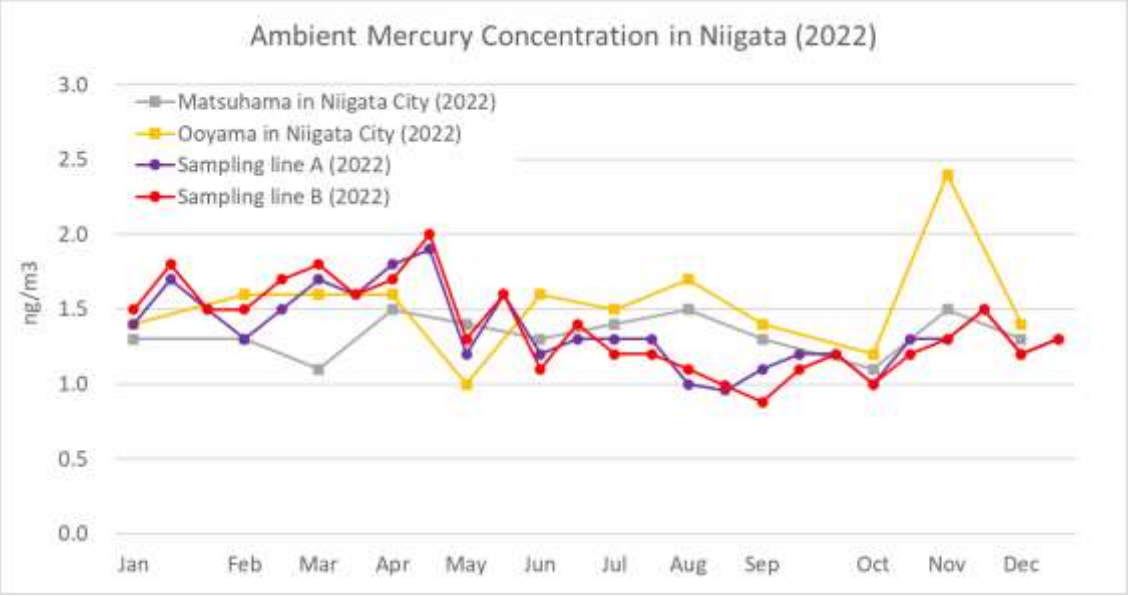


Fig. 5 Mercury concentrations obtained by the regular measurements at Niigata-Maki and near regular mercury monitoring stations in Niigata city in 2022. The mercury concentrations are 24-hour average.

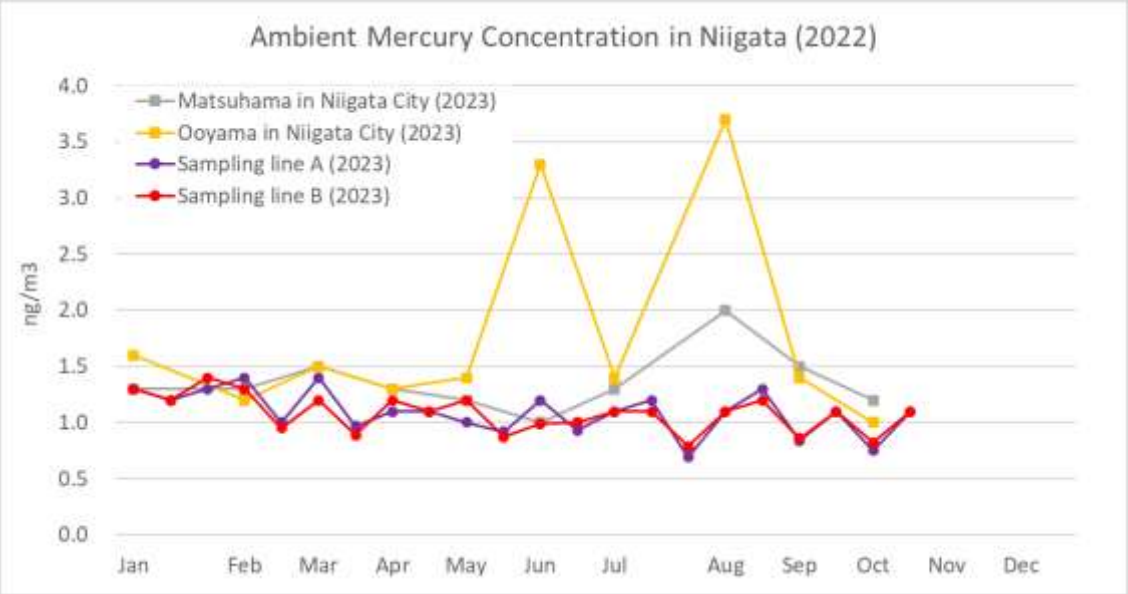


Fig. 6 Mercury concentrations obtained by the regular measurements at Niigata-Maki and near regular mercury monitoring stations in Niigata city in 2023. The mercury concentrations are 24-hour average.

Table 1 Monthly averages of meteorological parameters at Niigata-Maki in 2021.

Meteorological Statistics : Niigata-maki

2021

Month / Items		1	2	3	4	5	6	7	8	9	10	11	12
Temperature (ºC)	monthly mean	1.6	4.2	8.1	11.0	16.4	21.5	26.1	26.4	21.8	16.8	11.1	5.1
	max.daily mean	6.5	13.5	14.5	16.7	21.8	24.5	28.7	31.6	23.9	23.4	16.3	10.6
	min.daily mean	-2.6	-0.6	1.7	6.2	10.8	16.8	22.1	21.0	17.9	11.7	5.7	-1.6
Relative humidity (%)	monthly mean	80	70	68	66	74	75	78	76	73	75	75	78
	max.daily mean	94	90	83	94	93	89	93	92	89	93	85	92
	min.daily mean	62	52	48	50	57	61	65	60	57	59	59	59
Mean wind speed (m/s)		5.4	6.4	4.1	4.1	4.0	2.6	2.7	3.0	3.3	3.6	5.1	6.3
Most frequent wind direction (bearings)		SE	WNW	SE	SE	WSW	N	SE	SE	SE	SE	SE,SSE	WNW
Precipitation amount (mm/month)		256	96	62	114	104	75	225	195	136	120	197	222
Sunshine duration (hours/month)		--	--	--	--	--	--	--	--	--	--	--	--
Solar radiation (MJ/m^2/month)		154	227	404	539	539	615	640	531	474	321	213	135

Table 2 Monthly averages of meteorological parameters at Niigata-Maki in 2022.

Meteorological Statistics : Niigata-maki

2022

Month / Items		1	2	3	4	5	6	7	8	9	10	11	12
Temperature (ºC)	monthly mean	2.1	1.9	6.9	12.3	17.2	21.6	26.6	26.5	23.3	15.4	11.8	4.4
	max.daily mean	5.4	7.1	12.4	19.2	22.8	28.7	30.1	30.4	29.5	22.7	15.8	8.2
	min.daily mean	-0.3	-0.5	3.0	6.1	9.2	15.3	23.0	21.4	17.4	10.6	8.9	-0.2
Relative humidity (%)	monthly mean	73	75	70	67	65	73	76	76	74	74	74	82
	max.daily mean	85	90	88	93	88	89	88	87	91	90	86	94
	min.daily mean	61	59	53	46	44	59	64	64	60	57	58	61
Mean wind speed (m/s)		6.4	5.8	4.4	3.6	3.2	3.7	2.7	3.2	3.2	3.5	3.7	6.4
Most frequent wind direction (bearings)		WNW	WNW	W	SE	SE	WSW	SE	WSW	SE	SE	SE	WNW
Precipitation amount (mm/month)		70	94	76	117	85	121	159	207	87	111	156	367
Sunshine duration (hours/month)		--	--	--	--	--	--	--	--	--	--	--	--
Solar radiation (MJ/m^2/month)		177	208	375	526	673	602	644	469	418	316	223	116

Table 3 Monthly averages of meteorological parameters at Niigata-Maki in 2023.

Meteorological Statistics :

2023

Month / Items		1	2	3	4	5	6	7	8	9	10	11	12
Temperature (ºC)	monthly mean	2.5	3.3	8.8	12.3	16.6	21.7	26.3	30.6	25.5			
	max.daily mean	8.1	7.3	17.3	16.9	22.0	25.3	29.9	32.5	29.5			
	min.daily mean	-4.5	-0.6	4.5	7.8	10.2	18.5	22.5	27.8	20.9			
Relative humidity (%)	monthly mean	76	72	65	65	72	76	76	64	74			
	max.daily mean	92	88	89	88	94	90	91	76	91			
	min.daily mean	57	55	52	39	52	54	67	50	58			
Mean wind speed (m/s)		6.1	5.2	3.7	4.1	3.2	3.3	3.1	3.2	3.2			
Most frequent wind direction (bearings)		WNW	WNW	SE	W	SE	WSW	WSW	SE	SE			
Precipitation amount (mm/month)		138	86	87	74	176	191	126	8	172			
Sunshine duration (hours/month)		--	--	--	--	--	--	--	--	--			
Solar radiation (MJ/m^2/month)		154	239	459	532	607	577	605	720	406			

Ono et al. monitored mercury concentrations in the atmospheric deposits were measured from April 2017 to April 2020 in Niigata City (Ono et al., 2021). The total mercury concentration in the weighted average precipitation was 5.7±3.6 ng/L for total mercury, 2.8±3.0 ng/L for dissolved phase, and 2.9±2.0 ng/L for particulate phase. Asian dust was observed when the concentration of particulate mercury and the concentration of particulate matter increased, which may have affected the concentration of mercury. High concentrations of particulate matter are generally observed, and concentrations of heavy metals and toxic substances increase during Asian dust event. Asian dust and rainfall were observed during the period when an increase in insoluble total mercury concentrations was observed, suggesting that the Niigata area may have been affected by Asian dust. According to the Ministry of the Environment's survey on the state of Asian dust (2003-2008), the concentration of mercury in the air was mostly undetectable, and it was suggested that there was almost no impact on Japan due to the adhere of mercury to Asian dust (Ministry of the Environment, Japan, 2009). The amount of atmospheric deposition increased in winter when there was much rainfall and snow, and the concentration of dissolved mercury tended to increase. There is no clear reason of seasonal trend of mercury concentration in Niigata, but it should be paid attention this trend when atmospheric behabior of mercury is considered.

- Evaluattion on the effectiveness an major findings of the sampling methodology and the review of existing manual and training materials

From October 2021 to October 2023, the regular mercury measurement at the existing ambient monitoring site of Niigata-Maki has been conducted without any significant problems. The mercury concentrarion level represents the suburb of Niigata city, and seasonal trend of mercury concentration was observed. We confirmed that the sampling and analytical procedures followed by the manual of measurement method of hazardous air pollutants published by Ministry of the Environment, Japan are effective to conduct periodical mercury monitoring. We also reviewed the existing training materials followed by the manual. According to the review of manual and training materials, the following findings are identified.

- The sampling manifold in the station will not affect measurement values. The sampling air could be intoruced through a manifold or directly introduced in mercury collection tubes.
- The quartz wool used to fill the soda lime should be tightly fixed to avoid contamination of the sample.
- The pre-treatment of quartz wool with silane to prevent adsorption is difficult to be conducted.
- The mercury collection tubes should be carefully treated.
- The irregular event such as power outage, local contamination etc. should be record in the field note.

- Evaluation on the benefits and additional burden of existing monitoring sites

To use of existing monitoring sites for regular mercury measurement will save the additional cost of monitoring facility and power supply and could use meteorological data and other gaseous and particulate matter concentration data that will be useful for trend analysis. Therefore, it is more efficient compared with establishing independent monitoring sites. On the other hand, there is additional burden burden to use existing monitoring sites. For example, the space to install sampling pump and tubes is required when new mercury monitoring is implemented. If sampling manifold is used, the maecury sampling line should not interfere other gaseous and particulate matter concentration montiorings.

- Dissimination of knowledge obtained by the project

We developed the Standard Operating Procedures (SOPs) of ambient mercury sampling and analysis. These SOPs could be used for references when mercury monitoring is conducted in developing countries. However, the SOPs should be developed for in each institution by considering the available monitoreing instrument, apparatus and reagents and skill of staffs etc.

Furthermore, on-site training is recommended to acquire proficiency in regular monitoring operation followed by the SOPs.

Finally, the analysis of mercury monitoring observations and metadata is shown in Appendix 4.

Marumoto, K. and Sakata, M. (2007) Seasonal variations in concentrations of mercury and other chemical components in air and their wet deposition fluxes in a region facing the Sea of Japan. Environmental science, 20, 47-60.

Ministry of the Environment, Japan (2009) Report on the survey on the state of Asian dust (2003-2008) https://www.env.go.jp/air/dss/torikumi/chosa/rep2.htm.

Ono, T., Kobayashi, T., Matsuzaki, A., Tanahashi, S. and Yagoh, H. (2021) Observation of Mercury Species Concentration in Atmospheric Deposition in Niigata City in Japan. Journal of Environmental Chemistry, 31, 55-63.

Appendix 1

Standard Operating Procedure (SOP) of Ambient Mercury Sampling

1. Preparation before sampling

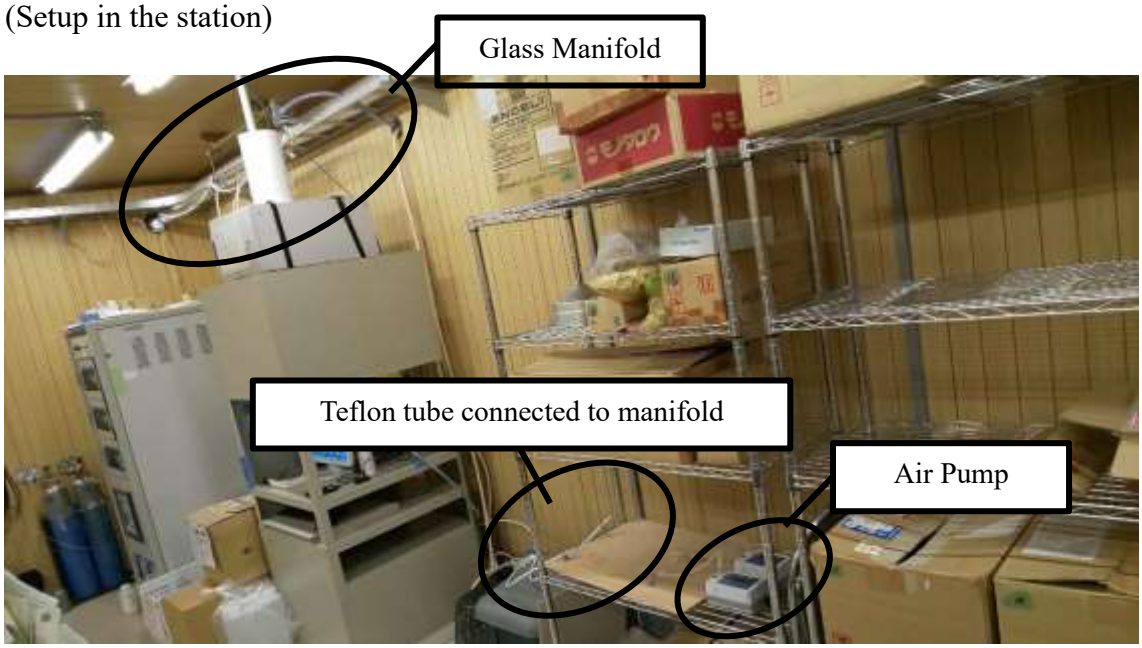
The following items are required for sampling (excluding those installed at the site).

- Mercury collection tubes (sent by JESC East Branch)
- Dehumidifying tubes (Teflon tubes filled with soda lime, prepared by ACAP*)
- Silicone tubes to connect the above two items. (May be stored in a Unipac or a similar bag at the site.)
- A field notebook and writing tools
- Camera (or smart phone)

(Note) Preparation of dehumidifying tubes will be described in the other document.

2. Field work at the start of sampling (Start time is generally 11:30-12:00)

(Setup in the station)



(1) Take a picture of the electric meter and record the amount of electricity used (kwh) in the field notebook. (At the first sampling of the month, press and hold the rate and CO_2 buttons on the meter at the same time to reset the meter.)

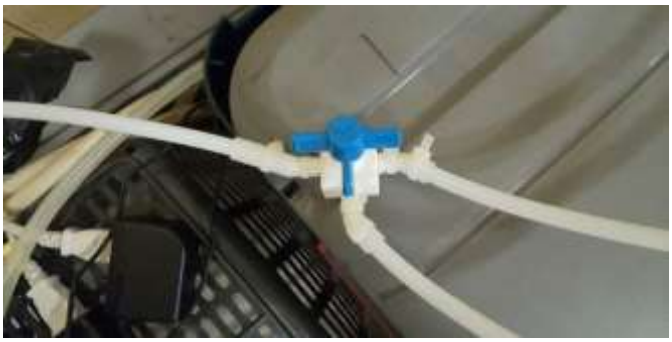
The following procedure should be conducted for two flow paths, A and B.

(2) Connect the dehumidification tube to the Teflon tube extending from the manifold. (Note: Connect for the appropriate direction)

(3) Connect the dehumidifying tube to the collection tube with silicone tubing. (Be careful not to damage the collection tube.)

(4) Connect the collection tube to the air pump. (Be careful not to damage the collection tube.)

(5) Open the three-way stopcock
Followed by the picture.
(Note: To prevent backflow of indoor air into the manifold, open the three-way stopcock after completing the step (4).



(6) After confirming that the pump is set to a flow rate of 500 mL/min and a sampling time of 24 hours, press and hold the start/stop button to start the pump. When the pump starts, the pump light will blink.

(7) Record the start time of the measurement (pump start time) and the flow rate after 5 minutes in a field notebook.
(The set of equipment may be left at the station until the next day.)

(8) If there is a sample for the travel blank test, open the stopper of the collection tube container for the travel blank during the step (3) to (6) and close it after starting the measurement.

3. Field work at the end of sampling (End time is after 24 hours. Should arrive at the station before 5 minutes of the end time)

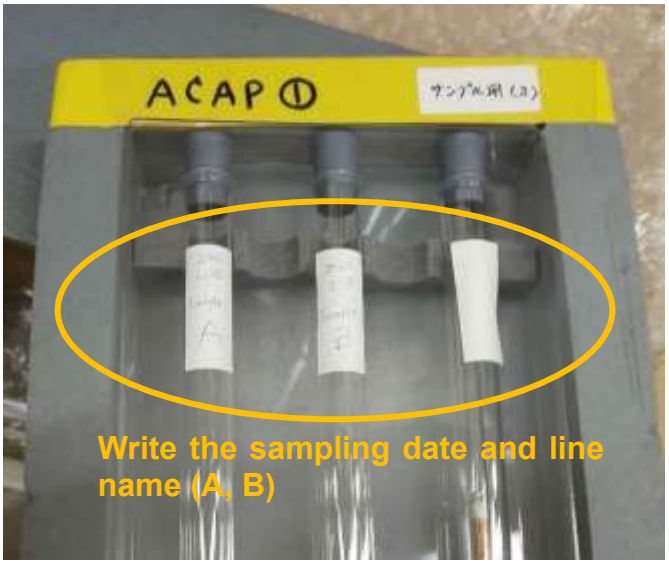
(1) Record the the flow rate before 5 minutes of the end time in a field notebook.

(2) After the pump stopped and the measurement is ended, record the integrating flow volume in the field notebook.

(3) Close the three-way cock. Make sure the manifold side is closed as shown in the photo. (Note: To prevent backflow of indoor air into the manifold, close the three-way stopcock after completing the step (2).

(4) Disconnet the collection tube and the dehumidification tube by the reverse order of installation, and put the collection tube in a container. (Be careful not to damage the collection tube.) Write the sampling date and line name (A, B) on the label.

After removal, cap the Teflon tube extending from the manifold and the silicon tube extending from the pump to prevent contamination.



(5) If there is a sample for the travel blank test, open the stopper of the collection tube container for the travel blank during the step (4), and close it after the work in (4) is completed.

(6) Take a picture of the electric meter and record the amount of electricity used (kwh) in the field note book.

4. Operation after the sampling

(1) Ship the collection tubes to JESC. (Measured by mercury analyzer at JESC)

(2) Photos of the electricity meter will be stored in a server.

(3) Report monthly electricity consumption to Niigata Prefecture office at the end of each month.

Appendix 2

Standard Operating Procedure (SOP) of Mercury Analysis

The analytical procedure is followed by the Manual of Measurement Method of Hazardous Air Pollutants - Monitoring of mercury in the Ambient Air (2011, Ministry of the Environment, Japan)

1. Instrument, apparatus and reagents

(i) Instrument (Ref: Fig. 1)

- Mercury analyzer
  Automatic direct combustion mercury analyzer (MA-3000, Nippon Instruments Co.)
  Desorption unit for mercury collection tube (RH-MA3, Nippon Instruments Co.)
- Muffle furnace
  High Performance Muffle Furnace (FP413, Yamato Scientific Co., Ltd.)

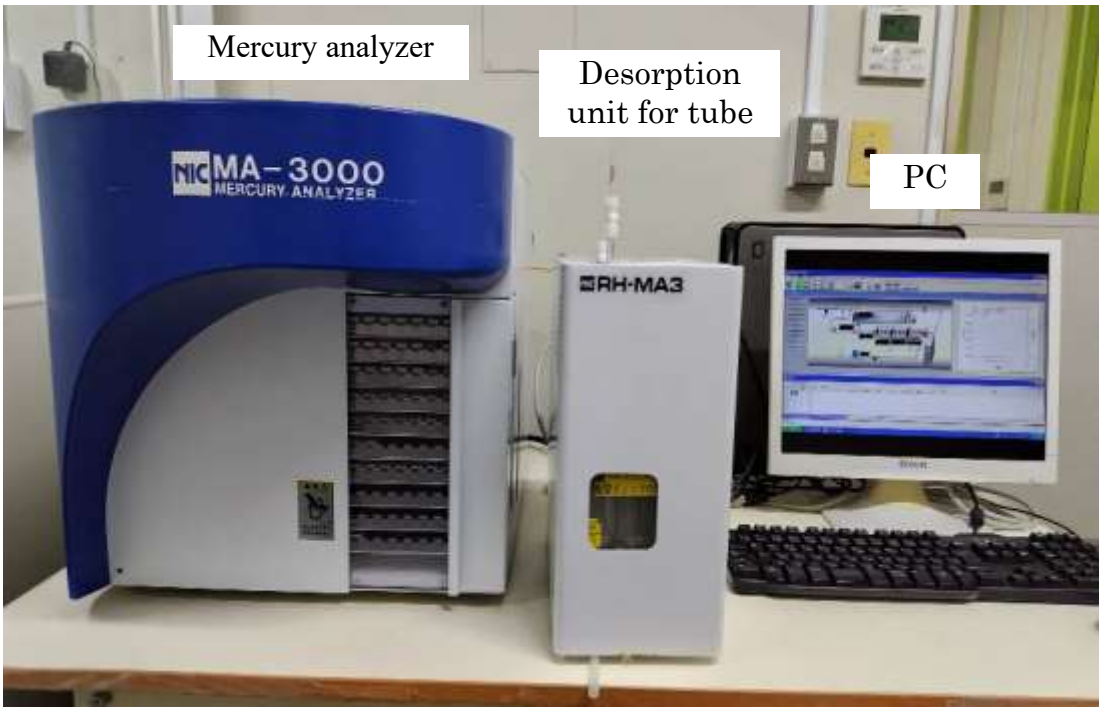


Fig.1 Configuration of mercury analysis instrument

(ii) Apparatus

- 0.10 mL gas tight syringe (Hamilton Inc.)
- Mercury collection tubes (N-160, Nippon Instruments Co.)
- Quartz glass tube (Used to measure instrument blank and standard gases, and attached to the instrument in place of the mercury collection tube.)
- Trap tube (Mercury-removed air is introduced into the analyzer as a carrier gas through the trap tube.)

(iii) Reagents

- 0.10 mL gas tight syringe (Hamilton Inc.)

- Standard buffer solution (Phosphate pH standard (pH=6.86), FUJIFILM Wako Pure Chemical Co.)
- Mercury standard gas generated by a mercury vapor saturation gas regulator (Ref: Fig.2, Nippon Instruments Co.)

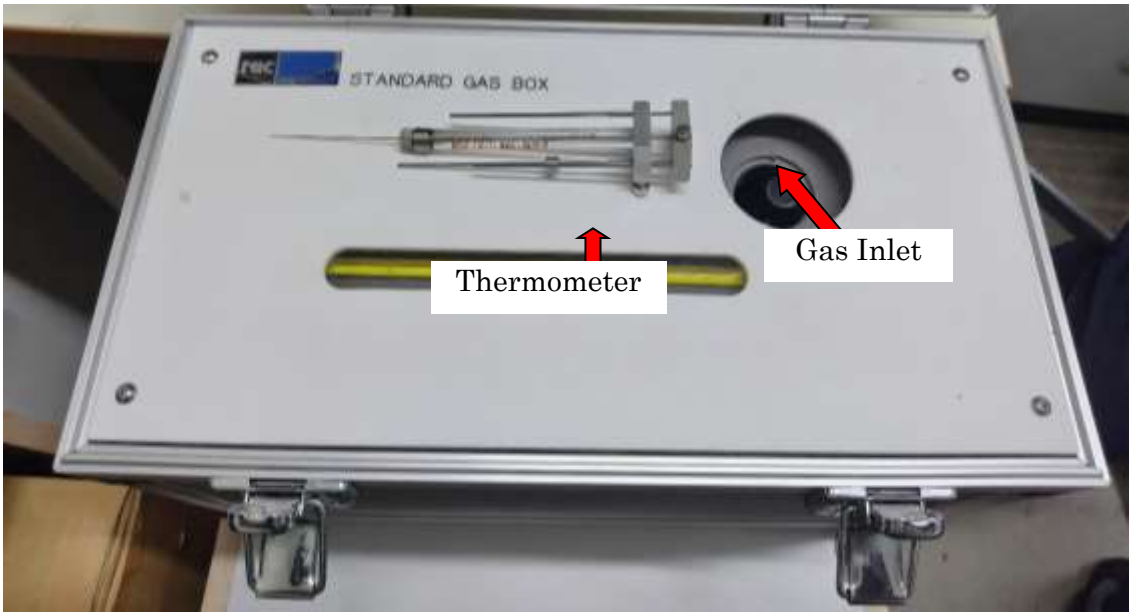


Fig.2 Mercury vapor saturation gas regulator

2. Preparation before ambient mercury sampling

(i) Baking out of mercury remaining in the collection tubes

(1) Heat the necessary number of collection tubes and blank tubes in a muffle furnace at 800 °C for 2 hours.

(2) After heating, cool the tubes to room temperature in the muffle furnace, and then place them in glass test tubes, and seal them tightly.

(ii) Blank confirmation of collection tubes

Before samplling, confirm that the blank value of the collection tube has sufficiently low (i.e., The tube does not contain mercury.).

(1) Measure two of the heat-treated tubes followed by the above procedure (i) by the specified operation.

(2) Record the analysis value (area value) on a recording sheet and confirm that the analysis value is less than 0.010.

3. Mercury analysis

(i) Analitical condition

- Sample introduction method: Double amalgamation method
- Carrier gas: Air with mercury removed
- Carrier gas flow rate: 0.15 L/min
- Furnace temperature: 660℃, 3min

- Washing liquid: Standard buffer solution (pH=6.86)
- Dehumidification: Cooling method
- Collection furnace temperature (during collection): 150 °C
- Collection furnace temperature (during heating): 700 °C
- Detection method: Non-dispersive triple-beam cold atomic absorption method
- Light source: Low pressure mercury lamp
- Analysis wavelength: 253.7 nm

(ii) Prerarationof analysis

(a) Preparation on 1 to 3 days prior to analysis

(1) On 1 to 3 days prior to analysis, quartz glass tubes and trap tubes are heated in a muffle furnace at 800 °C for 2 hours to expel mercury, and then cooled in the furnace, and those should be sealed and stored.

(2) Control the room temperature in advance by an air conditioner, so that the temperature in the laboratory will be kept constant at the period of analysis.

(b) Operation of mercury analyser

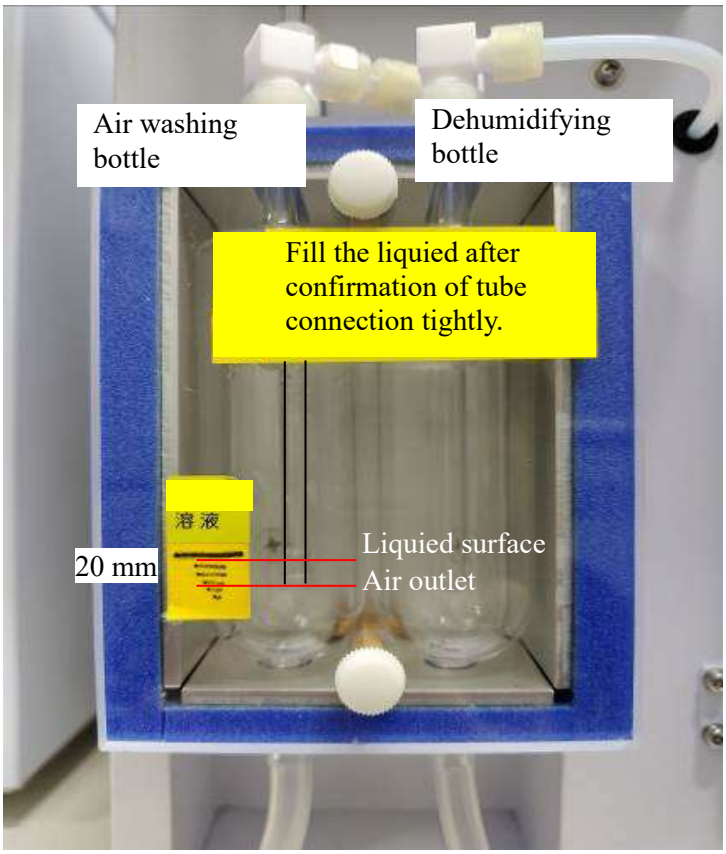


Fig.3 Air washing bottle and dehumidifying bottle of the device

(1) Make sure that there is no liquid in the air wash bottle of the device (RH-MA3).

(2) Start up the PC and launch the control software.

(3) Turn on the power of the devices (MA-3000, RH-MA3).

(4) Set the option unit setting to "Baking Furnace" in the control software (Open a window in System→Preferences and settings). Confirm that the PC and the equipment are connected (You will hear a beep from the equipment.).
(5) Fill the air washing bottle of the device (RH-MA3) with a 1:1 mixture of standard buffer solution and distilled water to a level about 20 mm above the air outlet, and tighten the tubes of both the air washing bottle and the dehumidification bottle with the clips (Ref: Fig.3).
(Note) Loose tightening of the tubes may cause leakage.
(6) Wait until the device is stable and the "STAND-BY" indicator disappears.
(7) Confirm that the device is stable, and measure the instrument blank. Set the quartz glass tube in the collection tube baking unit, attach the trap tube to the side that draws in air, and start the measurement.
(8) After the measurement is completed, record the analysis value (area value) on the recording sheet.
(9) Repeat the measurement until the instrument blank falls below 0.010 (area value) in the analysis value.

(iii) Creation of the calibration curve
After confirming that the instrument blank has been lowered followed by the above procedure (ii), measure different injection volumes of standard gas (about 0 to 2 ng) to create the calibration curve. The calibration curve should be prepared each time an analysis is performed.

Fig.4 Analyticical operation of standard mercury gas

(1) Remove the trap tube from the quartz glass tube, and then press the "Start measurement" icon on the control software.
(Note) Because the heating furnace of the burn-out unit of the collection tube will heat up and begin to remove the mercury, the following operations (2) and (3) should be conducyed promptly before the removal is completed.

(2) Take the standard gas into a syringe, and then read the thermometer of the mercury vapor saturated gas regulator.
(3) Inject the standard gas through the quartz glass tube set in the trap tube baking unit, attach the trap tube, and wait for the measurement to be completed (Ref: Fig.4).
(Note) - Close the lid of the mercury vapor saturation gas regulator at any time.
- Be careful not to be exposed to mercury on the operator.
- Be careful that the syringe needle tip does not contact with the wall or the quartz glass tube of the mercury vapor saturation gas regulator.
(4) Record the temperature read in the above procedure (2) and the analysis value (area value) obtained in in the above procedure (3) on a recording sheet.
(5) Using the saturated mercury gas density table, he amount of mercury introduced into the device is calculated from the temperature and the sampling volume of the standard gas.
(6) Create the calibration curve by linear regression between the introduced amount of mercury on the x-axis and the analyzed value on the y-axis.

(iv) Measurement of the ambient samples
(1) Set the collection tube to measure the ambient sample in the collection tube burnout unit, attach the trap tube to the side that draws in air, and start measurement.
(2) After the measurement is completed, record the analysis value (area value) on a recording sheet.
(3) The measured collecting tube and trap tube are kept connected, and repeat analysis to confirm that no mercury remains in the collecting tube or the measuring flow system. If the analyzed value is high, repeat the measurement and confirm that the value is sufficiently low before measuring the next sample.

(v) Sensitivity confirmation
(1) After measuring the ambient samples, measure the standard gas at the intermediate concentration of the calibration curve to check the sensitivity. The measurement procedure is the same as (1) to (4) in the above procedure of (iii), Creation of the calibration curve.
(2) Calculate the amount of mercury introduced using the saturated mercury gas density table, and confirm that the analysis value (area value) divided by the calculation value of introduced mercury amount does not exceed 20% from the slope of the calibration curve.

(vi) End of analysis
Confirm that no mercury remains in the measuring flow system of the device by measuring a blank, etc., before completing the measurement.
(1) Record the measurement results.
(2) Unclip the tube of the dehumidifying bottle.
(3) Unclip the tube of the air washing bottle, and drain the solution in the bottle.
(4) Rinse the inside of the air washing bottle once or twice with distilled water and drain all the solution.
(5) Set the option unit to "Heated Aeration" in the control software (Open a window in System→Preferences and settings). Confirm that the PC and the device are connected (You will hear a beep from the equipment.).

(6) Turn off the device (MA-3000, RH-MA3).
(7) Exit the control software and shut down the PC.

4. Calculation of atmospheric mercury concentration

Atmospheric concentrations are calculated as follows. The analytical values of the blank and the ambient sample shall be area values.

- Concentration of the blank (ng)
  = Average of (Analysis value of blank / Slope of calibration curve)

- Concentration of the ambient sample (ng)
  = Analytical value of the sample / slope of the calibration curve – Concentration in blank (ng)

(Note) If a travel blank is performed, compare the values of the operating blank and the travel blank and use the larger value for the blank.

- Atmospheric mercury concentration (ng/m^3)
  = Concentration in sample (ng) / Sampling air volume inhaled (m^3)

5. Repeat measurement of the reference materials (RMs)

Repeat measurement of the RMs is performed before the survey. The standard deviation is calculated from the results of five repeat measurements of 10 μL of standard gas (about 0.2 ng of mercury concentration).

6. Measurement of operational blank and travel blank

An operational blank is performed for each sample collection. The number of samples should be 5. The control blanks should be burned out in the same way as the collection tubes for ambient measurement, and kept in the laboratory until the measurement.
A travel blank should be performed every 10 sample collections. The number of samples should be 3. The travel blanks should be burned out and transported in the same manner as the collection tubes for ambient measurement.

7. Calculation of the detection and quantitation limits

The standard deviation of the larger of the operational blank and travel blank values is compared, and the standard deviation of the repeated measurement of the reference material is further compared, and the larger standard deviation is used. 3 times of the standard deviation for analyzed values is defined as the detection limit, and 10 times the standard deviation is defined as the quantitation limit.

Appendix 3

Numerical Data of mercury concentrations obtained by the regular measurements at Niigata-Maki

Start date	End date	Hg Concentration in Sampling line A (ng/m^3)	Hg Concentration in Sampling line B (ng/m^3)
2021/10/11	2021/10/12	1.5	1.4
2021/10/25	2021/10/26	1.7	1.1
2021/11/08	2021/11/09	1.4	1.3
2021/11/22	2021/11/23	1.2	1.3
2021/12/06	2021/12/07	1.8	1.8
2021/12/20	2021/12/21	1.6	1.7
2022/01/04	2022/01/05	1.4	1.5
2022/01/17	2022/01/18	1.7	1.8
2022/01/31	2022/02/01	1.5	1.5
2022/02/14	2022/02/15	1.3	1.5
2022/02/28	2022/03/01	1.5	1.7
2022/03/14	2022/03/15	1.7	1.8
2022/03/28	2022/03/29	1.6	1.6
2022/04/11	2022/04/12	1.8	1.7
2022/04/25	2022/04/26	1.9	2.0
2022/05/09	2022/05/10	1.2	1.3
2022/05/23	2022/05/24	1.6	1.6
2022/06/06	2022/06/07	1.2	1.1
2022/06/20	2022/06/21	1.3	1.4
2022/07/04	2022/07/05	1.3	1.2
2022/07/19	2022/07/20	1.3	1.2
2022/08/01	2022/08/02	1.0	1.1
2022/08/15	2022/08/16	0.96	0.99
2022/08/29	2022/08/30	1.1	0.88
2022/09/11	2022/09/12	1.2	1.1
2022/09/26	2022/09/27	1.2	1.2
2022/10/11	2022/10/13	1.0	1.0

2022/10/24	2022/10/25	1.3	1.2
2022/11/08	2022/11/09	1.3	1.3
2022/11/22	2022/11/23	1.5	1.5
2022/12/05	2022/12/06	1.2	1.2
2022/12/19	2022/12/20	1.3	1.3
2023/01/04	2023/01/05	1.3	1.3
2023/01/16	2023/01/17	1.2	1.2
2023/01/30	2023/01/31	1.3	1.4
2023/02/13	2023/02/14	1.4	1.3
2023/02/27	2023/02/28	1.0	0.95
2023/03/13	2023/03/14	1.4	1.2
2023/03/27	2023/03/28	0.97	0.89
2023/04/10	2023/04/11	1.1	1.2
2023/04/24	2023/04/25	1.1	1.1
2023/05/08	2023/05/09	1	1.2
2023/05/22	2023/05/23	0.92	0.87
2023/06/05	2023/06/06	1.2	0.99
2023/06/19	2023/06/20	0.93	1.0
2023/07/03	2023/07/04	1.1	1.1
2023/07/18	2023/07/19	1.2	1.1
2023/07/31	2023/08/01	0.69	0.79
2023/08/14	2023/08/15	1.1	1.1
2023/08/28	2023/08/29	1.3	1.2
2023/09/11	2023/09/12	0.84	0.86
2023/09/25	2023/09/26	1.1	1.1
2023/10/10	2023/10/11	0.75	0.82
2023/10/23	2023/10/24	1.1	1.1

Appendix 4

Metaata of the regular mercury measurements at Niigata-Maki

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
A. SUBMISSION OR ACCESS DETAILS *(ALL MATRICES)*		
A.1. Date of submission or access:*		December 28, 2023
A.2. Contact details of the person submitting or accessing the data :*	Name:*	Keiichi Sato
	Affiliation:*	Asia Center for Air Pollution Research
	Address:*	1182 Sowa Nishi-ku, Niigata-shi 950-2144, Japan
	Email:*	ksato@acap.asia
	Country:*	Japan
A.3. Contact details of the data owner or originator :*	Name:	Mitsugu Saito
	Affiliation:	Regional Office for Asia and the Pacific, United Nations Environment Programme
	Address:	2nd Floor UN Building, Rajdamnern Nok Avenue, Bangkok 10200, Thailand
	Email:	mitsugu.saito@un.org
	Country:	Thailand
A.4. Data use restrictions:	Data is publicly available:	□ Yes ☑ No If yes, please indicate where:
	Data subject to a specific use license:	□ Yes ☑ No If yes, please explain conditions for allowable use:
B. AIM AND SCOPE OF THE STUDY (ALL MATRICES)		
B.1. Aim of the study:*		☑ Identification of temporal trends □ Characterization of spatial patterns □ Estimation of source attribution □ Exposure assessment □ Impact / Health assessment □ Quantification of particular environmental processes ☑ Other, please specify: Evaluation on Monitoring Methdology
B.2. Brief description of the study:*		The project aims to evaluate the feasibility and challenges for introducing ambient mercury monitoring by gold trap method, which will be included in the monitoring guidance of Minamata Convention, to existing monitoring sites. First, the mercury monitoring system was established at the existing ambient monitoring site of Niigata-Maki Acid Deposition Monitoring station in Japan. Then, the pilot monitoring was conducted there from October 2021 to October 2023.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
B.3. Geographic scope:		□ Sub-national ☑ National □ Multi-Country Details on the geographic scope: Niigata-Maki national acid deposition monitoring station is selected as the mercury pilot monitoring site.
B.4. Type of organization carrying out the study:		□ Government agencies ☑ Universities or research institutions □ Non-governmental organizations □ Other, please specify:
C. SITE CHARACTERISTICS *(ALL MATRICES)*		
C.1. Characteristics of the monitoring site(s):	Human settlements:	□ Remote or unpopulated areas □ Low population density areas (<500 persons per square Km) ☑ Medium population density areas (500-1000 persons per square Km) □ High population density areas (>1,000 persons per square Km)
	Geographic coordinates:*[1]	Latitude: N37°48'33" Longitude: E138°51'09" Unit: □ decimal degrees *OR* □ degrees / minutes / seconds
	Elevation of site:	52 Unit: ☑ Metres *OR* □ Feet
	Proximity to point sources:	Distance: 30-35 of Northeast Unit: □ Metres *OR* ☑ Kilometres
		□ ASGM site □ Large-scale gold mining site □ Mercury mine □ Chlor-alkali plant □ Coal-fired power plant □ Hydroelectric power plant □ Non-ferrous metal processing/smelting facilities ☑ Oil and natural gas processing facilities □ Cement clinker production facilities □ Vinyl chloride monomer (VCM) production □ Acetaldehyde production □ Manufacturing of mercury containing products/devices □ Waste disposal, recycling or incineration facilities □ Forestry site

[1] It may be necessary to reduce the accuracy of geographic coordinates to protect privacy (e.g., when the samples were collected in private properties) while still allowing the data to carry spatial information that is relevant for the work of the OESG.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		☑ No local sources identified (i.e., long-range mercury transport) ☑ Other, please specify: LNG fired power plants
	Type of ecosystem(s):	Terrestrial ecosystems: ☑ Agricultural area □ Forest □ Inland wetland □ Savanna □ Steppe □ Desert Freshwater ecosystems: □ River □ Lake Marine and coastal ecosystems: □ Estuary □ Coastal area □ Open ocean □ Other, please specify:
	Details on the monitoring site(s): There is no industrial source near the site, but a small community (approximately 1,300 population) is located 2 km northwest of the station, and thus it is classified as a rural station.	
C.2. Co-location of other monitoring activities:		☑ Co-located with other Hg monitoring networks or other relevant measurement activities (e.g., monitoring in other matrices) – please explain: The site was designated as one of the sites of Acid Deposition Monitoring Network in East Asia (EANET). □ Not applicable
C.3. Monitoring frequency:		□ Single time point □ Continuous □ Daily □ Weekly □ Monthly □ Yearly □ Seasonal, please specify: ☑ Other, please specify: Once every 2 weeks
C.4. Monitoring period:*		From: October 11, 2021 To: October 24, 2023
C.5. Ongoing monitoring:		□ Yes ☑ No
C.6. Monitoring matrix:*		☑ Air **» Section D** □ Biota (animals and plants) **» Section E** □ Human biomonitoring **» Section F** □ Other matrices **» Section G**
D. AIR		
D.1. Sampling method:*		□ Continuous analysers

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		☑ Manual trap methods □ Passive samplers □ Wet deposition samplers □ Dry deposition samplers □ Bulk deposition samplers □ Litterfall □ Other, please specify:
D.2. Height of sample collection from ground:		5.2 Unit: ☑ Metres *OR* □ Feet
D.3. Sample collection date:*		□ Single date: *OR* ☑ Period: From October 11, 2021 To October 24, 2023
		Frequency: □ Automated measurements (in minutes): ☑ Manual measurements (in hours): 24
D.4. Mercury observations:*	Mercury species:*	☑ Gaseous Elemental Mercury (Hg^0, GEM) □ Gaseous Oxidized Mercury (Hg^{II}, GOM) □ Total Gaseous Mercury (TGM = GEM + GOM) □ PM10 □ PM2.5 □ Total mercury in precipitation □ Methyl mercury in precipitation □ Total mercury in litterfall □ Methyl mercury in litterfall □ Mercury isotopes□ Other, please specify:
	Unit of concentration measurement:*	☑ ng/m^3 □ pg/m^3 □ Other, please specify:
	Unit of deposition measurement:	□ ng/m2*week □ µg/m2*week □ ng/m2*year □ µg/m2*year □ ng/ha*year □ µg/ha*year □ Other, please specify:
	Measurement values:*	☑ Attached in the project report: *OR* □ Provide URL:
	Have the observations been aggregated?*	☑ Yes □ No If yes, please explain the data aggregation process: The compiled data were included in the project report.
D.5. Ancillary observations:	Precipitation & meteorological	☑ Air Temperature ☑ % relative humidity

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
	data (value and unit):	☑ Wind speed ☑ Wind direction □ Pressure ☑ Other, please specify: Precipitation amount, Solar Radiation
	Emission inventories:	Not applicable
	Air quality tracers (value and unit):	☑ SO_2 □ CO_2 □ CO ☑ O_3 ☑ PM10 ☑ PM2.5 ☑ Sea salt sulphate (SSF) ☑ Non-sea salt sulphate (NSSF) □ Radon ☑ Other, please specify: ionic and metallic components, water soluble organic carbon of particulate matter, HNO_3, NH_3, HCl gases
	Land cover:	Grass land and sand
	Land use:	Agricultural field
	Leaf area index:	Not applicable
	Other:	Please specify:
	Measurement values:*	☑ Attached in the project report: *OR* Provide URL:
D.6. Additional information regarding sampling, mercury measurement or ancillary information:		Mercury was monitored by 2 sampling lines simultaneously. The data are available for each line. The start and end of sampling time are generally noon on Monday and noon of Tuesday, respectively.
E. BIOTA		
E.1. Type:*		Aquatic: □ Invertebrates □ Fish □ Reptiles □ Birds □ Mammals (marine) □ Mammals (fresh water) □ Plants Terrestrial: □ Invertebrates □ Amphibian □ Reptiles □ Birds □ Mammals

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		□ Plants
		□ Other, please specify:
E.2. Species name(s):		
E.3. Brief description of the study population in terms of mercury exposure:		
E.4. Number of individuals sampled:		
		Further detail on sample size:
E.5. Sampling strategy:		□ Random
		□ Not random, please describe the level of representativeness:
		□ Other, please specify:
E.6. Characteristics of the samples:	Sample collection date:	□ Single date: *OR* □ Period: From To
	Type of sample:	□ Whole specimen
		□ Whole organ(s)
		□ Specific tissue(s), please specify:
	Sampled tissue(s):	□ Blood
		□ Kidney
		□ Liver
		□ Muscle
		□ Blubber
		□ Fur / Hair
		□ Feathers
		□ Eggs
		□ Brain
		□ Nails and others keratinoid tissues
		□ Leaves
		□ Shoots
		□ Roots
		□ Other, please specify:
	Sample digestion / extraction:	□ Direct analysis (no digestion)
		□ Aqua regia
		□ Nitric acid
		□ Hydrochloric acid
		□ Other, please specify:
E.7. Mercury observations:*	Mercury species:*	□ Total mercury
		□ Inorganic mercury
		□ Methyl mercury
		□ Other, please specify:
	Unit of measurement:*	□ µg/g (or mg/kg)
		□ ng/g
		□ µg/L

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		□ Other, please specify:
	Data reporting:*	□ Dry weight
		□ Wet weight
	Measurement values:*	□ Attach file in CSV format:
		OR
		Provide URL:
	Have the observations been aggregated?*	□ Yes □ No
		If yes, please explain the data aggregation process:
E.8. Ancillary observations:	Biota:	□ Species name(s)
		□ Weight
		□ Length
		□ Age
		□ Sex
		□ Maturity stage (e.g. juvenile, adult)
		□ Fatty acids
		□ Protein
		□ Selenium
		□ Other, please specify:
	Trophic level:	□ Primary Producers
		□ Primary consumers
		□ Primary carnivores
		□ Secondary carnivores
		□ Tertiary carnivores
		□ Other, please specify:
	Surrounding seawater, freshwater soil and sediment:	□ Temperature (value/unit)
		□ Depth (value/unit)
		□ pH (value)
		□ Salinity (value/unit)
		□ Conductivity (value/unit)
		□ Dissolved oxygen (value/unit)
		□ Total organic carbon (value/unit)
		□ Dissolved organic carbon (value/unit)
		□ Particle size distribution (sand, clay, etc)
		□ Total oxidized nitrogen (value/unit)
		□ Sulfur (species/value/unit)
		□ Trace elements (species/value/unit)
		□ Organic pollutants (species/value/unit)
		□ Other, please specify:
	Inland areas:	□ Landscape/watershed characteristics (e.g., lake and catchment morphology)
		□ Local data on mercury deposition
		□ Local pollution history
		□ Other, please specify:

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
	Stable isotopes (value and unit):	□ Carbon ($\delta^{13}C$) □ Nitrogen ($\delta^{15}N$) □ Mercury ($\delta^{202}Hg$) □ Mercury ($\delta^{199}Hg$) □ Sulfur ($\delta^{34}S$) □ Compound specific stable isotopes □ Other, please specify:
	Other:	□ Please specify:
	Measurement values:*	□ Attach file in CSV format: *OR* Provide URL:
E.9. Additional information regarding sampling, mercury measurement or ancillary information:		
F. HUMAN BIOMONITORING		
F.1. Ethics certificate:		Institutional Review Board (IRB): Date issued: *Please attach copy of ethics certificate*.
F.2. Study population exposure/ vulnerability:*	Demographics:	□ General population □ Early life (fetus, newborn, children: 0-11 years old) □ Adolescents (12-17 years old) □ Adult men (18+ years old) □ Pregnant women □ Women in child-bearing age (<50 years old) □ Women past child-bearing age (>50 years old) □ Workers □ Subsistence fishers/hunters □ Recreational fishers/hunters □ Other, please specify:
	Environmental or dietary exposure:	□ Indigenous Peoples □ Local communities □ People living in islands or coastal areas □ People living alongside freshwater ecosystems (e.g., rivers, lakes) □ People living near ASGM sites □ People living near mercury sources other than ASGM sites, please specify: □ People living in the arctic and subarctic □ Other, please specify:
	Occupational exposure:	□ Primary mercury mining □ Artisanal and small-scale gold mining (ASGM) □ Non-ferrous ore mining (e.g., zinc, lead, copper)

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		□ Chlor-alkali production
		□ Vinyl chloride monomer (VCM) production
		□ Acetaldehyde production
		□ Coal-fired power plants
		□ Oil and natural gas processing
		□ Healthcare (using mercury-containing measuring and control devices)
		□ Dentistry
		□ E-waste recyclers
		□ Healthcare waste processors
		□ Manufacture of mercury containing devices (e.g., mirrors, paint, fluorescent lights, batteries, barometers)
		□ Agriculture (using certain pesticides)
		□ Other, please specify:
F.3. Study population sample size:		Details regarding the sample size:
F.4. Study population sampling strategy:		□ Random
		□ Not random, please describe the level of representativeness:
		□ Other, please specify:
F.5. Study population sex:		% male: % female:
F.6. Study population age:	Interval:	Min.: Max.:
	Percentage:	% 0 – 5 years of age:
		% 6 – 11 years of age:
		% 12 – 17 years of age:
		% 18 – 49 years of age:
		% 50 years of age and older:
F.7. Characteristics of the samples:*	Sample collection date:	□ Single date: *OR* □ Period: From To
	Sampled tissue(s):*	□ Whole blood
		□ Cord blood
		□ Urine □ Specific Gravity Correction □ Osmolality Correction
		□ Creatine Correction□ Hair
		□ Other, please specify:
	Sample digestion / extraction:	□ Direct analysis (no digestion)
		□ Aqua regia
		□ Nitric acid
		□ Hydrochloric acid

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		□ Other, please specify:
F.8. Mercury observations:*	Mercury species:*	□ Total mercury □ Methyl mercury □ Inorganic mercury □ Other, please specify:
	Unit of measurement:*	□ µg/g □ ng/g □ µg/L □ Other, please specify:
	Data reporting:*	□ Dry weight □ Wet weight
	Measurement values:*	□ Attach file in CSV format: *OR* Provide URL:
	Have the observations been aggregated?*	□ Yes □ No If yes, please explain the data aggregation process:
F.9. Ancillary observations:	Mercury isotopes:	□ δ^{202}Hg □ δ^{199}Hg □ Other, please specify:
	Measurement values:*	□ Attach file in CSV format: *OR* Provide URL:
F.10. Additional information:	General:	□ Occupational exposure □ Dental amalgam status □ Use of skin-lightening creams □ Use of traditional medicine / homeopathy □ Education □ Socio-economic status □ Indigenous knowledge or local knowledge[2] Please provide details: and/or attach file:
	Dietary habits:	□ Freshwater fish □ Marine fish □ Marine mammal □ Subsistence or recreational fishing □ Commercial purchase □ Rice □ Other, please specify: Please provide details: and/or attach file:
	Dietary survey:	□ Available (please attach)

[2] Further information on indigenous knowledge and local knowledge, including similarities and differences, may be found at Houde et al. (2022).

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		□ Not available
F.11. Additional information regarding sampling, mercury measurement or ancillary information:		
G. OTHER MATRICES		
G.1. Matrix:*		□ Soil □ Sediment □ Freshwater □ Estuary/brackish water □ Seawater □ Snow □ Geologic □ "Natural archives"[3] □ Other, please specify:
G.2. Brief description of the matrix:*		
G.3. Characteristics of the samples:*	Sample collection date:	□ Single date: *OR* □ Period: From To
	Sample filtration	□ Yes, please explain: □ No
	Sample digestion / extraction:	□ Direct analysis (no digestion) □ Aqua regia □ Nitric acid □ Hydrochloric acid □ Other, please specify:
G.4. Mercury observations:*	Mercury species:*	□ Total mercury □ Inorganic mercury □ Monomethyl mercury □ Dimethyl mercury □ Dissolved Gaseous Mercury (DGM) □ Other, please specify:
	Fractions:	□ Reactive Mercury (R-Hg) □ Dissolved □ Suspended □ Extractable □ Recoverable □ Filtered □ Non-filtered □ Integrated
	Unit of measurement:*	□ µg/g (or mg/kg) □ ng/g

[3] Measurements from "natural archives", such as peat bogs and tree rings, may be used as a tool to aid the characterization of sites with no background information.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		□ µg/L
		□ Other, please specify:
	Data reporting:*	□ Dry weight
		□ Wet weight
	Measurement values:*	□ Attach file in CSV format:
		OR
		Provide URL:
	Have the observations been aggregated?*	□ Yes □ No
		If yes, please explain the data aggregation process:
G.5. Ancillary observations:	General information:	□ Landscape/watershed characteristics (e.g., lake and catchment morphology)
		□ Local data on mercury deposition
		□ Local pollution history
		□ Other, please specify:
	Sampling methodology and characteristics of the sampled area	Please describe:
	Measured parameters:	□ Temperature (value/unit)
		□ Depth (value/unit)
		□ pH (value)
		□ Salinity (value/unit)
		□ Conductivity (value/unit)
		□ Dissolved oxygen (value/unit)
		□ Total organic carbon (value/unit)
		□ Dissolved organic carbon (value/unit)
		□ Particle size distribution (sand, clay, etc)
		□ Total oxidized nitrogen (value/unit)
		□ Sulfur (species/value/unit)
		□ Trace elements (species/value/unit)
		□ Organic pollutants (species/value/unit)
		□ Other, please specify:
	Measurement values:*	□ Attach file in CSV format:
		OR
		Provide URL:
G.6. Additional information regarding sampling, mercury measurement or ancillary information:		
H. DETECTION AND QUALITY CONTROL *(ALL MATRICES)*		
H.1. Detection method:*		□ Cold-vapor atomic fluorescence spectroscopy (CVAFS)
		☑ Cold-vapour atomic absorption spectroscopy (CVAAS)
		□ Inductively coupled plasma mass spectrometry (ICP-MS)
		□ Multi-collector inductively coupled plasma

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		mass spectrometry (MC-ICP-MS) □ Combustion and CVAAS □ Direct mercury analyser □ Other, please specify:
H.2. Equipment used (e.g., producer and model):		□ Please specify: Automatic direct combustion mercury analyzer (MA-3000, Nippon Instruments Co.) Desorption unit for mercury collection tube (RH-MA3, Nippon Instruments Co.)
H.3. Performance parameters for analytical method validation:*[4]	Sensitivity:*	□ Limit of detection (LOD): 0.088 ng □ Limit of Quantification (LOQ): 0.29 ng □ Not available
	Analytical or linear range:*	0-1.8 ng (Injected standard Hg gas amount) □ Not available
	Trueness / systematic error:*	0.088 ng (Detection limit of instrument) □ Not available
	Precision / random error:*	0.7 % (Drift of senstivity) □ Not available
	Robustness:*	☑ Not available
	Accuracy / measurement uncertainty:*	□ Quantitative estimation of uncertainty (in %): 96.6 (from slope of calibration curve) □ Description of accuracy or measurement of uncertainty: □ Not available
	Other:	
H.4. QA/QC measures:	Quality scheme in place in the laboratory:*	□ ISO/IEC 17025 □ ASTM-D6784 □ Accreditation, please explain the scope (matrix, concentration range): ☑ Other, please specify: ISO 14001 □ Not available
	Use of traceable calibration reference standards:*	☑ Yes, please explain: Hg standard gas tracable to JCSS □ Not available
	Use of matrix-matched (certified) reference material(s):*	□ Yes, please explain: ☑ Not available
	Inter-laboratory comparisons:*	□ Yes, please explain: ☑ Not available
	Duplicate analysis:*	☑ Yes, please explain: Sampling tube measurement was repeated for 5 times. □ Not available
	Matrix spike:*	□ Yes, please explain:

[4] See https://link.springer.com/article/10.1007/s00769-014-1093-0#ref-CR11 for an explanation on how the terms are being used.

CATEGORY	SUB-CATEGORY	OPTIONS / FORMAT
		☑ Not available
	Proficiency testing:*	☑ Yes, please explain: Measuremt of artificial waste water was conducted in 2018 and Measuremt of sediment was conducted in 2019. □ Not available
	Other:	
H.5. Methods, manuals or standard operating procedures which were applied:	Sample collection and handling:	☑ Please attach method, manual or SOP or indicate publicly available source Attached as the Appendix 1 of the project report. □ Not available
	Sample digestion / extraction:	□ Please attach method, manual or SOP or indicate publicly available source ☑ Not available
	Analytical measurement:	☑ Please attach method, manual or SOP or indicate publicly available source Attached as the Appendix 2 of the project report. □ Not available
	Data validation and QA/QC:	☑ Please attach method, manual or SOP or indicate publicly available source Attached as the Appendix 2 of the project report. □ Not available
	Data analysis and reporting:	☑ Please attach method, manual or SOP or indicate publicly available source Attached as the Appendix 2 of the project report. □ Not available
H.6. Additional information regarding detection methods, validation, QA/QC and standard procedures:		

I. ADDITIONAL INFORMATION *(ALL MATRICES)*	
I.1. Relevant publications:	Please attach document and/or provide URL or DOI: Site information of Acid Deposition Monitoring Network in East Asia (EANET) https://www.eanet.asia/about/site-information/
I.2. Relevant analytical methods and/or SOPs	Please attach document and/or provide URL or DOI: Manual of Measurement Method of Hazardous Air Pollutants - Monitoring of mercury in the Ambient Air (in Japanese) https://www.env.go.jp/content/900402515.pdf
I.3. Additional information:	Please attach document and/or provide URL: Results of Monitoring of Hazardous Air Pollutants in Japan (in Japanese) https://www.env.go.jp/air/osen/monitoring/index.html