Concerns over Mercury Pollution in Asia

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Minamata Disease and Hg Pollution

- Minamata disease, a neurological disease caused by severe Hg poisoning due to consumption of contaminated fish, was first discovered in Minamata, Japan in 1956.
- Hg-containing industrial wastewater discharge was the major Hg source to the fish in Minamata Bay.

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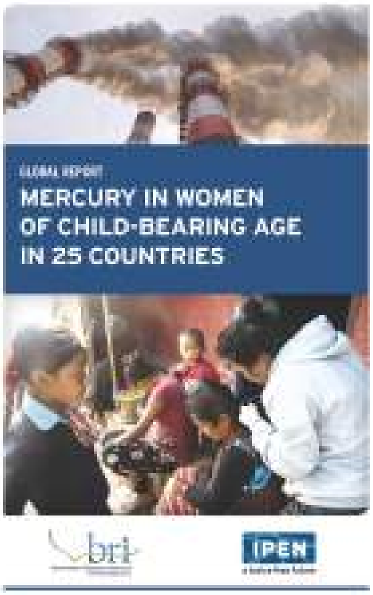
(Time, 2010)

Why Is Mercury Still A Concern?

Global Hg Pollution



KEY FINDINGS

- 1044 women of child-bearing age from 25 countries participated in the study. 42% of them had mercury levels greater than 1 ppm – the level that approximately corresponds to the US EPA reference dose.* 55% of the women had mercury levels greater than 0.58 ppm mercury, a more recent, science-based threshold based on data indicating harmful effects at lower levels of exposure. Mercury is a health threat to women and the developing fetus.
- Women of the Pacific Islands have elevated mercury levels, likely due to a fish-rich diet. Distant air emissions of mercury from coal-fired power plants, cement kilns and other industries contaminate ocean fish that serve as a primary protein source for Pacific Islanders.
- Artisanal small-scale gold mining results in high mercury body burdens in women from Indonesia, Kenya, and Myanmar. Two likely mercury exposure sources are burning mercury amalgam and eating contaminated fish.
- Industrial mercury emissions contaminate local fish and elevate mercury levels in Thai women living nearby.
- Indigenous women in Alaska have mercury levels of concern due to their subsistence diet of sea mammals and fish. Consumption of seals may be a key source of mercury exposure.
- Women from locations in Albania, Chile, Nepal, Nigeria, Kazakhstan, and Ukraine have mercury levels of concern due to localized pollution of waterways and suspected fish contamination.
- Women using mercury to gold plate statues in Nepal have elevated mercury levels.

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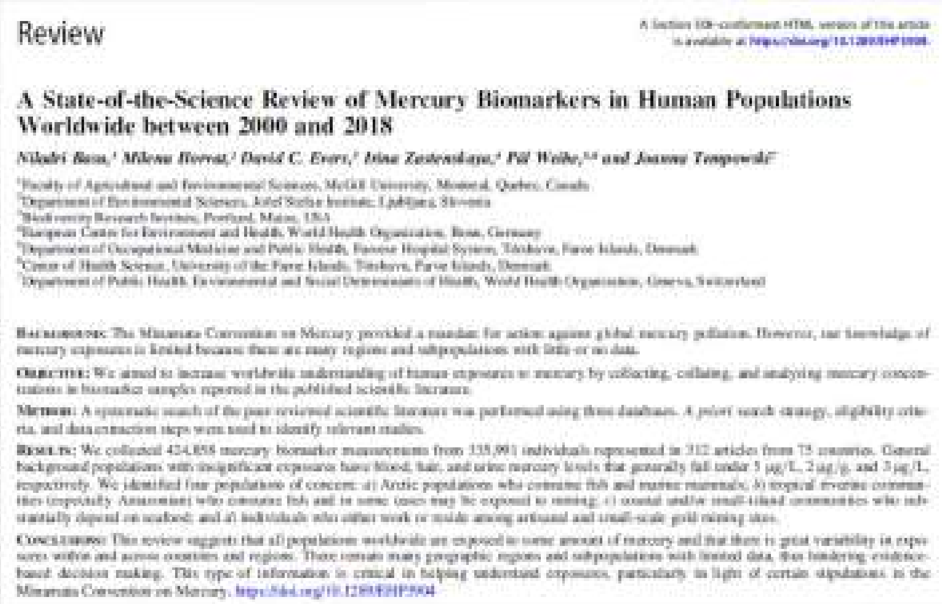
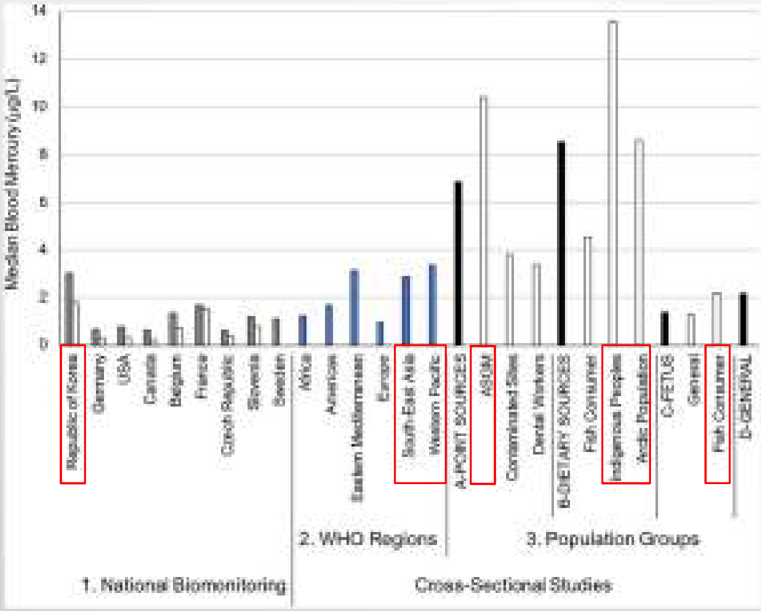


Review

A State-of-the-Science Review of Mercury Biomarkers in Human Populations Worldwide between 2000 and 2018

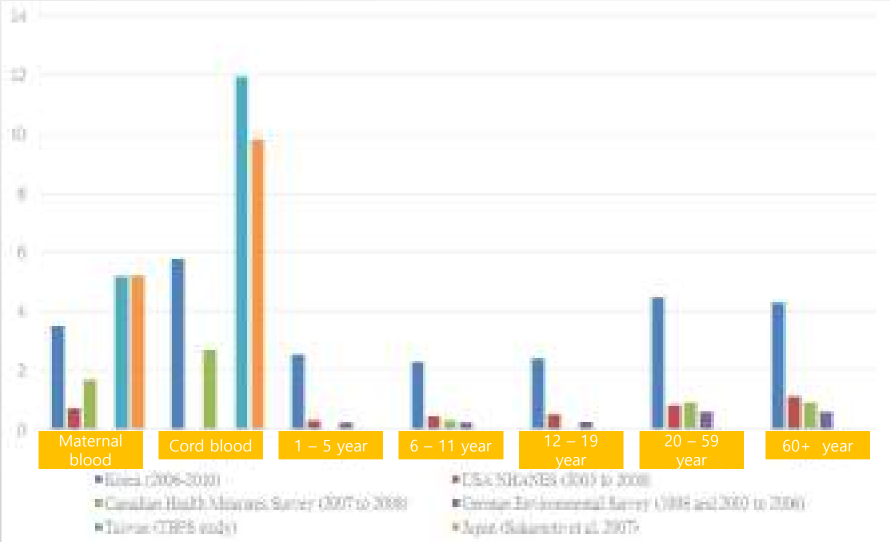
5 Published in Environmental Health Perspectives

Blood Hg Concentrations



6 Basu et al., 2018

Blood Hg Concentration by Countries



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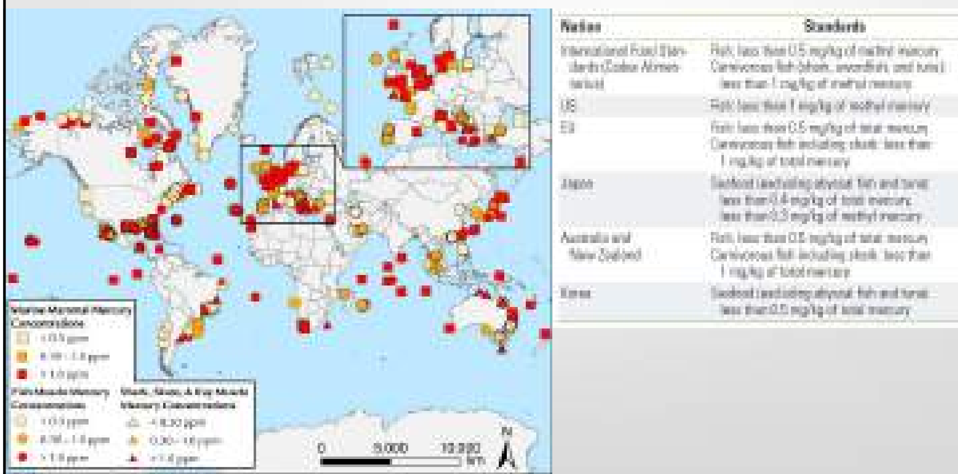
Courtesy of Dr. Eunhee Ha

Global Hg Pollution

- Fish consumption is the major exposure route of Hg to many people worldwide.
- Hg concentrations in fish are elevated globally.



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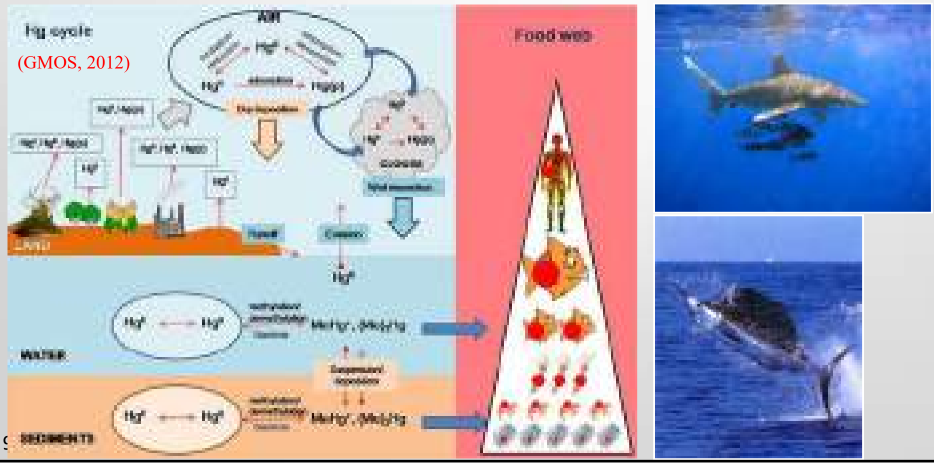
(Evers et al., 2012)

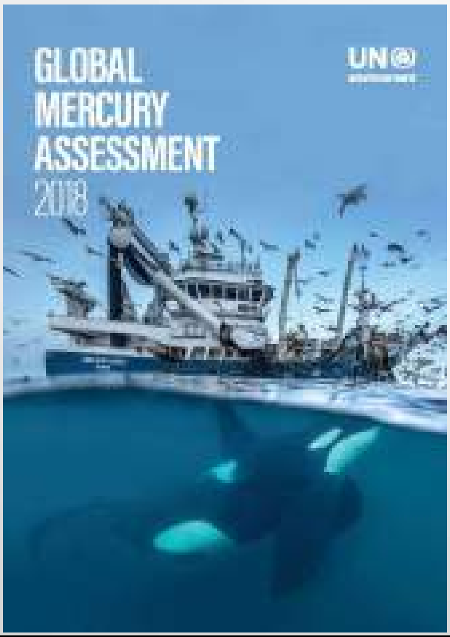
Global Hg Pollution

- Atmospheric deposition is the major source of Hg to many aquatic ecosystems.
- Once deposits from atmosphere, inorganic Hg can get methylated by bacteria to form MeHg then bioaccumulates through food chain, resulting in higher concentrations in large long-lived predatory fish.



Atmospheric Mercury Cycling

Global Mercury Assessment 2018



Sources of Atmospheric Hg

- **Natural emissions**: mercury released from natural weathering of Hg-containing rocks or by geothermal activity. **500 Mg yr^{-1}**
- **Anthropogenic emissions**: mercury released as a result of current human activities. **2500 Mg yr^{-1}**
- **Re-emissions**: mercury released to the atmosphere that are derived from past natural and anthropogenic releases. **5000 Mg yr^{-1}**

(Outridge et al., 2018)

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Anthropogenic Hg Emissions in 2015

- Anthropogenic Hg emission is an important contributor to the Hg in the atmosphere. Major sources include:
  - ASGM
  - Coal combustion
  - Cement production
  - Non-ferrous metal production

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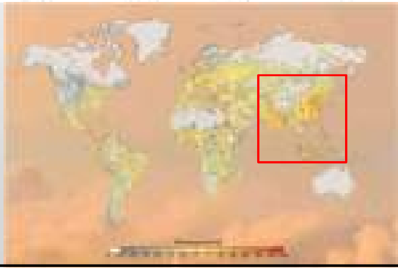
(UNEP, 2018)

Concerns in Asia

Anthropogenic Hg Emissions in 2015

▼ Quantities of mercury emitted to air from anthropogenic sources in 2015 by different sectors in different regions.

	Sector group (emissions, tonnes)				Regional total (range), tonnes	% of global total
	Fuel combustion	Industry sectors	Intentional use (including product waste)	Artisanal and small-scale gold mining		
Australia, New Zealand & Oceania	5.57	4.67	1.23	0.0	8.79 (6.93-13.7)	0.4
Central America and the Caribbean	5.69	18.1	6.71	14.3	45.8 (37.2-61.4)	2.1
CIS & other European countries	28.4	64.7	30.7	12.7	124 (105-170)	5.6
East and Southeast Asia	229	307	108	214	859 (685-1430)	38.6
EU28	46.5	22.0	8.64	0.0	77.2 (67.2-107)	3.5
Middle Eastern States	11.4	29.0	12.1	0.225	52.8 (40.7-93.8)	2.4
North Africa	1.36	12.6	6.89	0.0	20.9 (13.5-45.8)	0.9
North America	27.8	7.61	5.71	0.0	40.4 (33.8-59.6)	1.8
South America	8.25	47.3	13.5	340	409 (308-522)	18.4
South Asia	125	59.1	37.2	4.50	225 (190-296)	10.1
Sub-Saharan Africa	48.9	41.9	17.1	252	360 (276-445)	16.2
Global inventory	533	614	239	838	2220 (2000-2820)	100.0



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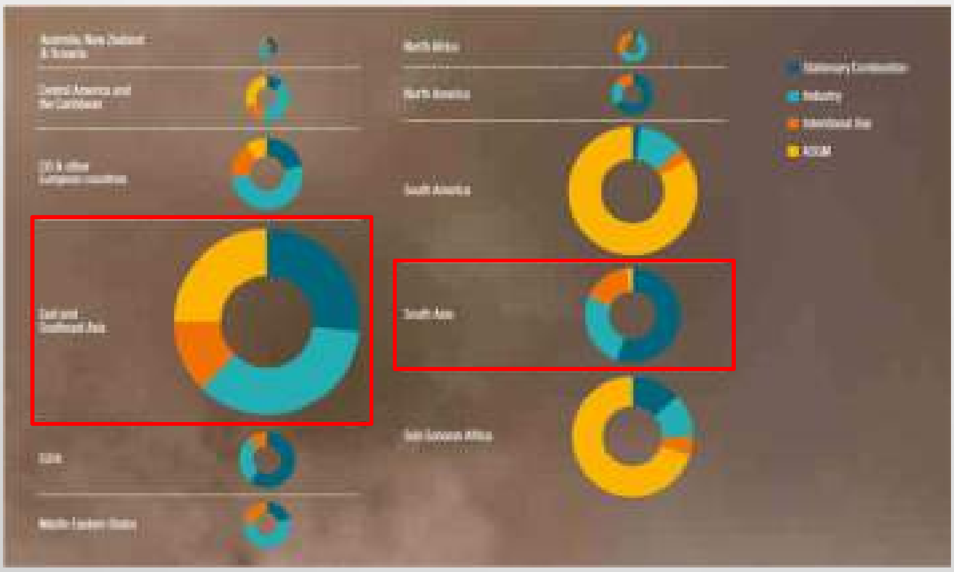
(UNEP, 2018)

Anthropogenic Hg Emissions in 2015



(UNEP, 2018)

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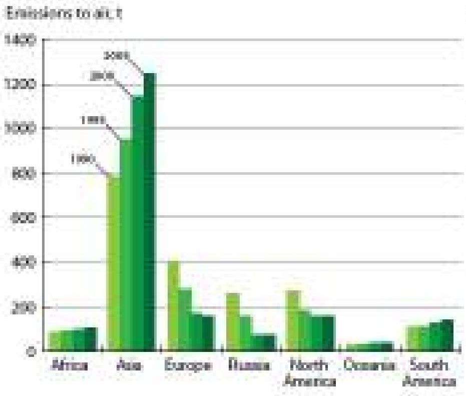
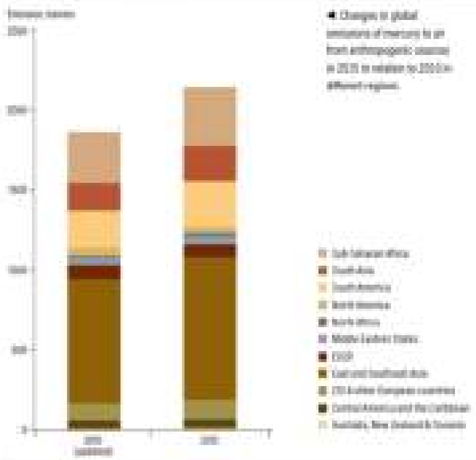
Trends in Anthropogenic Hg Emissions

- Anthropogenic Hg emissions from Europe and North America are declining, whereas emissions from Asia are increasing.



Estimates of annual anthropogenic mercury emissions from different continents/regions, 1990-2005.



17 (UNEP, 2013) (UNEP, 2018)

Projections of Global Hg Emissions in 2050

- It is likely that Hg emission will increase in the future. The main driving force is the expansion of coal-burning electricity generation, especially in Asia.

Projections of Global Mercury Emissions in 2050

DAVID G. STREETS,*,† QIANG ZHANG,† AND YE WU‡

TABLE 4. Mercury Emissions in 2050 by Scenario and World Region (Mg/yr)

scenario	North America	Central and South America	Africa	Europe, Russia, Middle East	Asia and Oceania	world
2050 A1B	225.9	473.6	509.6	676.5	2970.0	4855.6
2050 A2	239.1	415.6	375.5	667.3	2208.5	3905.9
2050 B1	121.9	340.4	357.0	358.1	1208.9	2386.2
2050 B2	131.3	331.2	308.1	398.0	1461.4	2629.9

(Streets et al., 2009)

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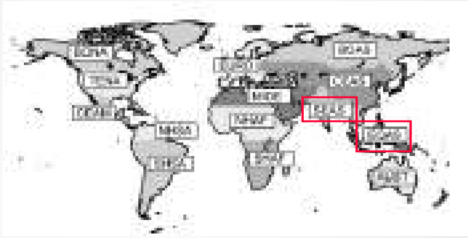
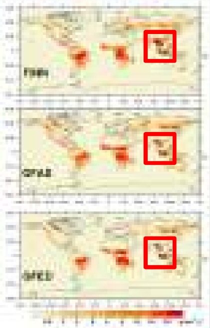
Biomass Burning Hg Emissions

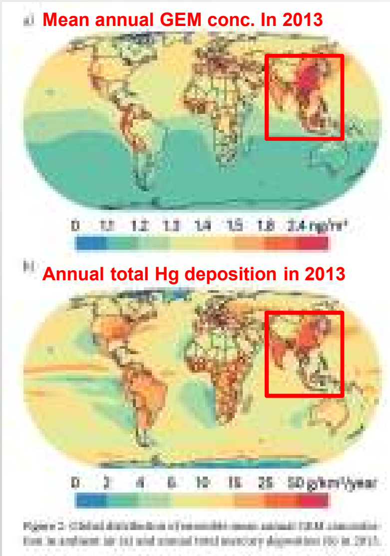


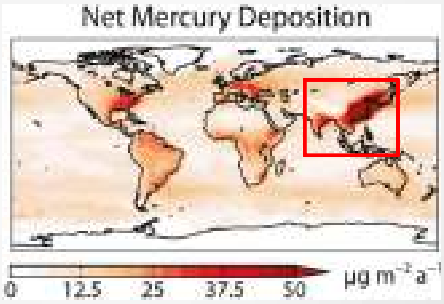


region	Hg emissions Mg Hg/year mean	SD
BONA	22	16
TENA	4	3
CEAM	22	25
NHSA	13	10
SHSA	96	36
EURO	2	1
MIDE	4	0
NHAF	83	13
SHAF	58	7
BOAS	39	83
CEAS	7	2
SEAS	57	35
EQAS	192	216
AUST	14	9
global	675	240
boreal	121	86
temperate	9	3
ROW	545	226

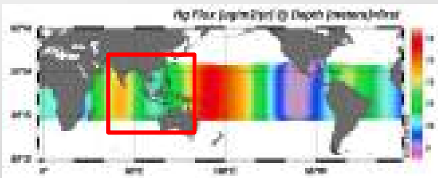
19 **SEAS + EQAS = 249 Mg Hg/year = 37% of global biomass burning emission**

Distribution of Atmospheric Hg Concentrations and Deposition Fluxes: Modeling Results



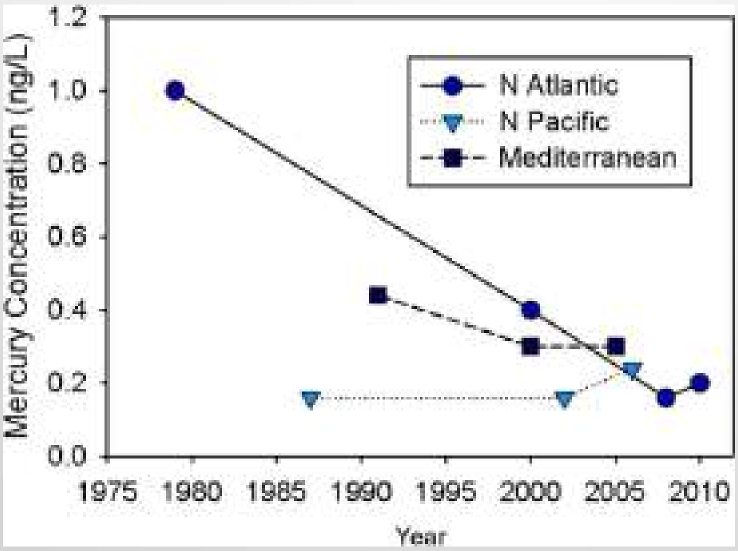


Corbitt et al., 2011



20 AMAP/UNEP, 2015 Costa et al., 2012

Trend in SW Hg Conc. in Surface Oceans



(Driscoll et al., 2013)

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Rising Hg Levels in the Pacific Tuna

Mercury levels in Hawaiian bigeye, yellowfin tuna rising

Mercury levels in Hawaiian yellowfin tuna increasing

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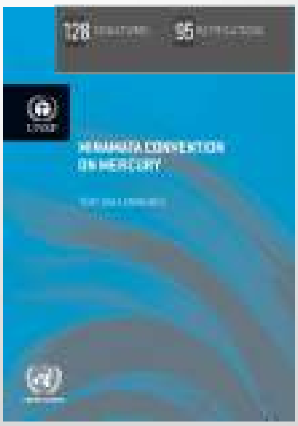
International Actions

Minamata Convention on Mercury

- The Minamata Convention on Mercury was opened for signature by governments at a Diplomatic Conference on October 9-11, 2013 in Japan.
- Minamata Convention on Mercury entered into force on August 16, 2017.



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Minamata Convention on Mercury

Article 19

Research, development and monitoring

1. Parties shall endeavour to cooperate to develop and improve, taking into account their respective circumstances and capabilities:

(a) Inventories of use, consumption, and anthropogenic emissions to air and releases to water and land of mercury and mercury compounds;

(b) Modelling and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media, including biotic media such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples;

(c) Assessments of the impact of mercury and mercury compounds on human health and the environment, in addition to social, economic and cultural impacts, particularly in respect of vulnerable populations;

(d) Harmonized methodologies for the activities undertaken under subparagraphs (a), (b) and (c);

(e) Information on the environmental cycle, transport (including long-range transport and deposition), transformation and fate of mercury and mercury compounds in a range of ecosystems, taking appropriate account of the distinction between anthropogenic and natural emissions and releases of mercury and of remobilization of mercury from historic deposition;

(f) Information on commerce and trade in mercury and mercury compounds and mercury-added products; and

(g) Information and research on the technical and economic availability of mercury-free products and processes and on best available techniques and best environmental practices to reduce and monitor emissions and releases of mercury and mercury compounds.

2. Parties should, where appropriate, build on existing monitoring networks and research programmes in undertaking the activities identified in paragraph 1.

Article 22

Effectiveness evaluation

1. The Conference of the Parties shall evaluate the effectiveness of this Convention, beginning no later than six years after the date of entry into force of the Convention and periodically thereafter at intervals to be decided by it.

2. To facilitate the evaluation, the Conference of the Parties shall, at its first meeting, initiate the establishment of arrangements for providing itself with comparable monitoring data on the presence and movement of mercury and mercury compounds in the environment as well as trends in levels of mercury and mercury compounds observed in biotic media and vulnerable populations.

3. The evaluation shall be conducted on the basis of available scientific, environmental, technical, financial and economic information, including:

(a) Reports and other monitoring information provided to the Conference of the Parties pursuant to paragraph 2;

(b) Reports submitted pursuant to Article 21;

(c) Information and recommendations provided pursuant to Article 15; and

(d) Reports and other relevant information on the operation of the financial assistance, technology transfer and capacity-building arrangements put in place under this Convention.

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Atmospheric Hg Monitoring Worldwide

Currently, long-term or background atmospheric Hg monitoring activities in SE and S Asia are still lacking.

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Asia Pacific Mercury Monitoring Network

Asia Pacific Mercury Monitoring Network

Systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region

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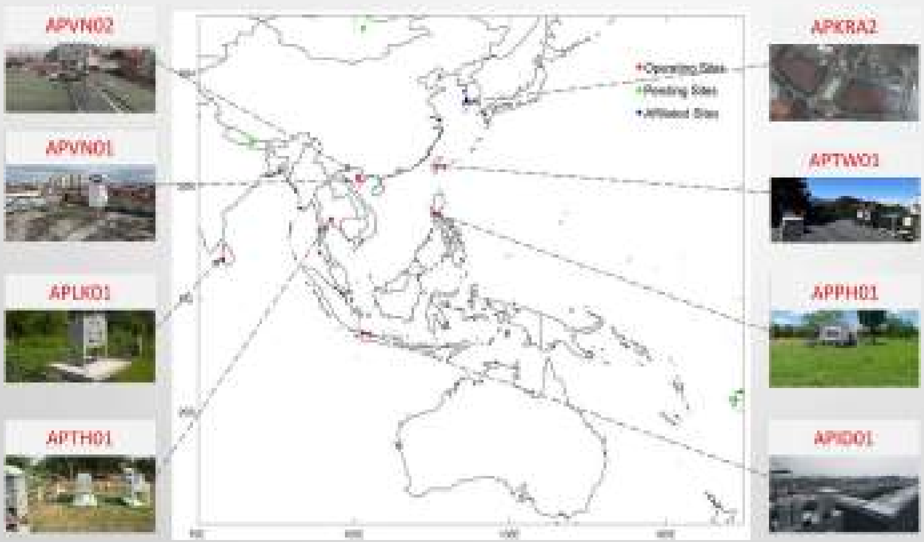
APMMN Site Map



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THANK YOU!

Contact:
grsheu@atm.ncu.edu.tw

State of the Network : mercury central analytical lab and site liaison reports

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Background

NCU has been working closely with EPA Taiwan (EPAT), USEPA and NADP since 2012 to establish the collaborative Asia-Pacific Mercury Monitoring Network (APMMN).

- 2012 in Taipei (1st)
- 2013 in DC (2nd)
- 2014 in Hanoi (3rd)
- 2015 in Minamata (4th)
- 2016 in Bangkok (5th)
- 2017 in Taoyuan (6th)
- 2018 in Manila (7th)
- 2019 in Jakarta (8th)

2

Background

- NCU Hg Lab serves as the center for ultra-trace level Hg analysis and training
  - To help analyze rainwater samples, and to train researchers from other Asian countries for capacity building on ultra-trace level Hg sampling and analysis
- EPAT funded the establishment of the Center for Environmental Monitoring and Technology on NCU campus in 2016
  - Administrative offices and lab expansion to support the operation of Asia-Pacific Mercury Monitoring Network

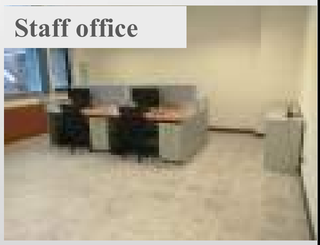
3

Center for Environmental Monitoring and Technology

Center Opening Ceremony in June 2016

5

Administrative Area



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Trace-Level Mercury Analytical Lab

Established in 2007. Expanded in 2016. Remodeled in 2019.

- 3 class 1000 cleanrooms and 2 clean benches
- 3 Tekran 2600 CVAFS mercury analyzers
- Tekran and Gardis atmospheric mercury monitoring systems
- 1 NIC MA-3 solo
- 2 DI water systems
- pH/conductivity meter
- 2 analytical balances
- 4 chemical hoods
- UHP Ar supply
- Chemical furnace
- Labware furnace

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New Lab Space and Equipment

Class 10000 Buffering Area

Air Shower

Class1000 Cleanroom (Acid Wash)

Class1000 Cleanroom (Chemical Preparation)

New Lab Space and Equipment

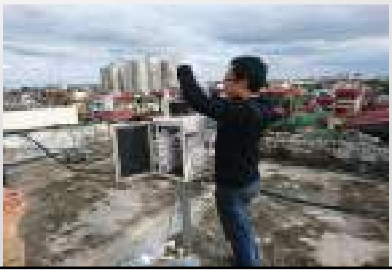
Remodel of Old Lab Space

Atmospheric and Rainwater Mercury Monitoring Training

Training Activities

Site visit and training, Thailand (February 2017)

Site visit and training, Vietnam (October 2017)



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Training Activities

Site survey and training, Philippines (June 2018)




13

Training Activities

Site visit and training, Indonesia (May 2019)




14

Training Activities

Visit of Vietnam CEM (April 2017)

Training Workshop (May 2017)

15

Training Activities

Training Workshop (June 2019)

16

Training Activities

Training Workshop (June 2019)

Training Activities

Advanced Training (4 sessions)

October 2018 (Thailand)

March 2019 (Vietnam)

Training Activities

Advanced Training (4 sessions)

March 2019 (Indonesia)

April 2019 (Philippines and Sri Lanka)

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Wet Sampler Inter-comparison

Inter-comparison of Wet Deposition Samplers

- There is no “standard” wet deposition sampler.
- APMMN uses MIC-B type sampler, whereas NADP/MDN uses N-CON sampler
  - MIC-B vs N-CON : since January 2017
  - MIC-B vs MIC-B : since April 2018

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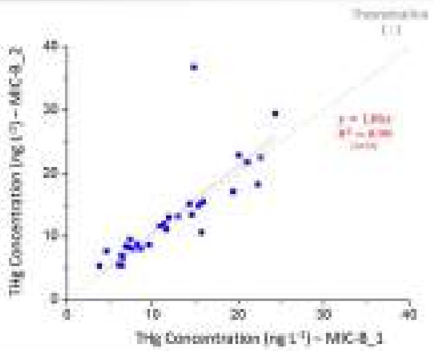
Inter-comparison of Wet Deposition Sampler

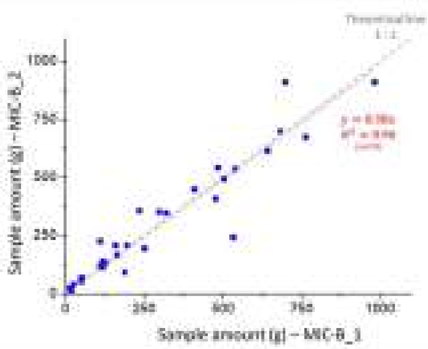
MIC-B vs MIC-B:

33-pair of samples until April 2019

THg concentration



Sample amount



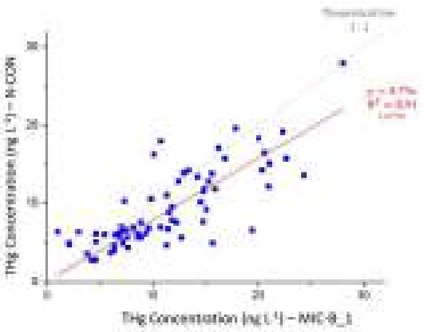
22

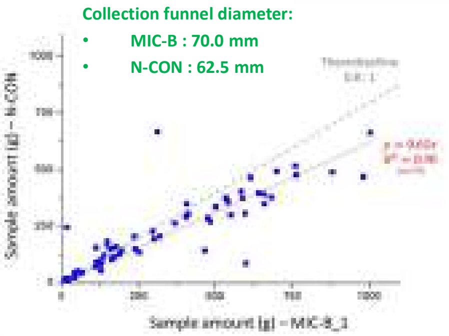
Inter-comparison of Wet Deposition Sampler

MIC-B vs N-CON:

70-pair of samples until April 2019

THg concentration | Sample amount





- Lid opening/closing time difference (sensor/motor difference)
- Raindrop bounce/splash
- Evaporation of water and/or Hg
- Wind speed and direction
- Other factors

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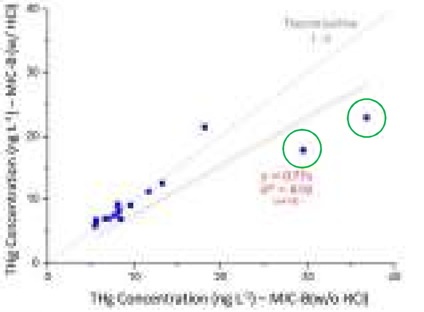
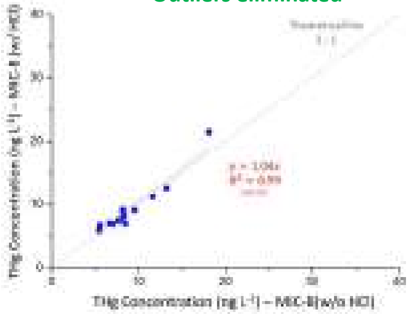
Inter-comparison of Wet Deposition Sampler

Acid preservation : MIC-B vs MIC-B



Outliers eliminated



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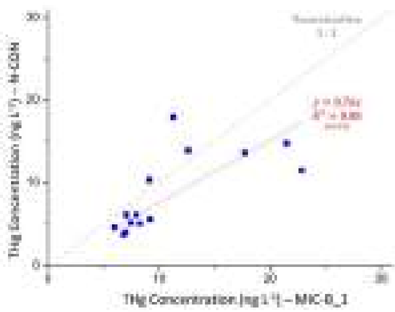
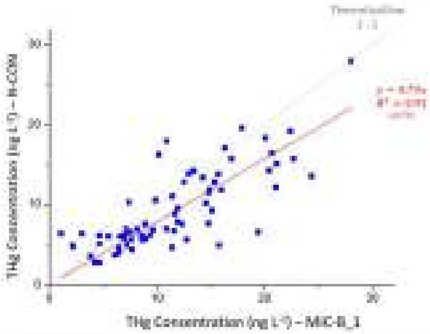
Inter-comparison of Wet Deposition Sampler

Acid preservation : MIC-B vs N-CON

Acidify



Non-acidify



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Passive Atmospheric Sampler Tests in Taiwan

Passive Atmospheric Hg Sampler

Advantages:

- Lower cost
- No need for electricity and gases
- Easy to use and deploy
- Improved spatial resolution


Environmental Science & Technology Letters
A High-Precision Passive Air Sampler for Gaseous Mercury
Environmental Research Letters
Identifying and evaluating urban mercury emission sources through passive sampler-based mapping of atmospheric concentrations
Global evaluation and calibration of a passive air sampler for gaseous mercury
The effects of meteorological parameters and diffusive barrier reuse on the sampling rate of a passive air sampler for gaseous mercury

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Passive Air Sampler Test in Taiwan

- From July 2018 to June 2019
- Deployed at site on NCU campus (ground, suburban) and at the Lulin Atmospheric Background Station (mountain, remote)
- Side-by-side with a Tekran system
- Various temporal resolution

NCU Site

LABS Site

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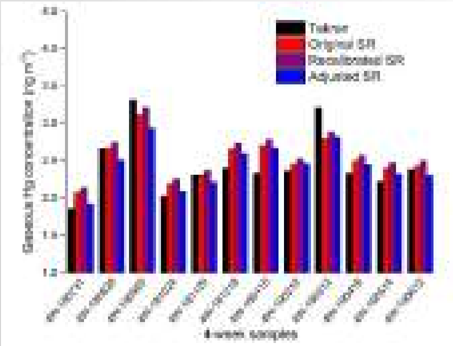
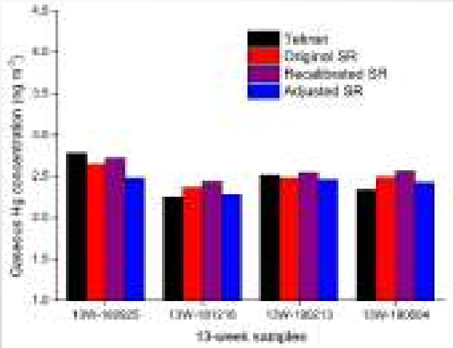
PAS Test Results – NCU

Deployment time	Active Conc. ($ng\ m^{-3}$)	Passive Conc. ($ng\ m^{-3}$)		
		Original SR	Recalibrated SR	Adjusted SR
4 weeks	**2.46** ± 0.43	**2.53** ± 0.28	**2.60** ± 0.29	**2.44** ± 0.29
13 weeks	**2.47** ± 0.23	**2.50** ± 0.12	**2.57** ± 0.12	**2.41** ± 0.09

4-week deployment



13-week deployment



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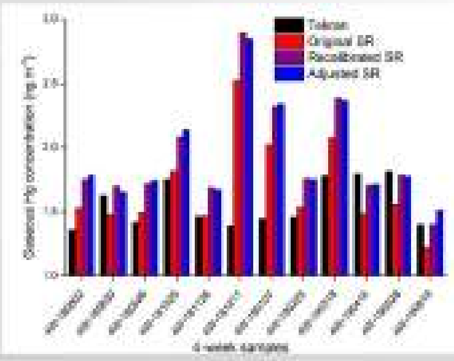
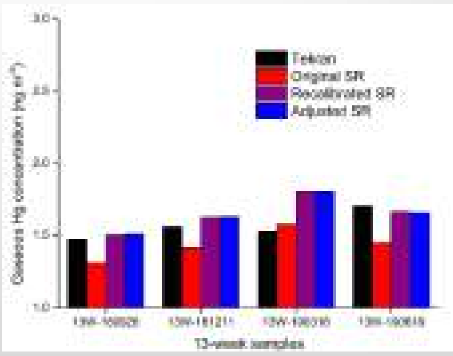
PAS Test Results – LABS

Deployment time	Active Conc. ($ng\ m^{-3}$)	Passive Conc. ($ng\ m^{-3}$)		
		Original SR	Recalibrated SR	Adjusted SR
4 weeks	**1.56** ± 0.18	**1.69** ± 0.36	**1.93** ± 0.41	**1.94** ± 0.40
13 weeks	**1.57** ± 0.10	**1.44** ± 0.11	**1.65** ± 0.12	**1.65** ± 0.12

4-week deployment



13-week deployment



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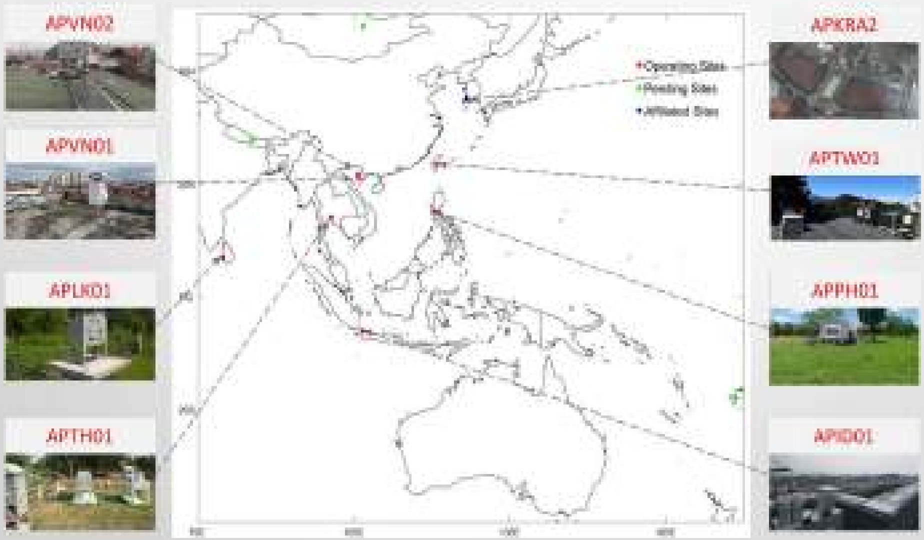
APMMN Site Information

APMMN Site Information



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APMMN Site Information

Country	Site ID	Sampler model
Indonesia	APID01	ACM
Korea	APKRA2	N-CON
Philippines	APPH01	MIC-B
Sri Lanka	APLK01	MIC-B
Taiwan	APTW01	MIC-B
Thailand	APTH01	MIC-B
Vietnam	APVN01	N-CON
Vietnam	APVN02	MIC-B

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Current Status

- **8** active sites, including **1** affiliated site.
- **3** sites began operation in 2018 and 2019.
  - APPH01 (2018/09)
  - APVN02 (2019/04)
  - APLK01 (2019/04)
- **3** new sites in progress.
  - Fiji
  - Mongolia
  - Nepal
- APID01 requested to replace the ACM wet sampler with a MIC-B sampler. (in progress)
- **5** sets of sampler are available.

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Progress on Wet Deposition Sample Analysis: QA/QC and Data Summary

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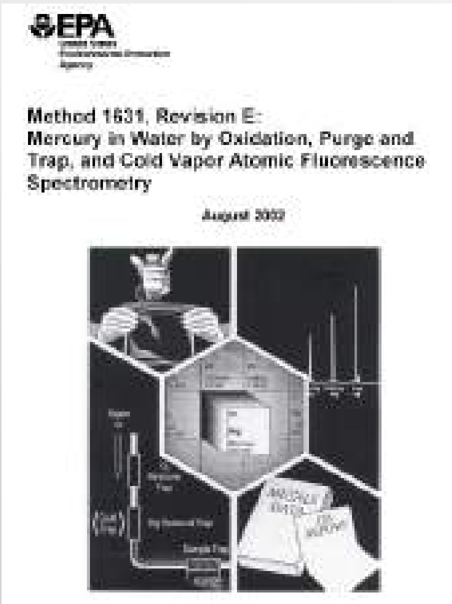
Rainwater Hg Analysis


EPA

Method 1631, Revision E:
Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

August 2002

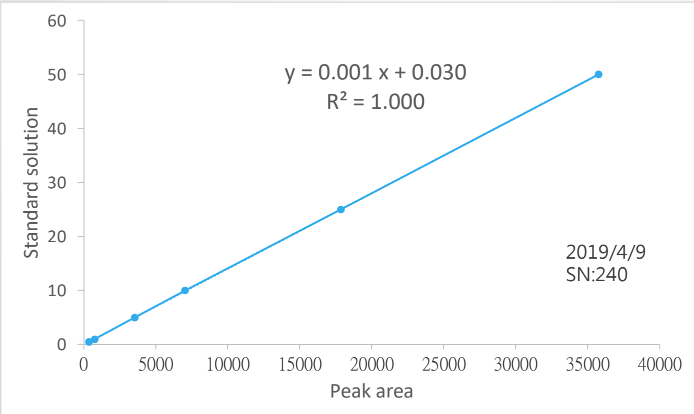
Total Hg is quantified by dual amalgamation Cold Vapor Atomic Fluorescence Spectrometry (CVAFS) after BrCl oxidation, $NH_2OH \cdot HCl$ neutralization, and $SnCl_2$ reduction.

36

Method Detection Limit

MDL of the NCU lab is 0.12 ng/L

Calibration Curve



37

Blanks

System blank

	Frequency	Mean (ng L^{-1})	Min. (ng L^{-1})	Max. (ng L^{-1})	1631 rev. E
2016 – 2017	127	0.18	0.05	0.53	< 0.5 ng L^{-1}
2018 – Apr 2019	67	0.06	0.03	0.15	

Bottle blank

	Freqency	Mean (ng L^{-1})	Min. (ng L^{-1})	Max. (ng L^{-1})	1631 rev. E
2016 – 2017	83	0.12	0.00	0.48	< 0.5 ng L^{-1}
2018 – Apr 2019	96	0.24	<MDL	1.95	

38

Duplicate Analysis and Matrix Spike

Duplicate analysis

	Frequency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016 – 2017	128	1.0	0.0	4.9	RPD < ±20 %
2018 – Apr 2019	88	2.4	0.1	11.2	

Matrix spike/duplicate

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016 – 2017	130	101.5	96.5	119.6	Recovery 71 – 125 %
2018 – Apr 2019	66	98.8	78.4	110.0	

39

Recovery of QCS and CRM

Quality control sample (QCS)

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2016 – 2017	83	100.5	95.6	106.3	Recovery 80 – 120 %
2018 – Apr 2019	86	101.2	91.7	113.7	

Certified reference material (CRM)

	Freqency	Mean (%)	Min. (%)	Max. (%)	1631 rev. E
2018 – Apr 2019	20	95.3	88.5	103.3	--

40

Samples Received and Analyzed

Rain water sample
From 2016 to April 2019

Site ID	Number of samples				Subtotal
	2016	2017	2018	2019	
APID01	19	20	22	13	74
APPH01	-	-	10	8	18
APLK01	-	-	-	1	1
APTW01	-	44	43	11	98
APTH01	44	43	43	5	136
APVN01	12	13	9	4	38
APVN02	-	-	-	2	2
APKRA2	29	30	29	8	94
Summary	104	150	156	52	462

41

Samples Received and Analyzed

QC sample (Reagent blank, bottle blank, …)
From 2016 to April 2019

Site ID	Number of samples				Subtotal
	2016	2017	2018	2019	
APID01	-	-	-	2	2
APPH01	-	-	-	2	2
APLK01	-	-	-	-	0
APTW01	-	45	64	32	141
APTH01	14	8	12	12	46
APVN01	4	1	-	1	6
APVN02	-	-	-	1	1
APKRA2	-	-	-	-	0
Summary	18	54	76	50	198

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Samples Received and Analyzed

Other samples (e.g. surface water)

From 2016 to April 2019

Site ID	Number of samples				Subtotal
	2016	2017	2018	2019	
APID01	-	-	-	-	0
APPH01	-	-	-	-	0
APLK01	-	-	-	-	0
APTW01	-	-	-	-	0
APTH01	11	9	18	8	46
APVN01	-	-	-	-	0
APVN02	-	-	-	-	0
APKRA2	-	-	-	-	0
Summary	11	9	18	8	46

43

APMMN Data Summary

From 2018 to April 2019

Site ID	Number of Sample	Rainwater Hg Conc. (**Mean**±S.D; ng L^{-1})
APID01	35	**13.1**±11.7
APPH01	17	**26.5**±27.8
APLK01	1	**7.9**
APTW01	55	**10.5**±7.3
APTH01	46	**9.7**±6.6
APVN01	12	**34.0**±6.6
APVN02	2	**41.3**±16.2
APKRA2	38	**7.7**±7.2
OVERALL	206	**12.4**±12.6

44

Summary of Rainwater Hg Conc. Worldwide

Location	THg conc. (ng L^{-1})	References
APMMN	7.7-41.3	January 2018 – April 2019
12 sites in Taiwan	6.6-14.3	Lin et al., 2018
10 sites in Japan (estimate)	5.2-9.5	Sakata and Marumoto, 2005
EMEP (2016)	3.5-24.0	EMEP, 2018
NADP/MDN (2017)	2.1-21.4	NADP 2017 Annual Summary
Chuncheon, Korea	8.8	Ahn et al., 2011
Seoul, Korea	10.1-16.3	Seo et al., 2012
Nam Co, China	4.8	Huang et al., 2012
Mt. Leigong, China	4.0	Fu et al., 2010
Chongqing, China	30.7	Wang et al., 2012
4 sites in Xiamen, China	11.4-14.0	Xu et al., 2014
Nanjing, China (9 months)	52.9	Zhu et al., 2014
Monterey Bay, CA, USA	5.8	Conaway et al., 2010
CBL, MD, USA	11.4-15.0	Mason et al., 2000
Moffett Field, CA, USA	11.6	Steding and Flegal, 2002
Bermuda	4.7	Gichuki and Mason, 2014
10 sites in UK	1.6-5.1	Rowland et al., 2010
2 sites in South Africa	10.6-15.8	Gichuki and Mason, 2013
2 sites in Mexico	7.9-8.2	Hansen and Gay, 2013

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Asia Pacific Mercury Monitoring Network

Session III

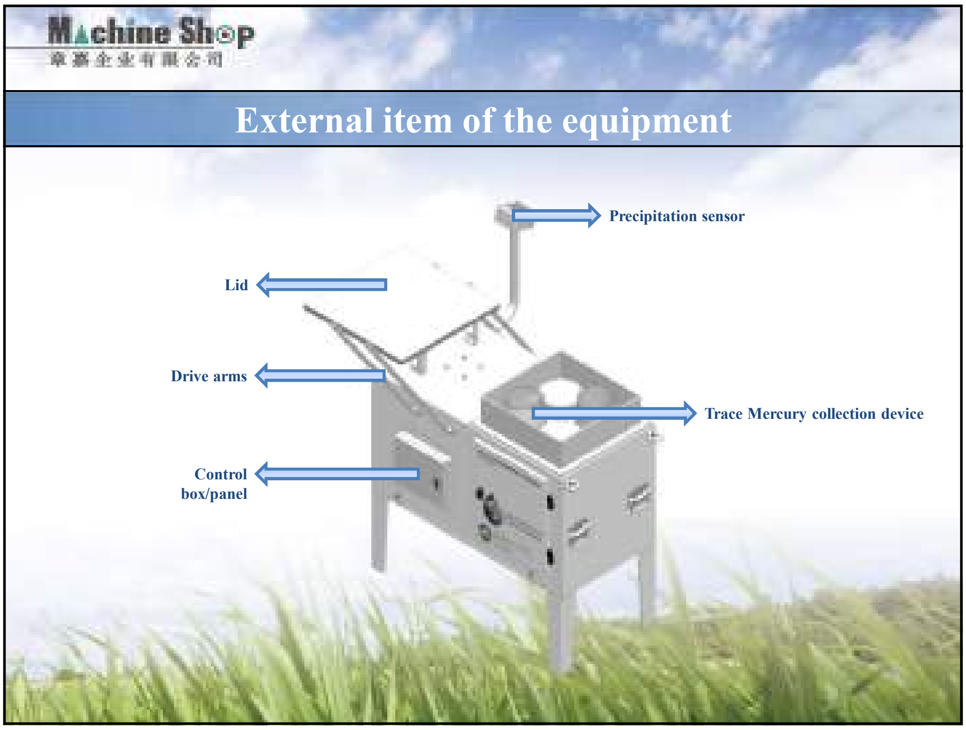
APMMN Mercury Wet Deposition Roundtable Discussion

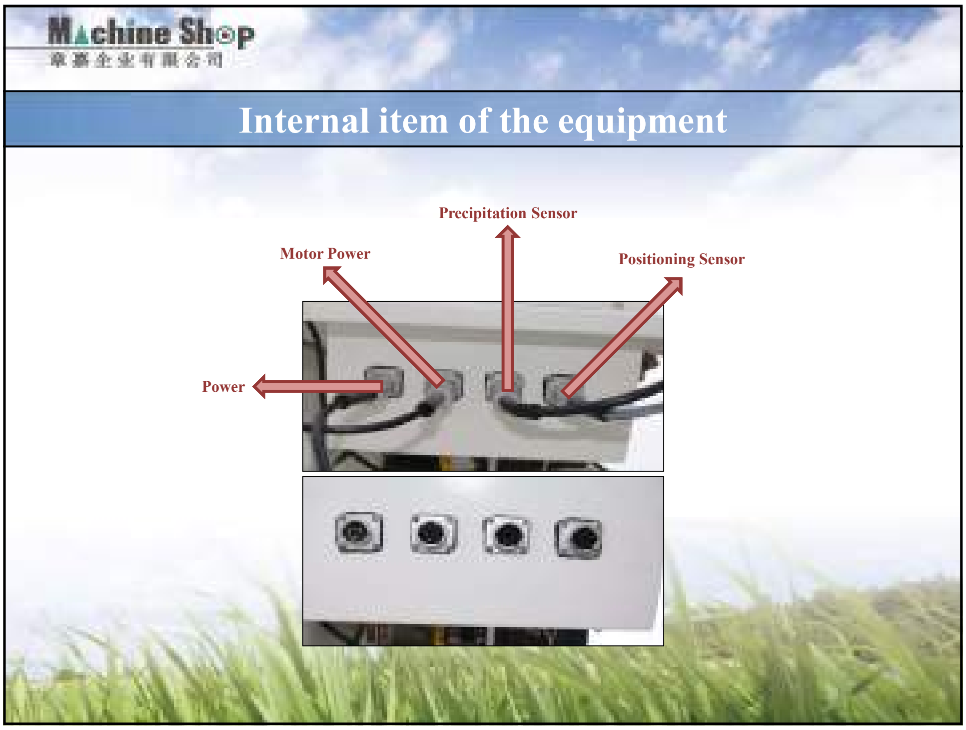
- Standard Operating Procedures
- Acid cleaning
- Case study
- Blank sample preparation

Machine Shop

Mercury Deposition Sampler

Contact:
Cheng Jung Huang, General Manager
asir@machine-shop.com.tw

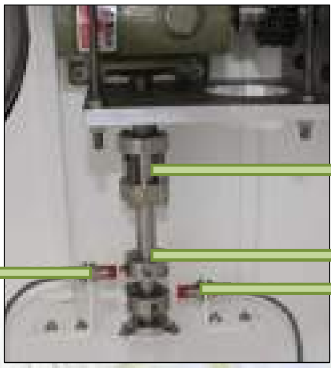

External item of the equipment
Precipitation sensor
Lid
Drive arms
Trace Mercury collection device
Control
box/panel


Internal item of the equipment
Precipitation Sensor
Motor Power
Positioning Sensor
Power

Control panel

- Homepage
  - Manual/Auto switch
  - Setting
    - Lid delay
      Heater delay
      Heater On/Off time
      Wet sensor delay
      Lib alert
    - Advanced setting (pin code)
      - Proximity sensors adjustment
    - Manufacturer Info
  - Stop
  - 4 indicators

Internal item of the equipment



Description of Operation

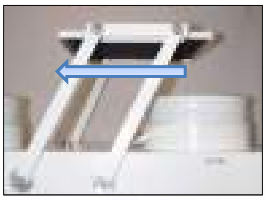
When precipitation sensor detects precipitation.

"Precipitation" light on controller monitor will be on. Then "Heater" will light on and shine followed by setting.

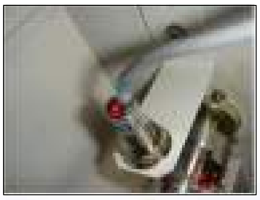
For example, set Heater ON to 10 seconds and Heater OFF to 5 seconds. "Heater" light will repeat shining 10 seconds and then going out 5 seconds until "Precipitation" light off.

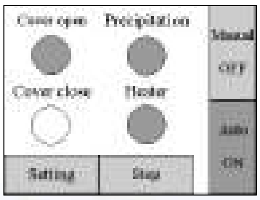
Description of Operation

When "Precipitation" lights on, flat cover will open and start to collect mercury deposition



While the flat cover opening, Sensor positioning sheet will synchronously rotate with it until be detected by Flat cover opening positioning sensor with lighting on. Then flat cover will stop. "Cover open" on controller monitor will light on.

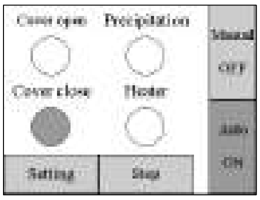




Description of Operation

When precipitation sensor doesn't detect precipitation.

"Precipitation" light on controller monitor will be off. Then "Heater" will light of.

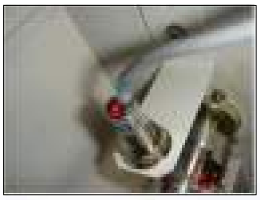


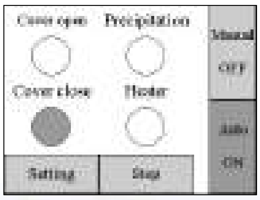
Machine Shop

Description of Operation

When "Precipitation" lights off, flat cover will close.

While the flat cover closing, Sensor positioning sheet will synchronously rotate with it until be detected by Flat cover closing positioning sensor with lighting on. Then flat cover will stop. "Cover close" on controller monitor will light on

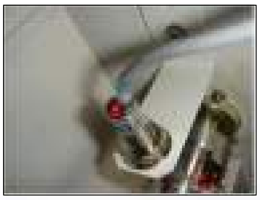


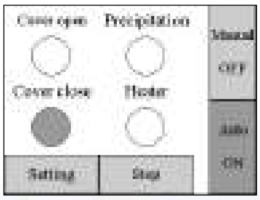


Description of Operation

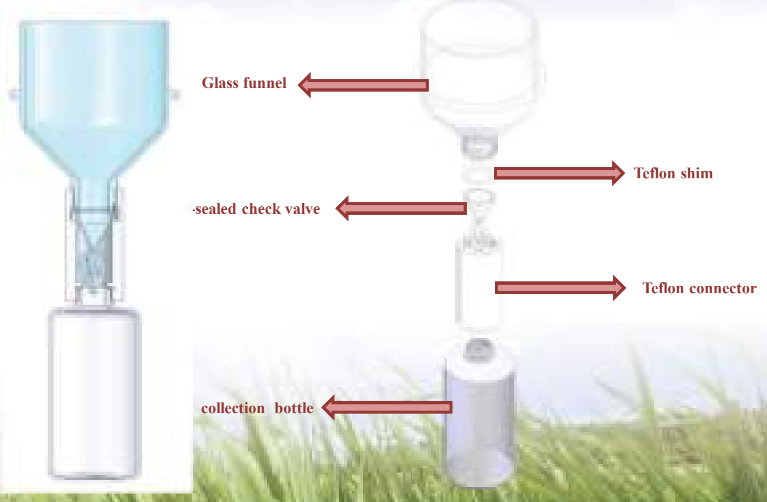
When "Precipitation" lights off, flat cover will close.

While the flat cover closing, Sensor positioning sheet will synchronously rotate with it until be detected by Flat cover closing positioning sensor with lighting on. Then flat cover will stop. "Cover close" on controller monitor will light on





Trace mercury collection device

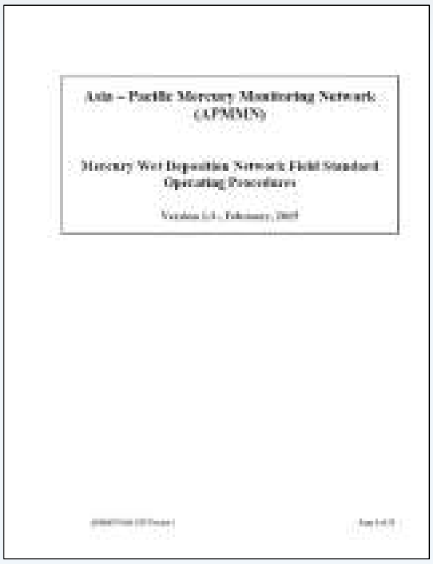


Standard Operating Procedures for APMMN

Asia Pacific Mercury Monitoring Network

Center for Environmental Monitoring and Technology
National Central University

Current SOP


Asia – Pacific Mercury Monitoring Network (APMMN)

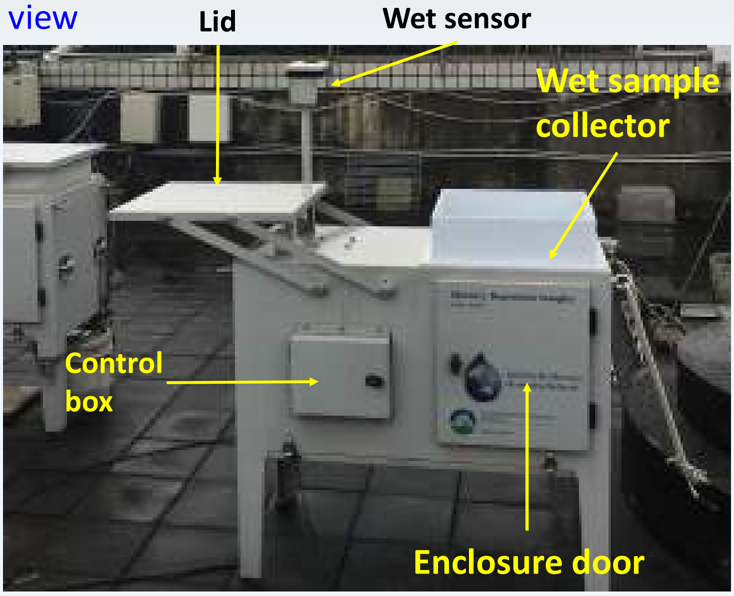
Mercury Wet Deposition Network Field Standard Operating Procedures

Version 1.3 – February, 2015

- Based on MDN/NADP SOP.
- Revised Ver. 1.3 by EPAT, USEPA, NADP, NCU, Vietnam and Thailand in 2015

Wet-only precipitation collector – MIC-B type

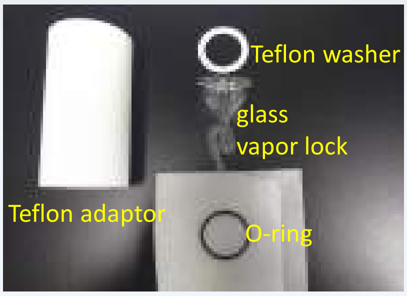
Front view



Wet-only precipitation collector-MIC type

Top view

Mercury collection device

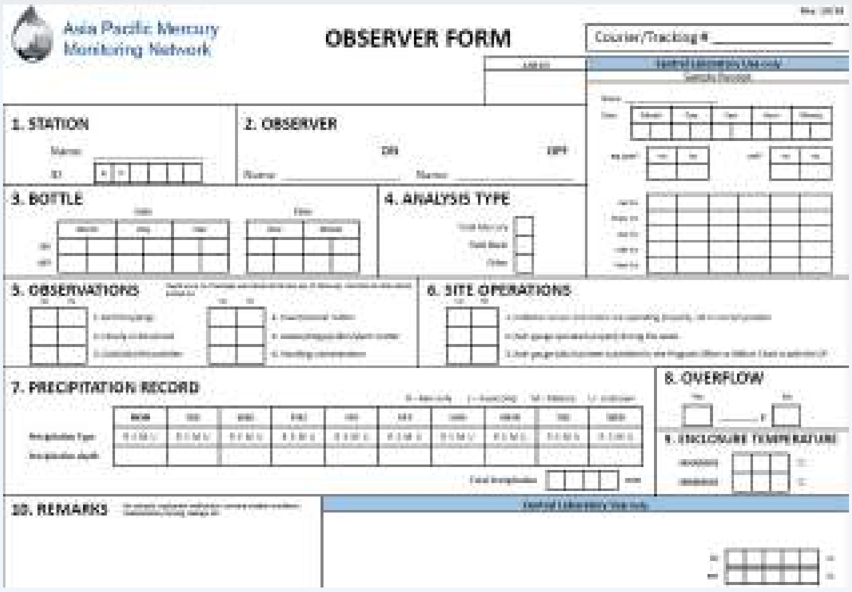


Sample changeout

Items needed:

- Network Observation Form (NOF), for previous week
- NOF, for current week
- Mercury collection device (precharged hydrochloric acid), covered with double plastic bags
- Fresh deionized water in a squeeze bottle (~300 ml)
- Paper towels or lab wipes
- 3 Pairs of glove
- 2 zipped bags

Network Observer Form (NOF)


Asia Pacific Mercury Monitoring Network

OBSERVER FORM

Courier/Tracking #

1. STATION

2. OBSERVER

3. BOTTLE

4. ANALYSIS TYPE

5. OBSERVATIONS

6. SITE OPERATIONS

7. PRECIPITATION RECORD

8. OVERFLOW

9. ENCLOSURE TEMPERATURE

10. REMARKS

Retrieve your sample

- Changes on Tuesday morning 9 am (local time)
- Approach collector facing into the wind
- Open the enclouse door
- Put ot the gloves
- Take off PFA sample bottle

Retrieve your sample

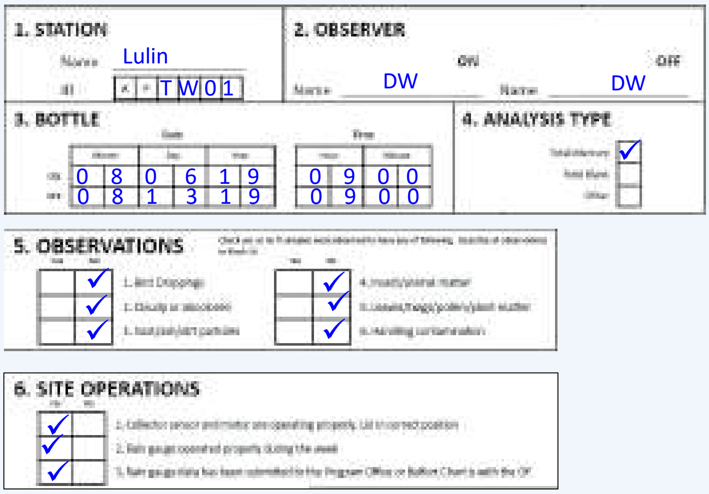
- Cap the bottle
- Take 2 zipped bags to cover bottle

Retrieve your sample

- Fill in the Network Observer Form
- Open the lid
- Take out the used sample collection device (funnel)

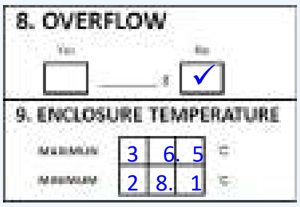
Retrieve your sample

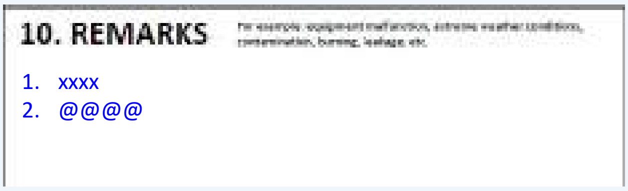
- Fill in the Network Observer Form (previous week)



Retrieve your sample

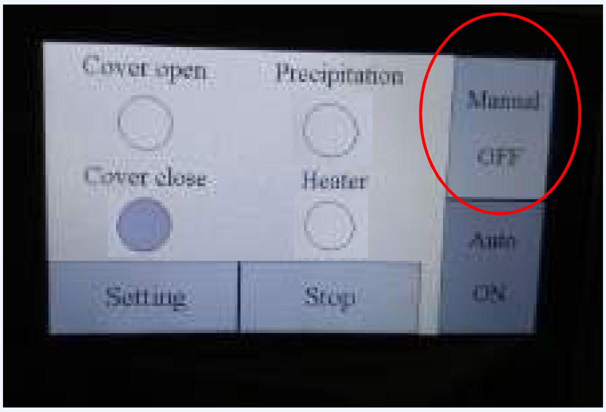
- Fill in the Network Observer Form (previous week)





Retrieve your sample

- Open the lid (switch to Manual OFF)
- Take out the used sample collection device (funnel)



Cleaning the collector

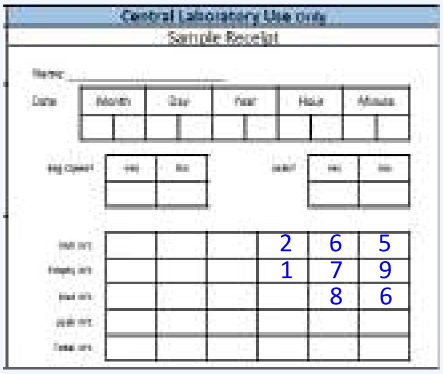
- Clean the sampler surfaces by Deionized water and paper towels
- Clean any debris off precipitation sensor

Deployment of new sample collector

- Change your gloves !
- Deploy new sample collection device
- Avoid to touch the inner surface of glass funnel
- Close the lid and enclosure door
- Note the date/time on the new NOF

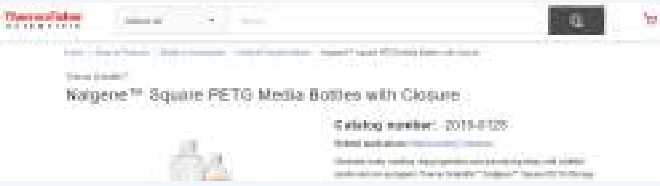
Weigh, transfer and storage

- Weigh the sample bottle and subtract the weight of empty bottle (recode it on the NOF)



Weigh, transfer and storage

- Carefully pour the sample from 1L PFA bottle to 125mL PETG shipping bottle
- Label the sample with sampling site ID, start/end date
- Place the sample into double sealable plastic bag
- Store the sample in a Hg-free and secure place (or refrigerator) if not shipping immediately.



Weigh, transfer and storage

- Capture rain gauge data

7. PRECIPITATION RECORD

R – Rain only S – Snow Only M – Mixture U – Unknown

	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED
Precipitation Type	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U
Precipitation depth			0.5	2.0				3.5		

Total Precipitation 6.0 mm

- Complete the NOF

Sample label

- The one of important part of taking sample

Site ID
Start Date (MM/dd/yyyy)
End Date

APTW01
08/06/2019
08/13/2019

Shipping Info.

Ship samples at least **monthly** by int'l logistics service
Ex:

- Pack samples and NOFs singly or in bulk
- Cold shipping is unnecessary
- Description of goods : Rainwater

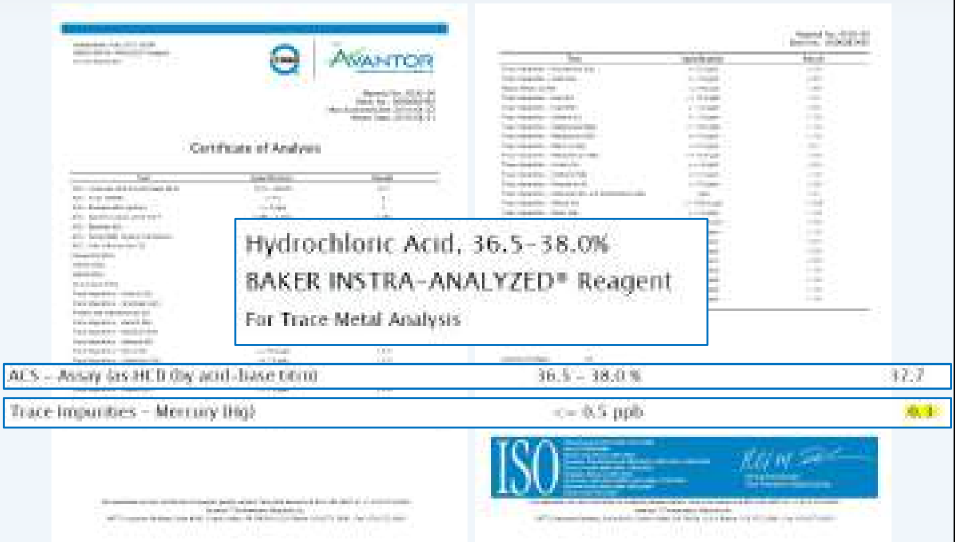
Dr. Guey-Rong Sheu
APMMN
Department of Atmospheric Sciences National Central University
300 Jhong-Da Road Jhong-Li 320, Taiwan

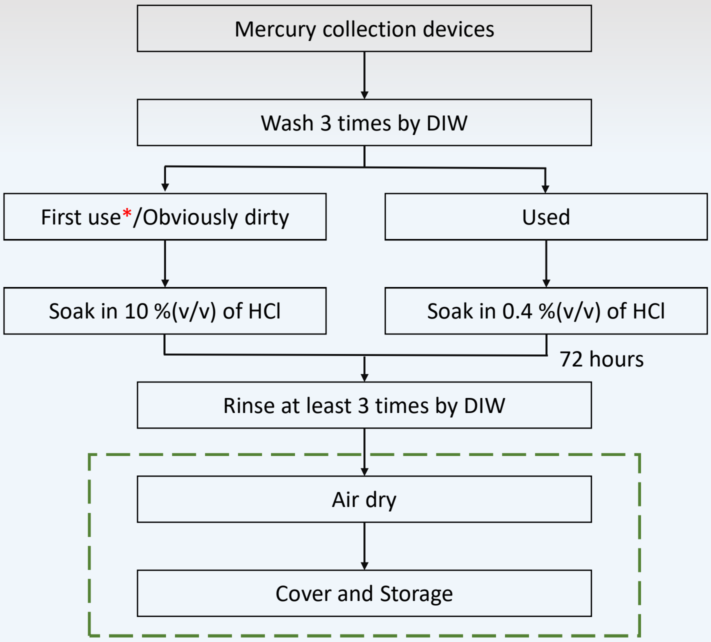
Acid Clean of Collection Devices

Material/Equipment

- Cleanroom w/ fume hood (1.5-15.4 ng m^{-3}, indoor air concentration in NCU ATEL)
- Personal protective equipment
- Deionized water – $\rho \geqq 18.2$ MΩ·cm, $\sigma \leqq 0.055$ µS/cm
- Hydrochloric acid – J.T Baker Hydrochloric Acid, 36.5-38.0%, BAKER INSTRA-ANALYZED® Reagent or equivalent
- Container (polyethylene)

Certificate of Analysis





* : independent tank, fresh solution

Under the clean room/clean bench

Acid Clean of Collection Devices

- Separate the collection device and wash by DIW

Acid Clean of Collection Devices

- Soak within hydrochloric acid for 72 hours (except O-ring)

Acid Clean of Collection Devices

- Rinse thoroughly each component with deionized water ($\rho \geqq 18.2$ MΩ) at least 3 times

Acid Clean of Collection Devices

- Air dry each component in the clean bench

Acid Clean of Collection Devices

- Cover each component with clean plastic bag and store
- Assemble each component before use

Cases in the past years

Case 1:
No sealable plastic bag (double bags)
No lable on sample bottle


Cases in the past years

Case 2:
Single sealable plastic bag only
Number of Sample bottle and NOF were unequal
Not use the suggest PETG bottle

Cases in the past years

Case 3:
No label on the bottle
No NOF

Field blank

Items needed:

- NOF, note the field blank on **block 4**
- Mercury collection device, covered with double plastic bags
- 100ml fresh deionized water in a squeeze bottle
- 1 PETG shipping bottle
- 2 zipped bags

Reagent blank

Items needed:

- NOF, note the other on **block 4** and describe it on **block 10**
- PETG shipping bottles
- Test reagent – hydrochloric, deionized water
- 2 zipped bags pre shipping bottle

1. 100 ml, 0.5% (v/v) of diluted acid solution.
   - **99.5 ml** of deionized water and **0.5 ml** trace-metal grade 12-Normal hydrochloric acid prepared into PETG shipping bottle.
2. 100 ml deionized water prepared

Bottle blank

Items needed:

- NOF, note the other on **block 4** and describe it on **block 10**
- Cleaned, dried 1L PFA bottle
- 100ml fresh deionized water
- PETG shipping bottles
- 2 zipped bags pre shipping bottle

Blank results

In the past three months at NCU ATEL

Type	Range (ng L^{-1})	Criterion
Field blank	0.38 – 1.29	-
Reagent blank – DIW	N.D – 0.04	-
Reagent blank – HCl	N.D – 1.12	-
Bottle blank	0.01 – 0.58	<0.5

THANK YOU

Asia Pacific Mercury Monitoring Network

Center for Environmental
Monitoring and Technology
National Central University

Emissions-Air-Biota-People

Why is Mercury Monitoring Important?

David A. Gay

Associate Scientist
National Atmospheric Deposition Program
State Laboratory of Hygiene, University of Wisconsin - Madison
1.217.898.1444, dgay2@wisc.edu

National Atmospheric Deposition Program

Summary:
Why is it important to Monitor For Mercury?

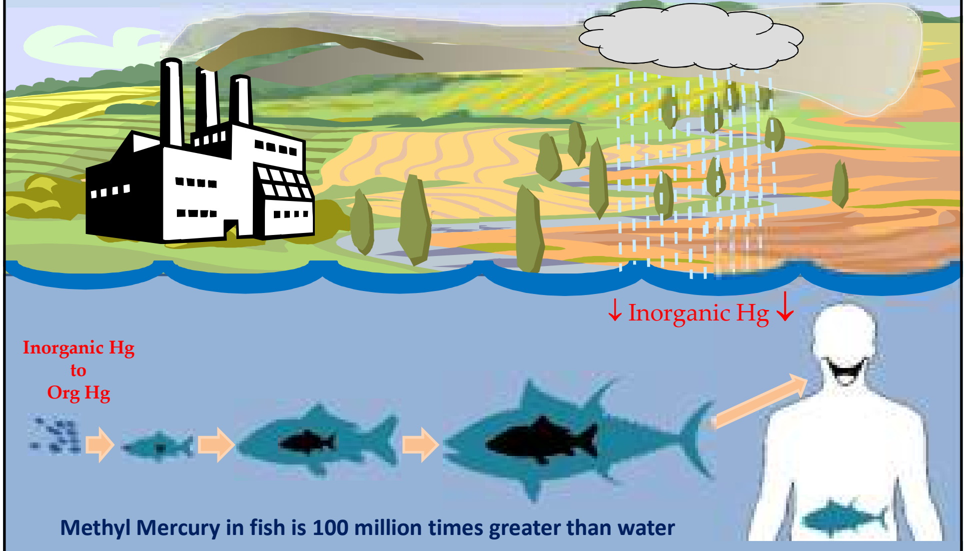
- Human Health
- Health of Animals and Insects
- General Environmental Health, Hg Cycling in the Environment
- Policy Ramifications
  - Local regulations
  - Minamata Convention on Mercury
- Scientific/Research, cycling of metals

Measuring Mercury For The Human Health Impact

A Human Health Concern

- Neurological Disorders
  - Persistent bioaccumulative neurotoxin
  - Large problem in children up to about 7-12 years
    - » Birth defects
    - » learning disabilities
  - Problem in adults under certain conditions

Human Health: Accumulation of Methyl Mercury in Fish and Shellfish



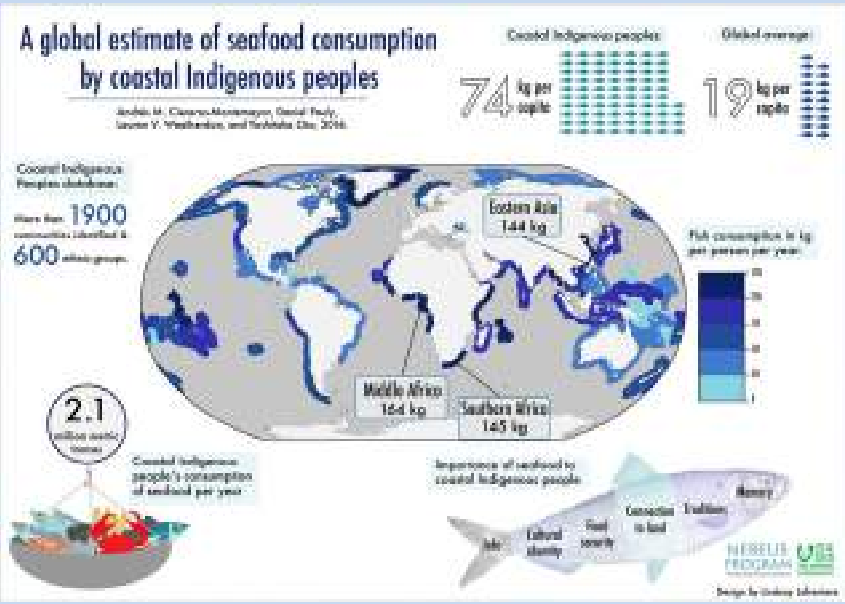
Measuring Mercury For Human Health

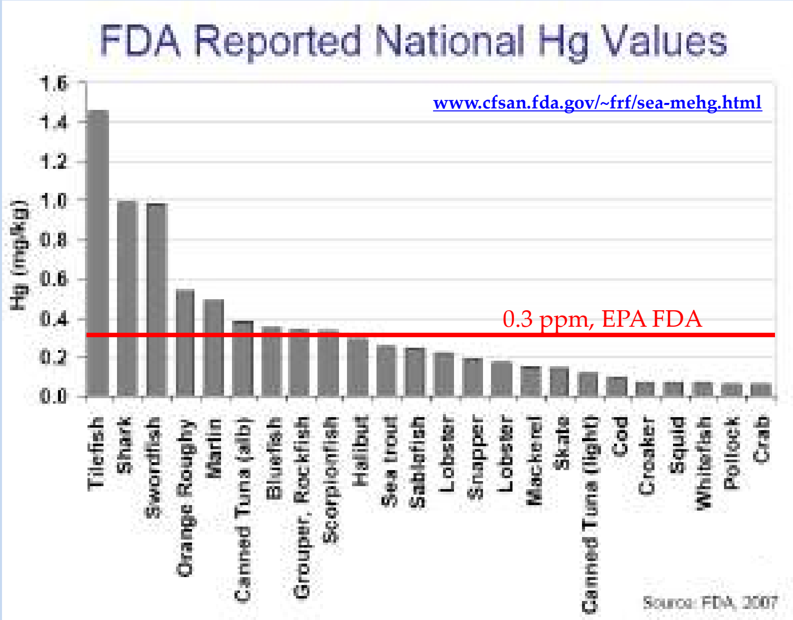
Asians in particular, along with Indigenous peoples

97

Mercury exposure to humans is primarily through the consumption of fish

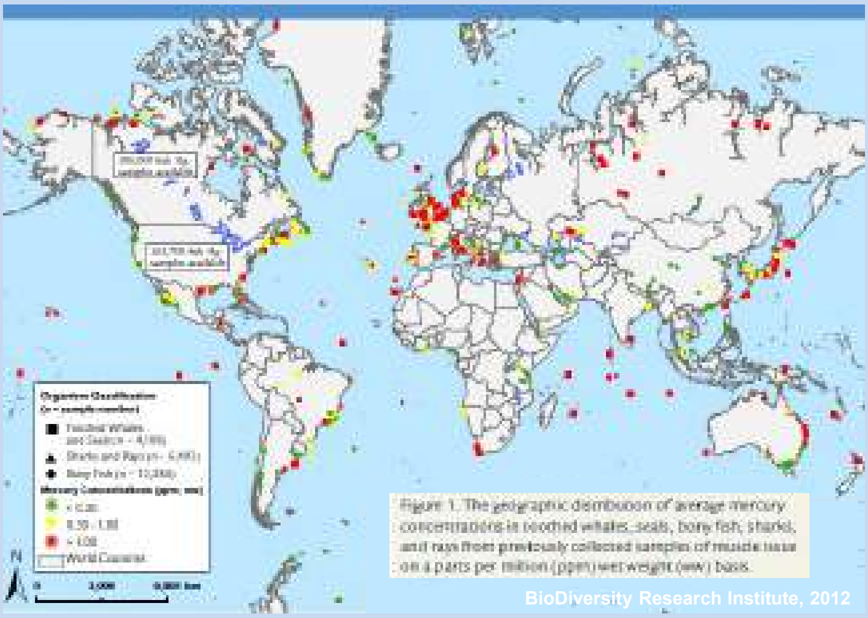
Fish Consumption High In Asia





From E. Sutherland, USEPA

Mercury in fish and marine mammals



Mercury is damaging to wildlife exposed to mercury

(eating within the same food chain)

But it isn't just humans….

Impacts on wildlife include

- reduced reproduction,
- changes to egg incubation times,
- behavioral changes, and
- neurological problems

From Wright et al, 2018; Aerosol and Air Quality Research, 18: 1953–1992

- Immunotoxicity
- nephrotoxicity
- diminishes neurological capacity and neurobehavioral function
- alters functioning of three major endocrine axes and impairs reproduction and
- alters offspring quality

From Eagles-Smith et al., 2018 Ambio 47, Issue 2, pp 170–197

Why

It Is Important To Monitor For Atmospheric Mercury

Atmospheric Deposition is the key input of Mercury in water bodies

Environ. Sci. Technol. 2006, 40, 6261–6268

Mercury in Soils, Lakes, and Fish in Voyageurs National Park (Minnesota): Importance of Atmospheric Deposition and Ecosystem Factors

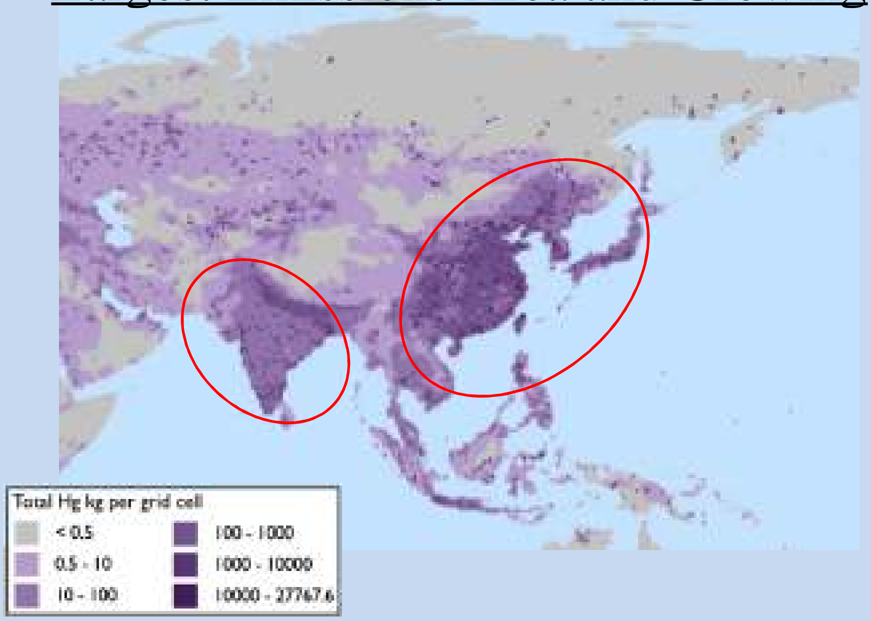
J. G. WIENER, B. C. KNIGHTS, M. B. SANDHEINRICH, J. D. JEREMIASON, M. E. BRIGHAM, D. R. ENGSTROM, L. G. WOODRUFF, W. F. CANNON, AND S. J. BALOGH

- Hg source to water bodies is *overwhelmingly atmospheric deposition and anthropogenic*

"We conclude that nearly all of the mercury in fish in this seemingly pristine landscape was derived from atmospheric deposition, that most of this bioaccumulated mercury was from anthropogenic sources, and that both watershed and lacustrine factors exert important controls on the bioaccumulation of methylmercury."

Asia is the world's largest atmospheric mercury source region

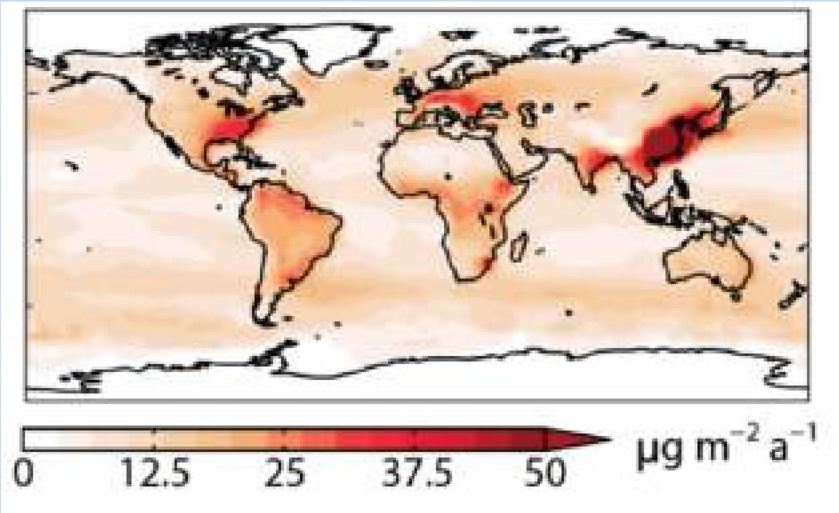
Largest Emissions Area and Growing



Small Scale Artisanal Gold Mining?

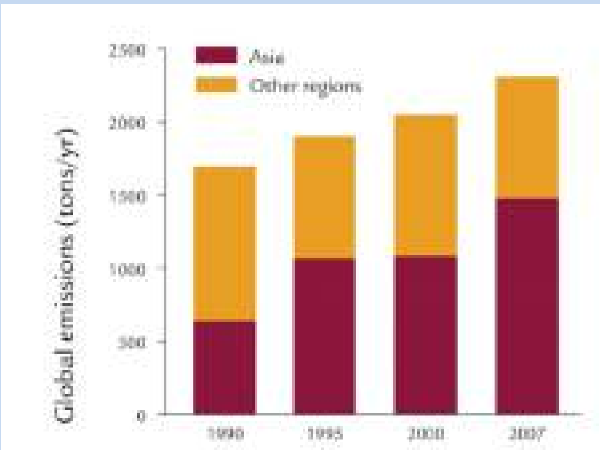
Estimated Global Wet Deposition of Mercury

Modelled Net Mercury Deposition, Corbitt et al, EST 2011



Emissions Are Increasing

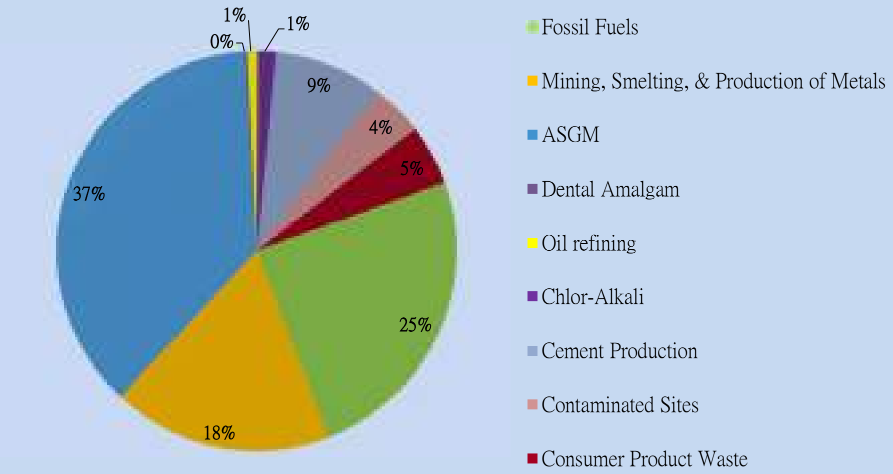
Asian Growth



Evers, et al., 2012

EMEP, 2012

What are the Mercury Sources?



Source: United Nations Environment Programme (UNEP)
The Global Atmospheric Mercury Assessment: Sources, Emissions and Environmental Transport, 2013

Mercury stays in the atmosphere for at least 6 months (as elemental Hg)

so regardless of whether your country emits mercury, you are receiving mercury as wet and dry deposition.

A true global pollutant……..

Responding to the Minamata Protocol

Minamata Convention On Mercury

- 128 signatories, 112 ratifications
- Controls emissions and releases
- Calls for *data and cooperative monitoring*

Many Asian Countries have signed onto this agreement

Country	Signature Date	Ratification et al.
Afghanistan		02/05/2017 (a)
Australia	10/10/2013	
Bangladesh	10/10/2013	
Cambodia	10/10/2013	
China	10/10/2013	31/08/2016
India	30/09/2014	18/06/2018
Indonesia	10/10/2013	22/09/2017
Japan	10/10/2013	02/02/2016 (A)
Korea (Republic of)	24/09/2014	
Lao People's Democratic Republic		21/09/2017 (a)
Malaysia	24/09/2014	
Marshall Islands		29/01/2019 (a)
Mongolia	10/10/2013	28/09/2015
Nepal	10/10/2013	
New Zealand	10/10/2013	
Palau	9/10/2014	21/06/2017
Philippines	10/10/2013	
Samoa	10/10/2013	24/09/2015
Seychelles	27/05/2014	13/01/2015
Singapore	10/10/2013	22/09/2017
South Africa	10/10/2013	29/04/2019
Sri Lanka	8/10/2014	19/06/2017
Thailand		22/06/2017 (a)
Viet Nam	11/10/2013	23/06/2017 (AA)

UN environment

MINAMATA CONVENTION ON MERCURY

Environmental Science & Technology

A Critical Time for Mercury Science to Inform Global Policy

Celia Y. Chen, Charles T. Driscoll, Collin A. Eagles-Smith, Chris S. Eckley, David A. Gay, Hsu-Kim, Susan E. Keane, Jane L. Kirk, Robert P. Mason, Daniel Obrist, Henrik Selin, Noelle E. Selin, and Marcella R. Thompson

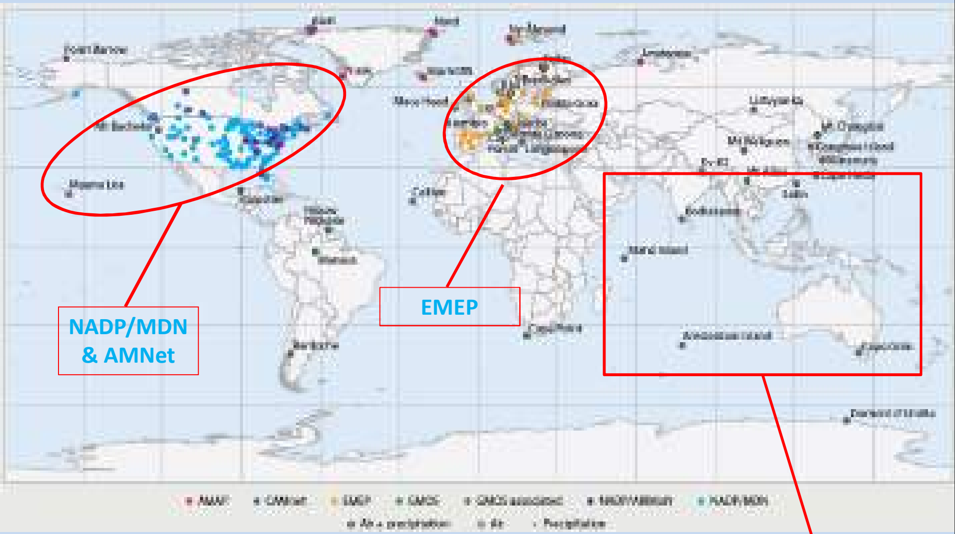
Dartmouth College, Department of Biological Sciences, Hanover, New Hampshire 03755 United States
Syracuse University, Department of Civil and Environmental Engineering, Syracuse, New York 13244 United States
U.S. Geological Survey, Corvallis, Oregon 97331 United States
U.S. Environmental Protection Agency, Region-10, Seattle, Washington 98101 United States
University of Wisconsin, Madison, Wisconsin 53706 United States
Duke University, Department of Civil & Environmental Engineering, Durham, North Carolina 27708 United States
Natural Resources Defense Council, Washington, D.C. 20005 United States
Environment and Climate Change, Canada, Burlington, ON L7P2X3 Canada
University of Connecticut, Department of Marine Sciences, Groton, Connecticut 06340 United States
University of Massachusetts, Lowell, Department of Environmental, Earth and Atmospheric Sciences, Lowell,

Digital copies

Much of Asia Deposition

is not currently being measured or measured consistently

Few Long-Term Mercury Measurements Made in Asia



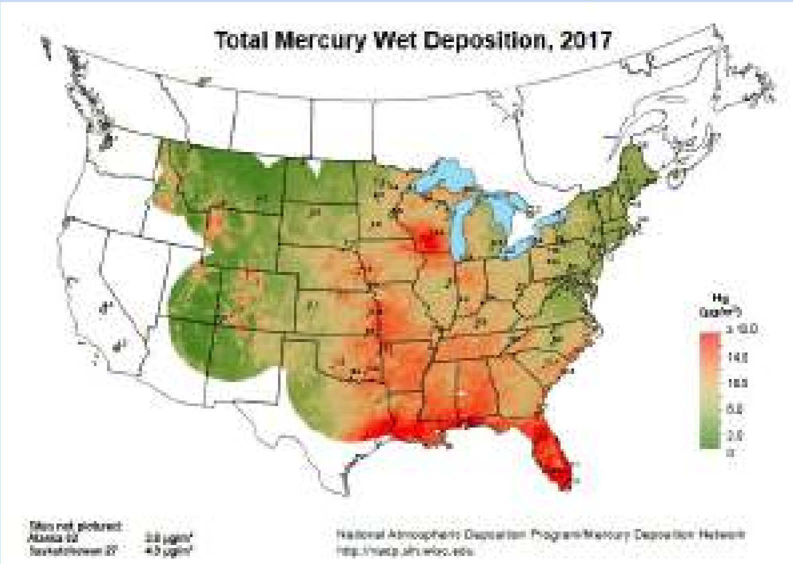
Currently, there is no long-term or background atmospheric Hg monitoring activity in SE Asia; few measurements in East Asia; limited accessible data; no regional network

Several East Asia Countries Have Monitoring Programs

- **Korea –** National Institute of Environmental Research (NIER)
- **Japan –** Dr. Maramoto, Dr. M. Sakata, et al., wet deposition
- **Taiwan –** Mt. Lulin and other stations – see work by Guey-Rong Sheu
- **China** - see work by Xinbin Feng, others

Scientific Needs for Understanding the Mercury Problem

Determining Rates of Deposition over Space

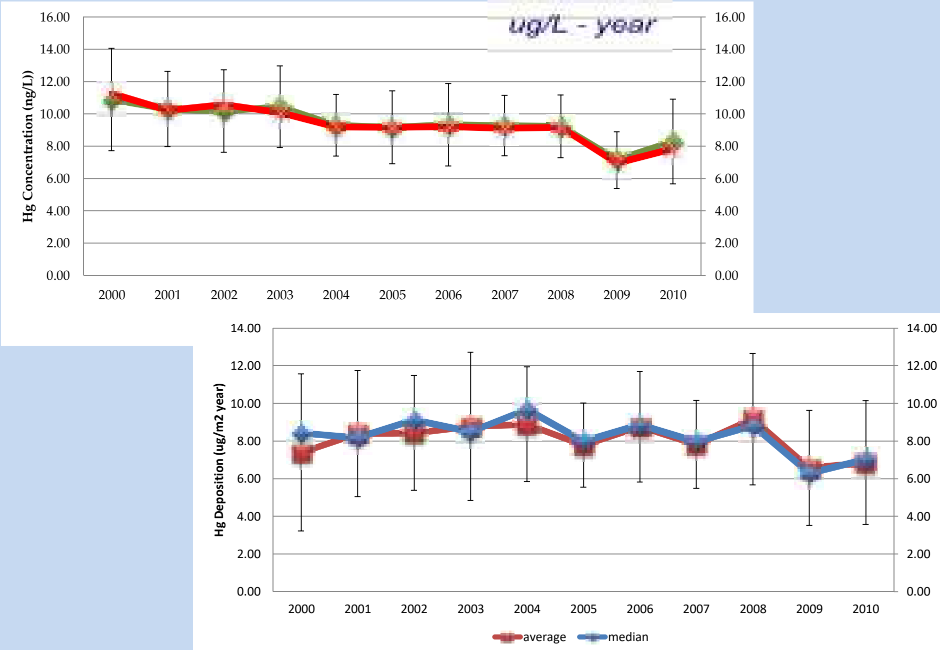


Trends in Concentrations

- Measurements are needed..
  - to determine if deposition is being reduced
  - How fast deposition is being reduced
  - If deposition is going down in all areas
  - If fish concentrations are also being reduced
  - If human exposure is decreasing

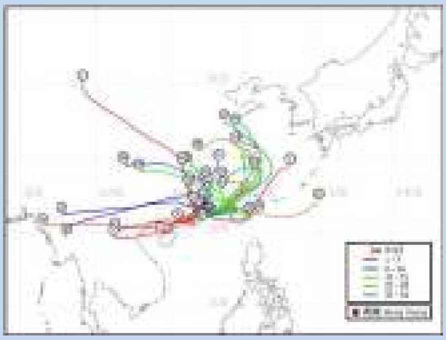
- Mercury reduction is proceeding in some countries, and the Minamata Convention should continue this trend.

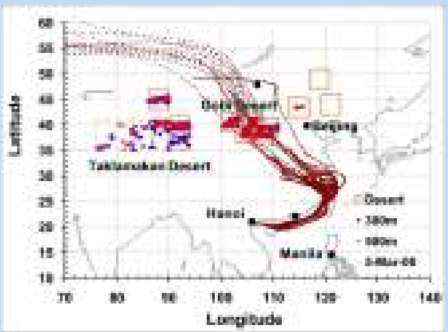
Great Lakes Mercury Wet Concentration and Deposition



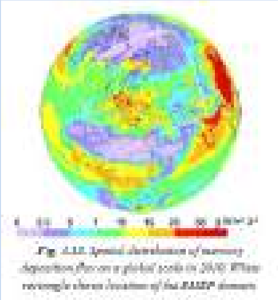
Given Measurements, you can determine where the Hg comes from…

Local
regional
or global





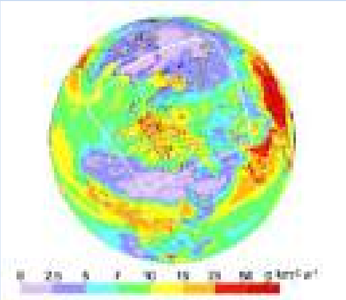
- All Scientists need sound measurements from everywhere, particularly in Asia
  - To understand the global problem…
  - To run global models…
  - To track results of the Minamata Convention



Strength in Network Design

The Value of Monitoring

- Using same methods!!!
  - "apples to apples"
  - on a global basis
  - Harmonization of measurements
- Long term monitoring is required to see small changes.
- Sharing Data
  - We need global data to understand a global pollutant
  - Working together is the *best way forward*
- Understand the problem through science
- Is Policy Working?
  - Put legislation in place
  - But is it working
  - Is the problem improving



Summary:
Why is it important to Monitor For Mercury?

- Human Health
- Health of Animals and Insects
- General Environmental Health, Hg Cycling in the Environment
- Policy Ramifications
  - Local regulations
  - Minamata Convention on Mercury
- Scientific/Research, cycling of metals

The Asia-Pacific Mercury Monitoring Network could provide these measurements!

Emissions-Air-Biota-People

Why is Mercury Monitoring Important?

David A. Gay

Associate Scientist
National Atmospheric Deposition Program
State Laboratory of Hygiene, University of Wisconsin - Madison
1.217.898.1444, dgay2@wisc.edu

National Atmospheric Deposition Program

Introduction to the Asia Pacific Mercury Monitoring Network (APMMN)

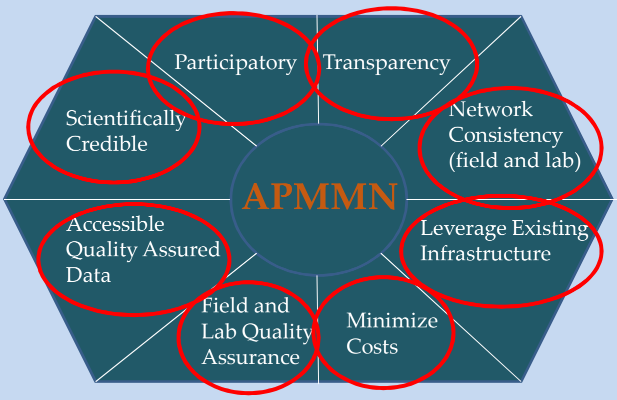
The Asia Pacific Mercury Monitoring Network (APMMN) is…..

- a cooperative effort to systematically monitor mercury in air and rainwater throughout the Asia-Pacific Region, and
- involves many different and voluntary groups, including environmental ministries and federal government agencies, academic institutions, and scientific research and monitoring organizations.

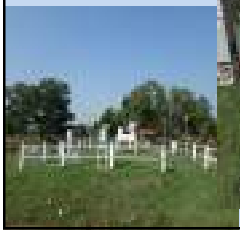
APMMN Goal and Objectives

- Goal
  - Systematically monitor wet deposition and atmospheric concentrations of mercury in a network of stations throughout the Asia-Pacific region
- Objectives
  - Determine the status and trends in concentrations of ambient mercury species, and wet, dry, and total atmospheric deposition of mercury
  - Develop a robust dataset for regional and global modeling
  - Assist partner countries in developing monitoring and assessment capacity
  - Share data and monitoring information

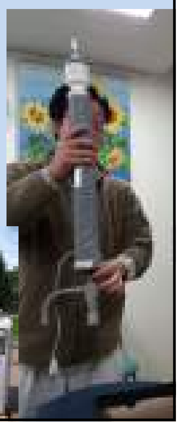
APMMN Network Principles



- **Our <u>first step</u> was mercury in precipitation**
  - Loadings to ecosystems
  - The atmosphere is the first place to identify changes in emissions
- Lots of monitoring experience; many experts regionally/globally
- We have an opportunity to help
  - Improve monitoring coordination
  - Assist countries with limited experience and build capabilities



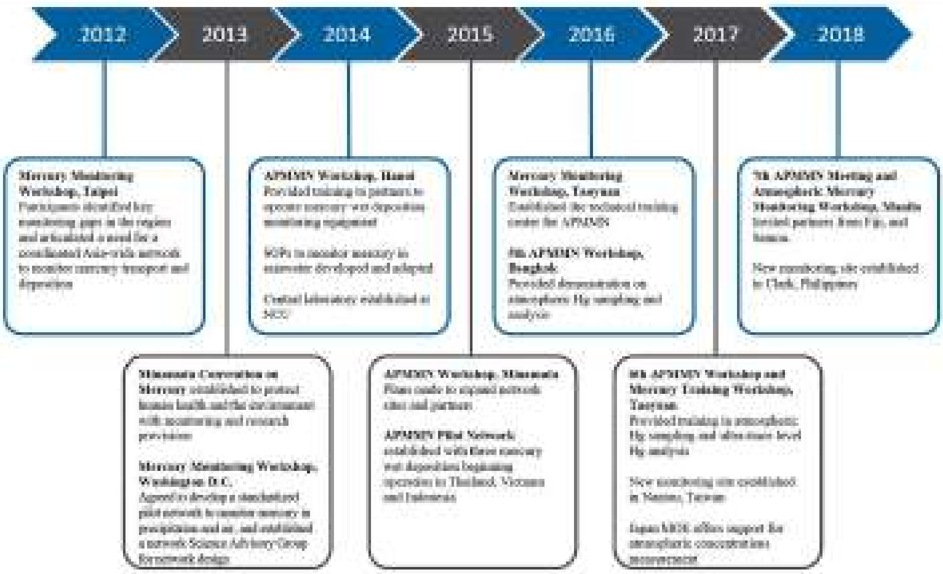

- **Our <u>second step</u> was mercury in the atmosphere**
  - Loadings to ecosystems
- Lots of monitoring experience; many experts regionally/globally
- Multiple types of measurement systems available
  - Automated Tekran Instruments
  - Manual methods, provided by Japan MOE

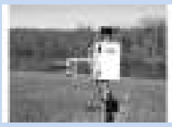
Asia Pacific Mercury Monitoring Network

What Progress Have We Made?

APMMN Milestones 2012-2018



Specifics of the APMMN for Wet Deposition



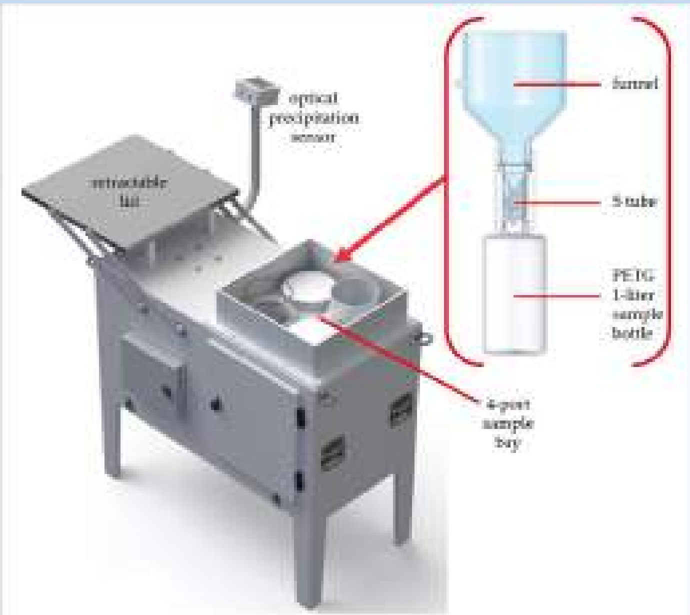
NCON Model
MDN 00-125-2

NADP-style
Aerochem 301

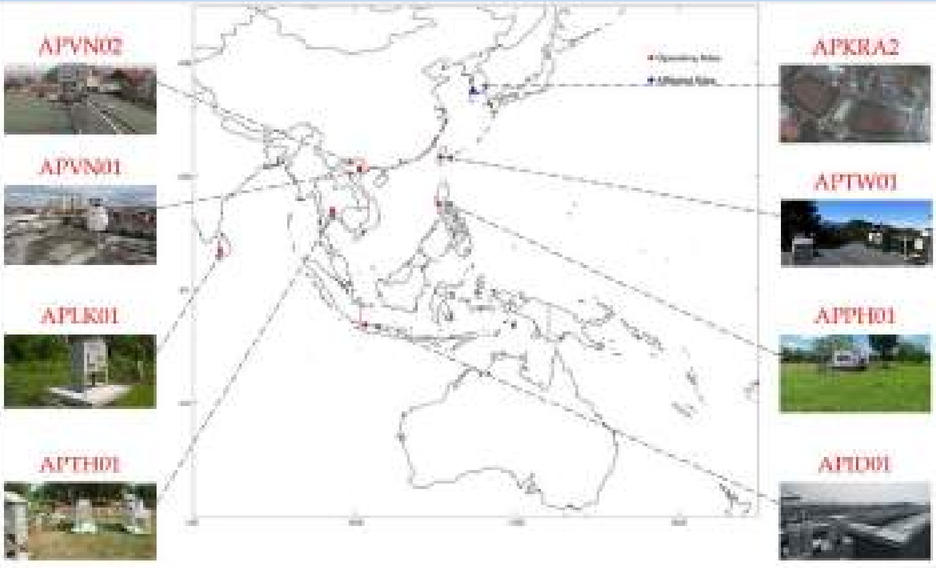
Taiwan-style
MIC

Sampler:	Automated wet only precipitation collection systems
Sampling Schedule:	Sample bottles and glassware are changed every Tuesday
Chemical Analysis:	Cold vapor atomic fluorescence spectroscopy (CVAFS)
Lab Location:	National Central University, Taiwan (Dr. G. R. Sheu)
Mercury Forms:	Total mercury wet deposition and precipitation concentrations
Site Locations:	Regionally representative; rural, urban, and suburban areas with estimated high levels of mercury emissions and deposition; and sensitive ecosystems

Taiwan-Style MIC Collector



Current Locations of Sites



Country	Site ID	Site Name	City	Latitude	Longitude	Elev. (m)	Status	Type	Sampler
Indonesia	APID01	MOEF	Jakarta	6.233 S	106.877 E	24	Active	Wet	AEROChem
Korea	APKRA2	GIST	Gwangju	35.228 N	126.841 E	33	Active	Wet	NCON
Philippines	APPH01	Clark	Pampanga	15.177 N	120.536 E	184	Active	Wet	MIC-B style
Sri Lanka	APLK01	U of Peradeniya	near Kandy	7.2518 N	80.595 E	481	Active	Wet	MIC-B style
Taiwan	APTW01	Lulin	Nantou	23.4689 N	120.873 E	2862	Active	Wet/ Gaseous	MIC-B style
Thailand	APTH01	ERTC	Pathum Thani	14.046 N	100.714 E	6	Active	Wet	MIC-B style
Vietnam	APVN01	CEM	Hanoi	21.0487 N	105.883 E	16	Active	Wet	NCON
Vietnam	APVN02	Thai Nguyen	Thai Nguyen	21.584 N	105.840 E	31	Active	Wet	MIC-B style

Asia Pacific Mercury Monitoring Network

Phase 1
Wet Deposition Sites

- Operating
- Operating (sampling splits)
- Affiliated Network
- Pending Sites (waiting equipment)
- Initial Interest/Acceptance

Central Laboratory (NCU)

Progress Made

- A 3-year pilot wet deposition network established
  - sites in Indonesia, Thailand, and Vietnam
  - Established Standard Operating Procedures
  - One Laboratory; National Central University of Taiwan
  - New Site in Philippines (last week)
  - 7 new monitors available for distribution
- Data reported back to operating country
- U.S. led capacity building and site operator training workshops
- Transition to fully-operational wet network anticipated by 2017

APMMN Laboratory at NCU Taiwan

APMMN Samplers are Available

Participation in the APMMN workshops

More Information Here

http://apmmn.org/

Asia Pacific Mercury Monitoring Network

What is Next?

What's Next?

- Full coverage of Asia; 20 operating sites or so, all countries;
- All APMMN data measured would be publicly available.
- total atmospheric deposition (wet deposition and dry deposition);
- work to develop a modeling methodology to estimate dry deposition fluxes using APMMN gaseous measurements;
- formally work more closely with other mercury networks;
- continue to have the highest of quality assurance in all of our network operation and measurement;
- We plan to continue our network training in all network activities, and to develop additional training programs

Journal Article in Productions

Title: A New Monitoring Effort for Asia: The Asia Pacific Mercury Monitoring Network (APMMN)

Authors: Guey-Rong Sheu[1], David A. Gay[2*], David Schmeltz[3], Mark Olson[2], Da-Wei Lin[1], and Ly Sy Phu Nguyen[1]

[1] Department of Atmospheric Sciences, National Central University, 300 Jhong-Da Rd, Taoyuan, Taiwan 320, +886 (3) 422-7151 x 65514, [illegible]; [illegible]

[2] National Atmospheric Deposition Program, Wisconsin State Laboratory of Hygiene, 465 Henry Mall, Madison, WI 53706 USA, (217) 244 – 0462, [illegible], mark.olson@slh.wisc.edu

[3] U.S. Environmental Protection Agency, Office of Atmospheric Programs, Clean Air Markets Division, 1200 Pennsylvania Avenue, NW, MC6204J, Washington, D.C. 20460, USA, schmeltz.david@epa.gov

* Corresponding Author

Submitted to "Atmosphere" journal, we should know this week if they will publish it

Summary

The Asia-Pacific Mercury Monitoring Network (APMMN) is…

- A group of countries, agencies, academics and monitoring groups
- Making measurements of mercury
  - Wet deposition
  - Atmospheric mercury in the future (for dry deposition)
- Using the same instruments and standard operating procedures across Asian countries and consistent with NADP
- Sharing data to solve the mercury problem

Asia Pacific Mercury Monitoring Network

Thanks!

Monitoring of Mercury Deposition Across Asia

Asia Pacific Mercury Monitoring Network (APMMN)

David A. Gay[1], David Schmeltz[2], Guey-Rong Sheu[3], Mark Olson[1]

[1] National Atmospheric Deposition Program, University of Wisconsin, Madison, USA, (217) 898 - 1444, dgay2@wisc.edu

[2] Office of Atmospheric Programs, Clean Air Markets Division, U.S. Environmental Protection Agency, schmeltz.david@epa.gov

[3] Department of Atmospheric Sciences, National Central University, Taiwan, grsheu@atm.ncu.edu.tw

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Mercury Scientific information: What the public needs

Ahmad Safrudin - KPBB

The 8th Asia Pacific Mercury Monitoring Network – Workshop
Ritz Carlton Jakarta, 14 – 16 August 2019

Sarinah Building 12th Floor, Jalan MH Thamrin # 11 Jakarta Indonesia 10350
Phone: +62-21-3190 6807 Fax: +62-21-315 3401
e-mail: kpbb@kpbb.org, www.kpbb.org

Outline

1. What's public needs in relation with mercury scientific data?
2. Atmospheric mercury exposure
3. Understanding complicated mercury scientific data
4. Capacity building to transform behavior changing and policy reform
5. Resume and recommendation

What's Public Needs?

- How to interpret, understanding , and using data in relation with:
  - Mercury exposure, and pathway
  - Mercury is a naturally occurring element that is found in air, water and soil.
  - Mercury is one of the top six toxic threats, and is considered one of the top ten chemicals of major public health concern by WHO.
  - Mercury is especially devastating to children.
  - The role of artisanal gold mining.
  - Toward Mercury exposure , pathway, and its effect to human health and environment
- How to handling?

Atmospheric Mercury?

- Mercury is utilized I human life, even though its volatilization (Hg) easy to be emitted to the atmosphere.
- Today, estimates for anthropogenic interferences range from about 50 to 75% of the total annual Hg emissions to the atmosphere.
- Recent modeling suggests that the present atmospheric Hg burden has increased by a factor of 3 during the last 100 years.
- This impact, which is significant, can be examined and assessed empirically. To date, however, atmospheric Hg programs have not employed an experimental design sufficient to account for short time scale atmospheric Hg variations of natural and anthropogenic origin, and to resolve the long term temporal pattern.
- Is Hg increasing in the atmosphere?
- How we would examine temporal and spatial variations in atmospheric Hg and assess the influence of natural and anthropogenic sources on the global atmospheric Hg cycle?
- How to measure it? And how to interpret its result of measurement to the simple information that can be understanding by common people?
  - Identify between anthropogenic processes versus natural biogeochemical cycling of Hg
  - Enhanced knowledge of the behavior of Hg in the atmosphere, and
  - Interpret data base atmospheric Hg to the health effect.

It is not easy for common people include decision makers to understanding with affective awareness toward scientific data on mercury poisoning in environment.

Understanding Complicated Scientific Data

To Utilize Scientific Data

- How to serve data and its analysis to interpret the meaning of its effect to human health?
- And invite people to have affective awareness?

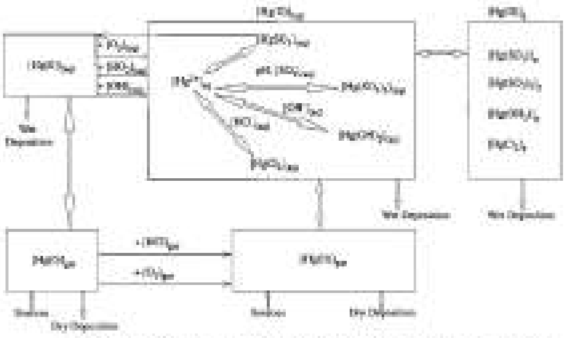
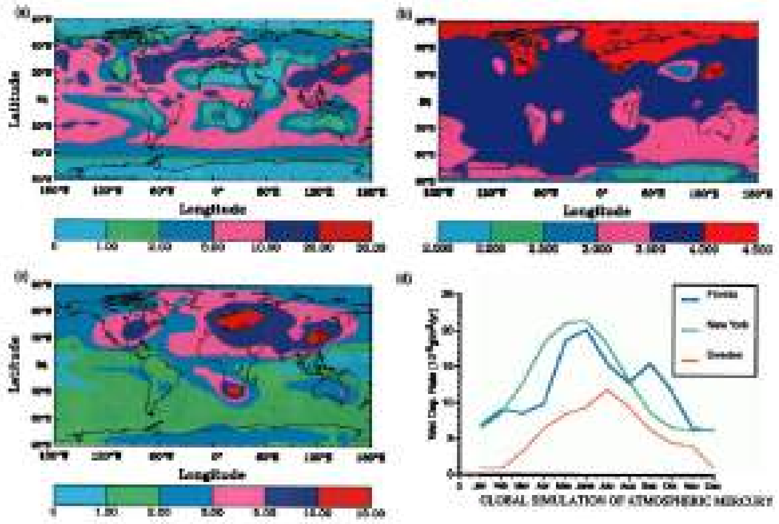


Table Global Hg Emission and Deposition Fluxes

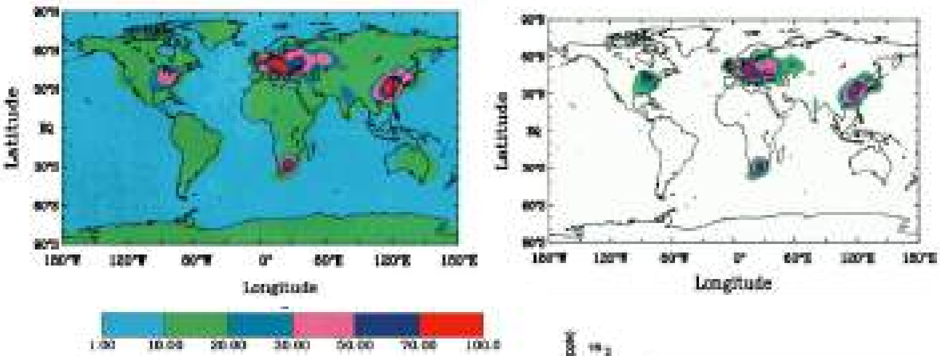
	Anthropogenic Emissions	Land Emissions	Ocean Emissions	Total Emissions	Wet Deposition	Dry Deposition	Total Deposition
Hg(0)	1070	2000	2000	5070	~0	1860	1860
Hg(II)	1070	0	0	1070	2880	1430	4280
Total Hg	2140	2000	2000	6140	2880	3290	6140

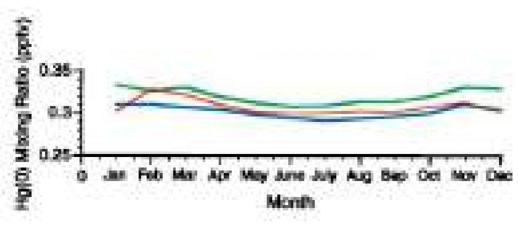
Fluxes are in Mg yr^{-1}.

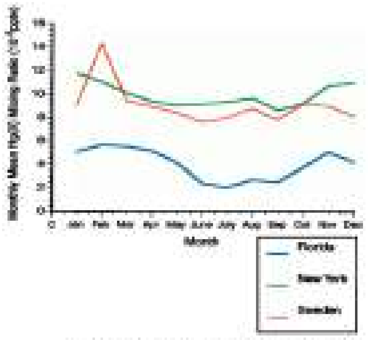
GLOBAL SIMULATION OF ATMOSPHERIC MERCURY

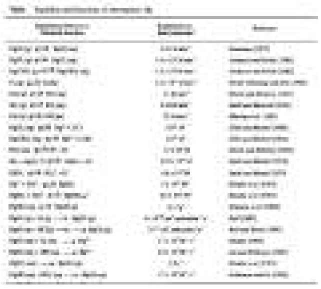


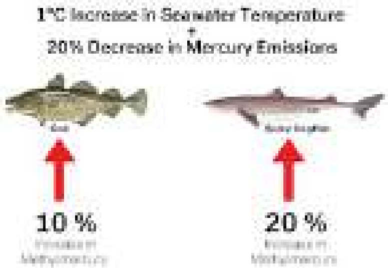
Annual average fluxes of Hg (μg m^{-2} yr^{-1}) for (a) wet deposition, (b) dry deposition of Hg(0), (c) dry deposition of Hg(II), and (d) monthly mean wet deposition flux for 12 months at three model locations, Florida, New York, and Sweden.

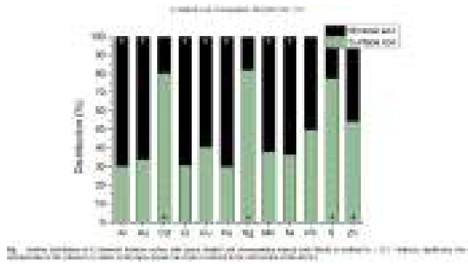




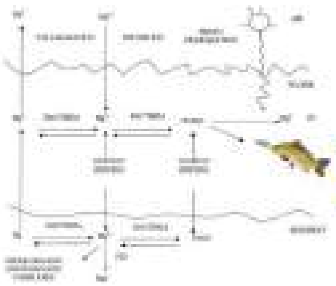


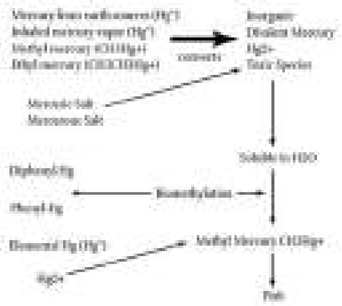


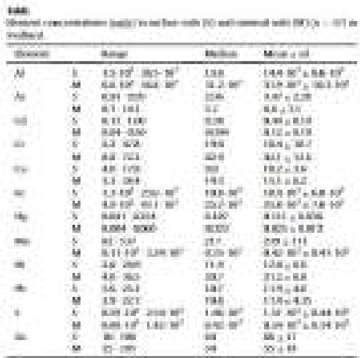


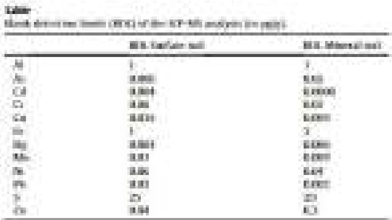


Complicated and details data toward Mercury

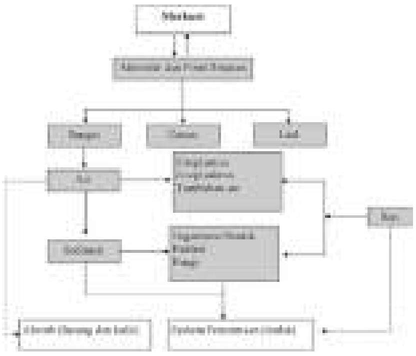


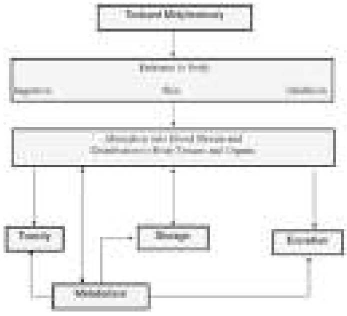






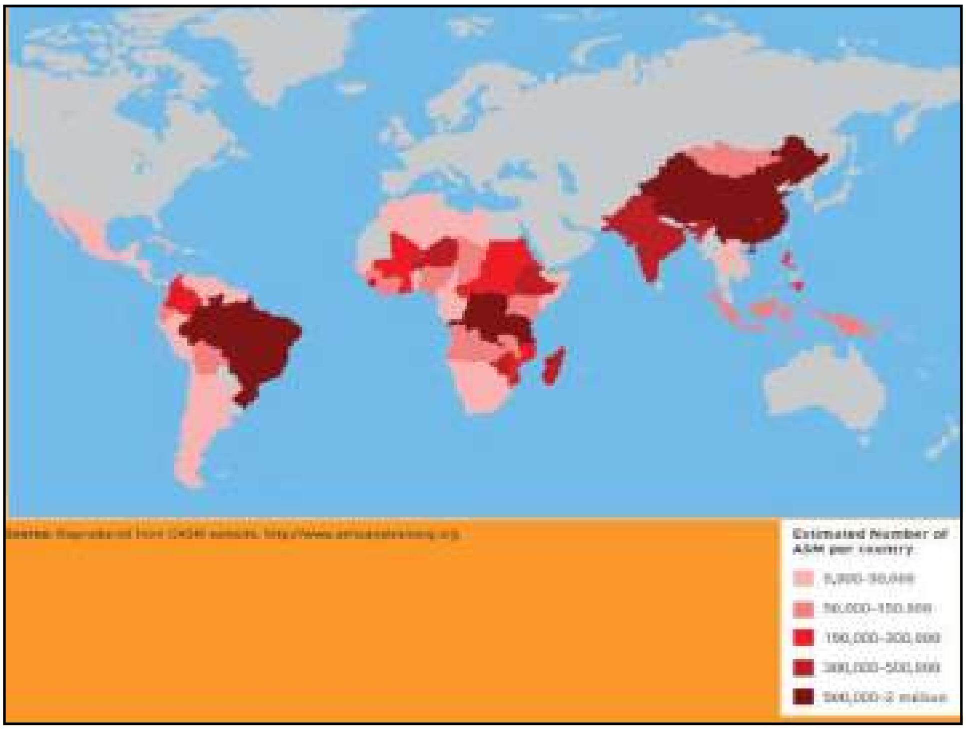
Complicated and details data toward Mercury



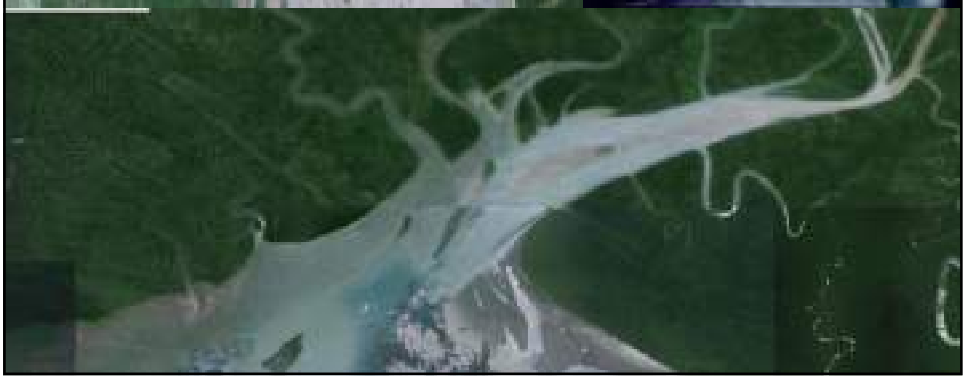


What's public needs?

- How to understanding toward complicated and details data to the simple meaning to implement and handle in their daily activities.
- Source of Mercury Exposure, the tools/equipment with content Mercury include household tools/equipment.
- Mercury as a pollutant exposure and pathway, and its characteristic (soil, water, air, atmosphere).
- Mercury effects to the human health and environment.
- How to handle toward the potential Mercury poisoning in the environment?


Estimated Number of
ASM per country
150,000–300,000
300,000–500,000
500,000–2 million

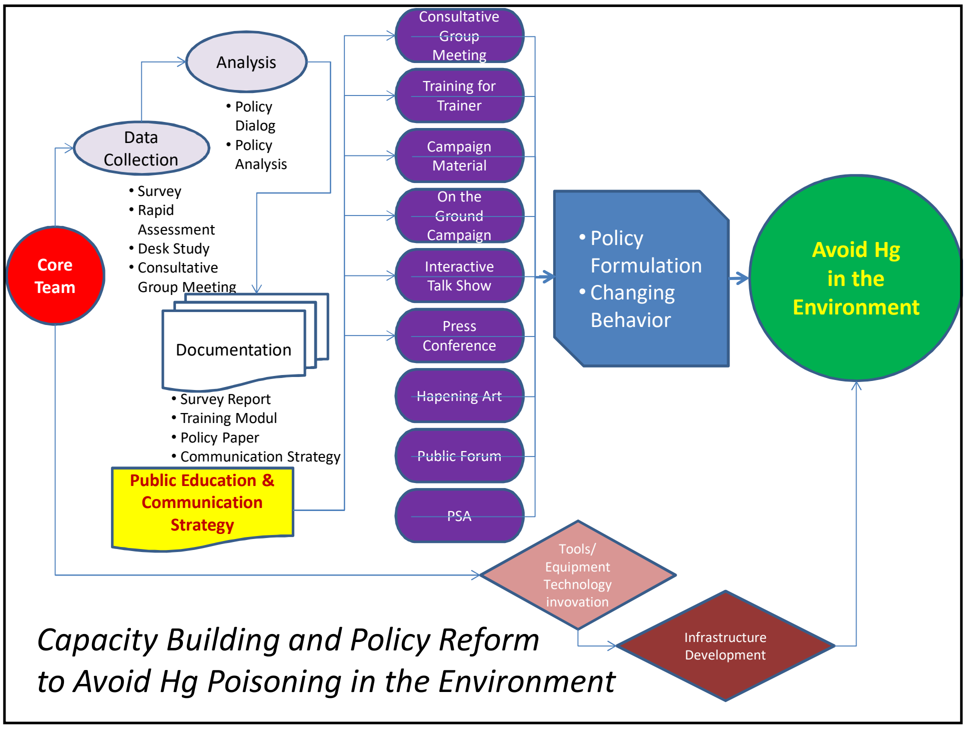

The "Vicious Cycle" of ASM
Low production



Capacity building to transform behavior changing and policy reform

The needs on scientific information:

- Simple monitoring
- Simple index of mercury exposure in the environment
- Simple to be interpreted without misperception
- Simple information on health effect
- How to handling.



Resume and Recommendation

- The facts show us that Mercury exposure, and its pathway in the environment include in the atmospheric layer has effected to human health and environment.
- Mercury is one of the top six toxic threats, and is considered one of the top ten chemicals of major public health concern by WHO.
- It is not easy for common people to understanding with affective awareness, include decision makers toward mercury exposure-scientific data to avoid its poisoning in the environment.
- Needs to simplification way to understanding the details and complicated scientific data for capacity building purpose ;to transform behavior changing and policy reform => simple information index.
- Needs to harmonize effort among scientist, government, private sector, int'l agencies, as well as civil society organization; to utilize mercury scientific data to emphasize change people behavior through policy reform to end mercury poisoning in the environment.

Thank you

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Phone/WA: +62 816 897959

Asosiasi Penambang Rakyat Indonesia

Indonesian Informal Miner Association

Founded: August 24, 2014, in Yogyakarta

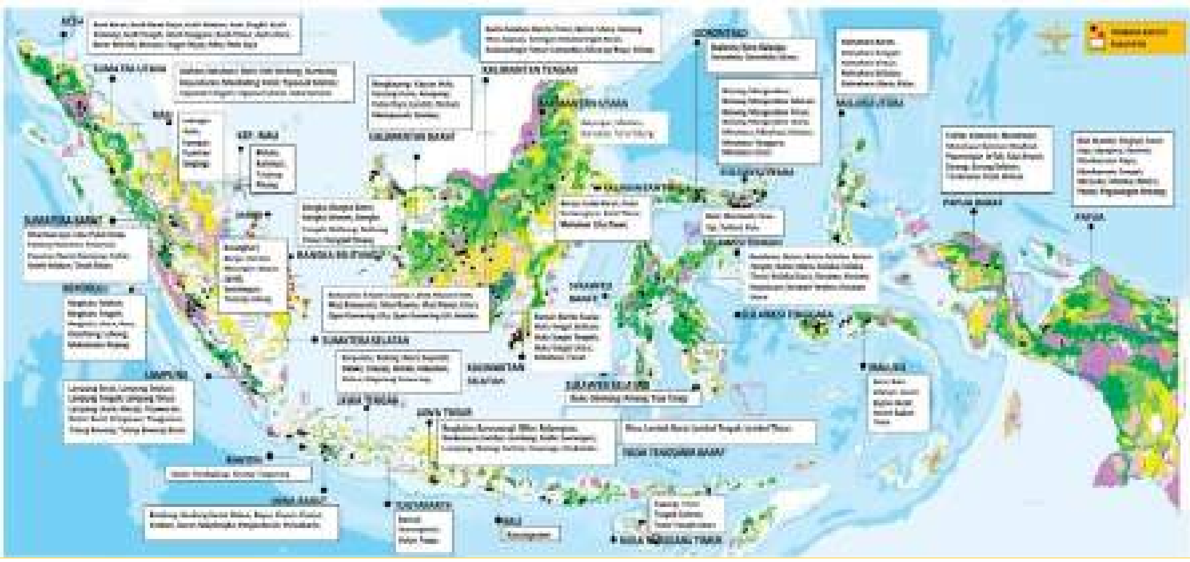
- 34 DPW (Provincial Level)
- 330 DPC(Regency Level)
- Member: >3.6 million miners
  (Gold miners: ± 1.2 million miners)
- Commodities: Gold, Silver, Copper, Lead, Plumbum, Manganese, Sulfur, Salt, Bentonit, Dolomit, Limestone, Kaolin, Zircon, Andesit, Sand, Iron Sand, Gemstone, Marble, Diamond, Crude Oil, etc.

Address:

Jl. Prof. Dr. Latumeten 50, Komp. Sentra Latumeten, Blok E1, Jakarta Barat – *Telp: (021) 56980444*

HP: 081318135059 Email: dpp.apri@gmail.com; Website: tambangrakyat.com

Map of Indonesian Miners Distribution (Still categorized as illegal miners)



Estimated Number of Indonesian Informal Miners, 2018

No.	Province	M	F	Total
1	Aceh (NAD)	102,000	18,000	120,000
2	Sumatera Utara	117,000	63,000	180,000
3	Sumatra Barat	119,000	21,000	140,000
4	Riau	26,000	14,000	40,000
5	Kepulauan Riau	2,250	750	3,000
6	Jambi	110,500	59,500	170,000
7	Sumatera Selatan	90,000	30,000	120,000
8	Bangka Belitung	39,000	21,000	60,000
9	Bengkulu	71,500	38,500	110,000
10	Lampung	90,000	30,000	120,000
11	Jakarta	425	75	500
12	Jawa Barat	172,500	57,500	230,000
13	Banten	165,000	55,000	220,000
14	Jawa Tengah	90,000	30,000	120,000
15	Yogyakarta	9,000	3,000	12,000
16	Jawa Timur	90,000	30,000	120,000
17	NTB	84,000	36,000	120,000
SUB TOTAL A		1,378,175	507,325	1,885,500
TOTAL A+B				

No.	Province	M	F	Total
18	NTT	227,500	122,500	350,000
19	Bali	3,900	2,100	6,000
20	Kalimantan Barat	52,000	28,000	80,000
21	Kalimantan Tengah	110,500	59,500	170,000
22	Kalimantan Selatan	39,000	21,000	60,000
23	Kalimantan Timur	61,750	33,250	95,000
24	Kalimantan Utara	10,400	5,600	16,000
25	Sulawesi Utara	169,000	91,000	260,000
26	Sulawesi Tenggara	78,000	42,000	120,000
27	Sulawesi Tengah	61,750	33,250	95,000
28	Sulawesi Barat	26,000	14,000	40,000
29	Sulawesi Selatan	52,000	28,000	80,000
30	Gorontalo	117,000	63,000	180,000
31	Maluku	26,000	14,000	40,000
32	Maluku Utara	29,250	15,750	45,000
33	Papua	39,000	21,000	60,000
34	Papua Barat	19,500	10,500	30,000
SUB TOTAL B		1,122,550	604,450	1,727,000
				3,612,500

INDONESIAN SMALL SCALE GOLD MINING

FROM 3.6 MILION MINERS

- 1.2 Milion are Gold Miners.
- 50% are full timer gold miners & 50% are part timer gold miners.

ANNUAL GOLD PRODUCTION OF INDONESIAN GOLD MINERS

- 1.2 Milion x 0.5 gram x 200 days = .120.000.000 grams = 120.000 Kgs = 120 Tons
- 1.2 Milion x 50% x 1 gam x 200 days = 120.000.000 grams = 120.000 Kgs = 120 Tons

ANNUAL USED OF MERCURI IN INDONESIAN GOLD MINERS

- Around 50% of 120 Tons gold are produced by amalgamation process → 60 tons
- In the amalgamation process, 1 gram of gold requires average of 5 grams of mercury.
- So for 60 tons of gold requires about **300 tons of mercury**.

WHERE DOES MERCURY EXPOSURE OCCUR?

- ✓ **Cinabar Processing**
- ✓ **Spill when transportation**
- ✓ **Spill when using on drum**
- ✓ **Wasted with tailings**
- ✓ **Furnishing**
- ✓ **Incorrect storage system**

WHY DO INFORMAL MINERS STILL USING MERCURY?

1. It's easy to use mercury to get gold.
2. Non-mercury processing is more complicated and requires more time to get gold.
3. The absence of a permit (IPR) has caused miners to be reluctant to invest in non-mercury equipment that is more expensive than mercury processing.
4. The community mining formalization program still has many obstacles to reach more than a thousand locations in Indonesia.
5. It's easy to get mercury in Indonesia, both from the market and by self processing from cinnabar.
6. There are still many miners who realize the danger of mercury.

BASICALLY, INDONESIAN INFORMAL MINER IS NOT OBJECTIVE TO THE MERCURY REDUKCTION & ELEMINATION PROGRAM

WITH CONDITIONS:

1) The formalization program for informal gold mining must be implemented.
2) The introduction and training of non-mercury gold processing systems must be carried out on a massive scale, so that it can reach the entire mining community in a short time.
3) The repressive approach and the criminalization of miners must be stopped, replaced with a training and supervision program by the mine inspector for the application of good mining practice.

__Note:__
Alternative non-mercury technology must be accepted by miners, because it has been proven to be cheaper and more effective than mercury technology and the cyanide process

行政院環境保護署
Environmental Protection Administration
Executive Yuan, R.O.C. (Taiwan)

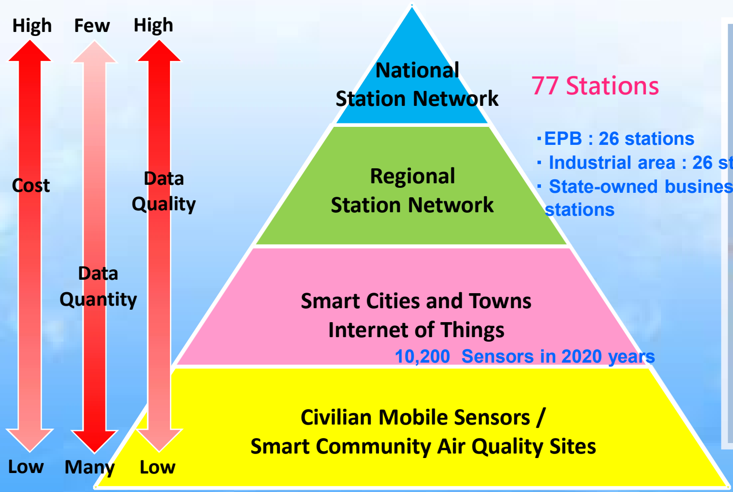
Taiwan's Air Quality Monitoring

Department of Environmental Monitoring and Information Management, Taiwan EPA
Technical Specialist
Hung-Po Hsu

Outline

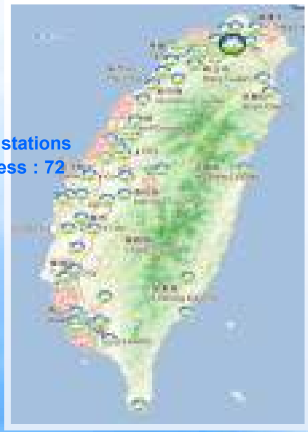
1. *Air Quality Monitoring Network*
2. *Monitoring Data Sharing*
3. *Air Quality Sensor*
4. *TAiWAN projects*
5. *For the Future*

Multi-Class Air Quality Monitoring Network



77 Stations

- EPB : 26 stations
- Industrial area : 26 stations
- State-owned business : 72 stations



1

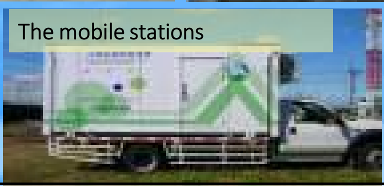
Types of Air Quality Monitoring Station

Since 1994, our monitoring data update online at TAQMN on a hourly basis

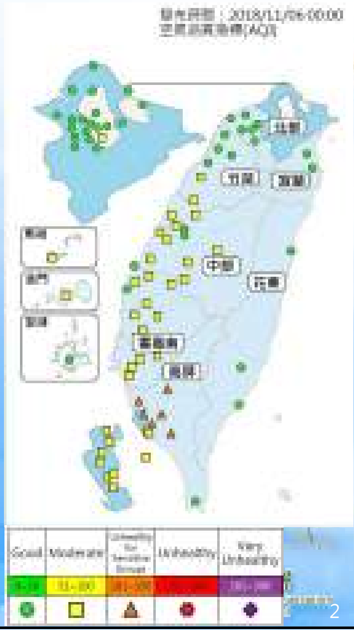
- Ambient air quality stations: 60
- Industrial monitoring stations : 5
- Traffic monitoring stations : 12
- National park monitoring stations : 2
- Air quality background stations : 4

Particulate matter composition stations

The photo chemical stations



The mobile stations



2

Monitoring Items

- Automatic

Criteria Pollutants	Meteorological Parameters	Others
• PM_{10} , $PM_{2.5}$ • CO • SO_2 • NO_2 • O_3 , $O_{3\text{-}8hr}$	• Wind Speed • Wind Direction • Temperature • Humidity • Rainfall	• Acid rain • THC Total hydrocarbons • CH_4 methane • NMHC • UVB UVA • BTEX • CO_2

- Manual

$PM_{2.5}$
$PM_{2.5}$ Chemical composition analysis

3

Photochemical Assessment Monitoring Stations

- Photochemical Assessment Monitoring Stations(PAMS)：11
- Monitoring items：54 types of O_3 precursors

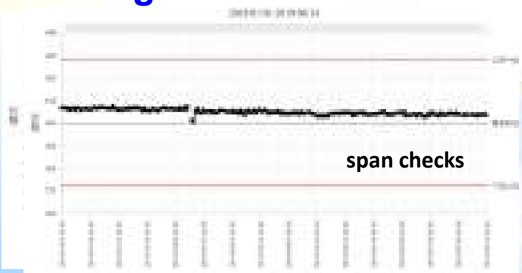
Ethane	2,3-Dimethylpentane
Ethylene	3-Methylhexane
Propane	2,2,4-Trimethylpentane
Propylene	n-Heptane
Isobutane	Methylcyclohexane
n-Butane	2,3,4-Trimethylpentane
Acetylene	Toluene
t-2-butene	2-Methylheptane
1-Butene	3-Methylheptane
cis-2-Butene	n-Octane
Cyclopentane	Ethylbenzene
Isopentane	m,p-Xylene
n-pentane	Styrene
t-2-pentene	o-Xylene
1-pentene	n-Nonane
c-2-pentene	Isopropylbenzene
2,2-dimethylbutane	n-Propylbenzene
2,3-dimethylbutane	m-Ethyltoluene
2-methylpentane	p-Ethyltoluene
3-methylpentane	1,3,5-Trimethylbenzene
Isoprene	o-Ethyltoluene
n-Hexane	1,2,4-Trimethylbenzene
Methylcyclopentane	n-Decane
2,4-Dimethylpentane	1,2,3-Trimethylbenzene
Benzene	m-Diethylbenzene
Cyclohexane	p-Diethylbenzene
2-Methylhexane	n-Undecane

6

4

QA/QC of Taiwan Air Quality Monitoring Network

- Scheduled quality control procedures
  - Daily zero and span checks
  - Biweekly precision checks
  - Quarterly multiple-point calibrations

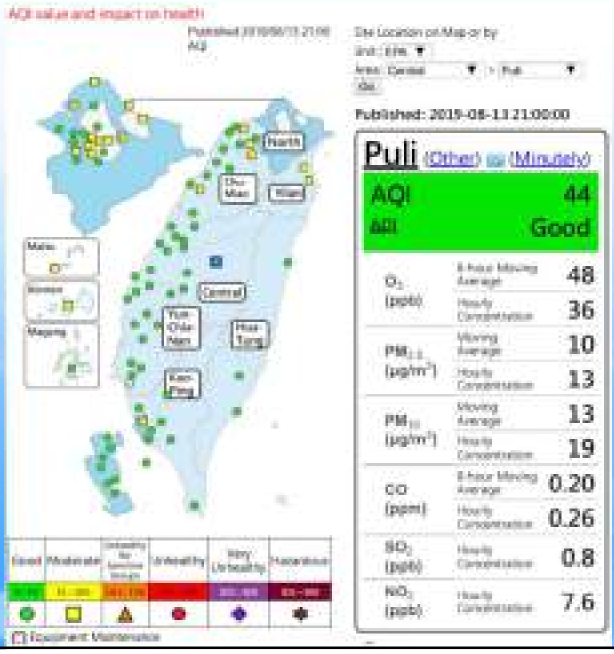


- Calibration standards
  - CO, SO_2, and NO are traceable to the US NIST standards within ±2%
  - Ozone transfer standard is traceable to US NIST Standard Reference Photometer # 30 and #57
- Quality assurance
  - Performance audit
  - Functional checks
  - Data validations

5

Long-term Trends of Air Quality

http://taqm.epa.gov.tw



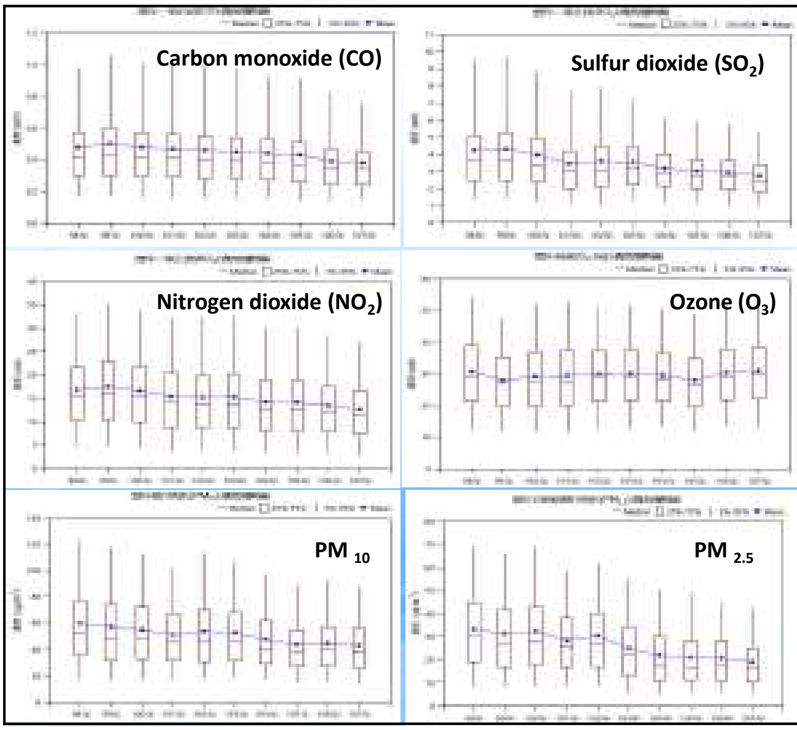
- The country map displays the current AQI's colorful icon which is updated hourly
- Users can select a region to view detailed data

6

Air Quality Forecast

- 3-days-forecast
- Forecast video

7



Since 2009, the primary pollutants decrease except for O_3 ,the challenge is to conduct lower concentration monitoring and to find ways to decrease the concentration

8

Briefing the Lulin station

23.51˚N, 120.92˚E ; 2862 m

9

The Lulin Background station

On top of Mt.Lulin to track the trans-boundary transport of atmospheric pollutants

10

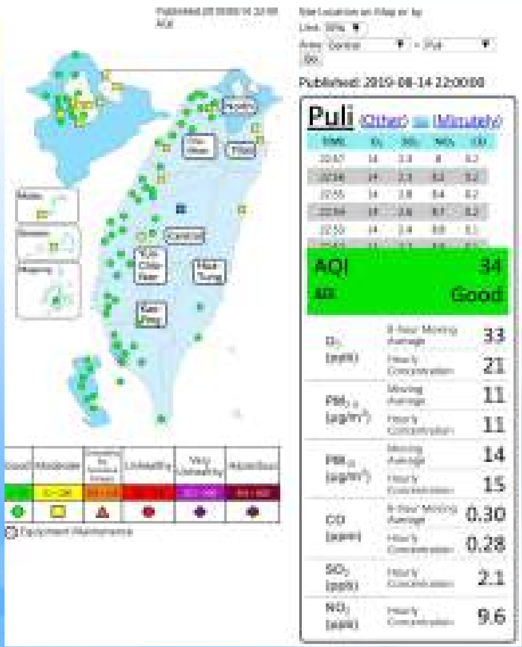
Monitoring Data

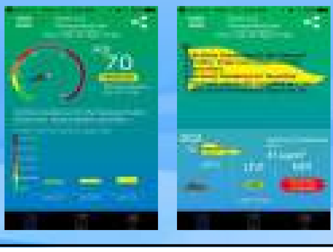
Transmit

Database Server

Primary analysis

- TAQMN(Taiwan Air Quality Monitoring Network)
  - Minute data(Gas items)
  - Hourly data
  - Historical data
- Environmental Instant Messages APP
- Data Open Platform





APP - Environment Info Push

Instant and local environmental information

GPS

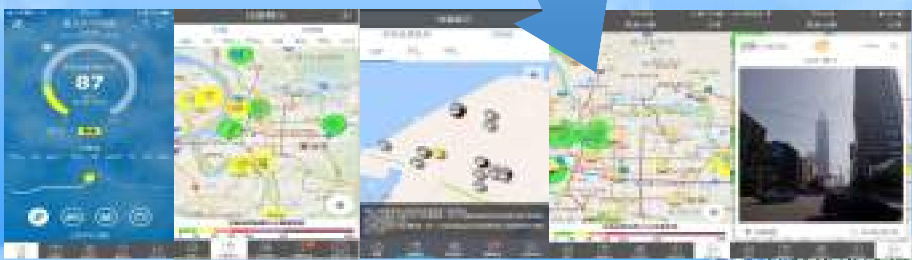
Immediately show user neighborhood real-time environment information

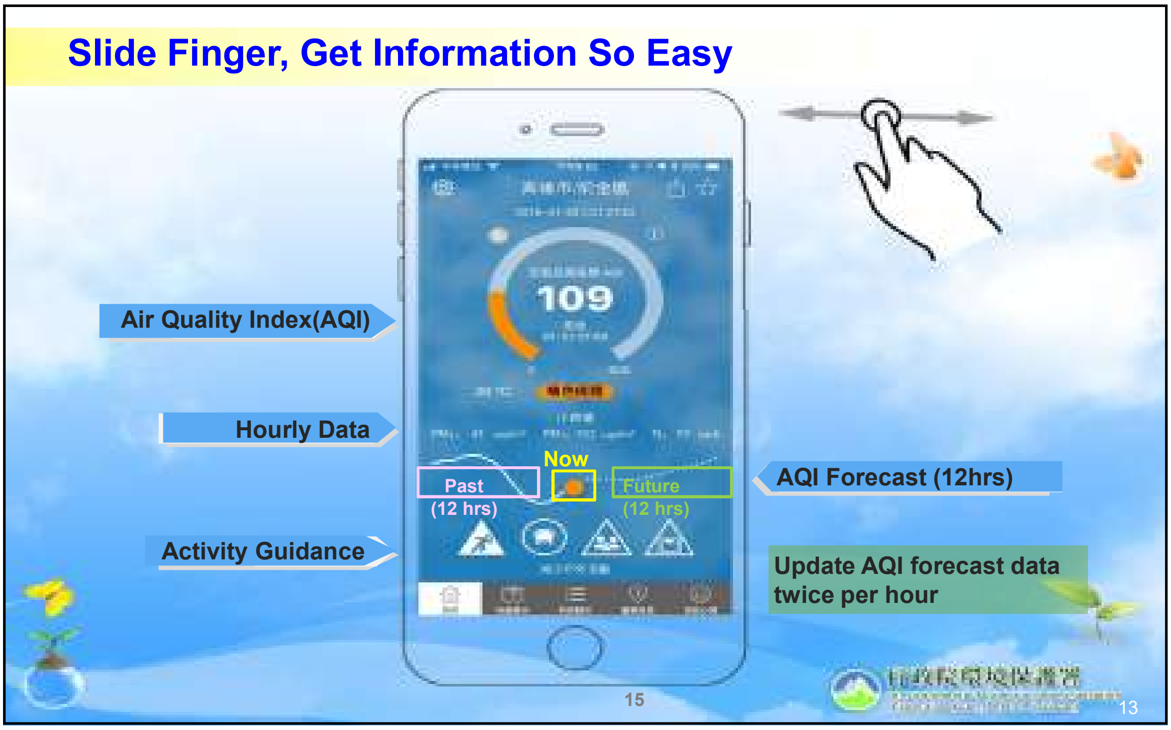
Information

- Past, now and future information on air quality
- Instant warnings such as air quality, heavy rain, flooding and earthquakes according to the user's location

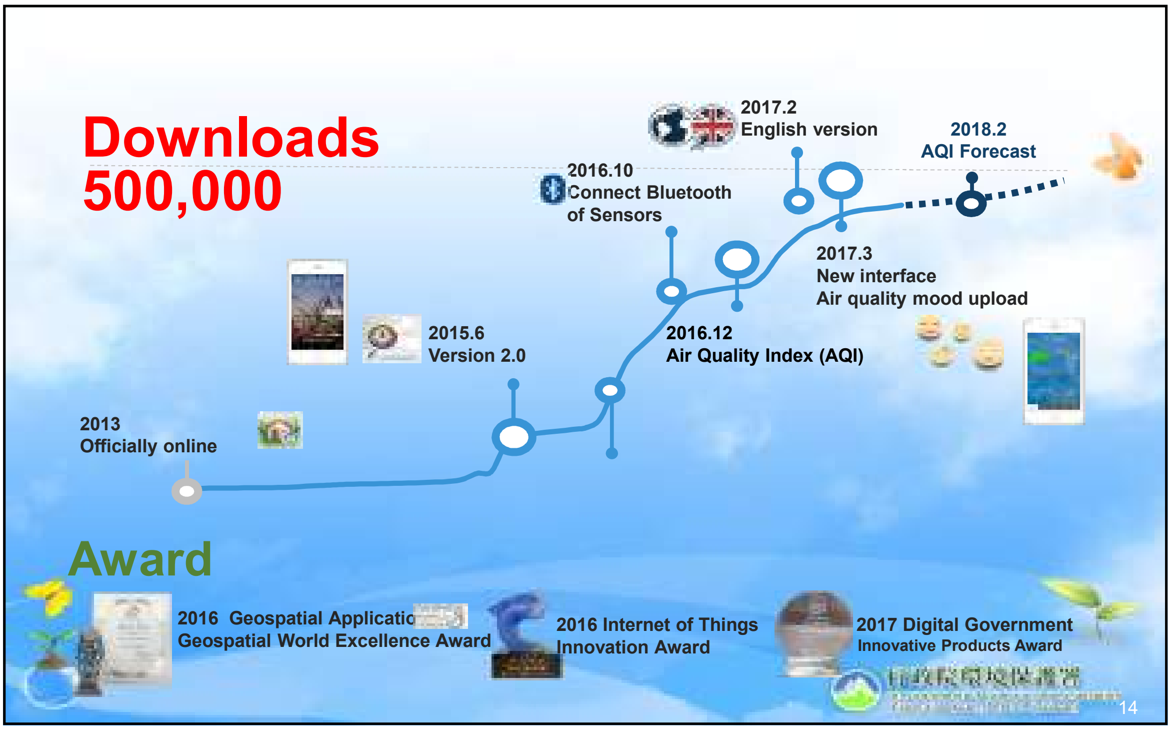
Post

Users upload the air quality photos and moods of their locations





Slide Finger, Get Information So Easy
109
Air Quality Index(AQI)
Hourly Data
Now
Past
(12 hrs)
Future
(12 hrs)
Activity Guidance
AQI Forecast (12hrs)
Update AQI forecast data twice per hour
15
13



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2015.6
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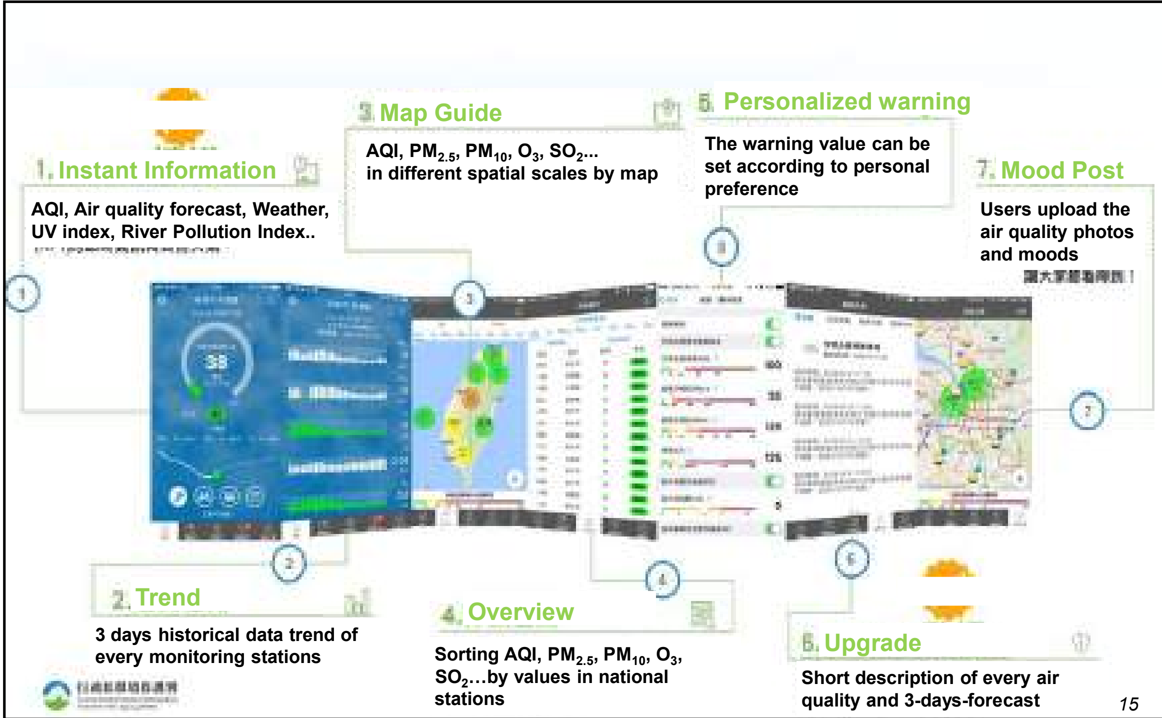
2016.12
Air Quality Index (AQI)
2013
Officially online
Award
2016 Geospatial Applicatio
Geospatial World Excellence Award
2016 Internet of Things
Innovation Award
2017 Digital Government
Innovative Products Award
14



Taiwan's OpenData - Air Quality Monitoring Data

(http://opendata.epa.gov.tw/)

Provides a platform for automatically tracking data lineage while monitoring workflow execution, supports tasks to systematically collect diverse monitoring data.

16

Total sensing solution of air quality sensor

Wall Mount

Street Light

Complete Housing & Mounting Solution

Multiple Sensors

Diverse Communications

Lte

NB-IoT

LoRa

WiFi

- **Capable of measuring temperature, humidity, O_3, CO, $PM_{2.5}$, noise, and TVOC**
- **Components**:
  1. Main chassis: Equipped with a power supply module, backup battery, control board, radio transmitter module, memory card, and terminal panel.
  2. Radiation shield: Equipped with a sensor board and various types of sensor components.
  3. Mount: A U-shaped ring or stainless steel tube bundle is used to secure the sensor to the utility pole.
  4. Power requirements: 110/220V AC, 1A.

Data analytical service and alarming pushdown dialing

Deployment of pilot fields (3,300 fields in total)

- **Provision of one sensing data, including temperature, humidity, and $PM_{2.5}$, every three minutes**
- **Coverage of 120 regional administrative areas, 44 industrial zones, and science parks**
- **Monitoring 3,8000 designated factories**

Data integration and AI analysis

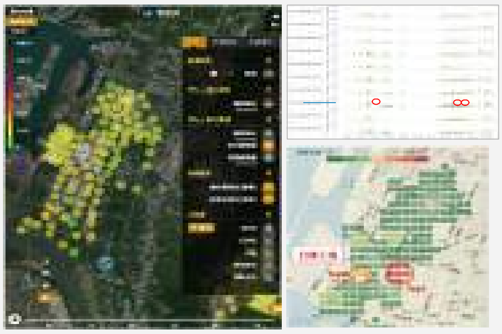
- **Inclusion of PRTR, CEMS, complaints of public nuisances, wind fields, and other related data, supplementing real-time analysis of potential pollutions and real-time alarming information**
- **Pinpointing polluting hot spots and times with big data**
- **Discovery of 47 enterprises in violation of environmental-protection laws/regulations**

Application scenarios for smart law enforcement

Long-term auditing

- IoT sensor data can narrow suspicious area
- Continuing data monitoring grasp of abnormal behaviors of factories
- In combination with on-site auditing with scientific tools

Pinpointing suspicious factories intensively with sensor data

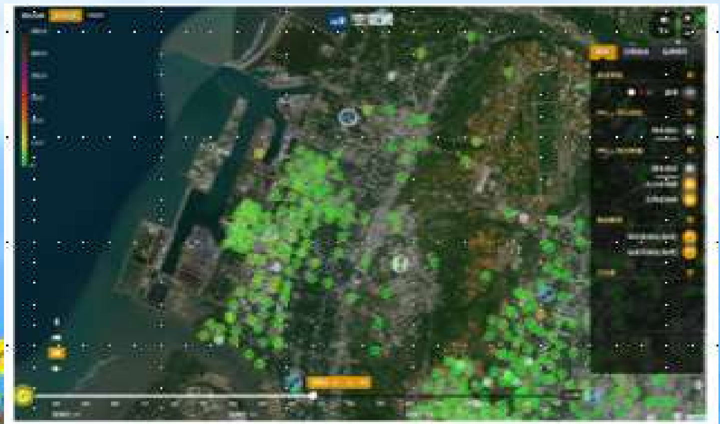


On-site inspection with the assistance of scientific tools

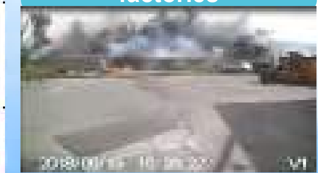
19

Short-term unexpected incidents

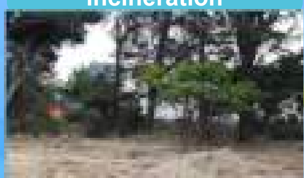
Fully automated computing of AI system assists environmental auditing units in grasping short-term unexpected incidents, as well as dissemination time and scope.



Incinerated wastes of factories



wastes of open-air incineration



20

TAiWAN projects

77 national-level standard sensing stations

10,000 smart urban & rural sensing points

10,000+ citizens' scientific sensing points

- Taiwan, as an IoT site, provides guidance on innovation and R&D
- Deploying a wide air quality network to control pollution and protect the environment
- Duplicating and exporting our services and experiences in software and hardware
- Improving our products and services for a sustainable TAIWAN

行政院環境保護署

Smart City-Internet of Everything

行政院環境保護署

22

For the Future

- Review TAQMN to meet the requirements of new air quality problems
- Provide more information about long-range and transboundary transport
- Look forward to further international cooperation in the future

Many thanks for your attention!

Continuous Atmospheric Monitoring Activities in Japan

The 8th APMMN workshop in 2019

Jakarta, Indonessia

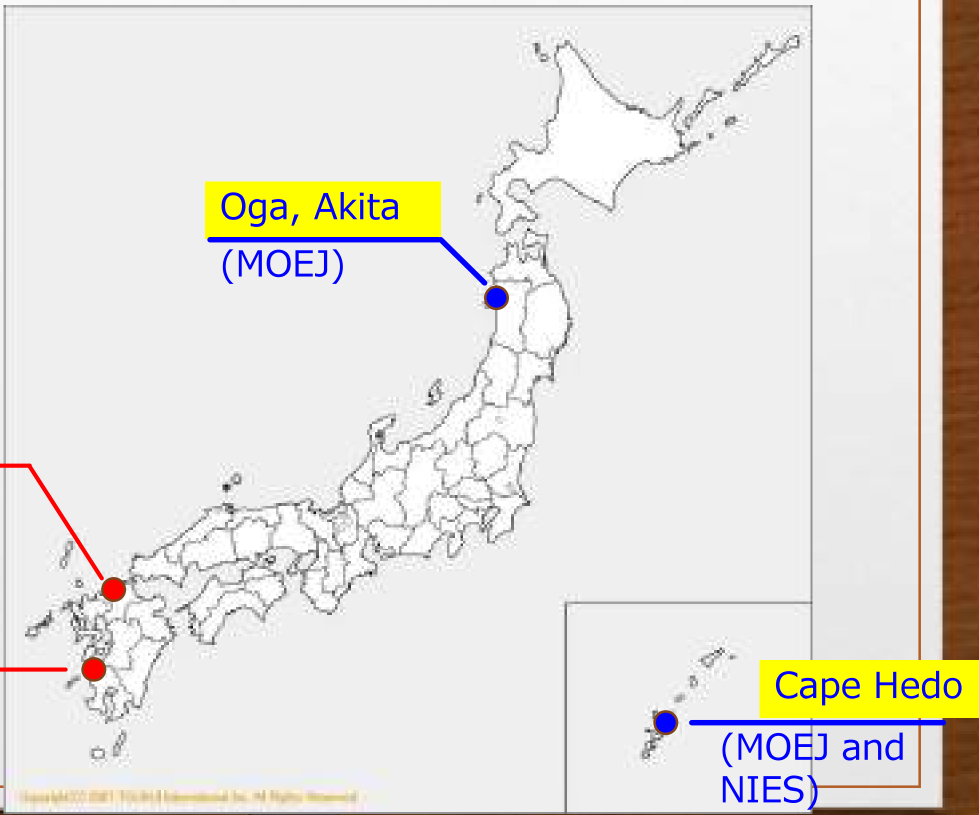
Objectives

- Monitor current levels of mercury and other heavy metals in air, particles, and precipitation;
- Obtain useful information on the long-range transportation of trace elements in Asia-Pacific region;
- Develop monitoring methodologies;
- Contribute to the international efforts in atmospheric monitoring

2

Japanese Atmospheric Mercury Monitoring Network

- NIMD
- MOEJ



* TGM = GEM +GOM

Japanese monitoring network on wet Hg deposition

- NIMD
- MOEJ

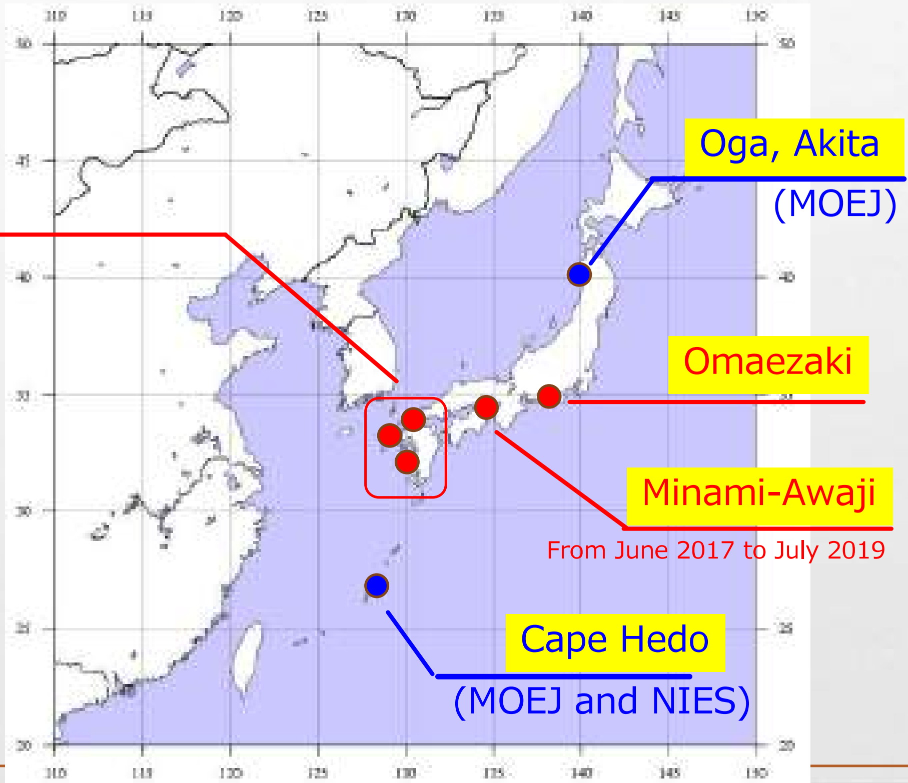
Kyushu 3 sites

Fukuoka

Hirado

Minamata

Wet-only sampler



Continuous Atmospheric Mercury / Wet Deposition Monitoring in the Background Area of Japan

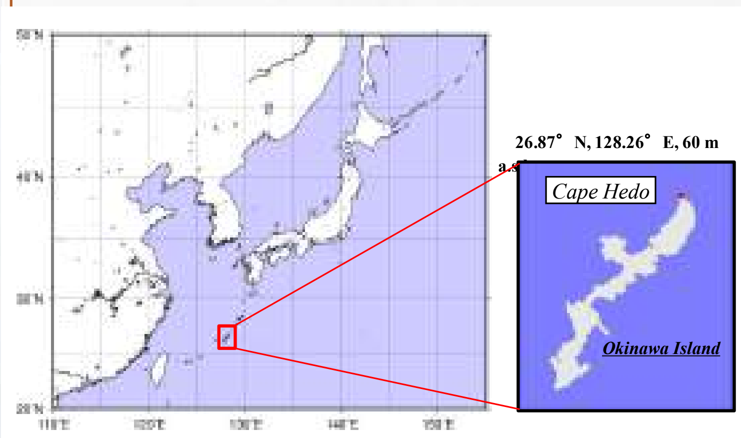
- Cape Hedo
- Oga Peninsula

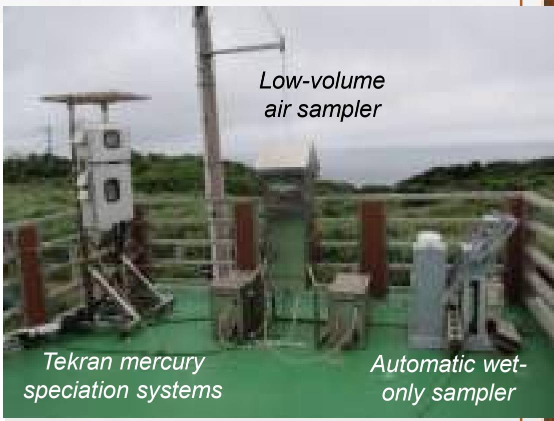
Measurement Items, Sampling, and Analytical Method

Component	Measurement items		Sampling and analytical methods	site
Atmosphere	Mercury	Mercury speciation (GEM, GOM, PBM)	Continuous measurement with Tekran® mercury speciation system	Cape Hedo, Oga
	Particulate matter	Pb, Cd, Cu, Zn, As, Cr, V, Ni, Se, Sb, Ba, Co, Mn, Sn, Te, Tl, Be, Al, Fe, Ca, Na, K,Mg	7 days continuous sampling by the low-volume sampler and analyzed by ICP/MS	Cape Hedo
Precipitation	Hg		Sampling by the automatic wet-only sampler and analyzed by CVAAS (EPA method 1631, Revision E)	Cape Hedo, Oga

GEM: Gaseous Elementary Mercury
GOM: Gaseous Oxidized Mercury
PBM: Particle-Bound Mercury
CVAAS: Cold Vapor-Atomic Absorption Spectrometry

Cape Hedo Atmosphere and Aerosol Monitoring Station (CHAAMS)



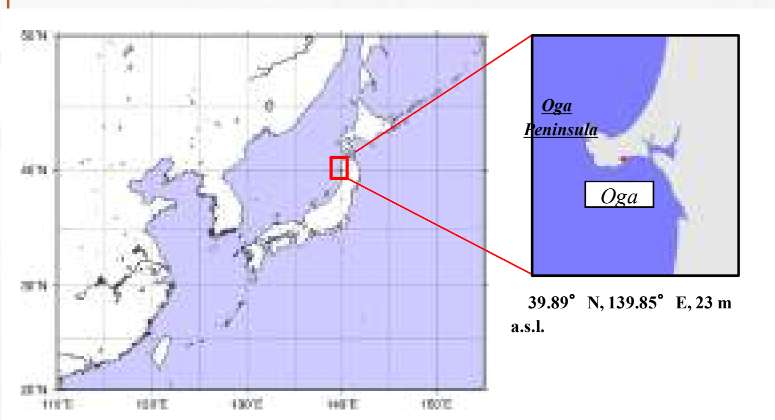


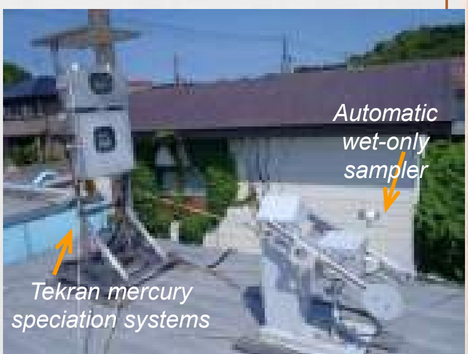
*: CHAAMS operated by National Institute for Environment Studies (NIES)

Tekran mercury speciation analyzer and other heavy metals monitoring systems

7

Mercury Monitoring Station in Oga Peninsula



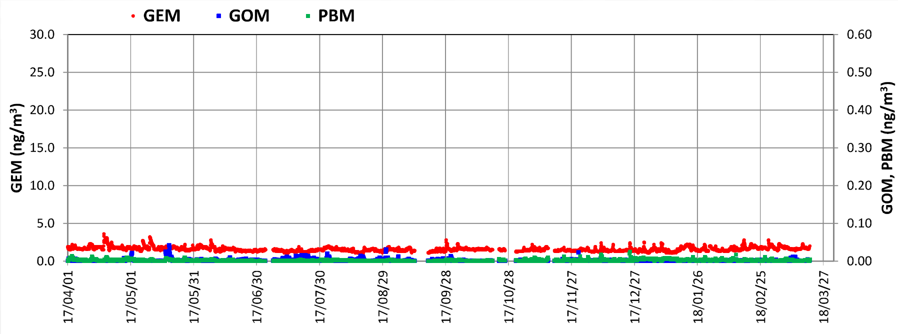


To strengthen the capacity of the mercury-observation network in Japan, a new observation site was set up at Oga city, Akita Prefecture, in September 2014.

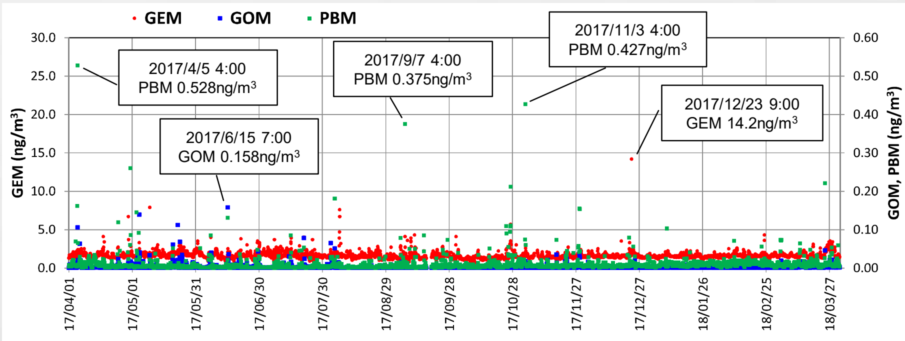
8

Observations of Mercury Species

Cape Hedo, FY2017 (Apr 2017-Mar 2018)



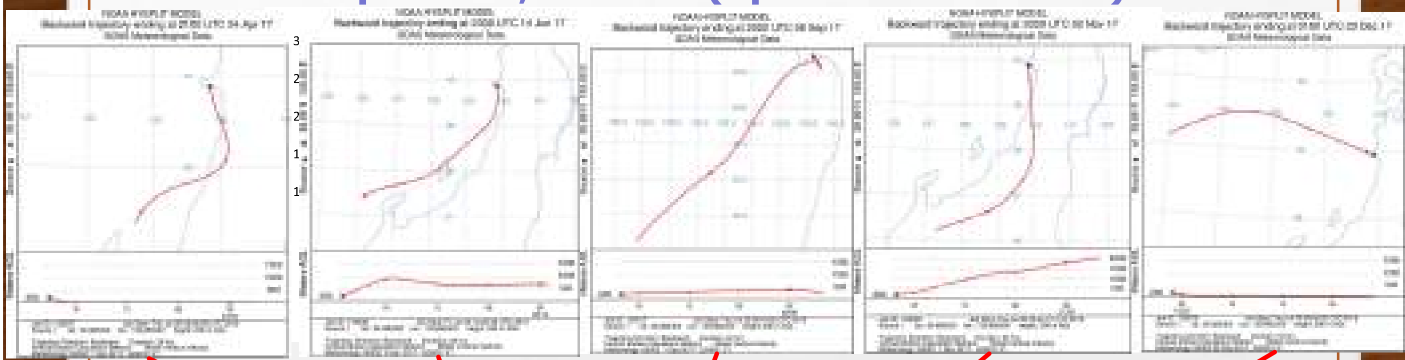
Oga, FY2017 (Apr 2017-Mar 2018)



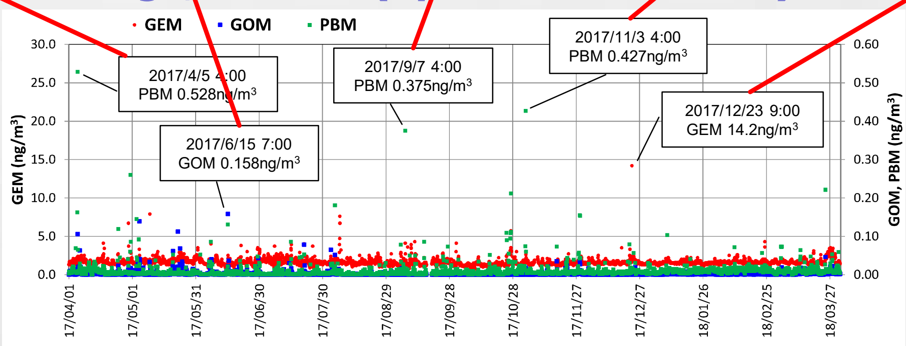
9

Observations of Mercury Species

Cape Hedo, FY2017 (Apr 2017-Mar 2018)



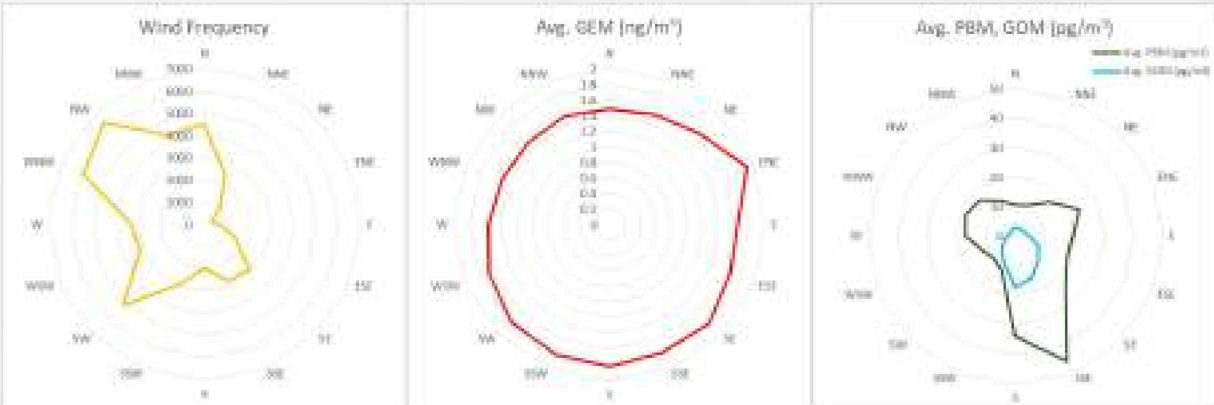
Oga, FY2017 (Apr 2017-Mar 2018)



10

Observations of Mercury Species

Wind and Atmospheric Mercury in Oga, FY2017



Observations of Mercury Species

Monthly Variations of GEM

Cape Hedo, FY2017 (Apr 2017-Mar 2018)

Unit: ng/m^3

FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean	1.8	1.7	1.6	1.4	1.5	1.4	1.6	1.5	1.4	1.5	1.7	1.8
Median	1.7	1.7	1.5	1.4	1.5	1.4	1.5	1.4	1.4	1.5	1.6	1.7
Min	1.4	1.3	1.2	1.0	1.0	1.1	1.2	1.2	1.1	1.1	1.3	1.4
Max	3.6	3.2	2.8	1.9	2.0	2.8	2.3	2.2	2.5	2.4	2.8	2.9
Standard Deviation	0.3	0.3	0.3	0.1	0.2	0.2	0.1	0.1	0.2	0.3	0.3	0.2
Samples (Hours)	464	471	465	422	464	366	352	416	458	463	421	472

Oga, FY2017 (Apr 2017-Mar 2018)

Unit: ng/m^3

FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean	1.7	1.8	1.6	1.7	1.6	1.6	1.4	1.5	1.6	1.5	1.6	1.8
Median	1.6	1.7	1.5	1.7	1.5	1.5	1.3	1.5	1.5	1.5	1.6	1.6
Min	1.2	1.3	0.7	0.7	1.0	0.8	0.7	1.1	1.3	1.2	1.2	1.2
Max	6.7	7.9	4.0	4.0	7.6	4.3	5.7	3.0	14.2	2.3	4.3	3.5
Standard Deviation	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.2	0.6	0.2	0.3	0.4
Samples (Hours)	449	479	462	481	475	430	479	435	477	478	434	480

Observations of Mercury Species
Monthly Variations of GOM and PBM

Cape Hedo, FY2017 (Apr 2017-Mar 2018)

Unit: ng/m^3

	FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
GOM	Mean	0.002	0.003	0.002	0.004	0.003	0.002	<0.001	0.001	0.001	<0.001	<0.001	0.002
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max	0.008	0.042	0.010	0.015	0.031	0.013	0.005	0.023	0.004	0.005	0.005	0.011
PBM	Mean	0.003	0.002	0.001	0.001	0.001	<0.001	0.001	0.002	0.003	0.004	0.002	0.002
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
	Max	0.014	0.010	0.006	0.004	0.004	0.004	0.006	0.012	0.025	0.011	0.017	0.007

Oga, FY2017 (Apr 2017-Mar 2018)

Unit: ng/m^3

	FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
GOM	Mean	0.004	0.006	0.004	0.002	0.002	0.001	<0.001	0.003	0.001	0.002	0.002	0.004
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max	0.106	0.139	0.158	0.078	0.065	0.016	0.006	0.036	0.019	0.008	0.005	0.046
PBM	Mean	0.015	0.006	0.005	0.004	0.005	0.009	0.010	0.012	0.008	0.010	0.013	0.013
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.002	<0.001
	Max	0.528	0.145	0.131	0.085	0.181	0.375	0.212	0.427	0.079	0.103	0.071	0.221

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Observations of Mercury Species
Annual Variations of GEM

Cape Hedo

	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Mean	1.9	2.1	2.0	1.7	1.7	1.6	1.7	1.6
Median	1.8	2.0	1.9	1.6	1.7	1.6	1.6	1.5
Min	1.2	1.1	1.3	0.9	1.2	1.0	1.2	1.0
Max	6.0	4.7	7.3	4.8	3.9	3.4	3.5	3.6
Standard Deviation	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3

Oga

Statistics
Hourly Mean of GEM
Unit: ng/m^3

FY2014	FY2015	FY2016	FY2017
1.6	1.6	1.6	1.6
1.6	1.6	1.6	1.5
0.9	0.7	0.7	0.7
6.7	21.8	20.2	14.2
0.4	0.4	0.5	0.4

*Fiscal Year in Japan: April to Next March
(e.g. FY2017: Apr 2017-Mar 2018)

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Observations of Mercury Species
Annual Variations of GOM, PBM

Statistics
Hourly Mean
Unit: ng/m^3

Cape Hedo

GOM	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Mean	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.002
Min	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.058	0.044	0.024	0.039	0.047	0.044	0.046	0.042

PBM	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Mean	0.002	0.002	0.002	0.004	0.004	0.002	0.003	0.002
Min	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.048	0.041	0.027	0.071	0.044	0.020	0.030	0.025

Oga

GOM	FY2014	FY2015	FY2016	FY2017
Mean	0.002	0.003	0.002	0.003
Min	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.048	0.152	0.165	0.158

PBM	FY2014	FY2015	FY2016	FY2017
Mean	0.009	0.009	0.011	0.009
Min	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.144	0.557	0.234	0.528

*Fiscal Year in Japan: April to Next March
(e.g. FY2017: Apr 2017-Mar 2018)

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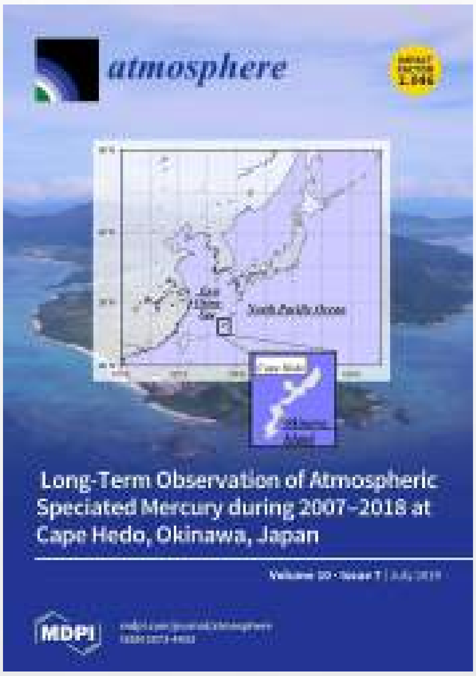
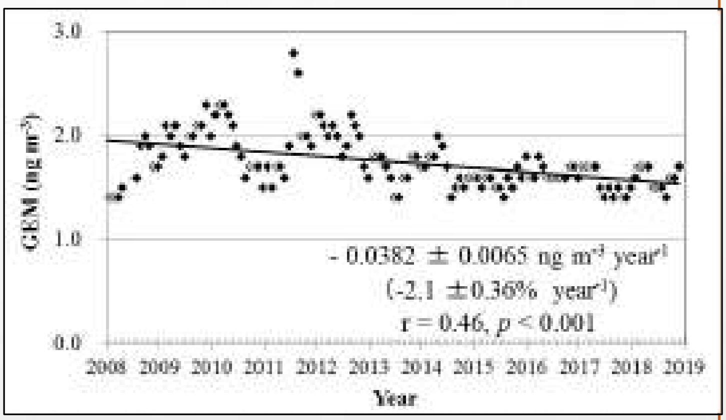
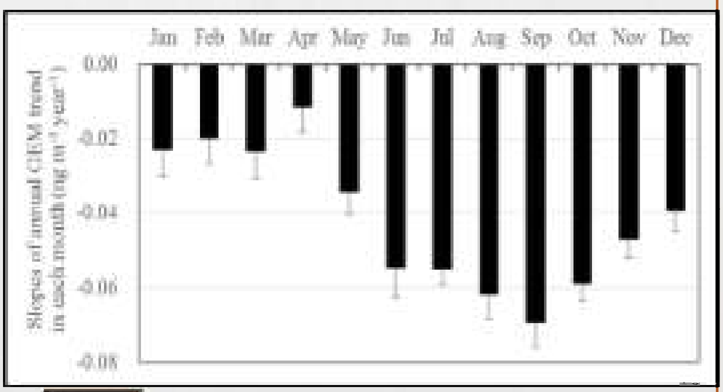


Atmosphere **2019**, *10*(7), 362;
https://doi.org/10.3390/atmos10070362





Observations of Precipitation
Mercury Concentration in Precipitation (Annual Mean)

◆Cape Hedo

Unit: ng/L

FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
3.4	3.1	2.4	3.0	1.9	2.2	1.4	2.0	4.3

↑ Previous Analytical Procedure

Improved Analytical Procedure →

FY2016	FY2017
6.6	4.8

◆Oga

Unit: ng/L

Previous Analytical Procedure →

FY2014	FY2015	FY2016
2.5	2.9	4.7

Improved Analytical Procedure →

FY2016	FY2017
6.3	5.7

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Observations of Precipitation
Improve the analytical procedure

Sampling PFA bottle

↓

Aliquot for measuring other metals

↓

HCl addition into the sampling bottle
(Stand for more than12 hours)

(Previous method)

↓

Transfer 100mL of sample into an analytical bottle

↓

BrCl Cl addition into the analytical bottle
(Stand for more than12 hours)

↓

(Improved method)

↓

BrCl addition into <u>the sampling bottle</u>
(Stand for more than12 hours)

↓

Transfer 100mL of sample into an analytical bottle

↓

Hg measurement by CVAAS or CVAFS

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Observations of Precipitation
Mercury Concentration in Precipitation (Annual Mean at other sites)

Fiscal year	Minamata		Hirado		Fukuoka		Omaezaki		Kashiwazaki		Minami-Awaji	
	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)
FY 2009	**5.6**	1677										
FY 2010	Jun. 2011 Restart		Jun. 2011 Start									
FY 2011	**6.3** *	2528	**5.8** *	2187								
FY 2012	**6.8**	2212	**6.7**	2109	Jun. 2013 Start							
FY 2013	**7.8**	1653	**7.4**	2062	**7.6** *	1786	Dec. 2013 Start		Jul. 2013 Start			
FY 2014	**9.0**	1876	**7.4**	1968	**8.1**	1410	**6.5**	1865	**6.7** **	2863		
FY 2015	**8.9**	2436	**6.8**	2269	**8.2**	1845	**7.2**	2165	**5.1**	2517		
FY 2016	**6.6**	2611	**5.5**	2652	**7.5**	2034	**6.2**	1834	**6.2**	2356	Jun 2017 Start	
FY 2017	**6.9**	1963	**6.5**	1685	**8.0**	1337	**5.3**	1668	Mar. 2017 End		**7.8** *	939
FY 2018	**5.8**	2191	**8.3**	1734	**10.4**	1291	**7.2**	1764			**9.8**	1338
FY 2019											Jul. 2019 End	

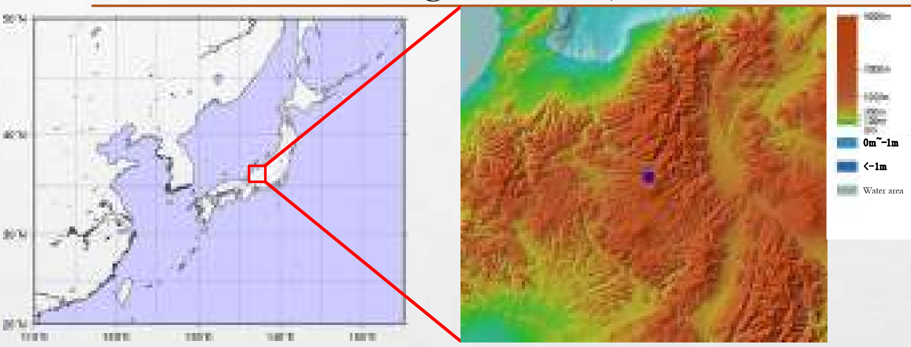
* The VWM values from June to next March (For 10 months) ** The VWM values from July to next March (For 9 months)

New Activities

- Continuous Atmospheric Mercury Monitoring in High Altitude
- Monitoring of Atmospheric Mercury in Large Particle Matter

Atmospheric Mercury Monitoring on High-Altitude Site

- Norikura Monitoring Station (36.17 N, 137.52E, 1950m a.s.l.)



Source: Geospatial Information Authority of Japan (https://maps.gsi.go.jp/development/ichiran.html)
*: Data of sea area is edited by the documents of Hydrographic and Oceanographic Department, Japan Coast Guard

To obtain the information of the concentration of GOM in high altitude atmosphere, continuous mercury speciation monitoring is begun in the mountains in the central area of Japan Main Island.

Monitoring of Mercury in Large Particle Matter of Atmosphere

PBM by Tekran 1135 is measured in the particle smaller than 2.5μm.
To obtain the information of mercury in larger particle (>2.5μm), the sampling and analysis of particle matter using a filter-pack is conducted in continuous mercury monitoring site (Cape Hedo and Oga)

Thank you!

For more information:

https://www.env.go.jp/en/chemi/mercury/bms2017.html

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STATUS OF MERCURY MONITORING IN NEPAL

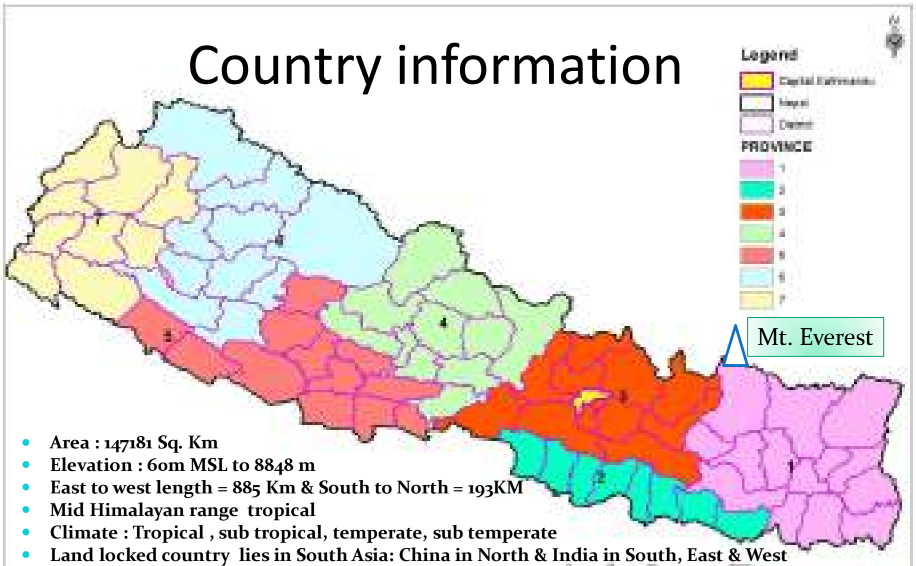
ATMOSPHERIC MERCURY MONITORING WORKSHOP 2019
(12th – 16th August 2019) Jakarta, Indonesia

Mrs. ASHMITA OLI
E-mail: ashmitaoli11@gmail.com
Chemist, Department of Environment , Kathmandu, Nepal

Contents of presentation

- Country's information
- Status of Mercury in Nepal
- What we are doing
- Our problem
- What we are planning
- What we expect

Country information

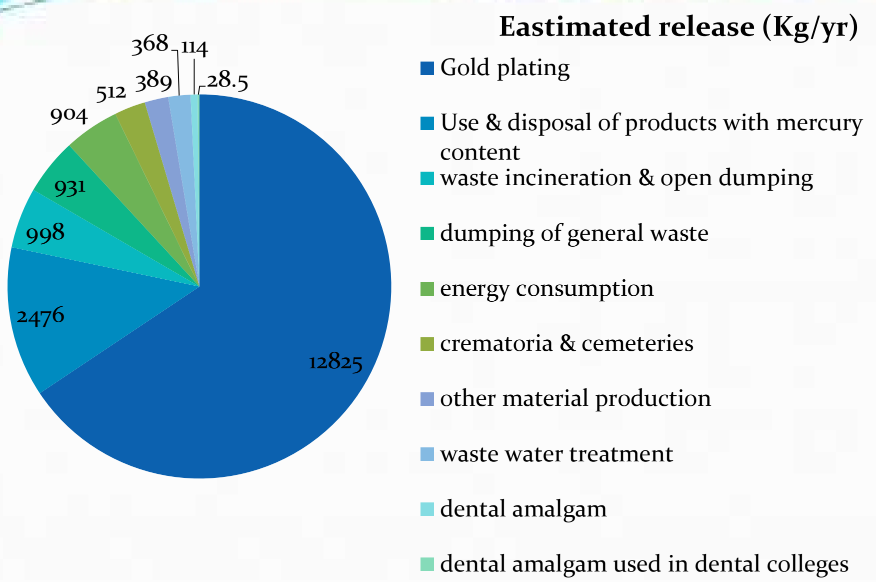


- Area : 147181 Sq. Km
- Elevation : 60m MSL to 8848 m
- East to west length = 885 Km & South to North = 193KM
- Mid Himalayan range tropical
- Climate : Tropical , sub tropical, temperate, sub temperate
- Land locked country lies in South Asia: China in North & India in South, East & West
- Population: 26.49M, (Rural 81%, Urban=19%)
- Per Capita Income = $ 1,047
- GDP Annual Growth Rate= 7.10

status of Mercury
(what Research show)

- Mercury has been using in Nepal from very beginning,
- It has been using for various purpose eg. Health care devices & services, amalgam formation, scientific purpose, educational purpose, electronics goods, cosmetic products etc.
- The main Sources of mercury in atmosphere are gold plating, use & disposal of mercury content, dental amalgam, waste water treatment, crematoria & cementries
- Research have proven the presence of mercury in the fish of Phewa Lake , human body & environment in Nepal

present Situation(sources)



- Total release of Mercury in Nepal for the baseline 2016/17 is 19615 Kg. Hg/Yr

what we are doing

- Nepal had signed the Minamata Convention on Mercury in Oct 10, 2013 in Japan
- Ministry of Forest & Environment & United Nation Industrial Development Organization have jointly started a project named "Enabling Activity to conduct Minamata Convention initial assessment in Nepal" since Dec 5, 2016
- Objective of project is to strengthen Napal's national capacity to fulfill the obligation under the Minamata convention & promote effective implementation of its provision in cooperation with development partner
- Nepal is in federal system, The local level government are making laws for the control of the pollutant. Technical personnel are appointing.

what we are doing(contd)

- Federal government is drafting Environment policy
- Ministry of health making prohibition of mercury used equipment in health service sector.
- Different government bodies are making awareness.
- Department of Environment and Department of Custom are going to strengthen the chemical laboratory.
- Department of food technology and quality control is measuring food and feed contaminants
- Participate in global mercury database & monitoring programs involving global & regional sampling efforts organized by UN agencies
- Establishing wet deposition sampling instrument

Our problem

- Environment issues are not prioritized
- Country political situation is still in transition. leaders are not paying enough attention on environment
- Some technical barrier are a head of us

what we are planning

- planning to Ratify the Minamata Convention on Mercury
- Promote mercury free alternative consumer products and medical equipment
- Reduce or ban the use of dental amalgam
- Developing proper separation method for the disposal of mercury added product both at the household consumer level and in the landfill management procedure
- Implement safety for capture & release of mercury emission during the process of gold plating activities
- More awareness

What we expect

- Technical support in measurement and control
- Exchange of mercury related information
- Pointing our deviation

Thank you !

You are invited to visit in beautiful places :

Update year 2019:

MERCURY MONITORING IN INDONESIA

INTRO DUCTION

- Research and Development Center for Environmental Quality and Laboratory, Ministry of Environment and Forestry of Indonesia
  - Rina Aprishanty
  - Fitri Yola Amandita
- Directorate for Toxic and Hazardous Waste Management, Ministry of Environment and Forestry
  - Aisyah Syafei
  - Aditya Febrian Masri

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OUTLINE

- Existing Activities
- Progress Activities
- Review APMMN Project in Indonesia
- Next Step Mercury related Activities

EXISTING ACTIVITIES

MONITORING ACTIVITIES

- **1994-1996**: Monitoring heavy metal in sea water and sediment also green muscle
- **1997-2000**: Monitoring mercury in ASGM (Artisanal and Small-scale Gold Mining) in Rejang Lebong, Bengkulu; Sungai Rungan dan Sungai Kahayan, Kalimantan Tengah; Lampung dan Pongkor, Jawa Barat
- **2012-2014**: EMC continuing Monitoring mercury in ASGM in Sulawesi Utara, Kalteng, Kalbar, Jambi, Sumbar
  PB3 MOEF start monitoring in ASGM Hotspot for soil and surface water sample
- **2017**: Monitoring mercury in Energy Sector for coal, fly ash and bottom ash and emission source
- **2018-present**: Monitoring of mercury pollution from ASGM and socio-economic study of the ASGM workers in Sukabumi, West Java

INDONESIAN GOVERNMENT COMMITMENT

- Indonesia ratified Minamata Convention through Law No 11 year 2017;
- Indonesia established Ministry Decree No 340 year 2018 about Committee for Research and Monitoring on Mercury (KPPM);
- Indonesia established National Action Plan under President Regulation No 21 year 2019 for Eliminating and Phasing-out Mercury .

PENYEBARAN PERTAMBANGAN EMAS SKALA KECIL (PESK) DI INDONESIA

Sumber : YTS, 2013, +/- 1.000 hotspots - > 500,000 penambang

- Produksi emas (KK+IUP) Tahun 2012 ± 75 tons, Tahun 2013 ± 59 tons (Pusdatin ESDM)
- Produksi emas dari ASGM diperkirakan mencapai 65-130 ton/tahun (Balifokus)

Inception Workshop : GOLD-GEF ISMIA PROJECT 2019

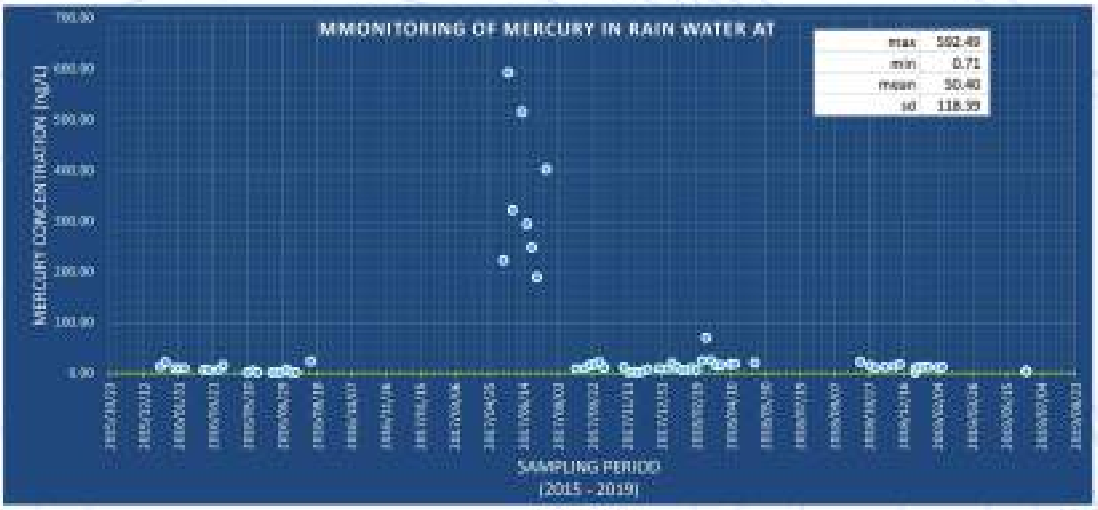
PROGRESS ACTIVITIES

TIM MoEF and P3KLL

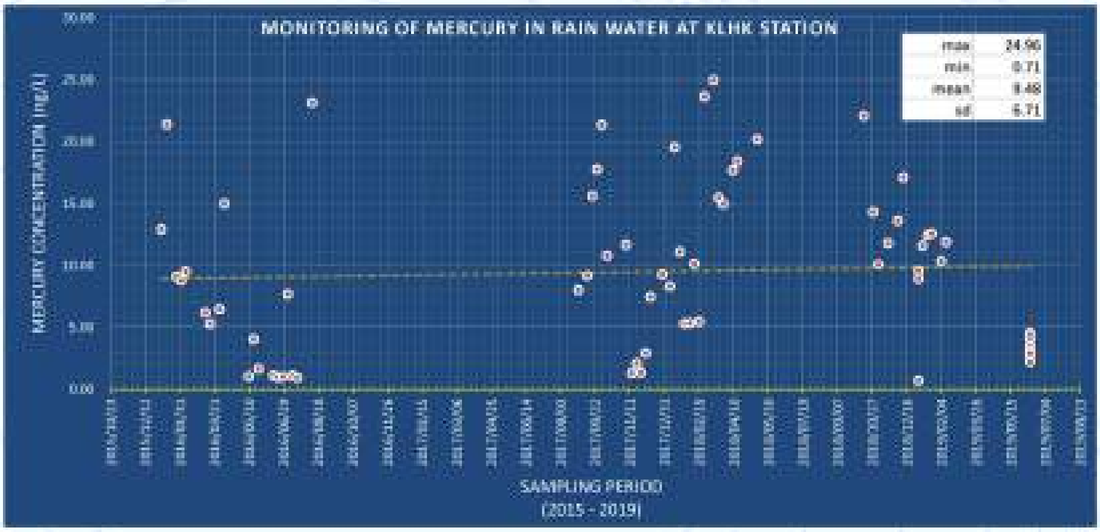
Wet Deposition Sampler for Mercury in Rain Water in East Jakarta Station

Regular sampling done by Hazardous and Toxic Substance Management Department MoEF (APMMN Rain Sampler)

DATA 2015 - 2019



DATA (edited) 2015 - 2019



Note: Slightly increasing from the start in year 2015 to year 2019 (1 ng/L)

EMC STATION

In Serpong

RESOURCES

Environmental Management Center

APPLICATION OF GOLD CATRIDGE IN P3KLL

Column No.	Concentration 24 hour (ng/m^3)
IDN2	5.3
IDN3	4.8
IDN4	4.6
IDN5	6.1

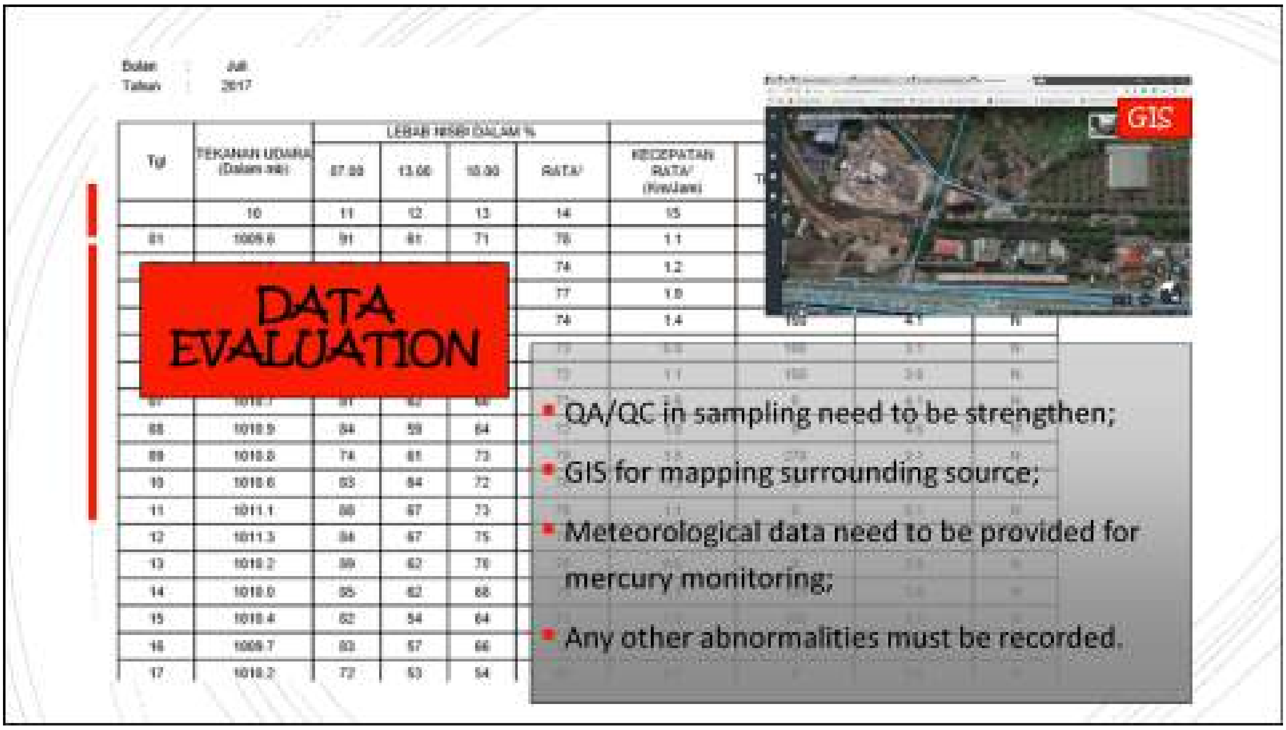
NOTE: Gold Cartridge sampling equipment provided by MoE Japan And analysis of Gold Cartridge was done by IDEA

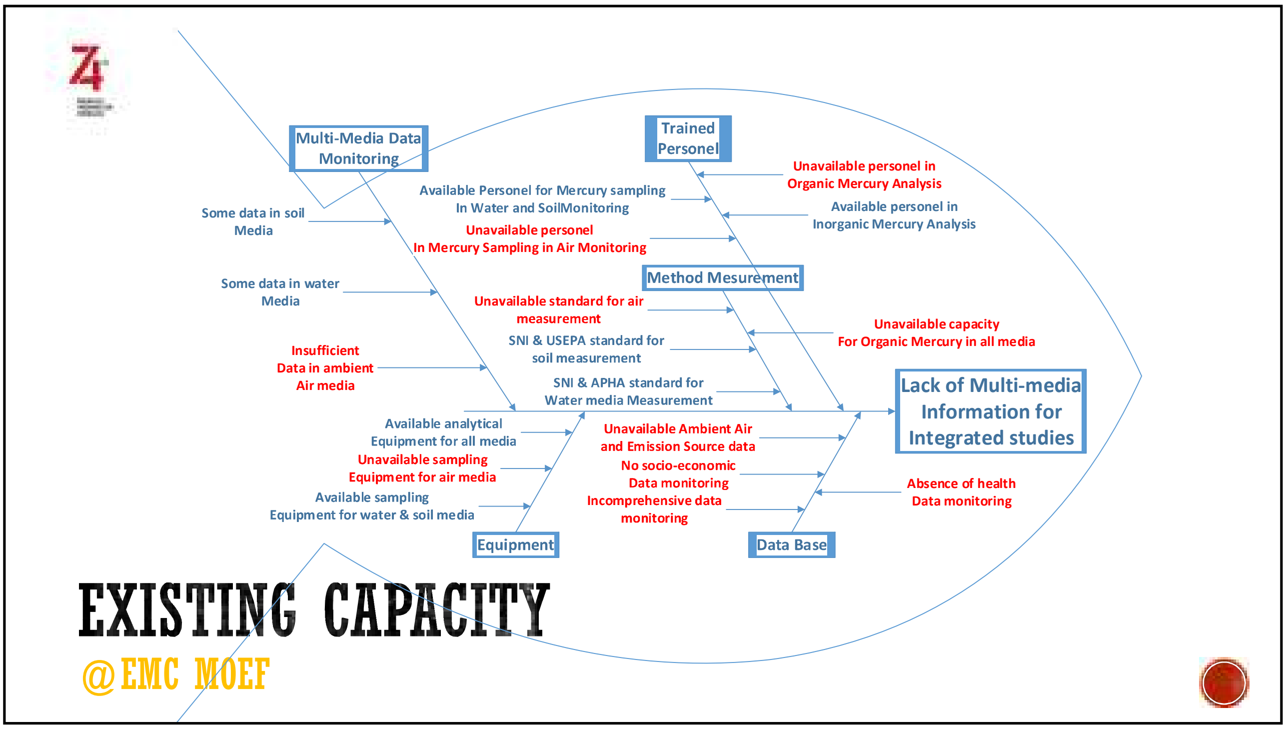
METEOROLOGICAL DATA: T=29°C RH=78% WS=0.2m/s (CALM)

CAPACITY BUILDING

- Training in National Central University (NCU) Taiwan:
  - Aditya Masri in 2017 for mercury monitoring from rain water and analysis using CV-AFS
  - Rina Aprishanty in June 2019 for mercury monitoring using various instrument and analysis using CV-AFS

REVIEW MERCURY MONITORING PROJECT IN INDONESIA


DATA EVALUATION
GIS
QA/QC in sampling need to be strengthen;
GIS for mapping surrounding source;
Meteorological data need to be provided for mercury monitoring;
Any other abnormalities must be recorded.


Multi-Media Data Monitoring
Trained Personel
Unavailable personel in Organic Mercury Analysis
Available personel in Inorganic Mercury Analysis
Available Personel for Mercury sampling In Water and SoilMonitoring
Unavailable personel In Mercury Sampling in Air Monitoring
Some data in soil Media
Some data in water Media
Insufficient Data in ambient Air media
Method Mesurement
Unavailable standard for air measurement
SNI & USEPA standard for soil measurement
SNI & APHA standard for Water media Measurement
Unavailable capacity For Organic Mercury in all media
Lack of Multi-media Information for Integrated studies
Available analytical Equipment for all media
Unavailable sampling Equipment for air media
Available sampling Equipment for water & soil media
Unavailable Ambient Air and Emission Source data
No socio-economic Data monitoring
Incomprehensive data monitoring
Absence of health Data monitoring
Equipment
Data Base
EXISTING CAPACITY
@EMC MOEF

NEXT STEP MERCURY ACTIVITIES in Indonesia

STEP EMC

Technical Capacity

- Applying QA/QC in place for next mercury monitoring in rain water
- Reestablish the sampling point for both mercury wet deposition and dry deposition
- Developing the system for mercury sampling from ambient air by means of gold-amalgamation
- Mercury baseline upgrade for 3 location (World Bank project)
- Developing Method standardization so that the monitoring could be applied widely in local laboratory in Indonesia (i.e. mercury in ambient air)
- Strengthening Local Capacity in monitoring mercury in multimedia (UNDP project)

World Bank

- Upgrading Baseline of multimedia monitoring in:
  - Landak District in Central Kalimantan
  - North Minahasa District in North Sulaweso
  - Kulon Progo District in Yogyakarta

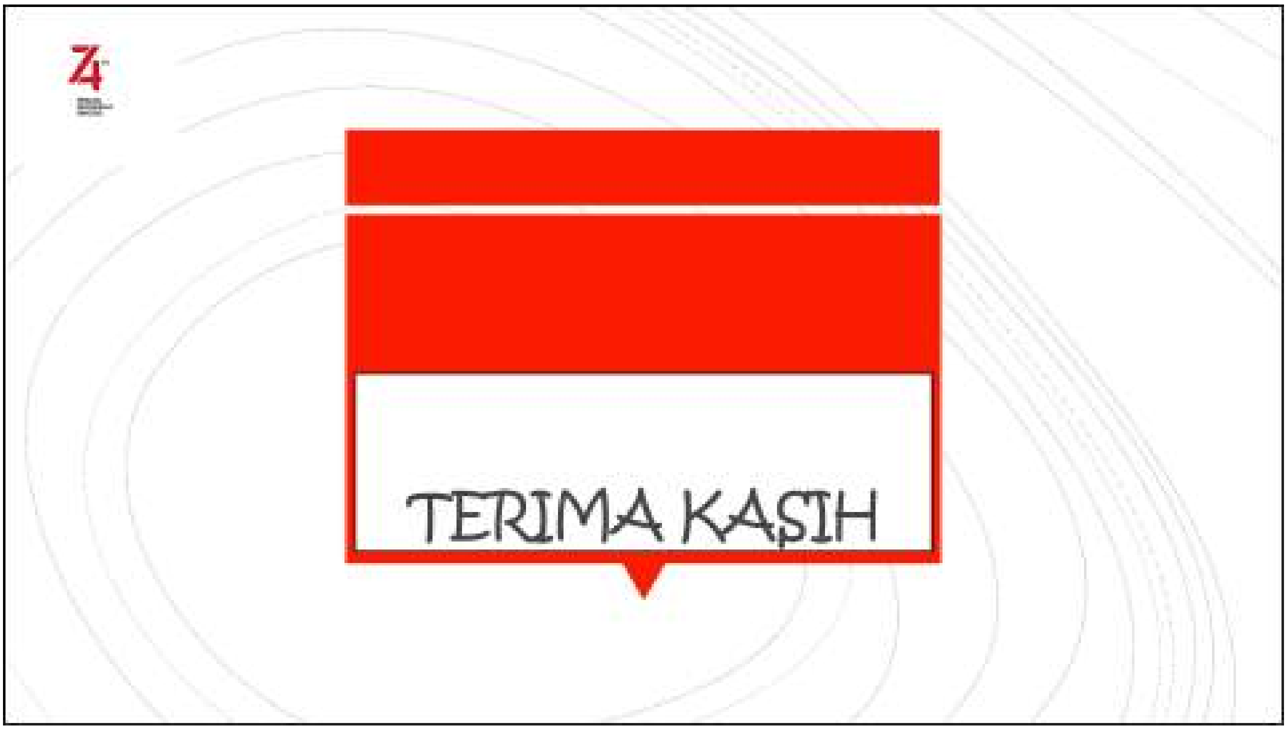
STEP EMC

Institutional Capacity

- Strengthening Local Action Plan for Eliminating and Phasing-out Mercury through KPPM
- Strengthening KPPM through coordination among sector involved:
  - Energy and mining
  - Manufacture
  - Health
  - Science and Technology
  - Academic


TIMELINE
KPPM
10 October 2017
Indonesia ratified Minamata Convention
28 March 2018
FGD on the Urgency of Mercury Research Center in Indonesia
20 April 2018
Expert Meeting to establish Mercury Research Center in Indonesia
3 May 2018
Workshop "Mercury Monitoring and Research as Policy Basis"
23 May 2018
FGD on the establishment of KPPM
3 August 2018
KPPM was established through the Ministry Decree No. 340/2018
7 August 2018
The launching of KPPM
30 August 2018
KPPM' first meeting to socialize KPPM action plan
3 September 2018
Formulation of Decree on the KPPM Secretariat
5 December 2018
FGD on the formulation of KPPM Grand Design
7 May 2019
Meeting to discuss collaboration between KPPM with ISMIA project
14 May 2019
FGD on the formulation of KPPM Roadmap


MAPPING LOCAL INSTITUTION
for environmental laboratory capacity
Kuantan
(Riau)
Bone Bolango (Gorontalo)
Minahasa Utara (Sulut)
Halmahera Selatan (Malut)
Progo (DIY)
Sekotong
Environmental Lab not available:
1. Kab.Minahasa Utara
2. Kab. Bone Bolango
3. Kab.Kuantan Singingi
Environmental Lab Available:
1. Kab. Sekotong
2. Kab. HalmaheraSelatan
3. Kab. Kulonprogo


TERIMA KASIH

Republic of Palau

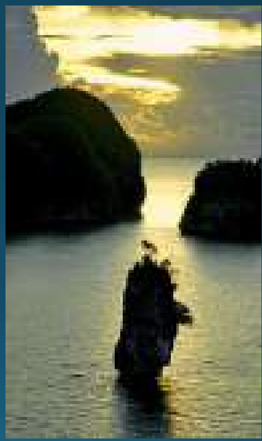
Monitoring of Mercury
August 15, 2019
Jakarta, Indonesia

Country Profile: PALAU

- Population: 22,061 (2015 est.)
- Area: 508 sq km (196 sq miles)
- Major languages: Palauan and English
- Birth rate: 11.05 births/1,000 population (2015 est.)
- Death rate: 7.99 deaths/1,000 population (2015 est.)
- Avg. Life Expectancy:
  - Male: 69.69 years (2015 est.)
  - Female: 76.23 years (2015 est.)
- Currency: US Dollar

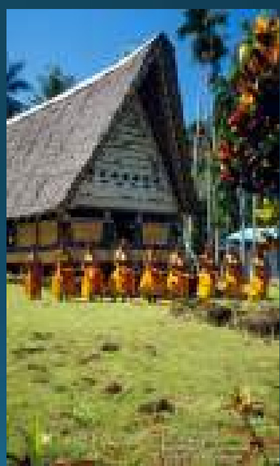
National Outlook on Mercury

- **Major uses and emissions**: Major uses are mercury-added imported products for essential use (energy sector, automobile, healthcare, research/lab reference equipment, household products) which are potentially released to the environment after use.
- **National Priority:** To protect the subsistence livelihood by preventing contamination of water, air, land and marine ecosystems.
  - Increase monitoring of mercury presence in water, air and land as well as marine ecosystem (fish)
  - Tracking and Management of Mercury Imported, Produced and Used
  - Worker Health and Safety;
  - Storage, Transport and Disposal of mercury waste
  - Contamination of Marine, Fresh and Ground Water



National Plans

- **Legislation :** Develop/Enhance existing regulation to comprehensively address Mercury management (importation, exportation, storage, transporting, spill reporting and cleanup, waste disposal) and worker's health and safety.
- Build capacity to include Mercury Management tracking system for all mercury and mercury added compounds/products imported, used and disposed in Palau and a provision of proper disposal facility
- Acquire equipment to monitor presence of mercury in the land, air and water



Monitoring Capabilities

- Limited monitoring capabilities (usually project based)
  - We are currently doing our Minimata Initial Assessment with assistance from SPREP
- We currently have a Water Quality Laboratory that is US EPA certified, would like to increase the lab capacity in terms of staff training and equipment to be able to test and monitor mercury and other chemicals of concern in land, air, and water

Kom Kmal Mesulang !

Any Questions?

P.O. Box 8086, Public Works Building
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Mercury Monitoring in South Africa

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Cape Point
Global Atmosphere Watch
SA Weather Service (SAWS)

South African Weather Service

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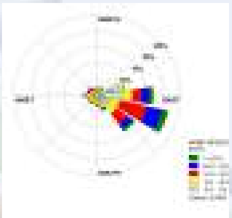
What is Global Atmosphere Watch (GAW)



summer

winter

- **Cape Point station started in 1978**
- **First measurement were CO and CFC's**
- **Reached GAW status in 1995 with WMO**
- **Only 31 GAW stations globally, 3 on African continent**

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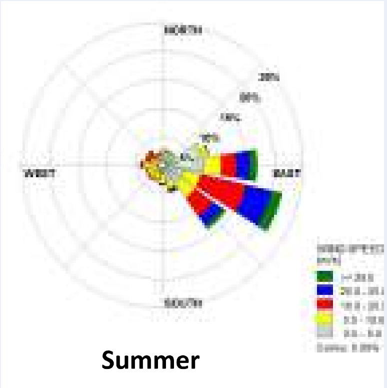

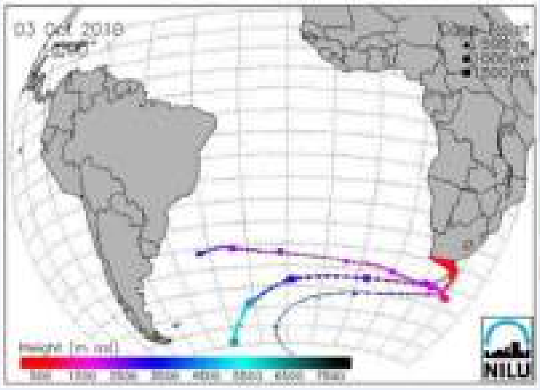

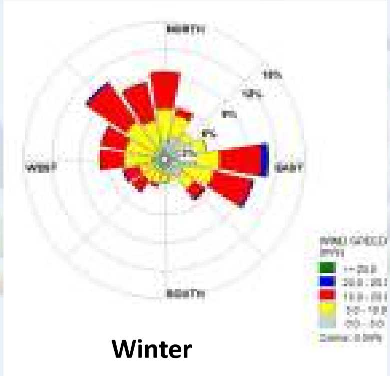

- GAW Stations monitor **BACKGROUND** concentrations of greenhouse and reactive gases therefore location is very important.
- Not interested in local city pollution sources just **BACKGROUND**.
- 40% of the air masses that reach CPT is classified as Clean AIR ^{222}Radon < 250mBq/m^3
- Back Trajectories is a tool to identify the Origin of Air Masses moving over the Station.
- Easily identify from where and for how long it's been in contact with ocean/land ect.

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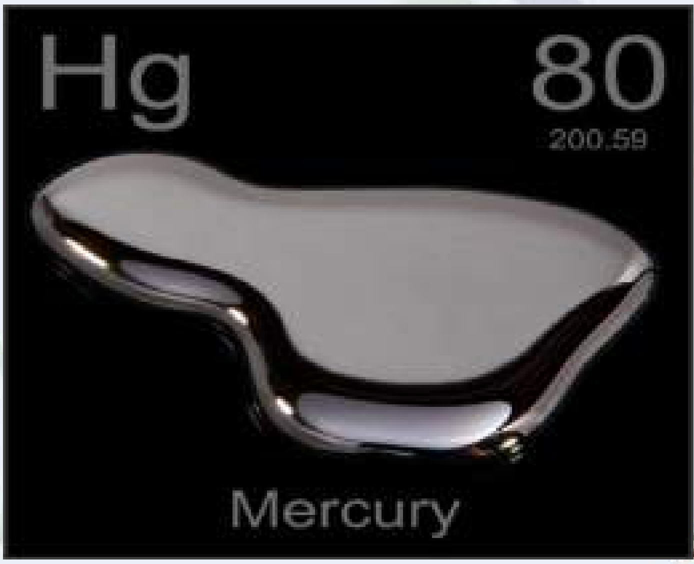
WHY MERCURY???



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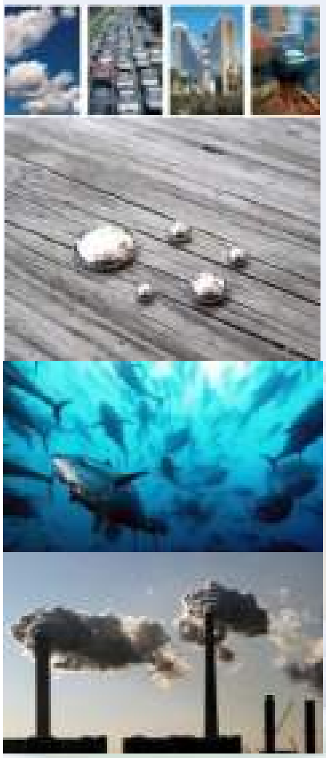

- Mercury and its compounds are very toxic and hazardous for human health and the environment
- Along the food chain it is enriched in organisms mainly as methyl mercury (CH_3Hg^+)
- Coal and oil combustion for the production of energy the main anthropogenic input pathways, followed by artisanal gold mining (**ASGM**), non-ferrous metal production
- Anthropogenic sources make up around 40% of total emissions into the atmosphere

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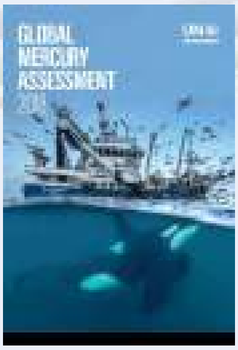
Cape Point Mercury Air Monitoring Programme

- CPT GAW started with manual mercury monitoring in Sep 1995 till Dec 2004
- First station in Southern Hemisphere to do **Continuous Mercury Monitoring**
- High Resolution Monitoring started in March 2007 (every 15 min a reading Tekran 2537 A)
- Only station in SA doing **Continuous Mercury Monitoring** which data is available to the public (SAAQIS)
- Cape Point data used in latest UNEP Mercury Report 2018



Published March 2019

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Mercury in Rainwater 2007 – 2009 data CPT and PTA

- ➢ **Hg in rainwater SA is comparable to NH-Sites.**
- ➢ **Hg concentrations higher in urban PTA than CPT.**
- ➢ **VWM for Hg CPT 10.6 ng/L PTA 15.8 ng/L**
- ➢ **CPT impacted by both marine air and local course**

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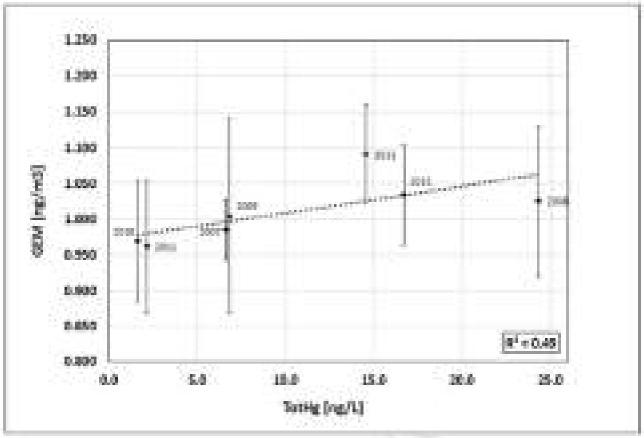
Mercury in Rainwater (2007-2013) at CPT



- **Observed a positive correlation between GEM vs TotHg.**
- **Positive correlation between GEM vs TotHg indicates that both are a function of Hg emissions.**

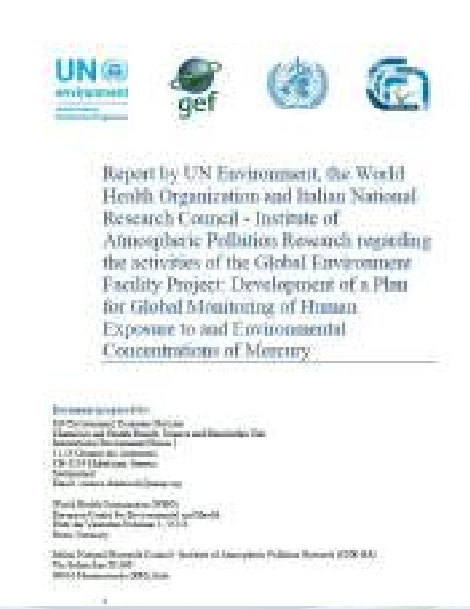
Clear Influence of El Nino Southern Oscillation (ENSO) on GEM

Brunke, E., Walters, ***C., Mkololo, T., Martin, L., Labuschagne***, C.,Silwana, B., Slemr, F.,Weigelt, A., Ebinghaus, R., and Somerset, V.: Somerset Mercury in the atmosphere and in rainwater at CapePoint. **Atmos. Environ**., 125, 24–32, 2016.

Outputs of CPT Hg Monitoring Programme

- **MSc**- PGL Baker 1999 (paper cited over 100 times publised in 2002)
- **Hons** Project 2005 LG Martin, Stellenbosch University
- **MSc**- LG Martin 2007, Mercury in Coal (Funded by ESKOM)
- 1x **PhD** A Venter 2016 North West University (Funded by SASOL)
- **± 25 Hg Publications since 2002**.
- GMOS Partner since 2010 now under GEO Flagship **GOS^{4}M**
- **Nature Geosience** April 2018, Martin, Mkololo, Labuschagne co-authors
- Several Oral and Poster presentations at SASAS, NACA, **ICMGP** and ICHMET
- **Longest Hg data set in the SH** and **2nd longest** in the World.

SAWS involvement in UNEP and GEF Projects (2016-2018) that reported to Minamata Convention on Mercury at COP2, 18 - 23 Nov 2018



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

ELEMENTS TO CONSIDER WHEN DESIGNING A GLOBAL MONITORING PLAN FOR MERCURY

Objectives:

Implementing partners of the GEF project are:

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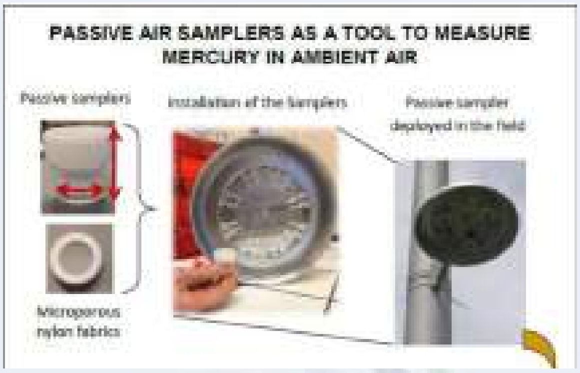
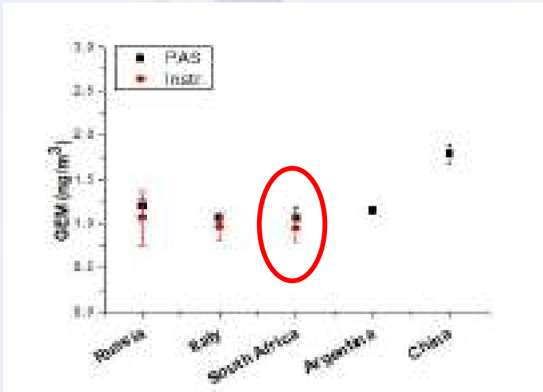
Pilot Project Results of Passive Air Samplers (PAS) CNR-Italy





Comparison between analytical instruments at Cape Point and PAS's:

- PAS values result within STD Deviation of Cape Point instrumental data
- PAS could give info when electrical troubles happened on the equipment
- PAS cheap and relaible to monitor Hg in Air
- Can easily be deployed in remote locations

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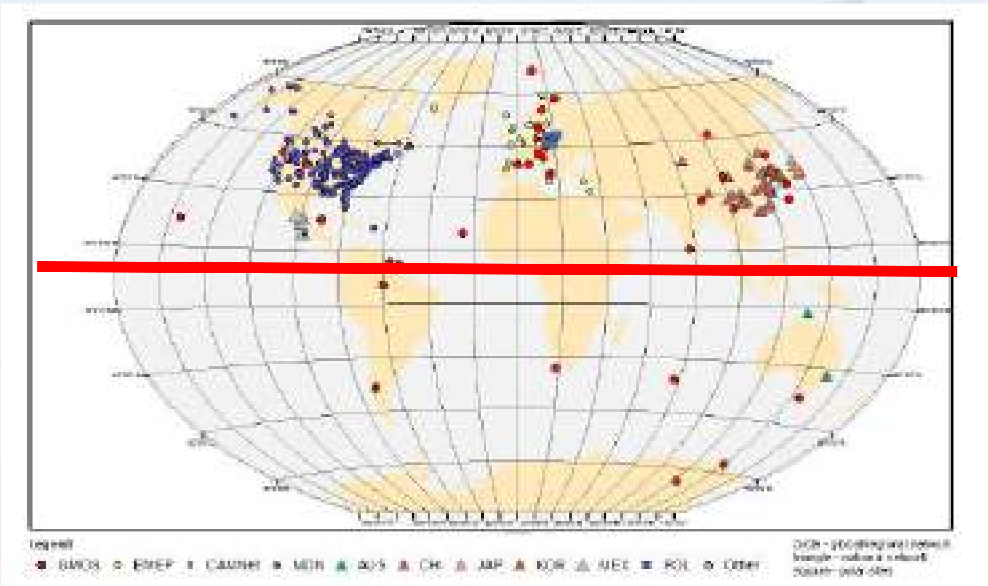
MerPas Exposure in De Aar (SA) started July 2019, in collaboration with Environment Canada

Global Mercury Monitoring Networks



Current global long-term atmospheric mercury monitoring sites. Africa **still lacking** yet Africa has the most countries that ratified the Minamata Convention 29 countries.

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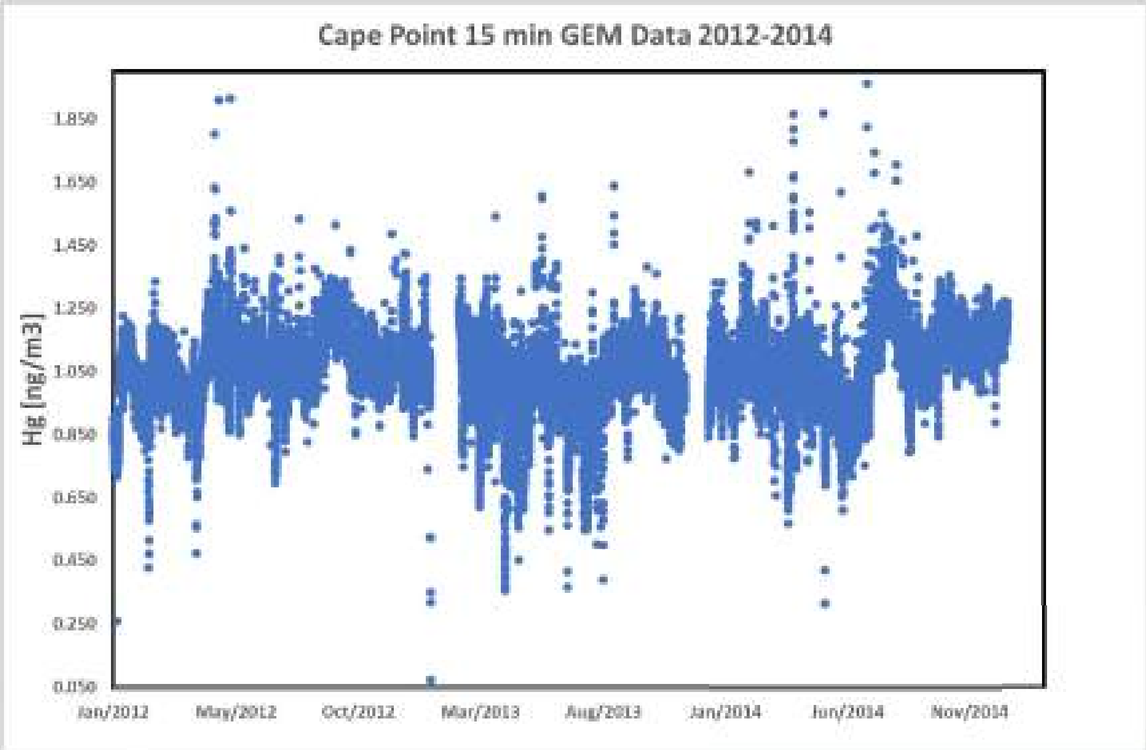
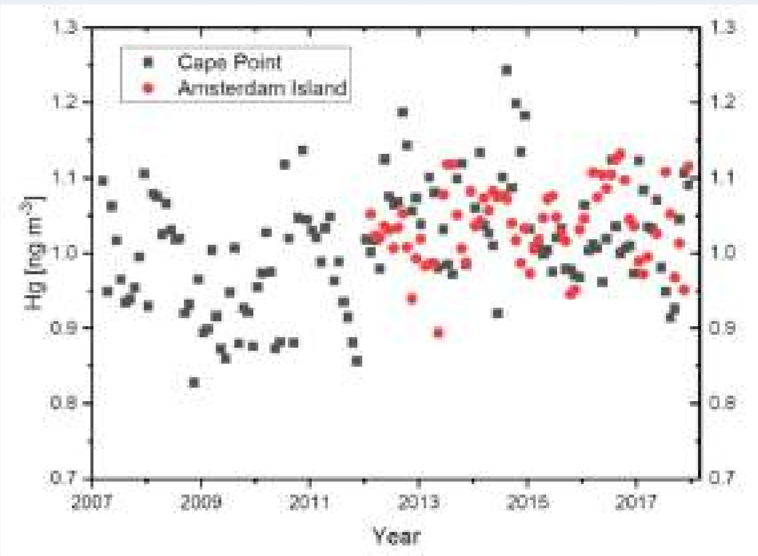
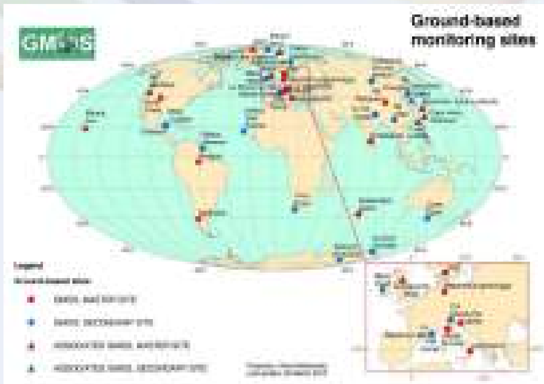


Latest Results on Hg Trend work in progress…..





Monthly median Hg concentrations March 2007 until December 2017.

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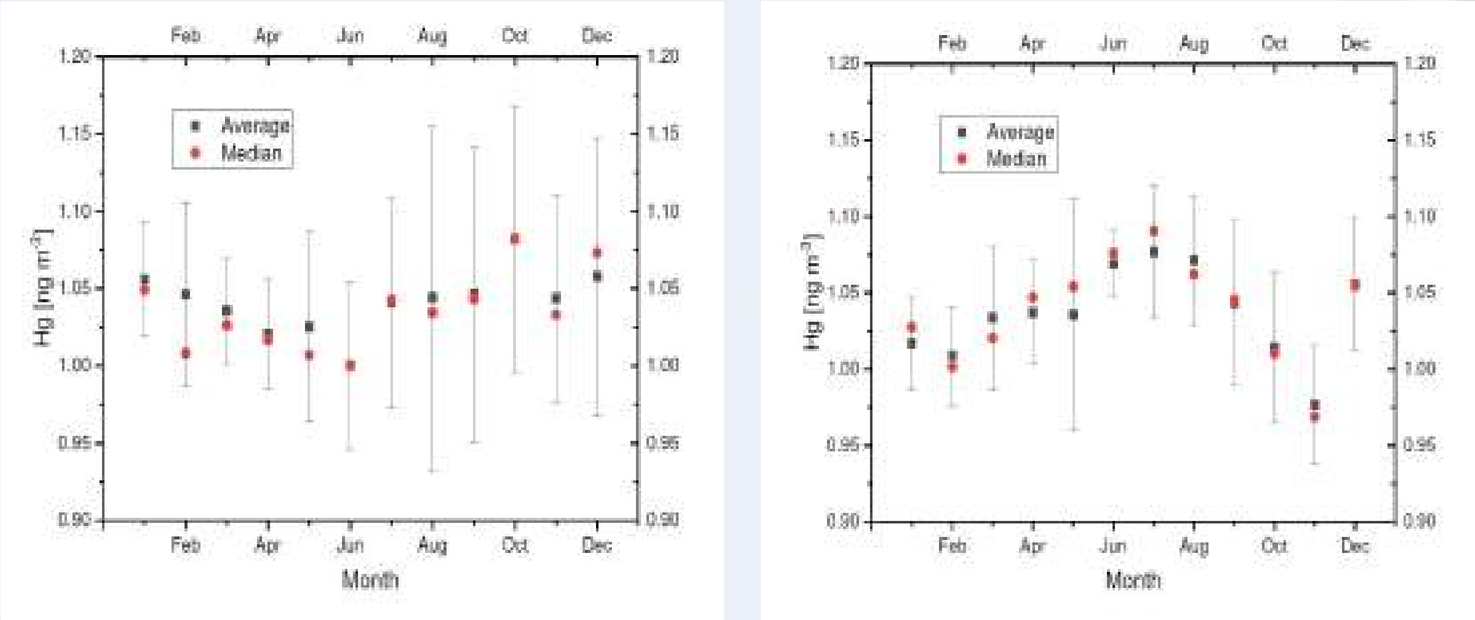

Seasonal variation of GEM in 2012 – 2017 at AMS (left) and CPT (right). The points represent averages and medians of monthly medians over the 2012 – 2017 period. The bars the standard deviations of the monthly averages.

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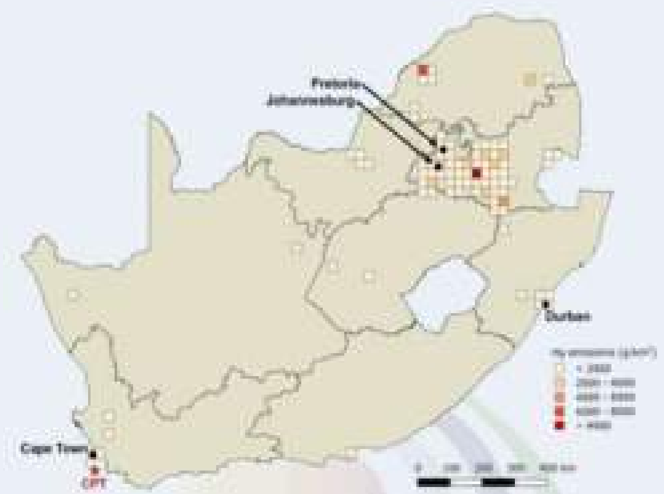

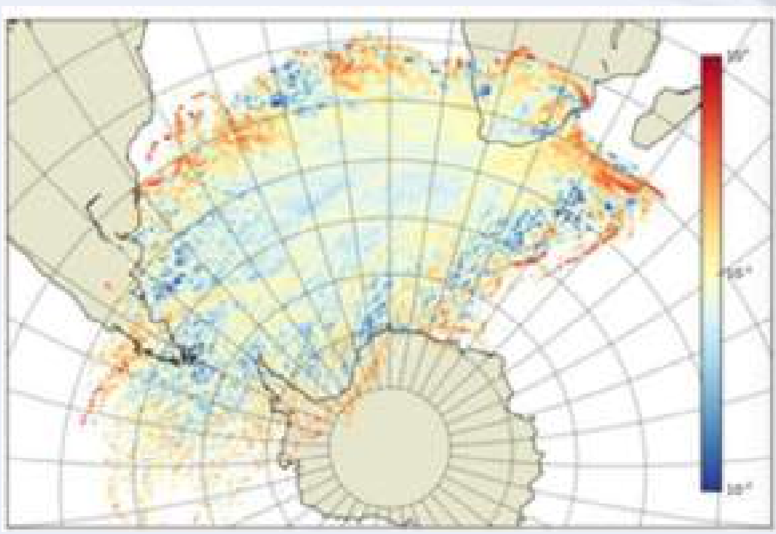

Prevalence of high (90th percentile) GEM concentrations using all hourly trajectories over ten years

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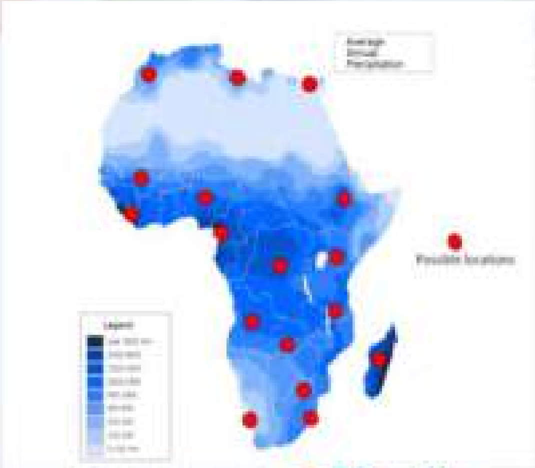
Future Plans with funding from DST through GOS4M Flagship Program of GEO



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WE CAN’T MANAGE what we DON’T MEASURE/MONITOR/REGULATE

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Minamata Convention on Mercury

Objectives of the convention

To protect the human health and environment from anthropogenic emissions and release of mercury and mercury compounds

✓October 2013, the Minamata Convention on Mercury opened for signature and was signed by 128 governments
✓SA signed the convention in 2013 Oct, **SA ratified on 29 April 2019**.
✓**Convention come into force August 16, 2017**
✓First Conference of the Parties (COP1) September 2017
✓Convention comprises of 35 articles
✓112 Countries Ratified Aug 2019
✓COP3 23 -29 November 2019, Geneva

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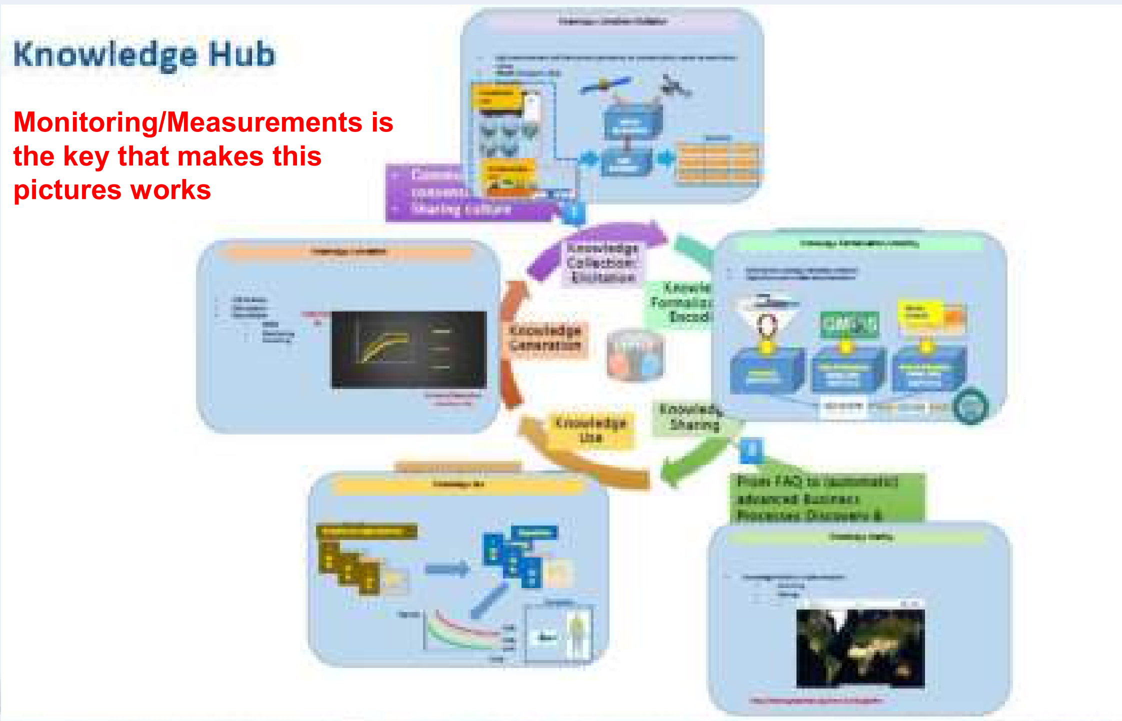
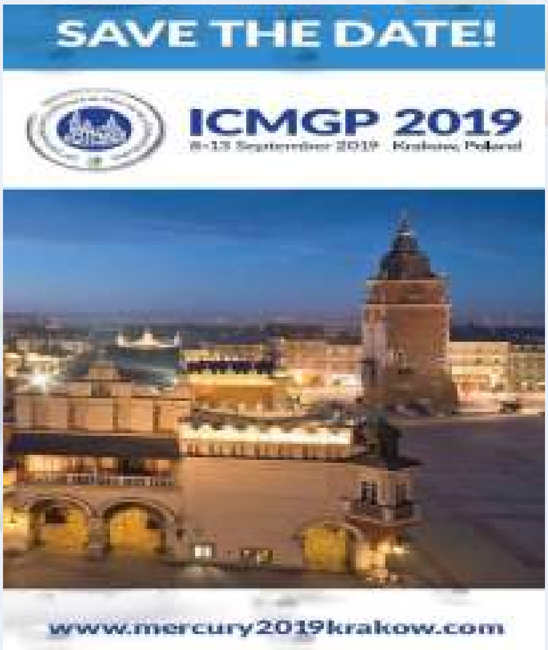


Bridging knowledge on global mercury with environmental responsibility, human welfare and policy response. ICMGP 2019



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From Minamata to Africa and Beyond

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THANK YOU FOR YOUR ATTENTION!
The End
Enkosi!
Hg
South African
Weather Service
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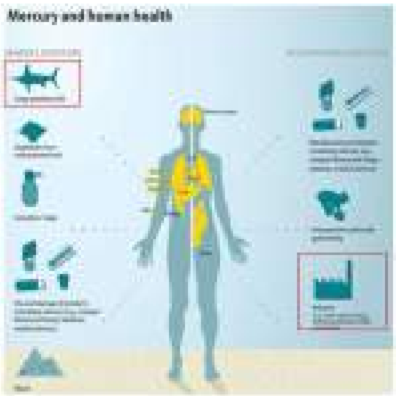
2019 APMMN meeting

National mercury monitoring activities in Korea

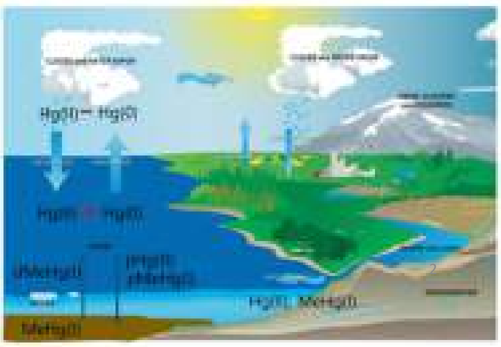
Sangwoo Eom and Seunghee Han
School of Environmental Sciences and Engineering
Gwangju Institute of Science and Technology (GIST)
Gwangju, Korea

1. Introduction



Zero-valent mercury, Hg(0)

- <0.01% bioavailability after ingestion
- After inhalation it easily crosses blood-brain barrier
- Disorder of central nervous system
- Nervousness, erethism

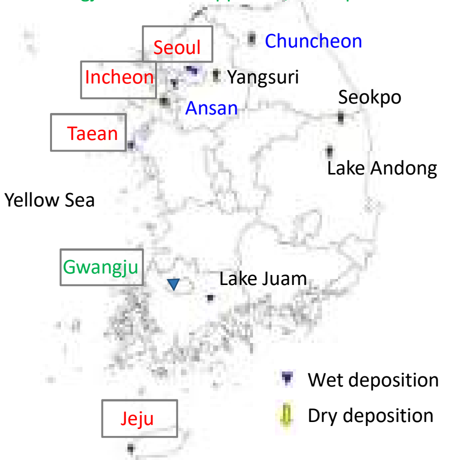


Divalent mercury, Hg(II)

- 7–15% bioavailability after ingestion
- Kidney damage
- Renal tubule damage
- Nephritis

2. National monitoring network for wet deposition

- Jeju, Taean, Incheon, Seoul: national monitoring sites, weekly sampling, 2015-present
- Andong, Seokpo: event sampling, 2010-2015
- Ansan: event sampling, 2006-2007
- Chuncheon: event sampling, 2015-2017
- Gwangju: APMMN supported, 2016-present



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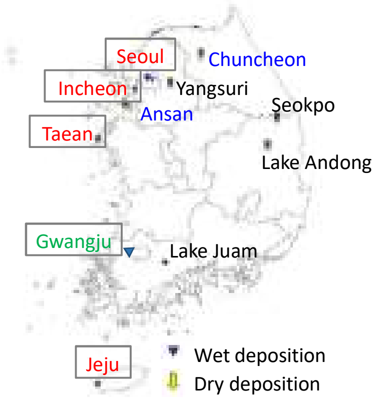
2. National monitoring network for wet deposition

- Demographic information

Site	Population
Seoul	9,757,144
Incheon	2,957,024
Taean	63,064
Jeju	669,771
Gwangju	1,459,024

- Annual precipitation depth (unit: mm)

Site	2014	2015	2016	2017	2018	Average
Seoul	809	792	992	1233	1284	1022
Incheon	788	652	864	1029	1134	894
Taean	720	536	748	715	991	742
Jeju	1272	1546	1293	861	1346	1264
Gwangju	1290	1050	1482	937	1428	1237
Korea	1174	949	1272	967.8	1387	1150



- Power plant scale (unit: MW)

Site	Gas	Coal	Coal gasification	Solar	Fuel cell	Petroleum	Wind	Bio	Hydro	Waste
Seoul	433			36	42			7	0.4	19
Incheon	8577	5080		68	75	36	49	71	13	3
Taean		6100	346	137		1			2	
Jeju				232		644	266	7	1	
Gwangju	115			148				2	2	1

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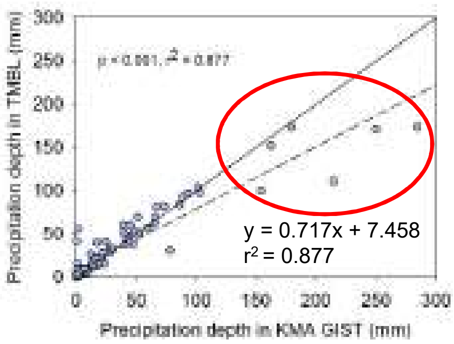
2. National monitoring network for wet deposition

- Gwangju site has been operated from April 2016.
- THg is measured at the Dr Sheu's lab in Taiwan and MeHg at the GIST lab.

2. National monitoring network for wet deposition

- The precipitation depth of Gwangju site was 28% lower than the KMA (Korea Meteorological Administration) data.



Duration: Apr 2016 – Mar 2019

Total: 108 samples

Enrichment Factor (EF) = $\frac{X/Na^{+}_{RW}}{X/Na^{+}_{SW}}$

(RW: rainwater) (SW: seawater)

Sea salt (SS) fraction = $\frac{1}{EF} \times 100$

Non-sea salt (NSS) fraction = $100 - \frac{1}{EF} \times 100$

Source characterization

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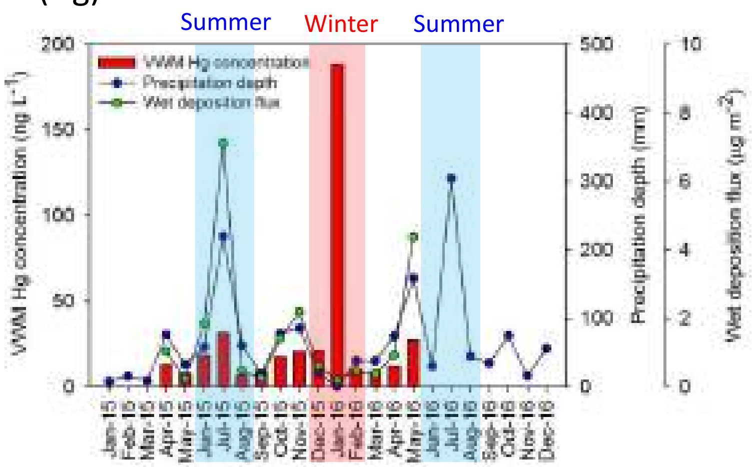
3. Regional wet deposition

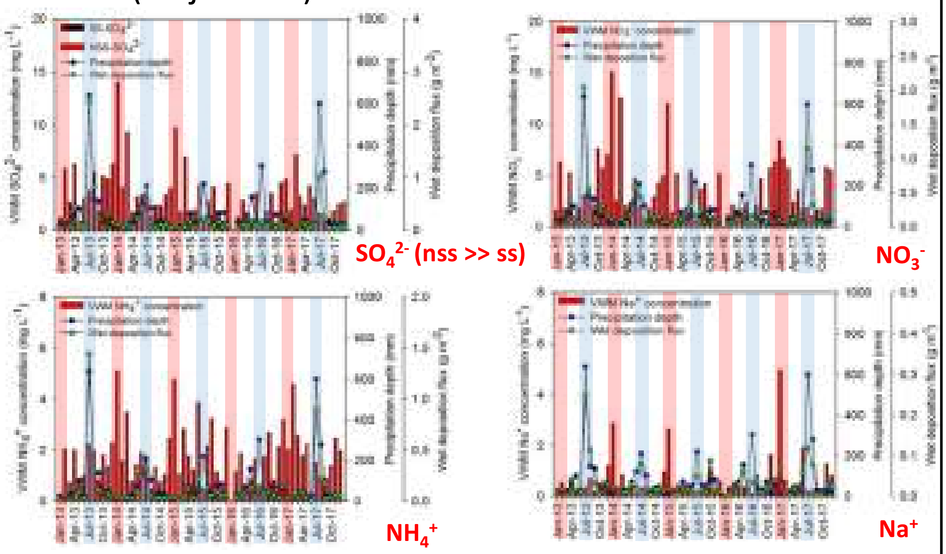
- Seoul (Hg)



- Seoul: April 2015 – March 2016, THg: 22.6 ng/L, THg flux: 16.1 mg/m^2/yr
- Trend of wet deposition flux follows that of precipitation depth

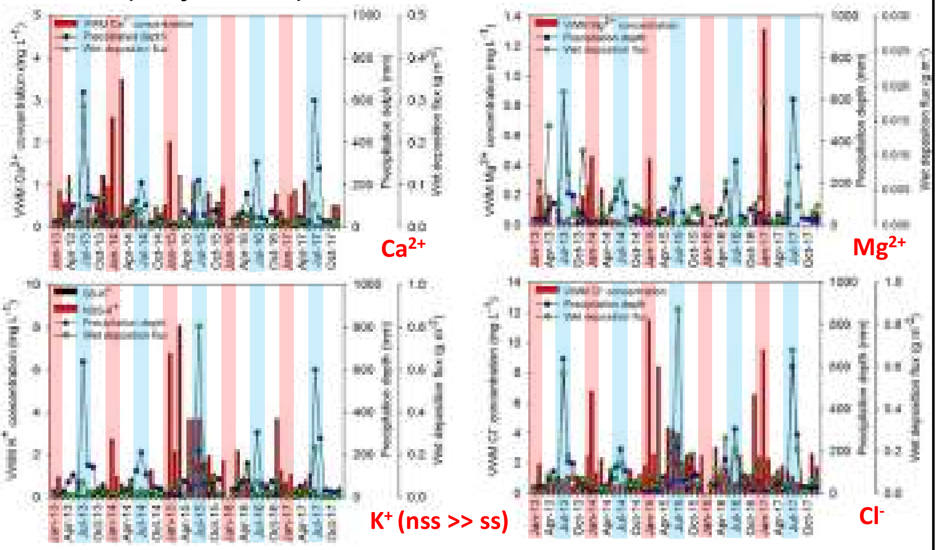
3. Regional wet deposition

- Seoul (major ions)



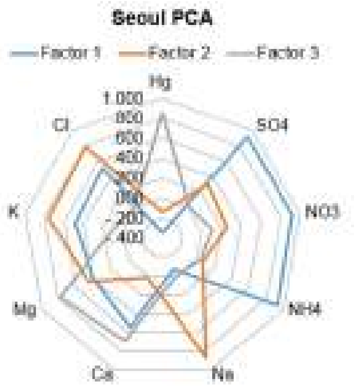
3. Regional wet deposition

- Seoul (major ions)



3. Regional wet deposition

- Hg source analysis - Seoul

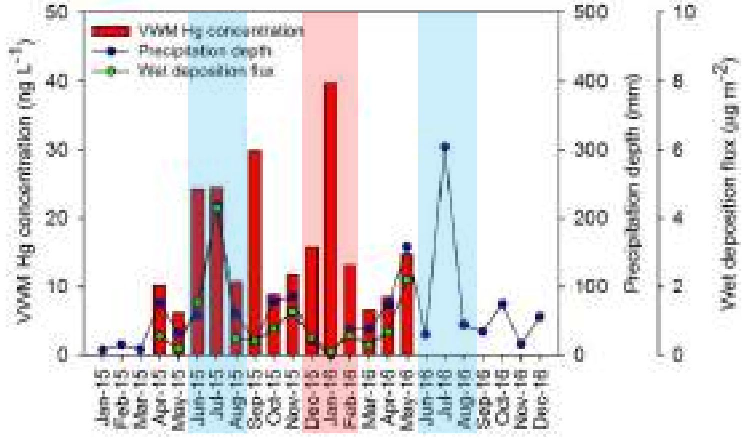


	Factor		
	1	2	3
Hg	-.339	-.136	.852
nss-SO_4^{2-}	.924	.303	.020
NO_3^-	.919	.253	.107
NH_4^+	.938	.070	.038
Na^+	-.074	.867	.000
Ca^{2+}	.552	.014	.696
Mg^{2+}	.400	.459	.784
nss-K^+	.494	.753	.094
Cl^-	.523	.805	.024
Eigen	3.68	2.35	1.84
Var %	40.9	26.2	20.5
Cum %		87.6	

- Hg concentration in Seoul was strongly related to Mg^{2+} and Ca^{2+} (soil dust).

3. Regional wet deposition

- Incheon (Hg)



- Incheon: April 2015 – March 2016, THg: 16.8 ng/L, THg flux: 11.0 mg/m^2/yr
- Trend of wet deposition flux follows that of precipitation depth

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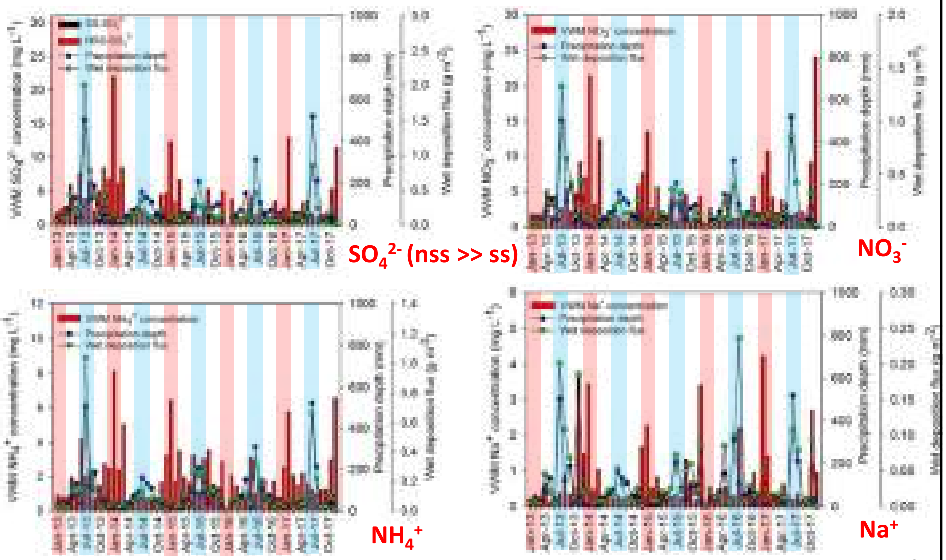
3. Regional wet deposition

- Incheon (major ions)



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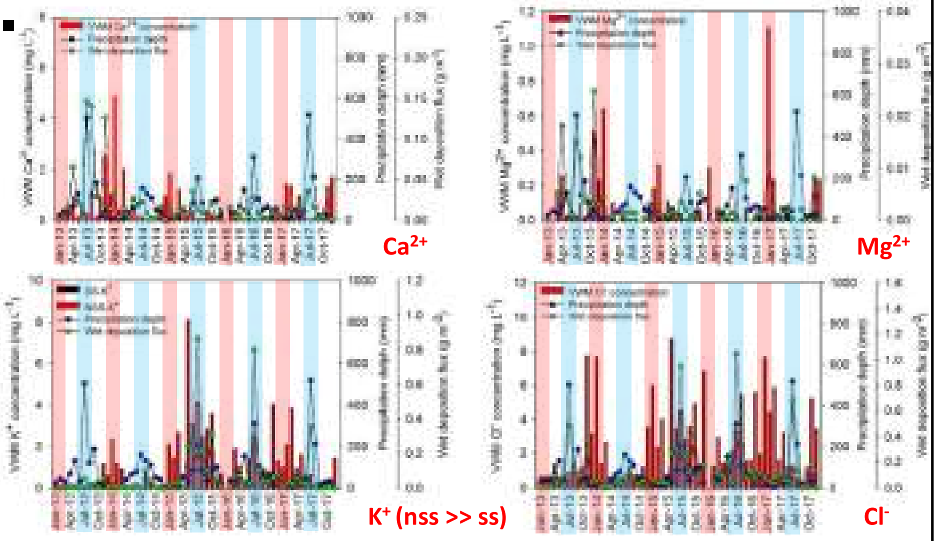
3. Regional wet deposition

- Incheon (major ions)



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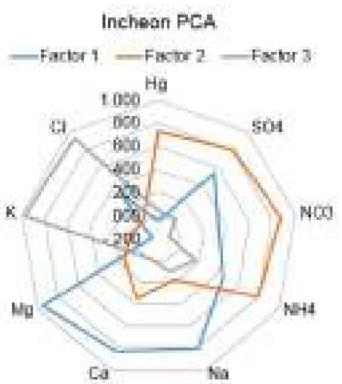
3. Regional wet deposition

- Hg source analysis - Incheon



	Factor		
	1	2	3
Hg	-.044	.727	.047
nss-SO_4^{2-}	.549	.805	.034
NO_3^-	.328	.876	-.115
NH_4^+	.450	.796	.170
Na^+	.804	.174	.094
Ca^{2+}	.839	.347	-.011
Mg^{2+}	.957	.145	.050
nss-K^+	-.151	.051	.974
Cl^-	.311	.010	.936
Eigen	3.00	2.75	1.88
Var %	33.3	30.6	20.9
Cum %		84.9	

- Hg concentration in Incheon was highly related to SO_4^{2-}, NO_3^-, NH_4^+ (power plants and vehicles), attributable to vicinity of coal power plants.

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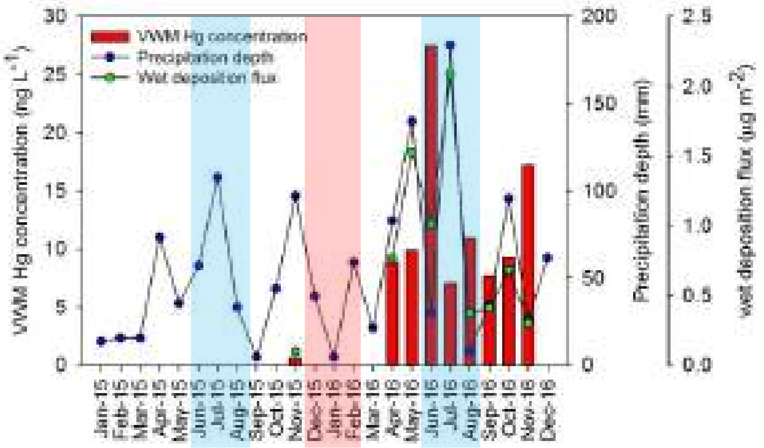
3. Regional wet deposition

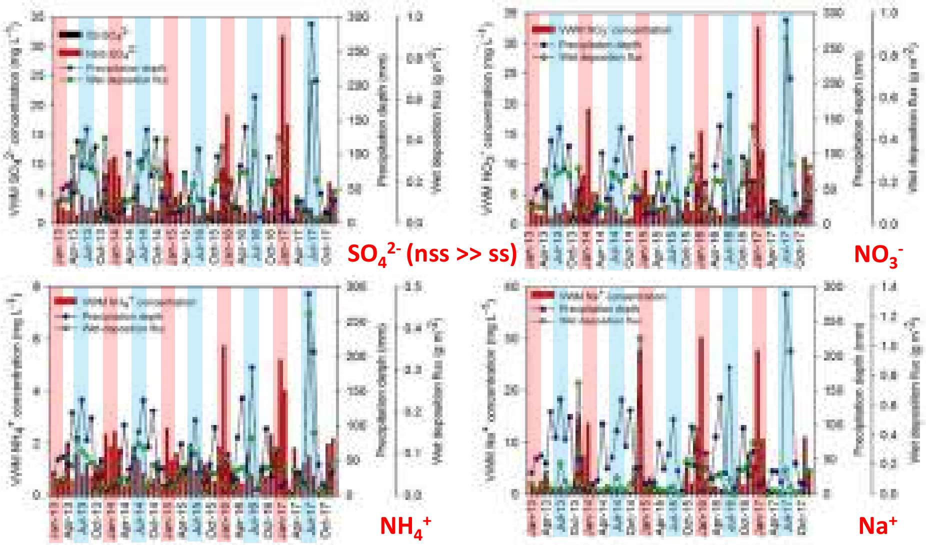
- Taean (Hg)



- Taean: November 2015, March 2016 – December 2016
- Trend of wet deposition flux follows that of precipitation depth

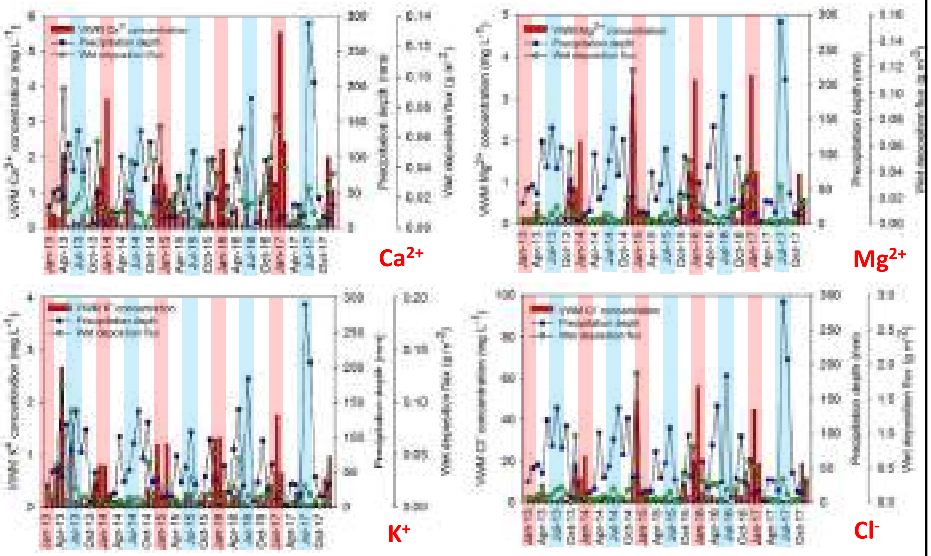
3. Regional wet deposition

- Taean (major ions)



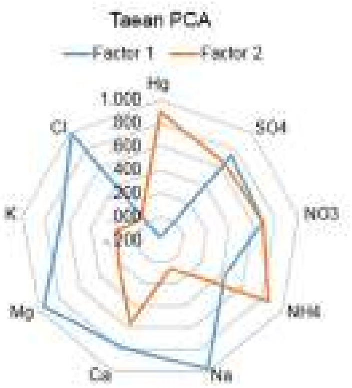
3. Regional wet deposition

- Taean (major ions)



3. Regional wet deposition

- Hg source analysis - Taean

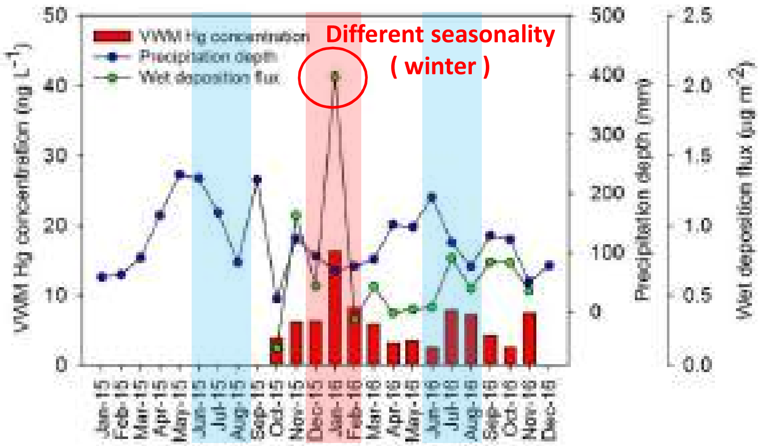


Factor		
	1	2
Hg	-.183	.897
nss-SO_4^{2-}	.740	.654
NO_3^-	.690	.686
NH_4^+	.423	.859
Na^+	.979	.052
Ca^{2+}	.780	.568
Mg^{2+}	.949	.216
K^+	.663	.183
Cl^-	.984	.045
Eigen	5.11	2.85
Var %	56.8	31.6
Cum %	88.4	

- Hg concentration in Taean was strongly related to NH_4^+ (power plants, vehicles), attributable to locality of coal power plants.

3. Regional wet deposition

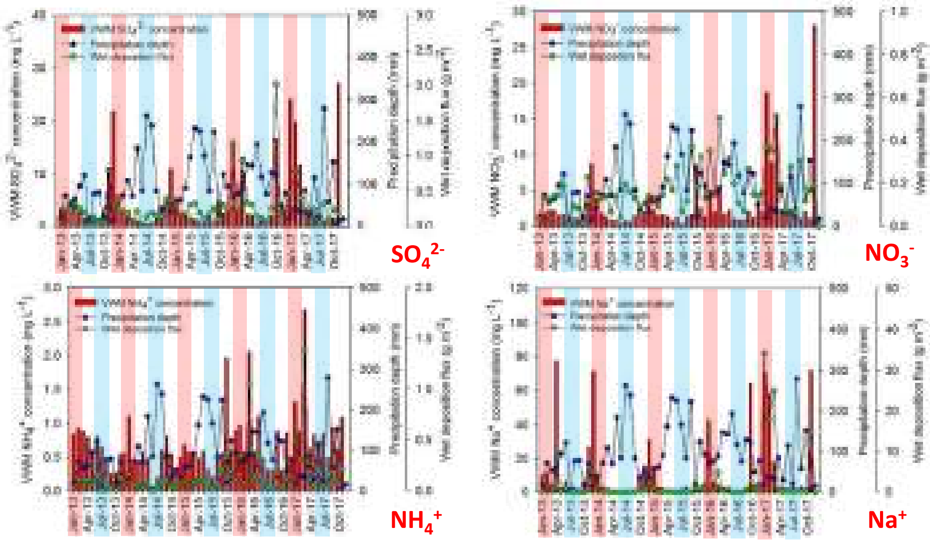
- Jeju (Hg)



- Jeju: Oct 2015 – Sep 2016, THg: 4.5 ng/L, THg flux: 8.0 mg/m²/yr
- Different seasonality of wet deposition flux from the other sites

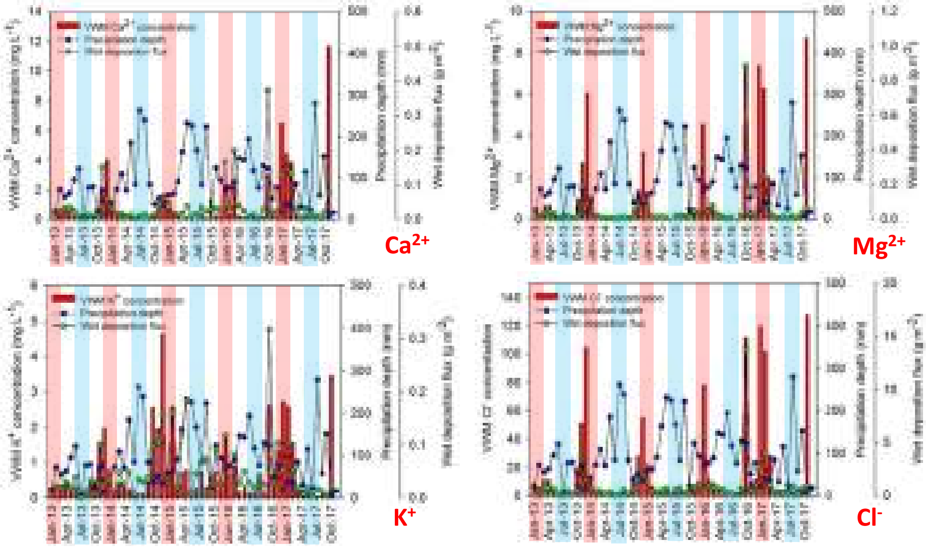
3. Regional wet deposition

- Jeju (major ions)



3. Regional wet deposition

- Jeju (major ions)



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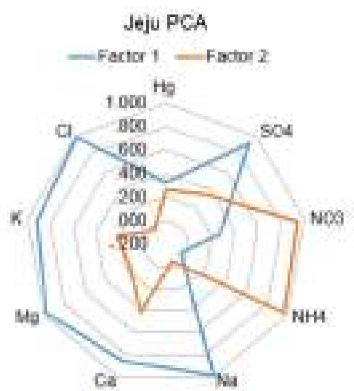
3. Regional wet deposition

- Hg source analysis - Jeju



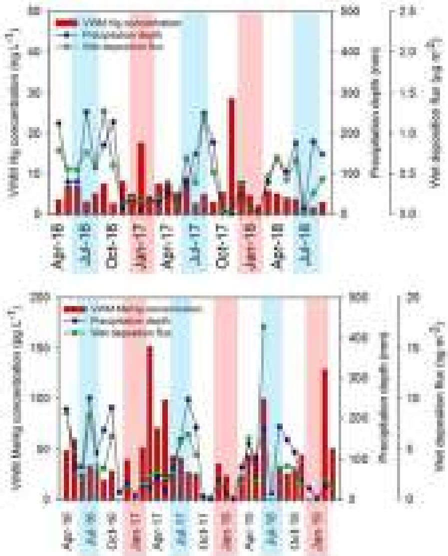
Factor		
	1	2
Hg	.326	.265
SO_4^{2-}	.918	.350
NO_3^-	.266	.941
NH_4^+	-.052	.964
Na^+	.989	-.049
Ca^{2+}	.863	.425
Mg^{2+}	.975	.163
K^+	.920	.217
Cl^-	.985	-.049
Eigen	5.51	2.23
Var %	61.2	25.2
Cum %	86.4	

- Hg concentration in Jeju was weakly related to Na^+ and Cl^- ions (marine and dust sources)

22

3. Regional wet deposition

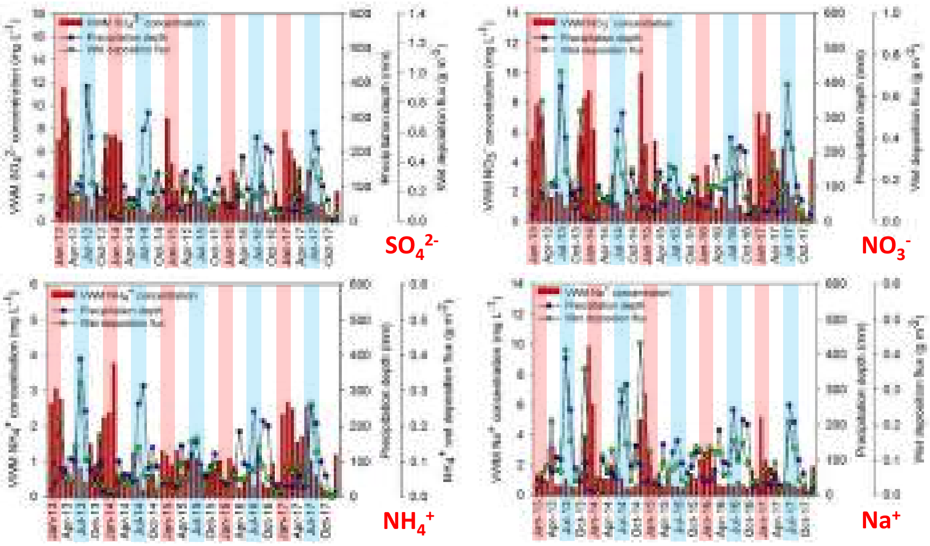
- Gwangju (Hg, MeHg)



- April 2016-March 2017
  THg: 4.7 ng/L, THg flux: 6.0 mg/m^2
- April 2017-March 2018
  THg: 4.9 ng/L, THg flux: 4.3 mg/m^2
- April 2016-March 2017
  MeHg: 35.2pg/L, MeHg flux: 44.1ng/m^2
- April 2017-March 2018
  MeHg: 33.8pg/L, MeHg flux: 30.3ng/m^2
- April 2018-March 2019
  MeHg: 50.7pg/L, MeHg flux: 65.5ng/m^2

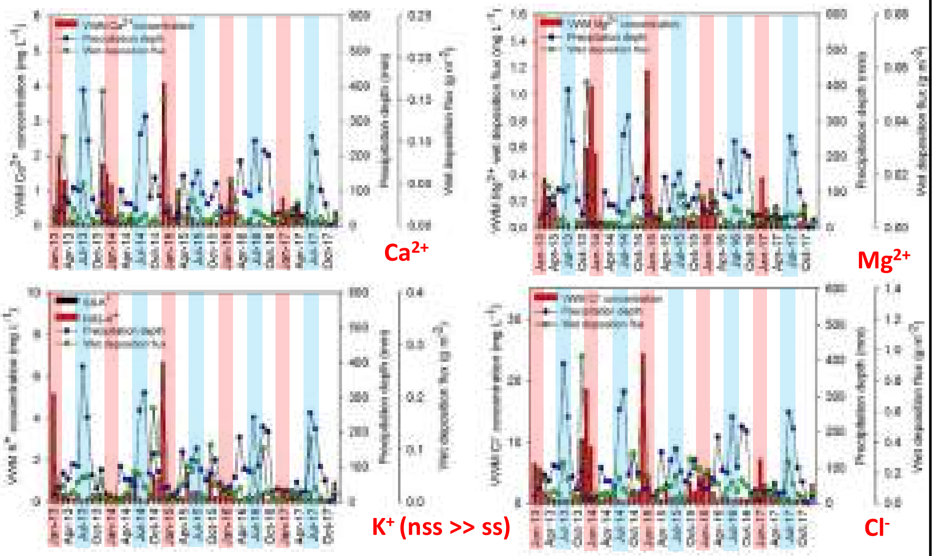
3. Regional wet deposition

- Gwangju (major ions)



3. Regional wet deposition

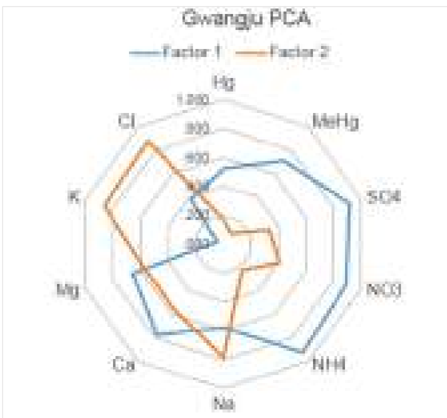
- Gwangju (major ions)



25

3. Regional wet deposition

- Hg, MeHg source analysis - Gwangju



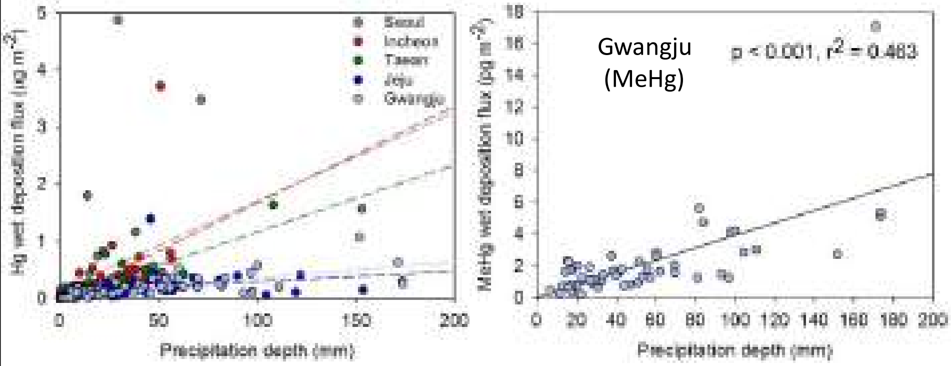
	Factor	
	1	2
Hg	.522	.164
MeHg	.711	.092
SO_4^{2-}	.914	.328
NO_3^-	.897	.408
NH_4^+	.925	.227
Na^+	.573	.784
Ca^{2+}	.779	.569
Mg^{2+}	.657	.568
K^+	.045	.862
Cl^-	.387	.883
Eigen	4.79	3.15
Var %	47.9	31.5
Cum %	79.4	

- Hg and MeHg concentration in Gwangju was related to SO_4^{2-}, NO_3^-, NH_4^+ ions (power plants and vehicles).

26

3. Regional wet deposition

- In-cloud vs below-cloud scavenging



Site	Seoul	Incheon	Taean	Jeju	Gwangju
p value	< 0.001	< 0.001	< 0.001	0.03	< 0.001
r square	0.216	0.298	0.723	0.0921	0.539

Site	Gwangju
p value	< 0.001
r square	0.463

- Significant correlation between precipitation and Hg wet deposition flux indicates dominance of the in-cloud scavenging process.

27

4. Summary

Site	Annual concentration (ng L⁻¹)	Annual Wet deposition flux ($\mu g\ m^{-2}$)	Factors controlling total ions distribution (Factor 1)	Factors controlling Hg distribution	In-cloud vs Below-cloud
Seoul	23	16	Anthropogenic	Soil dust	In-cloud
Incheon	17	11	Soil dust	Anthropogenic	In-cloud
Taean	11	9.2	Marine + Soil dust	Anthropogenic	In-cloud
Jeju	4.5	8.0	Marine + Soil dust	Marine + Soil dust	In-cloud
Gwangju (Hg)	4.8	5.1	Anthropogenic	Anthropogenic	In-cloud
Gwangju (MeHg)	0.040	0.045	Anthropogenic	Anthropogenic	In-cloud

28

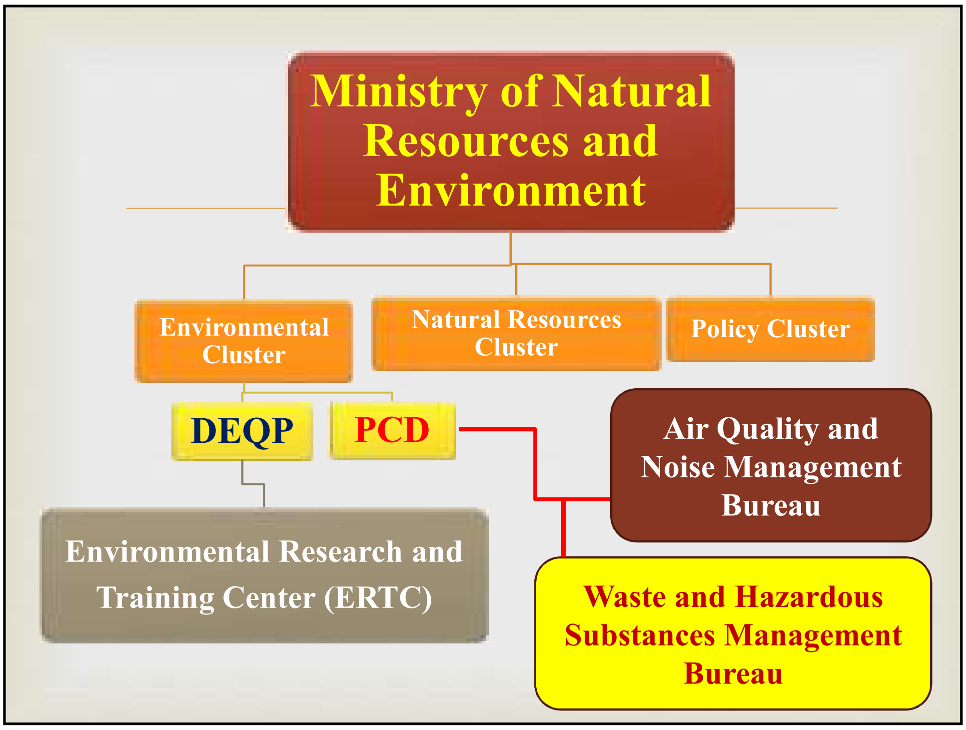
Thank you for your attention

Updates on Atmospheric Mercury Research and Mercury Wet Deposition Measurement in Thailand

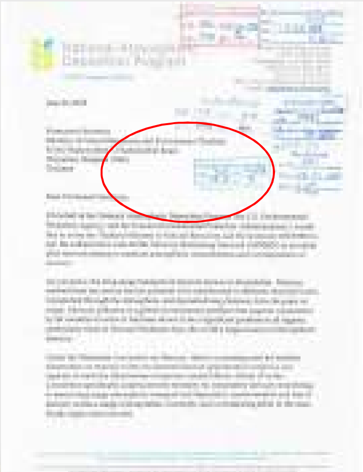
Hathairatana Garivait

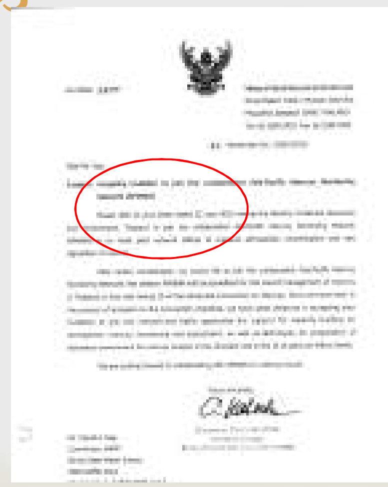
Environmental Research and Training Center, Department of Environmental Quality Promotion, Ministry of Natural Resources and Environment

The 8th APMMN Partners Meeting, Jakarta, Indonesia.
15 August 2019



Thailand has officially collaborated with APMMN since November 2015 by Ministry of Natural Resources and Environment (MONRE)





Participation in the APMMN Meetings

The 5th APMMN Meeting in Bangkok 2016

The 6th APMMN Meeting in Taiwan 2017

The 7th APMMN Meeting in Manila, Philippines 2018

Minamata Convention on Mercury

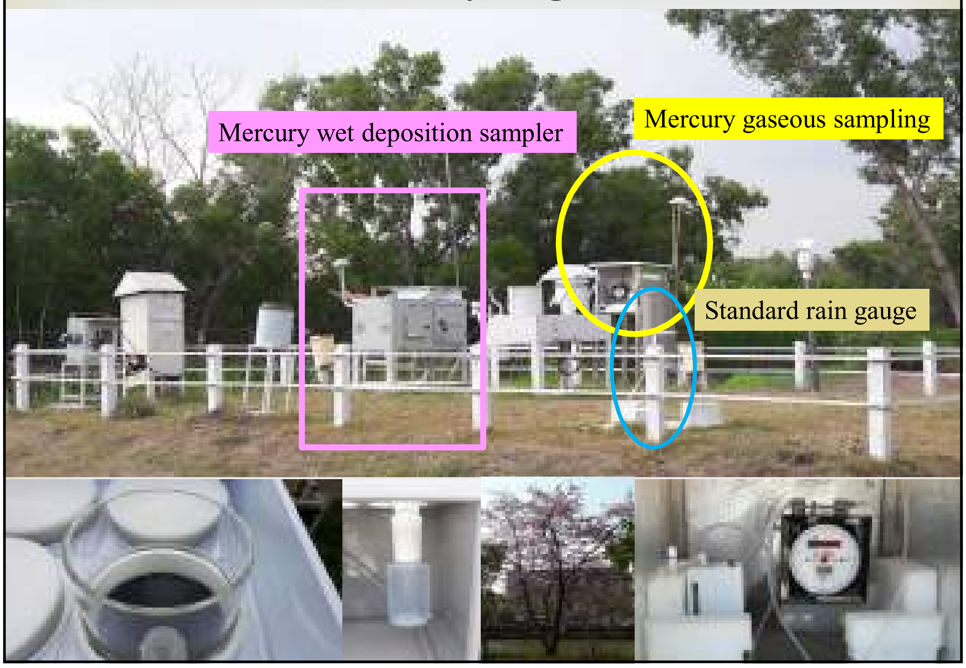
- Thailand ratified MC since 23 June 2017. We are the 66th country.

- With kind technical support of APMMN, ERTC continue building capacity on trace level mercury measurements to attain the MC on Mercury demand, especially on Article 19 (Research and Development) and Article 22 (Effectiveness Evaluation).

ERTC progress on ultra-trace mercury level measurement

- ERTC has established Ultra-trace Mercury Level Laboratory since 2016
- GEM measurement using Gold Amalgam Tube method analyzed by CVAFS technique
- Mercury wet deposition measurement using automatic rain sampler for mercury given by Taiwan EPA since November 2016 and US.EPA. Method 1631 revision E
- PBM measurement using thermal desorption method

ERTC, Sampling station



Ultra-trace Mercury level laboratory at ERTC

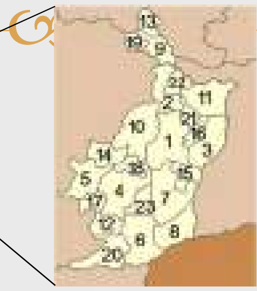
Atmospheric Mercury

"Study on mercury pollution from municipal wastes dumping sites"

Objective:

1. To compare ambient Hg level between good and bad management of municipal wastes dumping sites
2. To study emanation and emission rates of Hg from municipal wastes

Buriram Province



1. Mueang Buriram
2. Khu Mueang
3. Krasang
4. Nang Rong
5. Nong Ki
6. Lahan Sai
7. Prakhon Chai
8. Ban Kruat
9. Phutthaisong
10. Lam Plai Mat
11. Satuek
12. Pakham
13. Na Pho
14. Nong Hong
15. Phlapphla Chai
16. Huai Rat
17. Non Suwan
18. Chamni
19. Ban Mai Chaiyaphot
20. Non Din Daeng
21. Ban Dan
22. Khaen Dong
23. Chaloem Phra Kiat

area
10,322.9 km²

population
1,591,905 people

BURIRAM

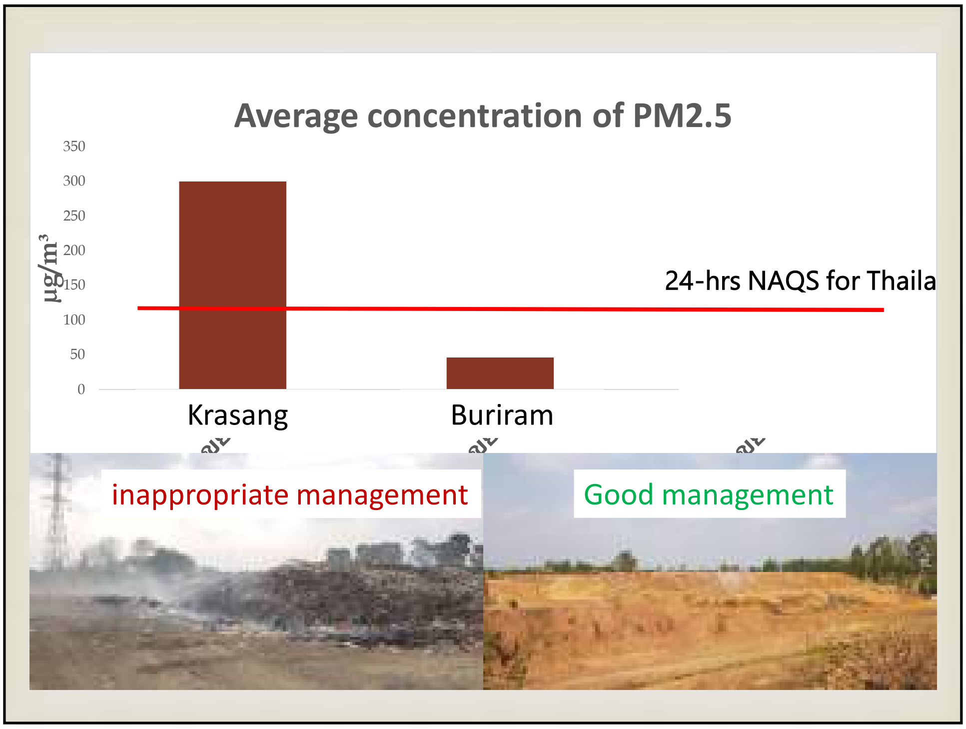
Sanitary Landfill

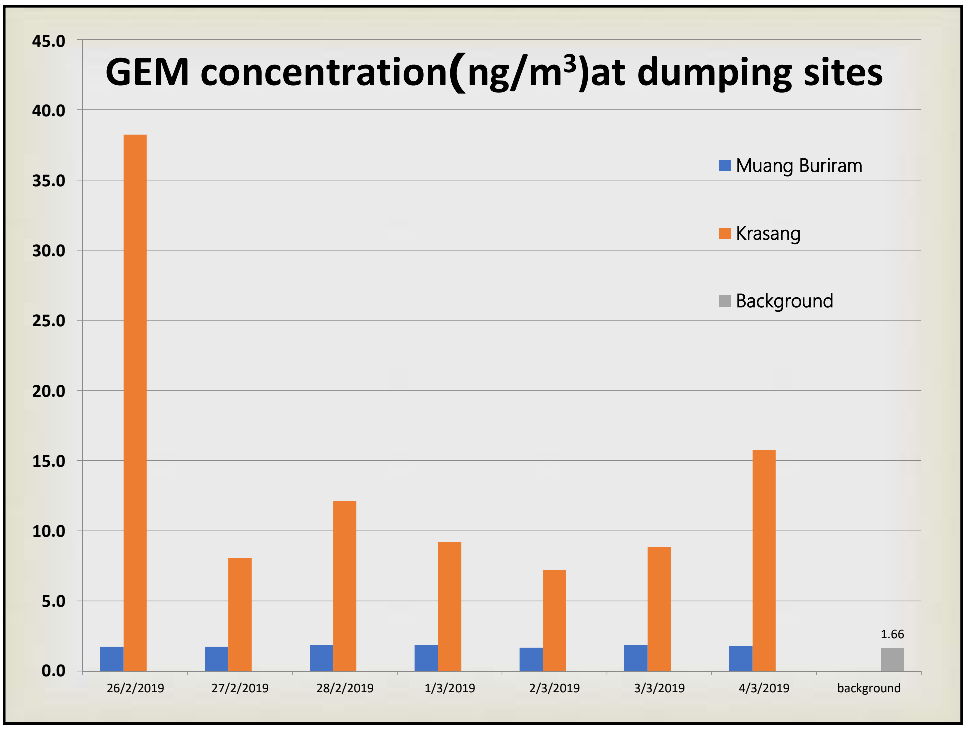
50 open dumping sites

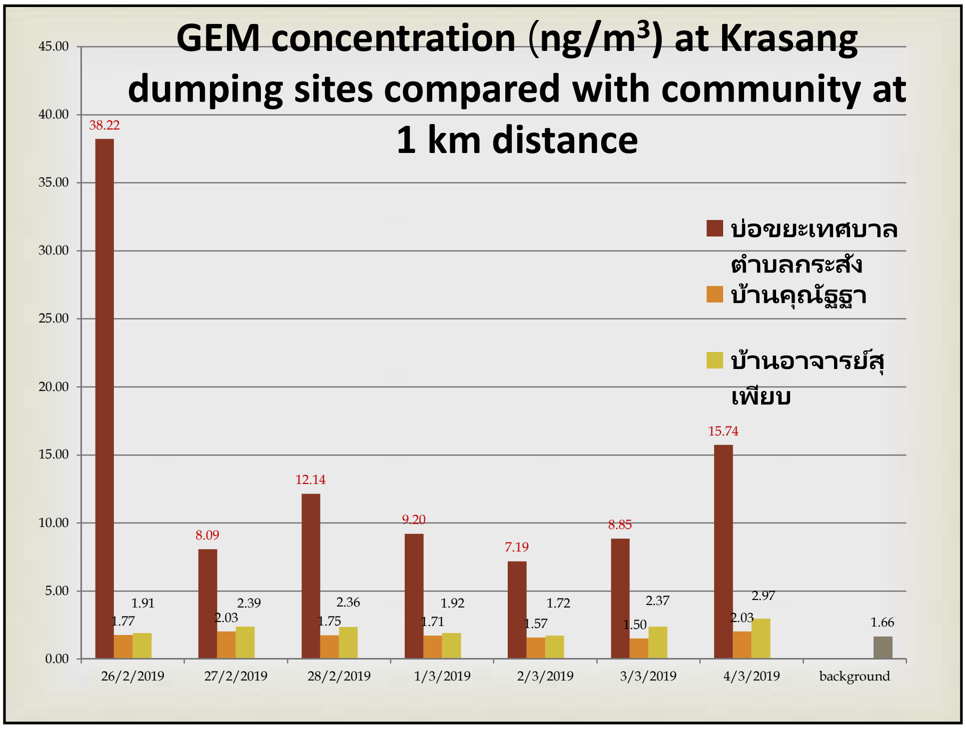
(red dot = locations)

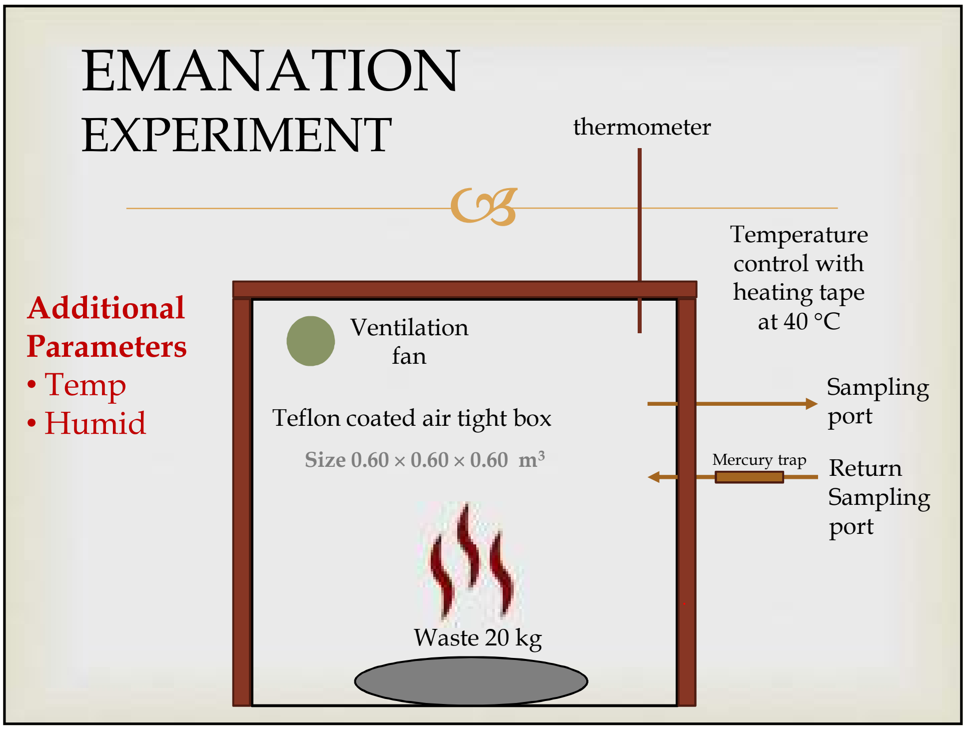

Muang Buriram
LANDFILL
Krasang
OPEN DUMPING SITE


Municipal Waste
COMPOSITION
20%
14%
9%
13%
6%


Average concentration of PM2.5
350
300
250
200
150
100
50
0
µg/m³
24-hrs NAQS for Thaila
Krasang
Buriram
inappropriate management
Good management


GEM concentration(ng/m³)at dumping sites
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Muang Buriram
Krasang
Background
1.66
26/2/2019
27/2/2019
28/2/2019
1/3/2019
2/3/2019
3/3/2019
4/3/2019
background


GEM concentration (ng/m³) at Krasang dumping sites compared with community at 1 km distance
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
บ่อขยะเทศบาลตำบลกระสัง
บ้านคุณัฐฐา
บ้านอาจารย์สุเพียบ
38.22
1.77
1.91
8.09
2.03
2.39
12.14
1.75
2.36
9.20
1.71
1.92
7.19
1.57
1.72
8.85
1.50
2.37
15.74
2.03
2.97
1.66
26/2/2019
27/2/2019
28/2/2019
1/3/2019
2/3/2019
3/3/2019
4/3/2019
background


EMANATION EXPERIMENT
thermometer
Temperature control with heating tape at 40 °C
Additional Parameters
• Temp
• Humid
Ventilation fan
Teflon coated air tight box
Size 0.60 × 0.60 × 0.60 m³
Sampling port
Mercury trap
Return Sampling port
Waste 20 kg

Mercury emanation sampling

MUNICIPAL WASTES

Papers

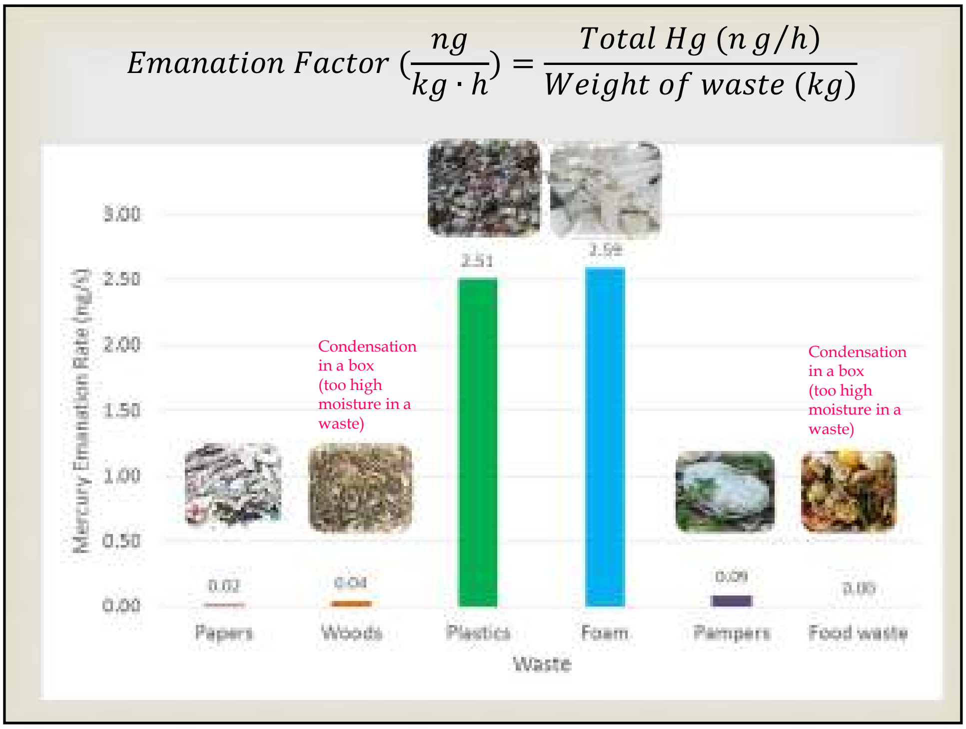
Leafs/wood

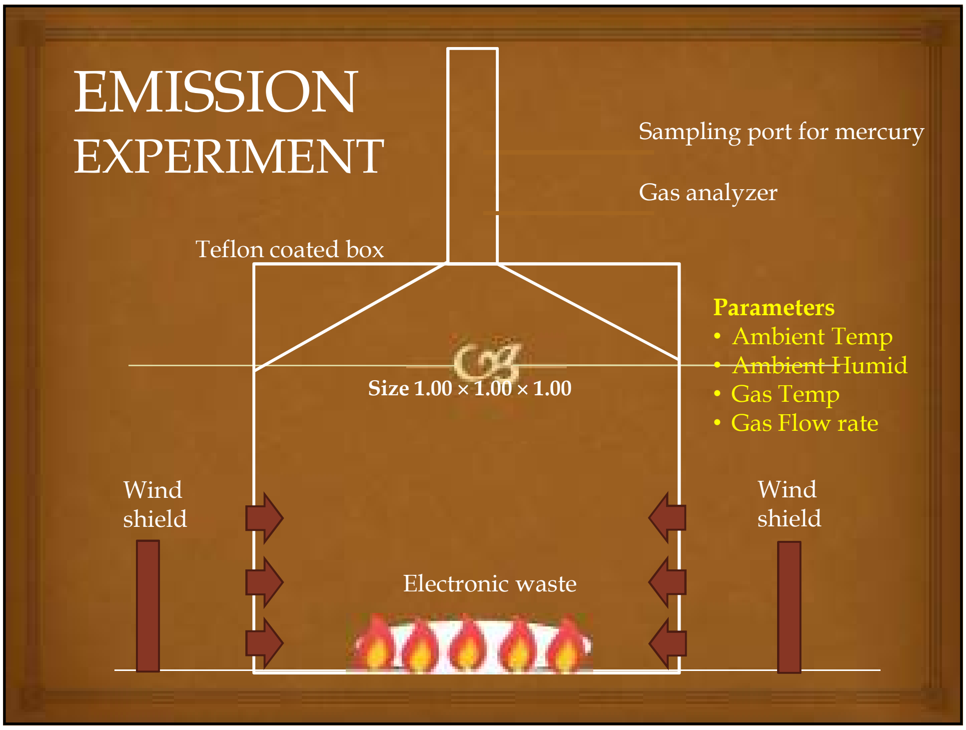
Plastics

Foam

Pampers

Food Waste


$$Emanation\ Factor\ (\frac{ng}{kg \cdot h}) = \frac{Total\ Hg\ (ng/h)}{Weight\ of\ waste\ (kg)}$$
Mercury Emanation Rate (ng/s)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.02
0.04
2.51
2.59
0.09
0.00
Papers
Woods
Plastics
Foam
Pampers
Food waste
Waste
Condensation in a box (too high moisture in a waste)
Condensation in a box (too high moisture in a waste)


EMISSION EXPERIMENT
Sampling port for mercury
Gas analyzer
Teflon coated box
Size 1.00 × 1.00 × 1.00
Parameters
• Ambient Temp
• Ambient Humid
• Gas Temp
• Gas Flow rate
Wind shield
Wind shield
Electronic waste

Emission sampling

Calculation of Mercury emission factors

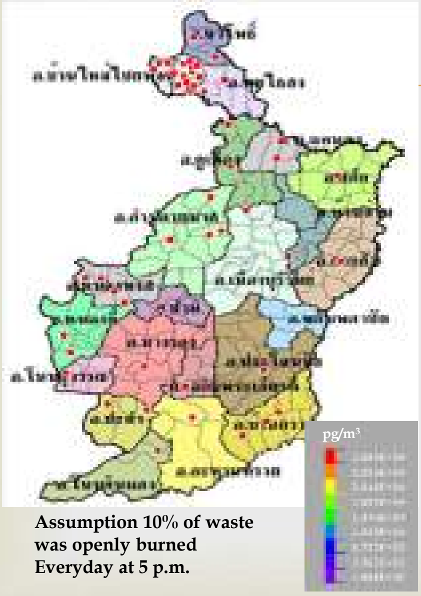
$$Stack\ conc.\,(ng/m^3) = \frac{Total\ Hg\ (ng)}{sampling\ rate\ \left(\frac{m^3}{min}\right) \times sampling\ time\ (min)}$$

$$Emission\ Factor\ \left(\frac{ng}{kg \cdot s}\right) = \frac{Stack\ conc.\,(ng/m^3) \times flow\ rate\ (m^3/sec)}{Weight\ of\ waste\ (kg)}$$

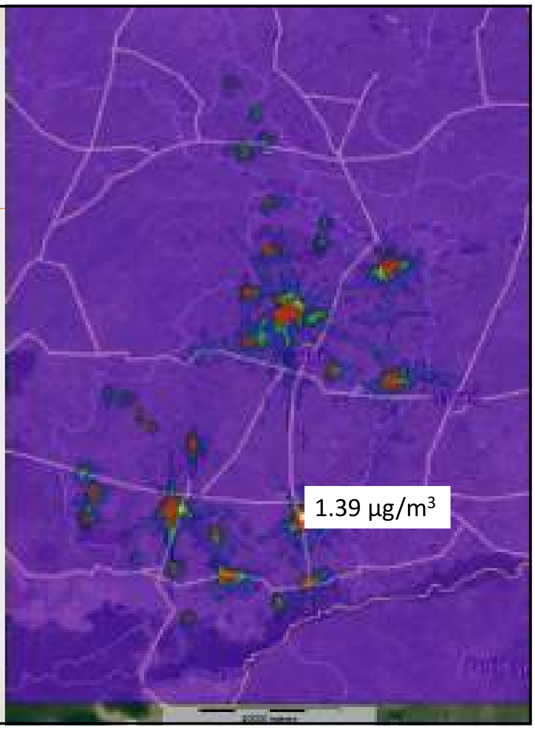
Mercury emission factor from municipal wastes

AERMOD

mercury dispersion
from opened burning



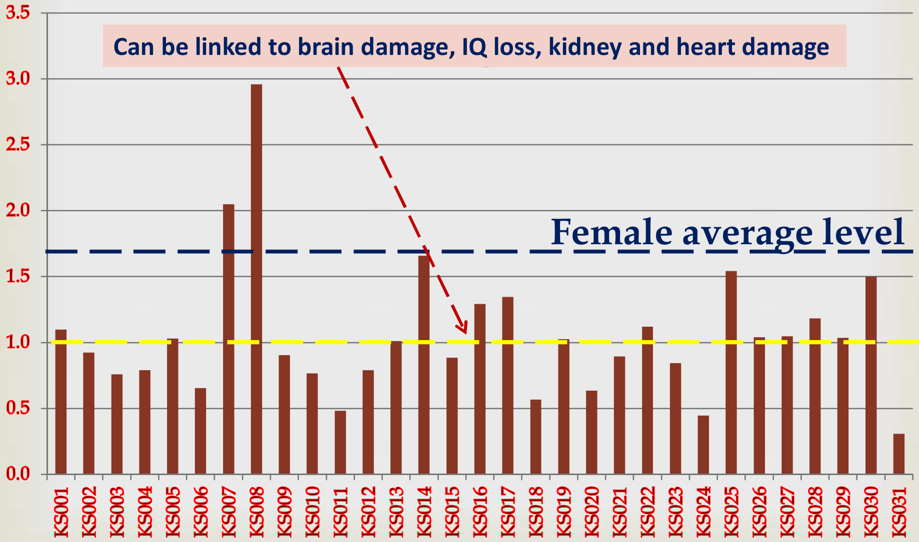
Assumption 10% of waste
was openly burned
Everyday at 5 p.m.



Mercury in Hair at Krasang municipality

Hg in human hair analyzed by thermal desorption method

Hg Concentration in hair (ppm), n=31



Mercury wet deposition monitoring (ERTC)

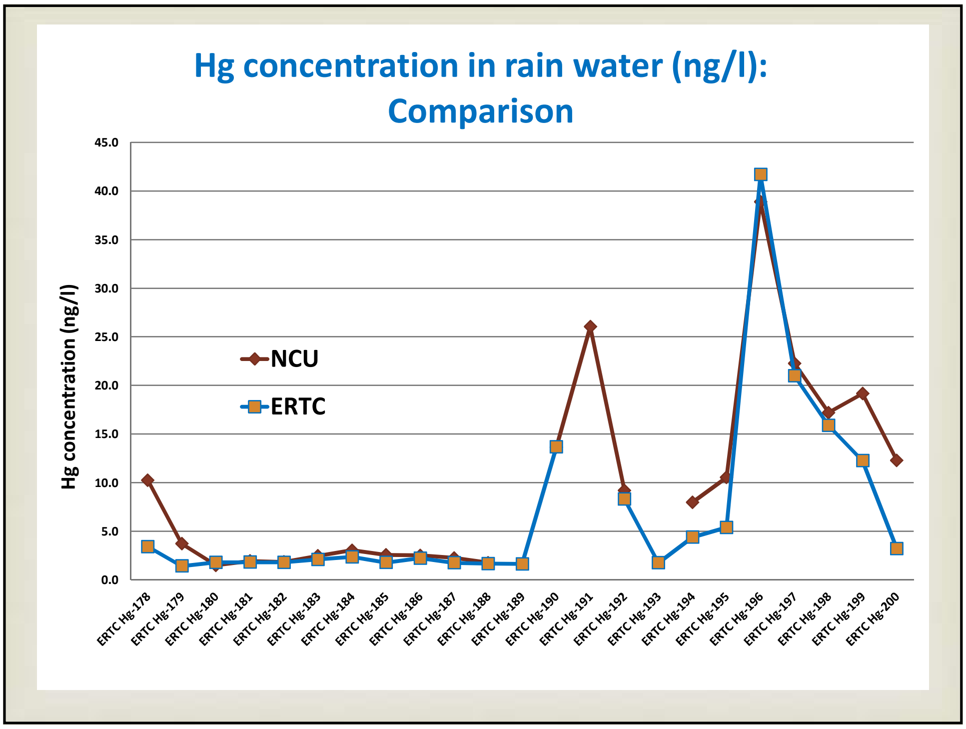
Hg wet deposition sampling with automatic rain sampler donated by Taiwan EPA has started since 27 September 2016

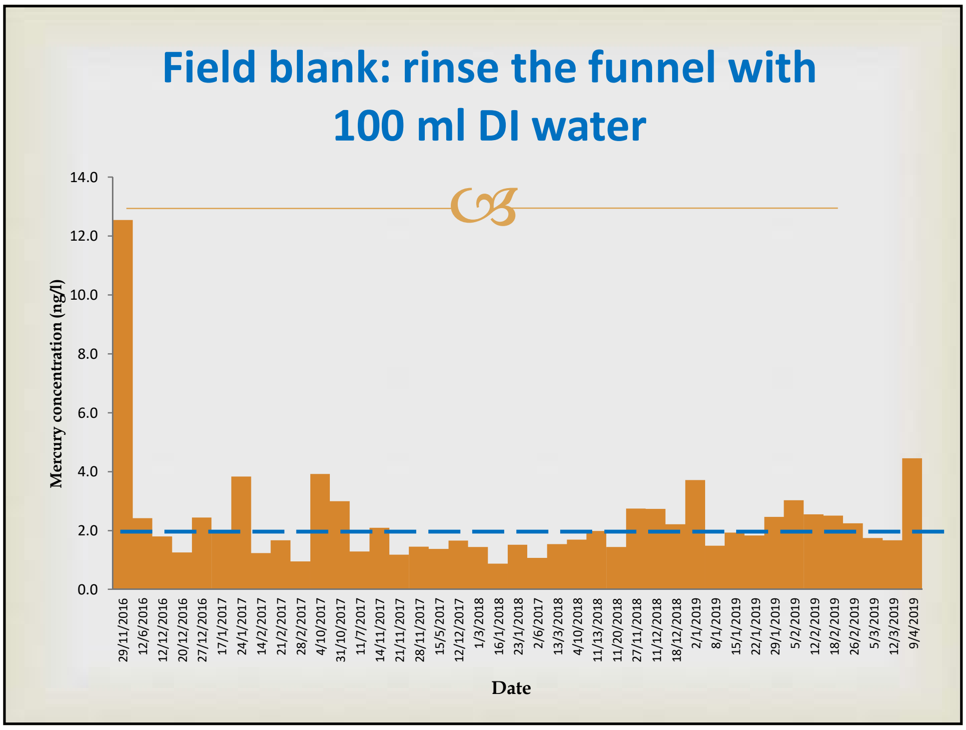
Guidelines for sampling and measurement

- APMMN Field Sample SOP
- EPA method: Method 1631 revision E

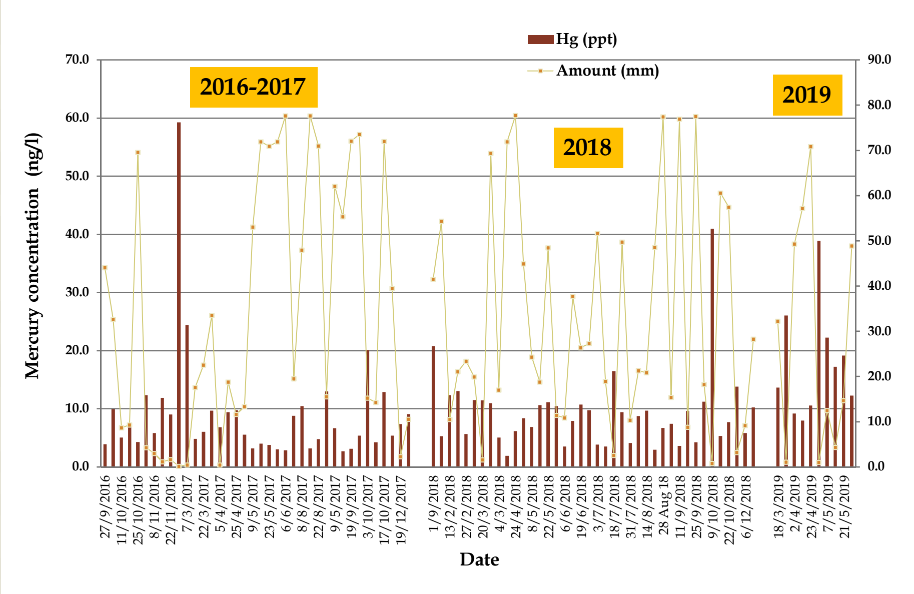
Acknowledgement

ERTC would like to acknowledge the National Central University, Taiwan, especially Prof. Sheu and Mr. Da-Wei, for their never ending supports to analyze mercury wet deposition samples from Thailand.

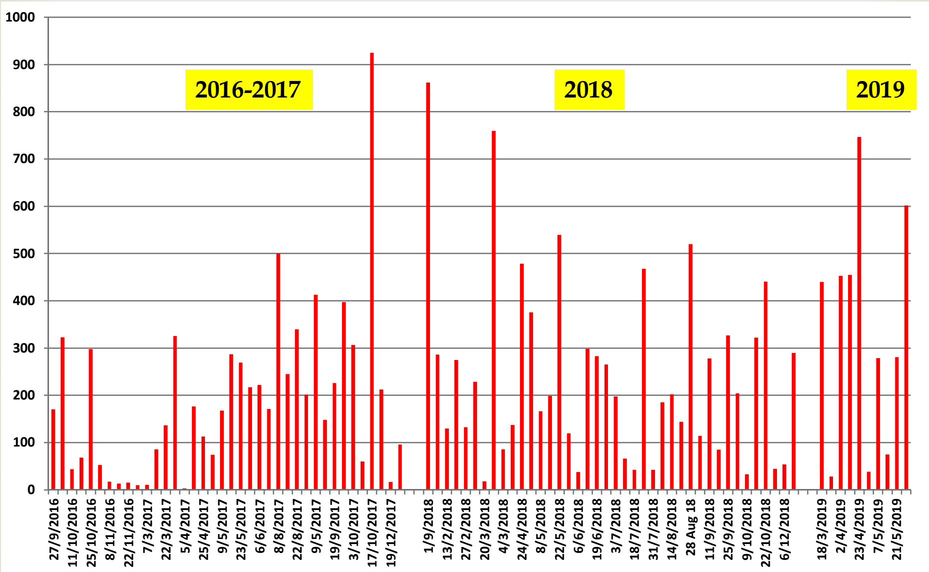

Hg concentration in rain water (ng/l): Comparison
Hg concentration (ng/l)
NCU
ERTC
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
ERTC Hg-178
ERTC Hg-179
ERTC Hg-180
ERTC Hg-181
ERTC Hg-182
ERTC Hg-183
ERTC Hg-184
ERTC Hg-185
ERTC Hg-186
ERTC Hg-187
ERTC Hg-188
ERTC Hg-189
ERTC Hg-190
ERTC Hg-191
ERTC Hg-192
ERTC Hg-193
ERTC Hg-194
ERTC Hg-195
ERTC Hg-196
ERTC Hg-197
ERTC Hg-198
ERTC Hg-199
ERTC Hg-200


Field blank: rinse the funnel with 100 ml DI water
Mercury concentration (ng/l)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
29/11/2016
12/6/2016
12/12/2016
20/12/2016
27/12/2016
17/1/2017
24/1/2017
14/2/2017
21/2/2017
28/2/2017
4/10/2017
31/10/2017
11/7/2017
14/11/2017
21/11/2017
28/11/2017
15/5/2017
12/12/2017
1/3/2018
16/1/2018
23/1/2018
2/6/2017
13/3/2018
4/10/2018
11/13/2018
11/20/2018
27/11/2018
11/12/2018
18/12/2018
2/1/2019
8/1/2019
15/1/2019
22/1/2019
29/1/2019
5/2/2019
12/2/2019
18/2/2019
26/2/2019
5/3/2019
12/3/2019
9/4/2019
Date

Mercury concentration in rain water at ERTC



Mercury wet deposition (ng/m^2)



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Volume weighted average concentration

Year	Total Hg dep.(ng/m²)	Total PPT (mm)	VWA (ng/L)	Number of samples
2016-2017	7356.5	1286.6	5.72	38
2018	9736.9	1316.1	7.40	40
2019*	3396.4	292.1	11.6	10

Thank you for your kind attention

USP
THE INSTITUTE OF APPLIED SCIENCES
Faculty of Science, Technology and Environment

Mercury monitoring activities in the Pacific Island Region

An update from Fiji

15 August, 2019

Jakarta, Indonesia

APMMN 2019- Dr. Vincent Lal, Manager Analytical Services

Background

- The Institute of Applied Sciences (IAS) is based at the University of the South Pacific (USP) in Fiji

IAS Analytical laboratories

- Service as a regional laboratory for the 12 member countries of USP
- Biofuel, Food, Water, Microbiology and Natural Products Research
- Facilitating regional research and commercial testing of mercury in different matrices since 2004
- Accredited to ISO/IEC 17025 since 2004, mercury is an accredited test (food and water samples) since 2006

Past experience and projects

- Thesis

  Kumar, Maureen C. and Aalbersberg, William G.L. and Mosley, Luke M. (2004) *Mercury levels in Fijian seafoods and potential health implications*
- FAO Pacific Islands Food Composition Tables (2004)

  The laboratory was accredited for 22 nutritional parameters, mercury testing was developed but was accredited in 2006
- Laboratory analysis of mercury in tuna since 2004 – 2019 at approximately 1000 samples per year

APMMN 2019 Jakarta, Indonesia

Seafood Sample	n	Average Length (cm)	Average Weight (kg)	Range [Hg] (mg/kg)	Average [Hg] (mg/kg) ± SD
Albacore Tuna	31	72.7	21.3	0.03 – 1.01	0.34 ± 0.22
Yellowfin Tuna	24	71.3	15.2	<0.02 – 0.40	0.11 ± 0.11
Skipjack Tuna	12	45.7	2.4	<0.02 – 0.16	0.06 ± 0.04
Bigeye Tuna	3	103.3	28.3	0.28 – 0.80	0.53 ± 0.21
Marlin	5	167.6	67.4	0.45 – 5.60	1.76 ± 1.94
Reef fish	5	17.2	0.09	<0.02 – 0.04	0.04 ± 0.01
Barracuda	4	61.25	1.32	0.18 – 0.38	0.26 ± 0.07
Mussels	3	-	-	<0.02 – 0.04	0.03 ± 0.01
Shellfish	3	-	-	<0.02 – 0.05	0.03 ± 0.01
Crab Meat	3	13.3	-	0.03 – 0.07	0.05 ± 0.02
Parrot fish	2	31-35	0.75	<0.02	<0.02
Wahoo	1	92	6	0.17	0.17
Goatfish	1	28	0.31	0.03	0.03
Rabbit fish	1	32	0.5	0.15	0.15
Peacock cod	1	33	0.62	<0.02	<0.02
Unicorn fish	1	39	1.07	<0.02	<0.02
Opah	1	111	65	0.27	0.27

Hg levels (range and average) in different fresh fish and shellfish from the Fiji islands, with length and weight data where available. (note: n = number of samples, SD = standard deviation)

Canned Fish Type	n	[Hg] range (mg/kg)	[Hg] average (mg/kg) ± SD
Canned Albacore	6	0.16 – 0.27	0.20 ± 0.03
Canned Skipjack	9	0.06 – 0.11	0.08 ± 0.02
Canned Tuna in oil	3	0.05 – 0.16	0.09 ± 0.05
Canned Mackerel	6	0.18 – 0.22	0.21 ± 0.01
Canned Salmon Style Mackerel	6	0.17 – 0.29	0.23 ± 0.05

Hg levels in canned fish sold in the Fiji islands. (note: n = number of samples, SD = standard deviation)

The total Hg levels in some of the large predatory fish species (marlin and swordfish) exceeded the Food and Agriculture Organization (FAO)/World Health Organization (WHO) Codex Alimentarius guideline level of 1 mg/kg. Other types

The total hair [Hg] in all men exceeded the USEPA safety limit of approximately 1µg/g in hair and 85% of them exceeded the recommended FAO/WHO safety limit of 3µg/g in hair. Only 69% of the childbearing age women had total hair [Hg] below the FAO/WHO safety limit and 6% of the childbearing age women had hair [Hg] above WHO safety limit of 10 µg/g, an earlier safety limit derived from the Iraqi data which estimated level at which health effects occur but did not include some uncertainty factors included in later safety limit. In the total fish consuming population 44% of the participants have exceeded the FAO/WHO safety limit.

Recent projects and capacity building in Fiji

- IDEA Inc Consultants and MOEJ (Government of Japan) - 2018 training and mercury monitoring studies in ambient air, human hair and ocean water in Fiji, PNG and Samoa
- APMMN workshop in Philippines (2018), a wet deposition sampler for mercury to be set-up in Fiji in 2019
- Taoyuan, Taiwan (ROC) – 2019 Training workshop on mercury wet deposition sampler and laboratory analysis

Recent reports on mercury

- Water (Ocean) and near shore in Laucala bay and Suva harbour, Fiji

Site	Depth (m)	Concentration (ng/L)
1	10	0.41
2	10	0.83
3	1	1.76

- Air (ambient) from Laucala bay, Fiji – (1.2 ng/m3)
- Hair (human) for USP-IAS Laboratory staff – (1.46 ng/mg)

Current instrument capacity for heavy metals

- Flow Injection Mercury System (using FIA cold vapor AA)
- ICP-OES
- MP-AES
- GF-AAS
- IDEA Inc Consultants – ambient air sampler (with pump)
- APMMN – set-up of sampler system for wet deposition (2019)

Future directions

- Training on mercury samplers, sampling and laboratory analysis
- Method development and further capacity building in laboratory analysis (e.g. matrices – air, biological samples, reference methods or instruments)
- Postgraduate student (MSc. And PhD) and Postdoctoral research
- Strengthen collaboration (MoU, LoA)
- Accreditation of test methods (technical assistance from experts)

Acknowledgements

- USP-IAS graduate assistants and laboratory technicians
- Late Prof. William Aalbersberg – initiating Hg testing capacity in Fiji
- IDEA Consultants Inc and MOEJ (Government of Japan)
- US EPA
- APMMN
- Taiwan EPA
- National Central University (Prof. Guey-Rong Sheu and his team)

Thank you

8th Annual Asia-Pacific Mercury Monitoring Network Partners Meeting
August 14-16, 2019 Ritz Carlton Hotel, Jakarta, INDONISIA

Partner and Stakeholder Updates from Sri Lanka
"Present Status of Mercury Monitoring & Future Planning"

Anurudda Karunarathna, PhD

Senior Lecturer in Environmental Engineering, University of Peradeniya, SRI LANKA

Progress of atmospheric mercury monitoring activities in Sri Lanka

- MoU between Ministry of Environment & University of Peradeniya (28th February, 2019)

This MOU is made and entered into at Battaramulla in the Democratic Socialist Republic of Sri Lanka on this 28th day of February Two Thousand Nineteen (28.02.2019) by and between the **Secretary of the Ministry of Mahaweli Development & Environment, "Sobadam Piyasa", 416/C/1, Robert Gunawardhana Mawatha, Battaramulla, Sri Lanka** (hereinafter referred to as the **MOMD&E)**, which term shall include his assign and or successors in his Office).

A N D

The Vice-Chancellor of the University of Peradeniya, Peradeniya Sri Lanka and referred to as the **University**, which term shall include her assign and or successors in his Office)

a.
resources of University on mercury monitoring activities.

b.
University to improve the implementation of mercury related activities.

c. MOMD&E and University agree to conduct joint workshops, confere academic meetings sharing the existing resources of the both parties.

AND WHEREAS the MoMD&E and University seek to enhance relations between Institutes developing Research Collaboration on **Investigation of mercury related issues and monitoring in Sri Lanka**.

2

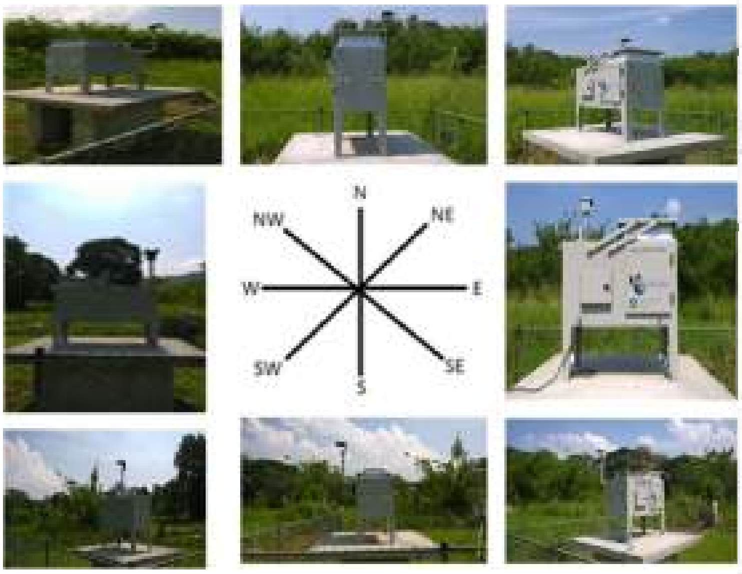
Progress of atmospheric mercury monitoring activities in Sri Lanka

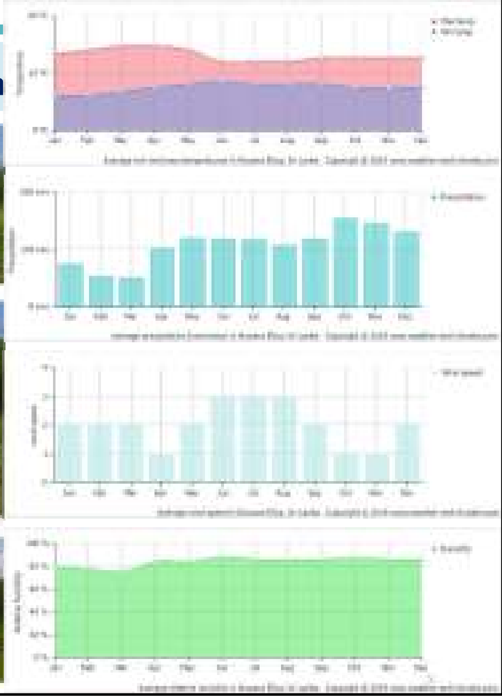
- Installation of wet deposition sampler at University of Peradeniya

Wet deposition sampler at University of Peradeniya

- Adjacent to University weather station
- Surrounded by fallow lands (grass, bush)
- Senior technicians (Ms Darshini) at Department of Agricultural Engineering

Wet deposition sampler at University of Peradeniya





Wet deposition sampler at University of Peradeniya

- Sample collection started from early April, 2019
- Senior staff technician Ms. Dharshini participated in recent training program (April 10-15, 2019) at National Central University, Taiwan
- No major rainfall events in May, 2019
- Rainy season will be starting from mid-June
- Renovation of a separate laboratory facility for equipment cleaning and sample processing is in progress
- Plan to continue sampling and send samples to National Central University, Taiwan

Site	Sample Name	Date On	Date Off	Date Analyzed	Sample Type	Conc. (ppt)
APLK01	SL-190412	4/9/2019	4/12/2019	4/16/2019	Sample	7.87

6

PART 2

PRESENT STATUS OF POLLUTION CONTROL & MONITORING

Elemental Mercury & Mercury Containing Substances Flow

- No primary mercury mining in Sri Lanka
- No Artisanal and small-scale gold mining (ASGM)
- According to the Customs Bureau, around 500 kg of mercury is imported annually, mainly from India
- Industrial, power generation & manufacturing sector
  - No production of chlor-alkali, acetaldehyde and VCM in Sri Lanka
  - Major point sources - Coal-fired power plants (01), Cement clinker production facilities (01)
- Small and medium industries
  - Gem & Jewelry industry - Estimation by MMDE, there are 200,000 traditional goldsmiths in Sri Lanka, and ~ 2,000 kg of mercury is used per year
- Health sector
  - Thermometers, sphygmomanometers, dental amalgam, CFL /mercury bulbs, mercury containing laboratory chemicals. Initiating phasing out of Mercury containing Sphygmomanometers (BP Apparatus) in 2014
  - It is estimated that as much as 5% of mercury waste in the environment, is generated by the Healthcare institutions

Present status of hazardous & general waste management

Industrial hazardous waste
Incineration (Cement kiln)

Agrochemical & industrial effluents
contribute to non-point sources

Open dumping of
Household waste
[Land/ Rivers/ Ocean]

Incineration (healthcare waste)
Landfilling (20 TPD of MSW)
Recycling (E-waste, informal)

Export
(scrap metal, recycled-E-waste)

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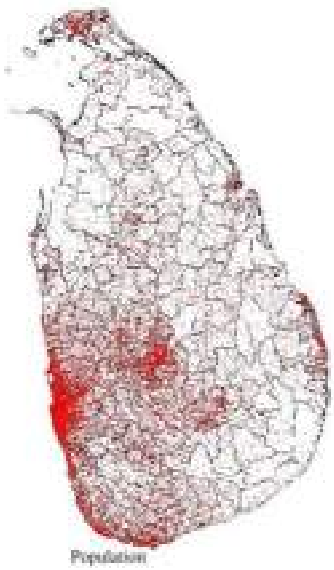
Solid waste open dumps



Population

Sanitary disposal sites for residual waste

1st Sanitary Landfill started in 2014
20 Metric Tons/ Day

2nd Sanitary Landfill (Aruwakkalu)
500 Metric Tons/ Day (by 2020)

11

Research, assessment and monitoring

Table 1: Concentrations and quality rating scales for heavy metals in leachate

Metal	Concentration in leachate ($mg\ L^{-1}$)	Tolerance limit ($mg\ L^{-1}$)		Quality rating scale (%)	
		Surface water	Drinking water	Surface water	Drinking water
Cu	0.137	3.0	1.50	4.6	9.1
Cr	0.037	0.1	0.05	37.0	74.0
Cd	0.031	0.1	0.005	31.0	620.0
Ni	0.084	0.3	-	28.0	-
Pb	0.054	0.1	0.05	54.0	108.0
Zn	0.173	5.0	5.0	3.46	3.46

- ✓ National Standards for wastewater (National Environment Act, No. 47 of 1980, Order published under the Gazette Notification No. 1534/18 dated 01.0.2008)

Category	Tolerance Limit
Discharge of industrial waste in to Inland surface waters	0.0005 mg/L
Industrial waste discharged on land for irrigation purpose	0.01 mg/L
Industrial and domestic waste discharged into marine coastal areas	0.01 mg/L
Discharge of effluents into public sewers with central treatment plants	0.005 mg/L

- ✓ Mercury is not yet included in the National Air Quality Monitoring Programme

- ✓ The National Steering Committee on Minamata convention is already established
- ✓ Both Marine Environmental Pollution Prevention Authority (MEPA) and Central Environmental Authority (CEA) have to play vita role
- ✓ Collaboration between ministry of Environment and Academic/ Research institutes continues
  - ✓ Biological Monitoring (Human especially Jewelers and marine fish)
  - ✓ Environmental Monitoring (Mercury in rainwater, air and soil)

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Capacity development

- **Our Strength**: Human resources, basic facilities, multidisciplinary & collaborative research
- **Training Needs**: Mercury Monitoring (for academics, researchers, technicians)
- **Collaborative Research & Development**: Policy & legislation formulation, environmental assessment, monitoring
- **Knowledge & Technology Transfer**: Recovery and recycling, alternative technologies
- **Networking**: APMMN

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Acknowledgement

- Ministry of Environment and Forestry, Indonesia
- Environmental Protection Administration, Taiwan
- US EPA, NADP and
- Prof. Shue, Mr. Da-Wei and others at National Central University, Taiwan
- Ministry of Environment, Japan
- IDEA Consultants, Inc.
- NIMD, Japan
- All partners of APMMN

END

14

Issues & Challenges

1) **Insufficient infrastructure for MSW, Hazardous, Industrial waste management**
   - Collection & Transport
   - Treatment, processing and
   - Disposal
2) **Policy & Regulations**
   - Gaps in monitoring and regulating (prioritization)
   - Implementation
3) **Lack of Research and Development initiatives**
   - Research and development infrastructure
   - Research funds
4) **Knowledge / Awareness**
   - Academics, researchers, administrators
   - Public

Research initiatives: Material Flow Analysis

- Hazardous waste flow with general municipal solid waste
- Contamination issues
- No proper data on quantities, fate & transport
- Considerable number of small scale metal recovering (smelting) and processing businesses processing industrial & post-consumer metals and E-waste

Vision 2030: Circular Economy

Material Flow Analysis / Life Cycle Analysis

VIETNAM ENVIRONMENT ADMINISTRATION (VEA)
NORTHERN CENTER FOR ENVIRONMENTAL MONITORING (NCEM)

UPDATE 2019 ON MERCURY MONITORING IN VIETNAM

Mrs. NGUYEN THI NGUYET ANH
Vice Director of NCEM, VEA

2019 ASIA-PACIFIC MERCURY MONITORING NETWORK WORKSHOP

Jakatar - August, 2019

CONTENTS

GENERAL INTRODUCTION

INTRODUCTION OF VIETNAM

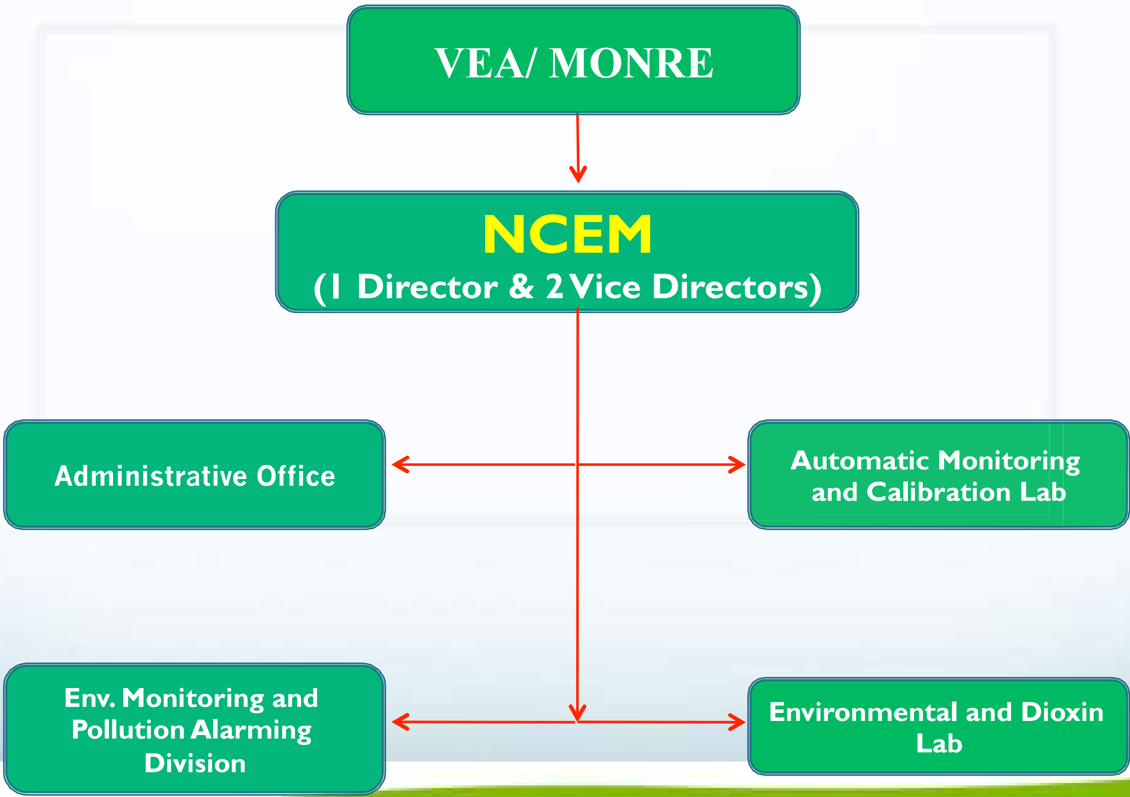
- Located at the Southeast of Asia
- Area: 331.210 km^2
- Population: 96,2 million
- Density: 290 people/km2
- Urban population: 34,4 %
- Rural population: 65,6 %

INTRODUCTION OF VIETNAM

National Technical Regulation on Environment for Mercury

No.	Component	Maximum value
1.	Surface water quality	
	- Water supply, Irrigation water purposes	0.001 mg/L
	- Waterway traffic	0.002 mg/L
2.	Underground water quality	0.001 mg/L
3.	Sea water quality	
	- Aquaculture and aquatic conservation areas	0.001 mg/L
	- Beach and amusement areas	0.002 mg/L
	- Other areas	0.005 mg/L
4.	Ambient air quality (hazardous substances)	0.3 $\mu g/m^3$ (24 hours)
5.	Sediment quality	
	- In surface water	0.5 mg/kg
	- In sea water	0.7 mg/kg

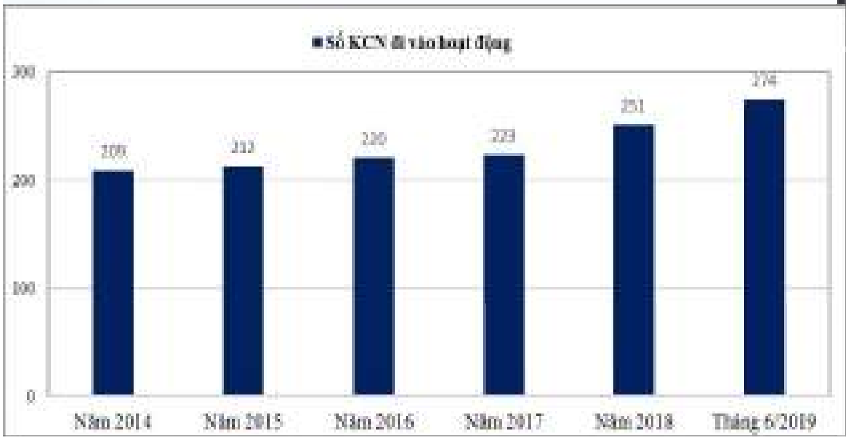
About NCEM, VEA



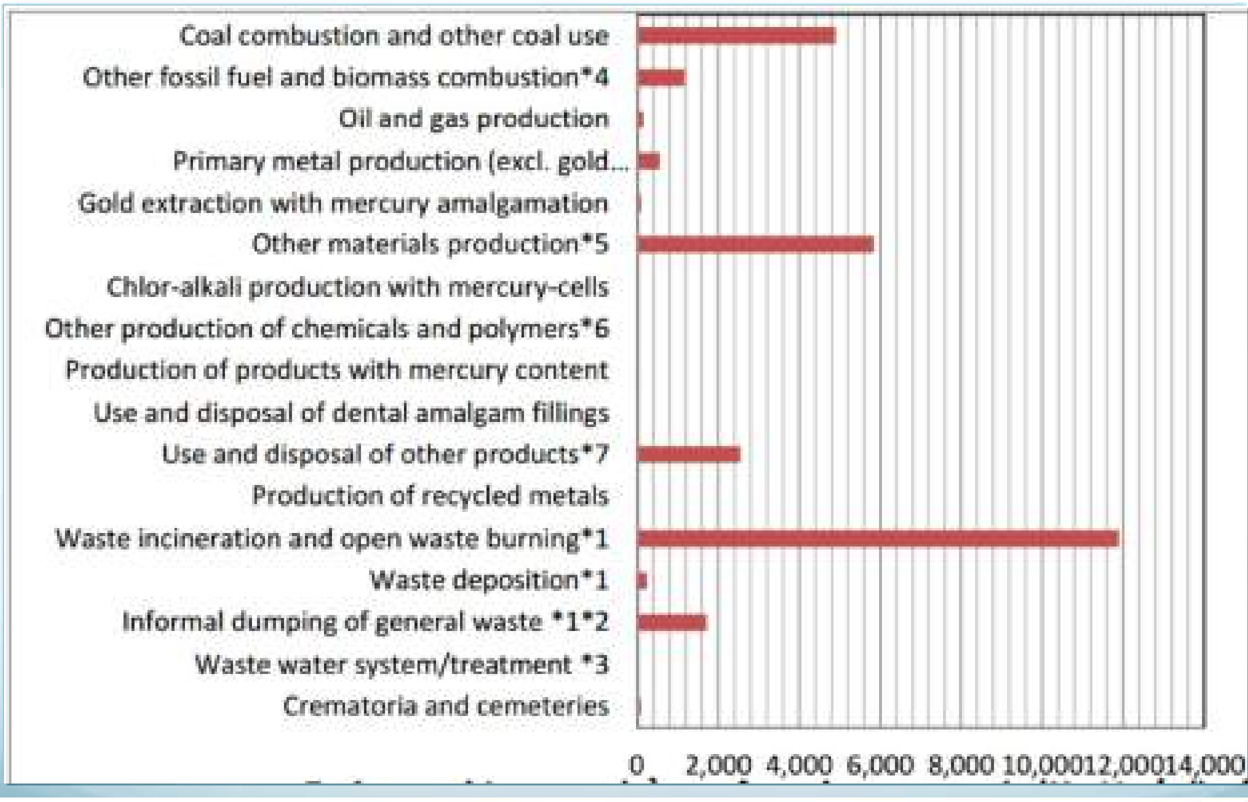
SOURCES OF MERCURY

SOURCES OF AIR POLLUTION

- Transportation
- Industrial sector
- Incinerator and waste open burning
- Construction
- Agriculture and craft villages
- Gold mining, thermometer, etc…
- Landfill



Estimated mecury releases to air



Kg Hg/year

Source: Report on National Mercury Survey, MoIT -2016)

UPDATE ON MERCURY MONITORING ACTIVITIES IN VIETNAM

Asia Pacific Mercury Monitoring Network

Hg

Mercury monitoring activities in environment in Vietnam

- **2005:** Monitoring mercury in river and water, soil, sedimen
- **2015**: Monitoring mercury in stack (cement, steel, pow plant, incinerator).

  - Mercury Emissio Inventory for power plant industrial (201

  - Mercury Emissio Inventory for steel a cement industrial (2017-2018)

  - Emission Survey Domestic Solid Was Incinerator - includir Mercury (2019)

Mercury monitoring activities in atmosphere in Vietnam

- **2010:** Joint the 7-SEA program.
- **2012**: set up 01 automatic station for air quality monitoring in Hanoi *(including Hg parameter)*.
- **2014**: Vietnam has joined the Asia-Pacific Mercury Monitoring Network (APMMN).

Mercury monitoring activities in atmosphere in Vietnam

Mercury monitoring activities in atmosphere in Vietnam

- **From 2016 - 2019**: participate in APMMN's activities *(02 wet samplers, 01 dry sampling site for Hg analysis in gold trap)*

Mercury monitoring in rain water

Site Information

Country	Site ID	Site Name	County	Latitude	Longitude	Elevation	Status	Type
Indonesia	APID01	MOEF	Jakarta	-6.2088	106.8455		Active	Wet
Philippines	APPH01	Clark	Pampanga	15.177	120.536	184	Active	Wet
Taiwan	APTW01	Lulin	Nantou	23.4689	120.8729	2862	Active	Both
Thailand	APTH01	ERTC	Pathum Thani	14.0462	100.7143	6	Active	Wet
Sri Lanka	APLK01	U of Peradeniya	Central Province	7.2518	80.5946	481	Active	Wet
Vietnam	APVN01	CEM	Hanoi	21.0487	105.8829		Active	Wet
Vietnam	APVN02	Thai Nguyen	Thai Nguyen	21.5987	105.8231		Active	Wet

Mercury monitoring in rain water

- Operating the wet deposition sampler in Hanoi, Vietnam from 2014;
- Taking sample every month and send the samples to NCU for Hg analysis

Mercury monitoring in rain water

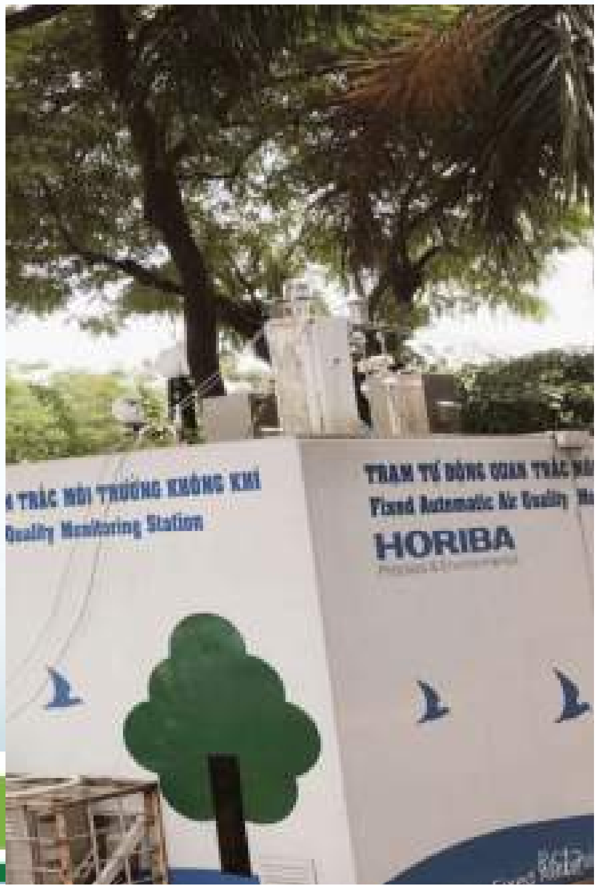
- Setting up the second wet deposition sampler in Thai Nguyen province from March 2019;
- Taking sample every month and send the to NCU for Hg analysis

SAMPLING FOR GASEOUS MERCURY IN AMBIENT AIR

- Starting time: 2019
- Monitoring site: Hanoi, Vietnam
- Using tool kit from Japan (gold traps)
- Collected samples were sent to Japan for analysis Hg

SAMPLING FOR PARTICULATE MERCURY IN AMBIENT AIR

- Starting time: 2017 (for research);
- Monitoring site: 5 provinces in Vietnam;
- Using medium volume instrument to take sample PM2.5 (Comde Deredan) and analyse Hg and some other heavy metal in the filter.



New instruments for mercury analysis in NCEM's laboratory

Mercury analyser
NIC WA-5F

New instruments for mercury analysis in NCEM's laboratory

Mercury Analyser
NIC RA-5A

Update on instruments for mercury monitoring in NCEM - VEA

Instrument	Method	Quantity	Note
Wet deposition sampler	APMMN SOP	02 sampler	01 new instrument
Isokinetic sampler	US EPA 29	03 sampler	01 new instrument
Mercury on-site sampling and analysis (Apex Airinstruments)	US EPA 30A	01 module	
Mercury analyzer (AAS)	US EPA 29	01 analyzer	
Mercury analyzer (ICP-MS)	US EPA 200.8	02 analyzer	
Mercury analyzer (SMS 100)	US EPA 1631	01 analyzer	
Mercury analyzer (NIC WA-5F)	US EPA IO-5	01 analyzer	New instrument
Mercury analyzer (NIC RA-5A)	US EPA 7470A	01 analyzer	New instrument
PM2.5 Sampler (Comde Deredan)	US EPA IO-5	03 sampler	02 new instrument

CHALLENGES

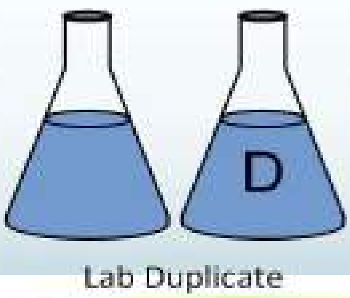
Challenges

- ➢ Limitation on capacity (technical and finance resources)
- ➢ Limited mercury monitoring site
- ➢ Big gaps of mercury monitoring data
- ➢ Old and small area for the laboratory (difficult to control the lab's environment condition and avoid contamination…)
- ➢ Not easy to have the pure chemical for upper trace level analyse, cleaning mercury sampling tools

Challenges

- QA/QC for sampling, reservation and deliver to NCU Taiwan

Travel Blank



FUTURE PLAN

Future plan

- Capacity building of mercury sampling and analyse
- Set up a mercury atmospheric monitoring program/network (dry and wet) in Vietnam
- Doing analyse the rain water and gold trap samples in NCEM laboratory
- Building the new office (big area and modern design for the laboratory)
- Enhancing the collaboration and sharing experience between APMM countries (for example: learning by doing in the lab in US, Japan, Taiwan, Thailand…)


Thank you!
TERIMA KASIH!

8th Annual Asia-Pacific Mercury Monitoring Network Partners Meeting
12-16 August 2019 Jakarta, Indonesia

Environmental monitoring network in Mongolia

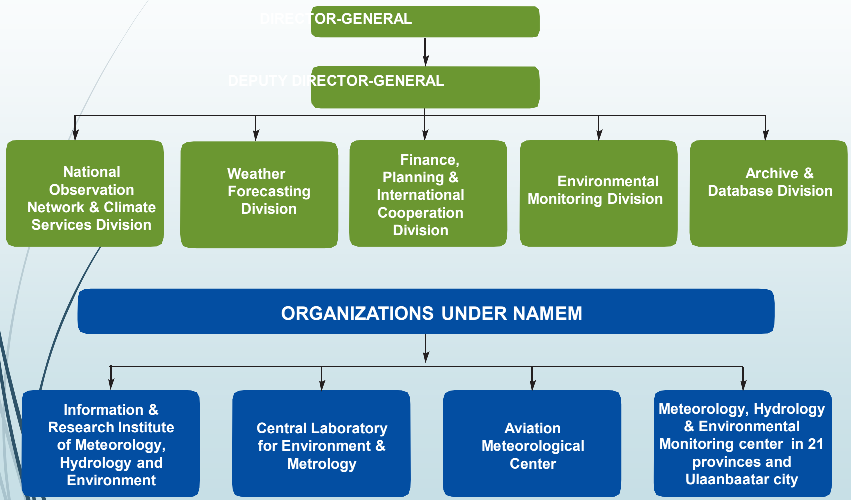
S.Enkhmaa
National Agency for Meteorology and Environment Monitoring

Contents

The mission of the NAMEM

to monitor state of water, weather and environmental, to provide actual and preventive data and information for social immediate needs, to warn from probable natural disasters.

Organizational structure of NAMEM



Activities of the NAMEM

- To provide national network of meteorology and environmental monitoring with integrated professional and methodological guidance
- to plan and implement the meteorology and environmental monitoring network
- to ensure uniformity of domestic and international data exchange and compliance with integrated standards and measurement technology

Environmental monitoring network in Mongolia

№	Monitoring network	Stations, point
1	Environmental monitoring laboratories	22
2	Surface water quality monitoring	194
3	Soil quality monitoring	390
4	Radioactive monitoring	37
5	Acid deposition monitoring	2
6	Waste water monitoring	31
7	Air quality monitoring	37
8	Soil quality monitoring for evaluation desertifacation	1550

Air quality monitoring network in Mongolia

Location of the air quality monitoring station of Ulaanbaatar

Air quality monitoring network

	Pollutant	Automatic method		Wet chemical method & laser dust equipment	
		In Ulaanbaatar	In Provinces	In Ulaanbaatar	In Provinces
1	SO2	7	-	3	27 (3 times per day)
2	NO2	7	-	3	27 (3 times per day)
3	CO	7	3	-	-
4	PM10	7	2	-	5 (2 per week, 24 hours)
5	PM2.5	3	-	-	-
6	O3	4	-	-	-

Wet & dry deposition monitoring site

Urban site- Ulaanbaatar

Longitude 106° 54' E,
Latitude 47° 55' N,
Altitude 1275m a.s.l

Remote site - Terelj

Longitude 107° 29' E,
Latitude 47 ° 59' N,
Altitude 1550 m a.s.l

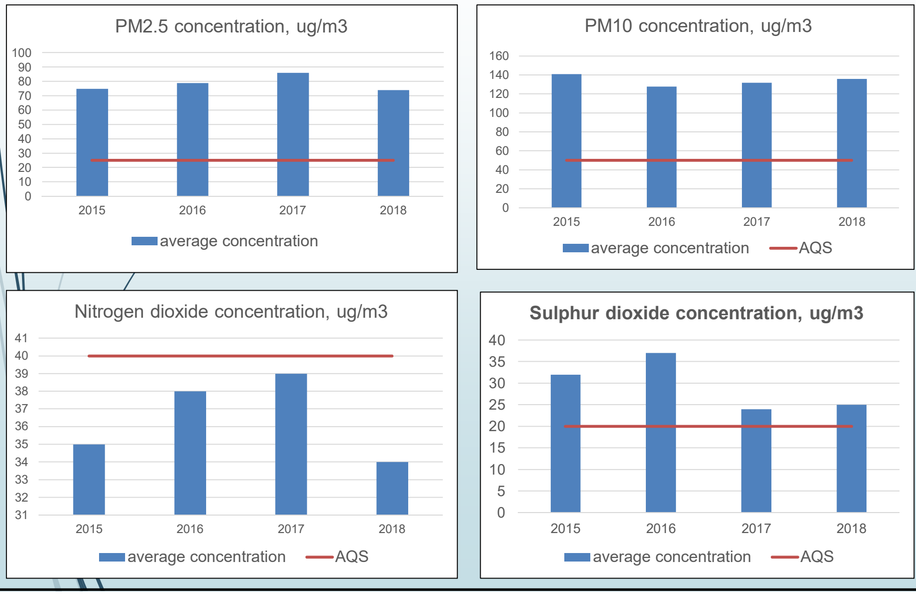
Dry & wet deposition monitoring program

Items	Monitoring site	Monitoring interval	Monitoring parameters
Wet deposition	Ulaanbaatar Terelj	May to October	pH, EC, SO^{2-}_4, NO^-_3, Cl^-, NH^-_4, Na^+, K^+, Ca^{2+}, Mg^{2+}
Dry deposition	Ulaanbaatar Terelj	Weekly Biweekly	Gases: SO_2, HNO_3, HCl, NH_3 Aerosol: SO^{2-}_4, NO^-_3, Cl^-, NH^-_4, Na^+, K^+, Ca^{2+}, Mg^{2+}
Inland aquatic environment	Terelj river	6 times per a year	pH, EC, alkalinity, SO^{2-}_4, NO^-_2, NO^-_3, Cl^-, NH^-_4, Na^+, K^+, Ca^{2+}, Mg^{2+} , PO^{3-}_4
Soil	Ulaanbaatar	Every 3-5 years	pH (H2O), pH (KCL), Exchangeable acidity

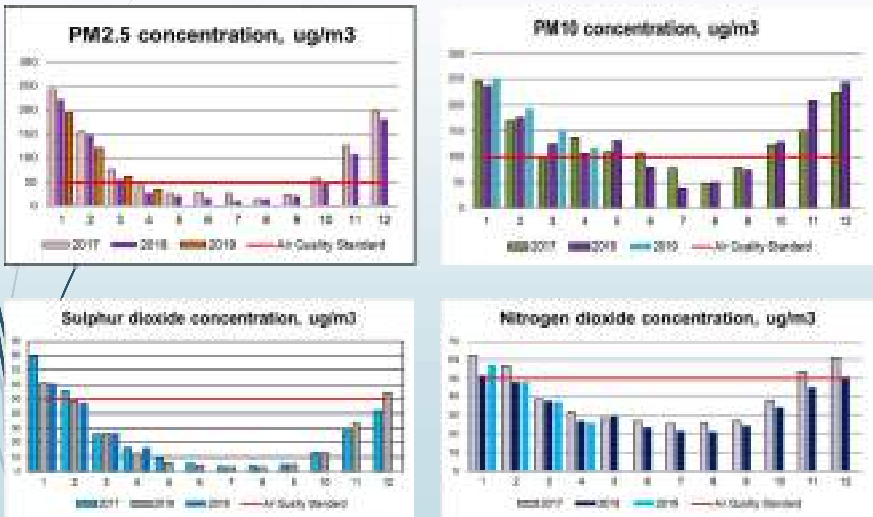
Air Quality standard, MNS4585:2016

Pollutant	Method of measurement	20 minutes	8 hours	24 hours	Annual
SO_2	1. Pulse U.V. Fluorescence method 2. Photometric method	450 ug/m3	-	50 ug/m3	20 ug/m3
NO_2	1. Chemiluminescence Method 2. Griss-Zaltsmany method	200 ug/m3	-	50 ug/m3	40 ug/m3
CO	Non-dispersive Infrared Method	60000ug/m3	10000ug/m3	-	-
PM10	Beta Ray Absorption Method	-	-	100 ug/m3	50 ug/m3
PM2.5		-	-	50 ug/m3	25 ug/m3
O_3	U.V. Photometric Method		100 ug/m3		
Hg		5ug/m3 /30min/		2ug/m3	1ug/m3

Annual concentration of air pollutants in Ulaanbaatar, 2015-2018 year



Monthly concentration of air pollutants in Ulaanbaatar, 2017-2019year



The plan of NAMEM

- To create the mercury monitoring site
- Capacity building

8th Annual Asia-Pacific Mercury Monitoring Network Partners Meeting

Environmental Monitoring Activities in Myanmar

Kyu Kyu Sein (PhD in Environmental Technology)
Assistant Director
Department of Meteorology and Hydrology (DMH)
Ministry of Transport and Communications

August 14-16, 2019 Ritz Carlton Hotel, Jakarta, Indonesia

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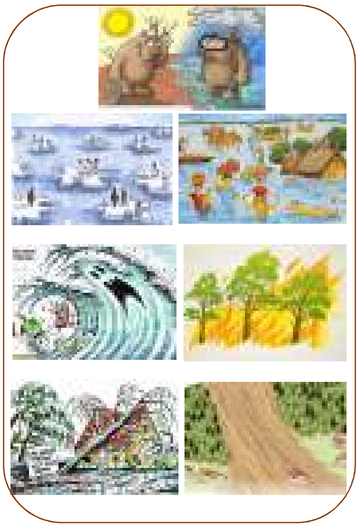
Outlines

- Introduction
- Environmental Activities
- Current Efforts for National Level
- Limitations and Challenges

Introduction

- Myanmar (676,575 km²)
- Population 53.37 million (2017 census)
- Three season (summer, rainy, winter)
- Capital : Nay Pyi Taw
- Rich in Natural resources

- Third most affected countries in terms of extreme weather events.



Source: Global Climate Risk Index (CSI), 2018

Introduction

Meteorological Section

Hydrological Section

Engineering Section

Seismological Section

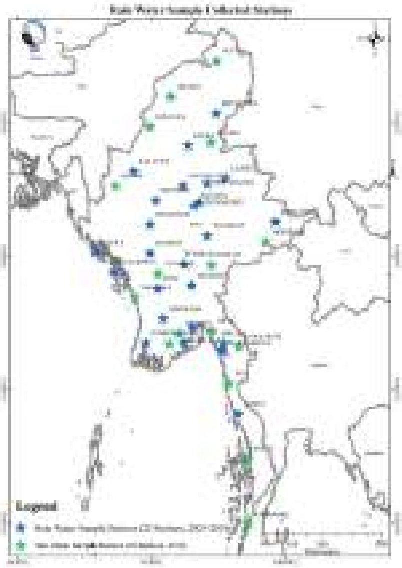
Water Quality Lab

Acid Deposition

Air Quality Monitoring

- Department of Meteorology & Hydrology
- Issue:
  - Forecast
  - Warning
  - Bulletin
  - News
- Main responsibility is Early Warning

Environmental Activities



- Department of Meteorology and Hydrology (DMH) is National Focal in EANET to monitor acid deposition since 2003 with 9 stations.
- Monitoring stations increased up to 25 stations until March, 2019.
- Due to the transboundary haze pollution, 16 rain sample collection stations increased on April 2019, near border areas to monitor acid deposition.
- Total of 41 rain sample collection stations are operation to monitor acid deposition across Myanmar.

Source: Department of Meteorology and Hydrology, Myanmar

Environmental Activities

Wet & Dry Deposition, and PM2.5 Monitoring Site (Yangon, Myanmar)

Wet Deposition Monitoring

Set up	- started in 2007
Sampling Interval	- Daily Collection Weekly Composite
Measurement Parameters	- pH, EC - NH_4^+, Na^+, K^+, Ca^+, Mg^{2+} - SO_4^{2-}, NO_3^-, CL^-

Source: Department of Meteorology and Hydrology, Myanmar

Environmental Activities

Dry Deposition Monitoring

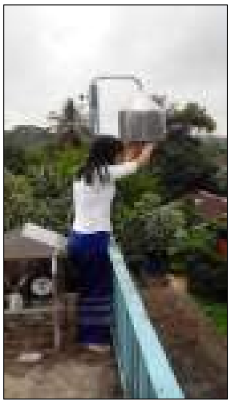
Filter Pack Sampler System

Set up : started in Nov 2011
Sampling Interval : Biweekly
Parameters
Cations : NH_4^+, Na^+, K+,Ca^{2+} ,Mg^{2+}
Anions : SO_4^{2-}, NO_3^-, CL^-

Environmental Activities

Analysis of Wet Deposition

Analysis of Dry Deposition



Environmental Activities

$PM_{2.5}$ Monitoring (Air Quality)

- Set up - 26 March 2018
- Sampling Interval- Hourly
- Parameter -$PM_{2.5}$

Automatic $PM_{2.5}$ Monitor

pH and EC Range Across Myanmar

Annual Range of pH of Whole country

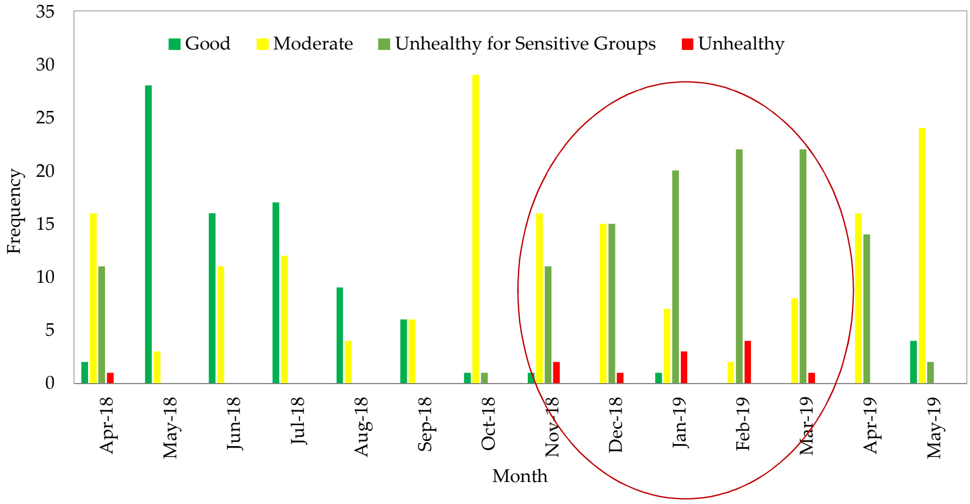
Year	No. Of Stations	Range of pH	Mean
2003	9	5.5 to 7.6	6.5
2004	12	5.2 to 8.1	6.3
2005	15	4.8 to 7.9	6.0
2006	15	5.0 to 8.2	6.4
2007	15	4.4 to 8.2	6.5
2008	15	5.1 to 8.6	6.2
2009	18	4.9 to 10.3	6.5
2010	18	5.3 to 8.8	6.6
2011	25	5.1 to 9.2	6.7
2012	25	5.2 to 8.0	6.5
2013	25	4.7 to 7.9	6.7
2014	25	5.3 to 7.9	6.5
2015	25	4.7 to 8.0	6.6
2016	25	4.4 to 7.4	6.5
2017	25	4.2 to 8.4	6.6
2018	25	5.2 to 8.7	7.0

Annual Range of Electric Conductivity of Whole country

Year	No. Of Stations	Range of EC	Mean
2005	15	2.61 to 143.60	62.60
2006	15	23.00 to 23.00	23.00
2007	15	0.27 to 1.73	0.87
2008	15	0.146 to 8.30	2.18
2009	18	0.07 to 6.18	1.11
2010	18	0.01 to 6.56	0.92
2011	25	0.10 to 11.20	0.57
2012	25	0.01 to 36.60	3.40
2013	25	0.04 to 23.00	1.71
2014	25	0.04 to 7.44	1.54
2015	25	0.04 to 35.00	2.51
2016	25	0.10 to 43.30	21.50
2017	25	0.30 to 99.00	47.50
2018	25	0.10 to 48.10	24.10

Source: Department of Meteorology and Hydrology, Myanmar

PM2.5 Monitoring Site (Yangon, Myanmar)



Source: Department of Meteorology and Hydrology, Myanmar

Current Efforts for National Level

Source: Environmental Conservation Department, Myanmar

Implementing Departments and Organizations for Action Plan for Transboundary Haze Pollution Control

- General Administrative Department
- Fire Services Department
- Department of Agriculture
- Department of Agriculture Land Management and Statistics
- Department of Meteorology and Hydrology
- Department of Disaster Management
- Department of Public Health
- Department of ASEAN Affairs
- Forest Department
- Dry Zone Greening Department
- City Development Committees
- Environmental Conservation Department

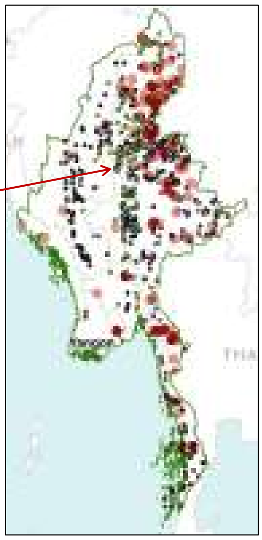
Action Planned To Implement Transboundary Haze Pollution

- "Integrated National Strategic Action Plan on Fire Management in Myanmar" (April 2019 to December 2019) - Cooperation with Food and Agriculture Organization (FAO) aiming to develop Integrated Strategy and Action Plan on Fire Management in Myanmar.
- "Sustainable Management of Peat Land Ecosystems in Mekong Countries" (2019-2022) – Cooperation with International Union for Conservation of Nature (IUCN) aiming to develop policy, framework, strategies and action plans for sustainable peat land management.
- Proposed Project for Ambient Air Quality Assessment along Mekong River Area in Shan State (2020-2022) – Aiming to monitor the Transboundary Haze Pollution.
- Proposed Project for Improvement of Capability of Air Quality Monitoring in Myanmar – Proposed to Japan Government for Financial and Technical Assistance.

Source: Environmental Conservation Department, Myanmar

Limitations and Challenges

Source: UNEP Chemicals and Waste Branch, 2016



Myanmar mining risk map.

Source: Tractus Research and Analyaia, Myanmar Directorate of Geologival Survey and Exploration, US Campaign for Burma

Limitations and Challenges

- Limitation on the temporal and spatial information including data availability and quality, instrumental devices and monitoring network. (Not yet mercury monitoring station)
- Inadequate financial commitment and allocation of resources to tackle both acid deposition and air pollution monitoring, particularly in most polluted areas and sensitive areas.
- Necessary to develop technical staff to undertake activities such as capacity building, analysis and station maintenance and research activities.
- Lack of the implementation of pollution control laws, strategies, guidelines and compliance as well as emission inventories, public education and public participation.

Thank You!

SAMOA MERCURY ASSESSMENT AND MONITORING - CURRENT STATUS

8TH ASIA PACIFIC MERCURY MONITORING NETWORK (APMMN) PARTNERS MEETING
Aug 14TH – 16TH , 2019

Positive thinking achieves positive results

14th - 16th August 2019

P.O. Box 6597, Nafanua, Apia
Ph:(+685) 20664, Fax:(+685) 27769
Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

HOW MUCH DO YOU KNOW ABOUT SAMOA??

- **LOCATION :**

SAMOA lies south of the equator, about half way between Hawaii and New Zealand, in the Polynesian region of the Pacific Ocean

- **PEOPLE :**

SAMOAN people are a Polynesian ethic group of the Pacific Islands

Total Population : Almost 200,000

P.O. Box 6597, Nafanua, Apia
Ph:(+685) 20664, Fax:(+685) 27769
Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

HOW MUCH DO YOU KNOW ABOUT SAMOA??

CLIMATE :

SAMOA's weather is warm and tropical all year round, with two distinct seasons:
Dry Season – May to October
Wet Season – November to April
Average Temperature : 29 ^{o}C

FOOD

SAMOAN FOODs are agricultural and fishery based diet

SCIENTIFIC RESEARCH ORGANISATION OF SAMOA (SROS)

- **What is SROS?**

It is a Samoa Government Public Beneficiary Body…Samoa Government Research & Development Organisation

- **Some of SROS Functions?**

- ***To carry out research and develop technologies..***
- ***Act as a means of liaison between Samoa and other countries in matters related to R & D***
- ***Carry out Environment Impact Assessment***

SROS ANALYTICAL SERVICES
Accredited Testing Laboratories - Biological

- **Biological Laboratory**

SCOPE of Accreditation
1.11 Foods
Meat, Poultry and derived products, Fish and Fish Products, other specified fresh foods

1.12 Waters
Potable, Effluent and trade waste, Marine waters


IANZ

Laboratory Accreditation Programmes

CERTIFICATE OF ACCREDITATION

Scientific Research Organisation of Samoa

Testing Services Summary

1.11 Foods
1.12 Waters

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Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

SROS ANALYTICAL SERVICES
Accredited Testing Laboratories - Chemical

- **Chemistry Laboratory**

SCOPE of Accreditation
2.31 Foods
Cereals and cereal products, edible oils, fats and products, nuts, fruits and vegetables, sugars and sugar confectionery, dairy products, meat, poultry and derived products, fish and fish products


IANZ

Laboratory Accreditation Programmes

CERTIFICATE OF ACCREDITATION

Scientific Research Organisation of Samoa

Testing Services Summary

2.31 Foods

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Website: http://www.sros.org.ws

SAMOA & MINAMATA CONVENTION ON MERCURY

SAMOA SIGNED THE CONVENTION ON *10/10/2013* AND RATIFIED IT ON *24/09/2015*

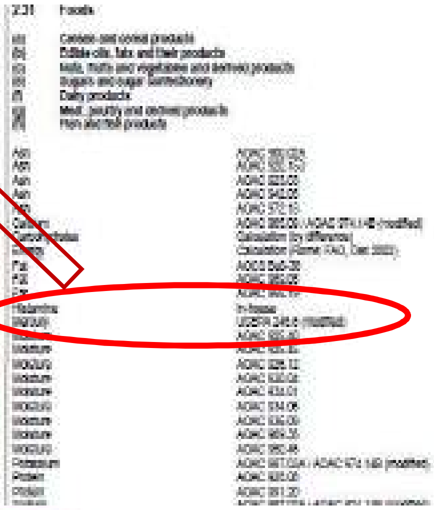
WHAT SAMOA HAS DONE SO FAR TO ACHIEVE ITS MINAMATA CONVENTION ON MERCURY OBLIGATIONS

- **OPEN THE FIRST SUB REGIONAL MINAMATA WORKSHOP FOR PACIFIC ISLANDS (PI)**
- **MINAMATA INITIAL ASSESSMENT**
- **CONTROL IMPORTATION OF MERCURY CONTAINING PRODUCTS**
- **MANAGEMENT OF MERCURY WASTES**

MERCURY ANALYSIS AND MONITORING OPPORTUNITIES

- **Chemistry Laboratory**

Histamine	In house
Mercury	USEPA 245.6



SAMOA VIA SROS HAS THE CAPACITY TO ANALYSIS MERCURY IN FOOD AND FOOD PROUCTS, CURRENTLY USING FOR FISH AND FISH PRODUCTS MERCURY ANALYSIS

MERCURY ASSESSMENT AND MONITORING : CHALLENGES

- **SAMOA YET TO HAVE ITS FULL CAPACITY TO ANALYSIS MERCURY IN OTHER MEDIA**
- **SAMOA YET TO HAVE A FORMAL MONITORING PLAN IN PLACE FOR MERCURY IN ALL MEDIA**

SOME MERCURY ANALYSIS RESULTS

Table 2 Result of Atmospheric Monitoring Demonstration

Venue/sample	Date	Total mercury (ng/m^3)
SROS	2017/11/22 – 23	1.1
SROS (Duplicate)	2017/11/22 - 23	1.1

IDEA CONSULTANTS, INC. AND MOEJ VISIT TO SAMOA, 2017

Fig. 1 Scene of Atmospheric Monitoring Demonstration

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Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

SOME MERCURY ANALYSIS RESULTS

Table 3 Result of Seawater Monitoring Demonstration

St.	Lat / long		Depth (m)	Date & time	Total mercury (ng/L)
St.1	S13°19.001'	E171°47.453'	1.0	2017/11/22 13:20	0.87
St.2	S13°47.709'	E171°46.849'	20.0	2017/11/22 14:00	0.66
St.3	S13°49.163'	E171°45.989'	20.0	2017/11/22 14:30	0.74

IDEA CONSULTANTS, INC. AND MOEJ VISIT TO SAMOA, 2017

Fig. 2 Scene of Seawater Monitoring Demonstration

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Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

SOME MERCURY ANALYSIS RESULTS

Table 4 Result of Hair Monitoring Demonstration (Statistical Data)

Venue	Date	No. of participants	Total mercury (ppm : mg/kg)				
			average	median	min	max	SD
SROS	2017/11/22	10	0.83	0.94	0.12	1.43	0.36

Fig. 3 Scene of Hair Monitoring Demonstration

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Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

SOME MERCURY ANALYSIS RESULTS

- Fish Mercury Analysis

Year	Mercury Level (mg/kg)	Stand. Dev
2015	0.18	0.06
2016	0.11	0.05
2017	0.27	0.19

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Email: enquiries@sros.org.ws
Website: http://www.sros.org.ws

WAY FORWARD!!

- STRENGTHEN NATIONAL CAPACITY ON MERCURY MONITORING IN ALL MEDIA
- COLLECT AS MANY COMPARABLE MONITORING DATA AS POSSIBLE FOR NATIONAL USE AS WELL AS FOR EVALUATION TO ASSESS THE EFFECTIVENESS OF MINAMATA CONVENTION ON MERCURY
- TO ASSIST AND PARTICIPATE IN APMMN ACTIVITIES AS MUCH AS POSSIBLE

THANK YOU FOR YOUR ATTENTION

THANK YOU FOR THE INVITATION TO ATTEND THIS MEETING

LOOKING FORWARD TO OUR NEXT MEETING

ATMOSPHERIC MERCURY MONITORING BY GOLD AMALGAMATION TRAP

Tatsuya Hattori

Institute of Environmental Ecology,

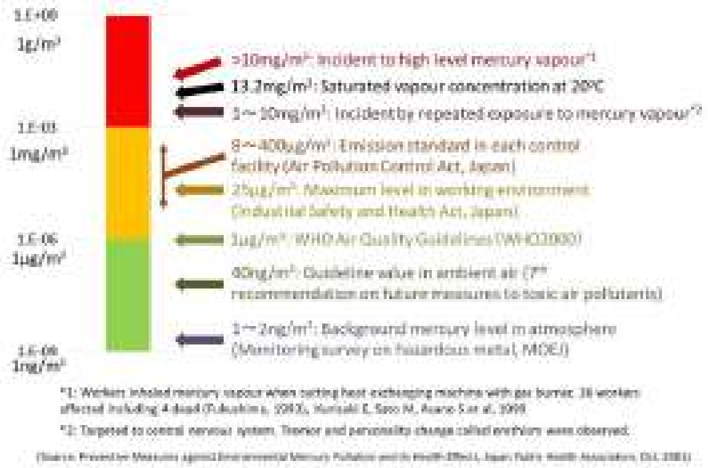
IDEA Consultants, Inc.

Mercury from Air to Human

- In high concentration area such as ASGM, serious health risk by **inhalation of gaseous mercury** is concerned. (Absorption efficiency of mercury by inhalation is high(GEM-80%))
- Atmosphere plays an important role in global mercury cycle **as transportation media**, **stage of chemical reaction**, etc. Therefore, atmospheric mercury monitoring is also important to know the situation of global mercury cycle.

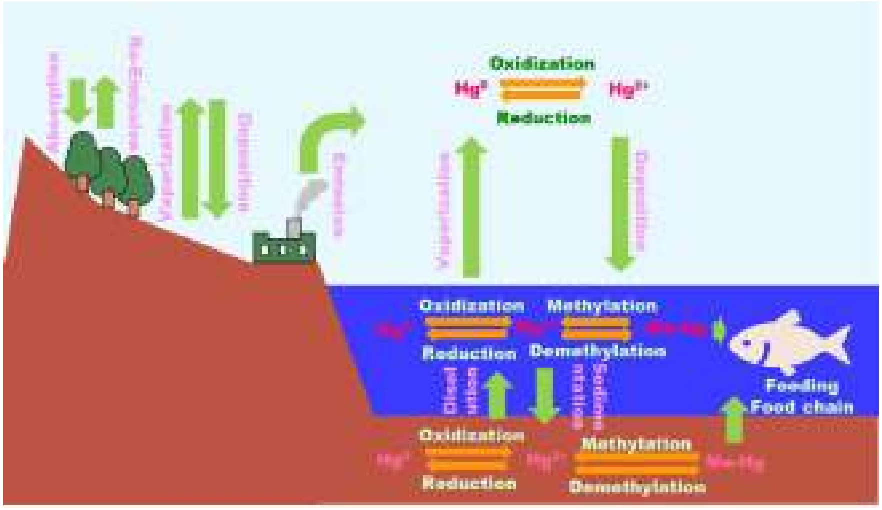
2

Indicative Scale of Ambient Mercury levels and Human Health



3

Transportation, Distribution and Transformation



4

Atmospheric Mercury Monitoring

- **Continuous active sampling – measurement on site**
- **Active sampling – analysis in laboratory**
- **Passive sampling – analysis in laboratory**

5

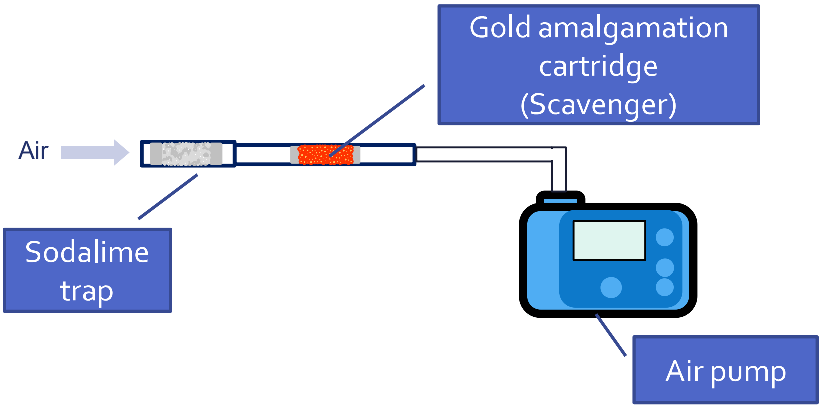
Method of Atmospheric Mercury Monitoring

- Continuous active sampling – measurement on site
  - Actual concentration is obtained continuously
  - Cost of instrument is high
  - It is not easy to measure on the distant site
- Active sampling – measurement in laboratory
  - Actual concentration is obtained (periodical)
  - Duration of sampling is not so long (24hrs)
  - Instrument and apparatus are economical and easy to carry
- Passive sampling – measurement in laboratory
  - Many site could be surveyed simultaneously
  - Actual concentration cannot be measured – calculation by factor is needed
  - Cost of material is low

6

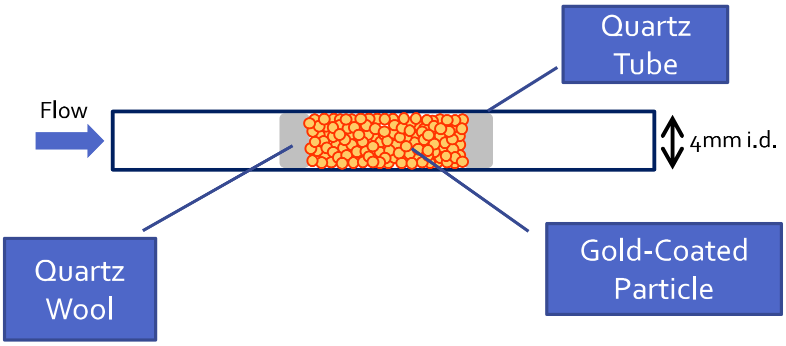
ACTIVE SAMPLING BY GOLD AMALGAMATION METHOD- SAMPLE COLLECTION

Gold Amalgamation Trap Method



- Gold amalgamation trap method is the official method of atmospheric mercury monitoring in Japan, and conducted over 200 monitoring sites every month.

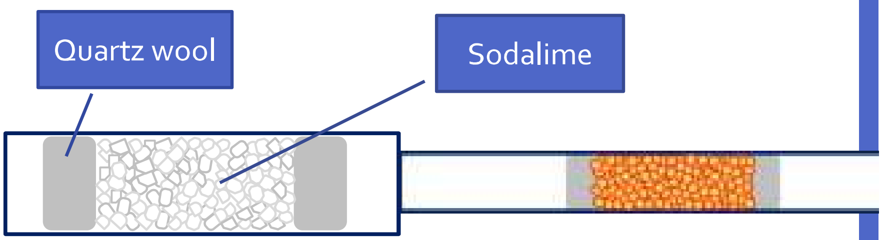
Gold Amalgamation Trap



- Good Recovery
- Cost: approx. USD100
- Reusable (over 10 times)

9

Sodalime Trap



- To remove **moisture** in air sample
- Sodalime: **Refill** on every sampling to avoid contamination

10

Air Pump

- Flow: ~ 0.5L / min
- Flow controller / Integrator are also needed
- For sampling, it is small enough and not expensive.
- They can be used on small space and small electric power supply.

- To convert the concentration into standard condition, Information of temperature and air pressure is also needed.

11

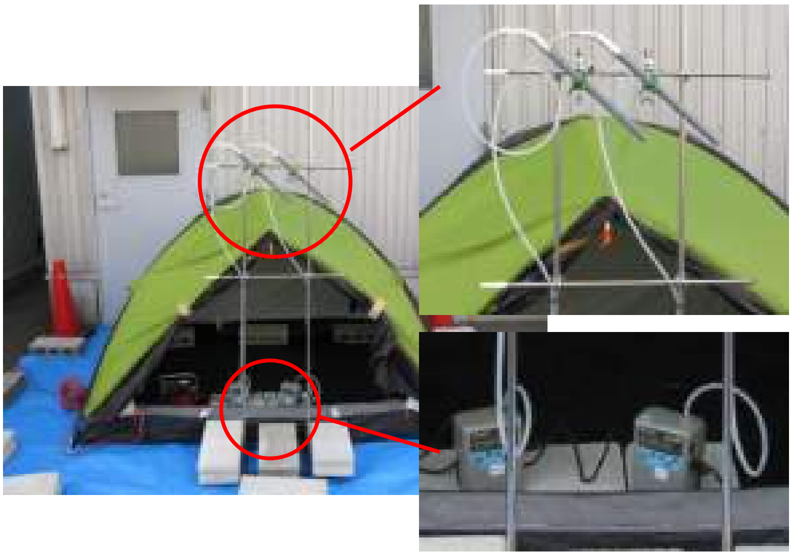
Tubes

- Silicon rubber or other sort of plastic
- It should not be made by glass/fluoropolymer
  - (Tubing follows the amalgamation cartridge, so it does not affect the sample concentration)

On sample collection, it should be confirmed that tubes are clean and there is no leakage

12

Picture of Sample Collection

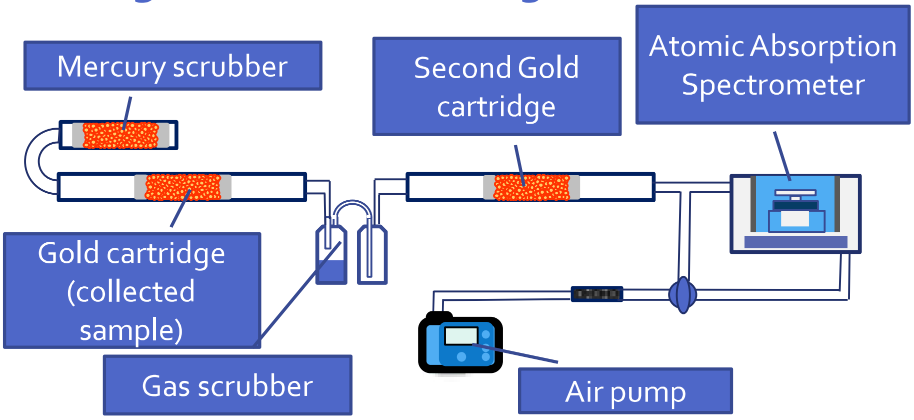


13

ACTIVE SAMPLING BY GOLD AMALGAMATION METHOD-MEASUREMENT

14

Diagram of Measuring Instrument



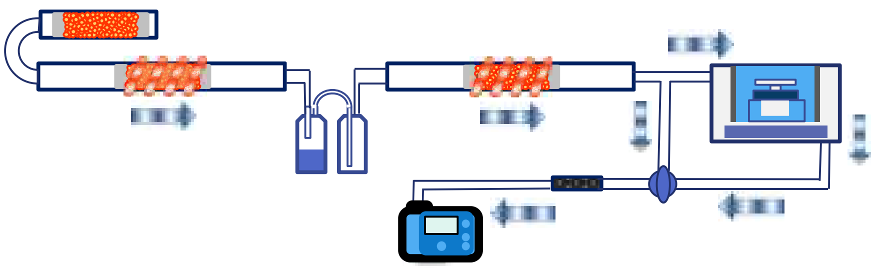
Conventional atomic absorption spectrometer could be used for the measurement for gold amalgamation cartridge

Picture of measuring device

16

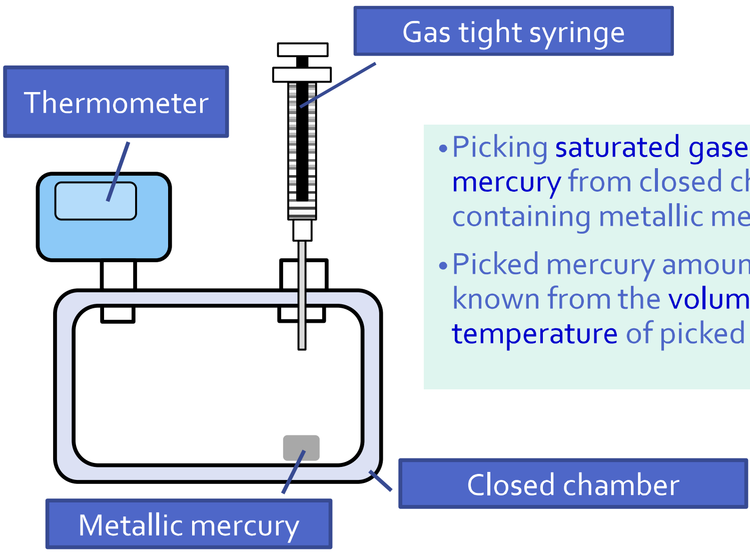
8

Diagram of Measuring Instrument



17

Gaseous Mercury Standard



- Picking saturated gaseous mercury from closed chamber containing metallic mercury.
- Picked mercury amount is known from the volume and temperature of picked gas

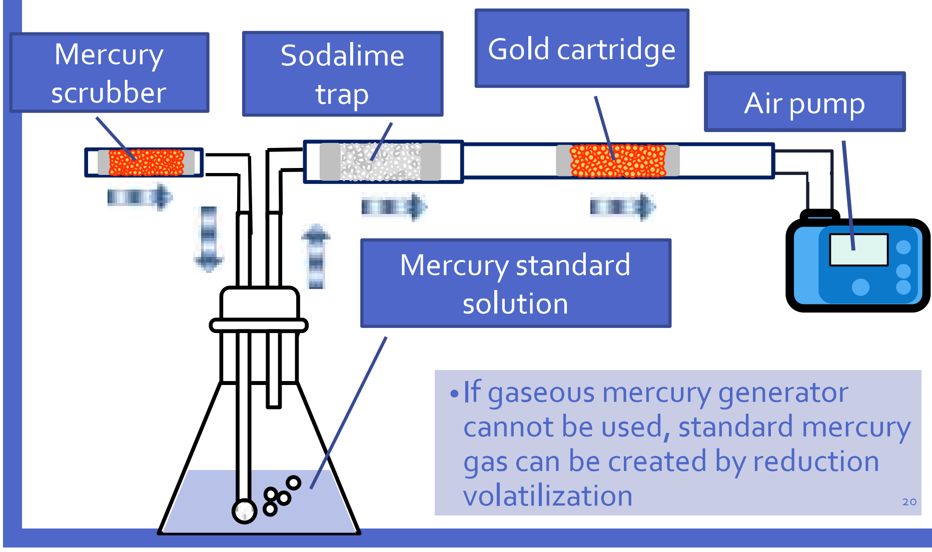
18

Mercury Gas Generator

Some types of mercury gas generators are commercially supplied.

19

Standard Gaseous Mercury Made by Reduction Volatilization



- If gaseous mercury generator cannot be used, standard mercury gas can be created by reduction volatilization

20

10

Thank you for your attention

Tatsuya Hattori: tatsuya@ideacon.co.jp
IDEA Consultants Inc.: https://ideacon.jp/en/

Material 1

24 hours Continuous Sampling of Mercury in the Ambient Air by Gold Amalgamation Method

The explanation of

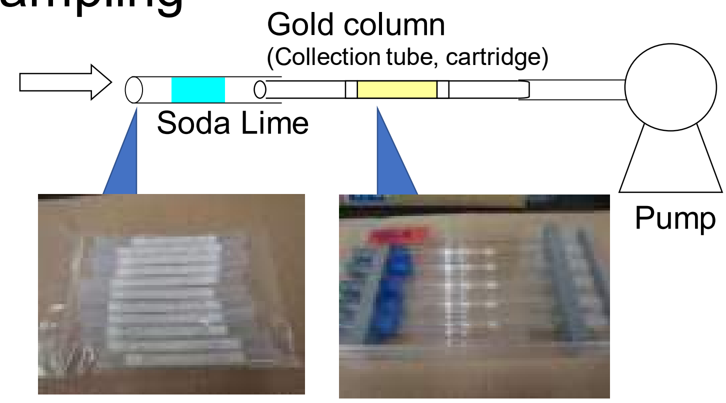
Sampling Method of Mercury in the Ambient Air

Referred Manual:
An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

Contents

Overview of Gold Amalgamation Sampling



Flow rate : 0.5 L/min.
24 h sampling = 0.5×60×24= 720 L (total sampling volume)

3

Preparation of a Gold Column

■Baking

Described in the manual as…

*"Heat the collection tube **at 600-700°C for 5 minutes** with mercury free gas passing through the tube at a flow rate of 0.2-0.5 L/min. After heating, cool the collection tube with flowing gas and place it in a sealed container to prevent contamination. This procedure should preferably be performed immediately before use. When baking multiple numbers of collection tubes all at once, blank value check should be performed at a rate of at least 10% of the samples from the same baking lot."*

Same procedure as measurement operation should be conducted twice on gold columns before sampling.
(cf. Material 2 page 14-15).

- ✓ To remove mercury in gold columns
- ✓ To confirm blank value is almost zero

Gold columns can be used **multiple times.**

4

Preparation of a Soda Lime Tube

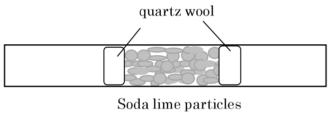


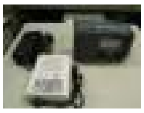
Figure: Example of a soda lime tube

- Inner diameter: 6 mm (to fit the gold column whose outer diameter is 6 mm.)
- Weight of filled soda lime: 0.5 – 1 g

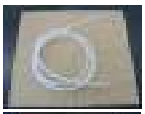
As shown in Figure above, a 6 -8 cm **tetrafluoroethylene tube** whose inner diameter fits the outer diameter of the collection tube should be prepared. Few grams of soda lime should be put into the center of the tube, and both sides should be closed by quartz wool (The quartz wool should be treated with silane in advance). The soda lime tube should be refilled with new soda lime for every sampling.

5

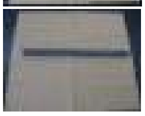
Preparation of Other Instrument



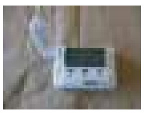
Mini Pump
・Able to aspirate at 0.5L/min
→0.5 L/min×60 min×24 h＝720L



Silicon Tube
i.d. 4 mm o.d. 8 mm Length 2 -2.2 m



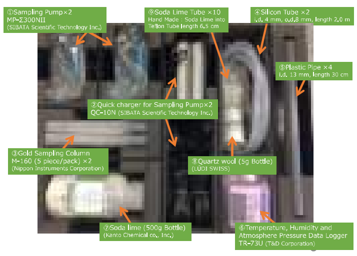
Plastic Pipe
i.d. 18 mm Length 30 -33 cm



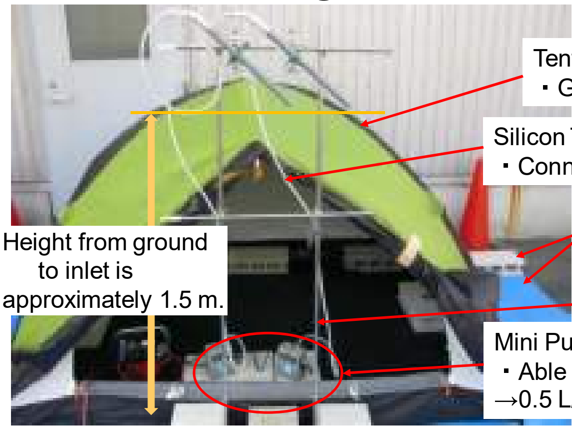
Portable Temp. and Pressure Recorder

Others
>Tent, Plastic sheet, Aluminum Foil, Disposable Gloves

Stand, clips, clamps



Setting for Sampling 1



Tent
・Guarding mini pump

Silicon Tube
・Connecting column and pump

Plastic sheet and weight
・Avoid rolling of dust

Stand, clips, clamps

Mini Pump
・Able to aspirate at 0.5L/min
→0.5 L/min×60 min/h×24 h＝720L

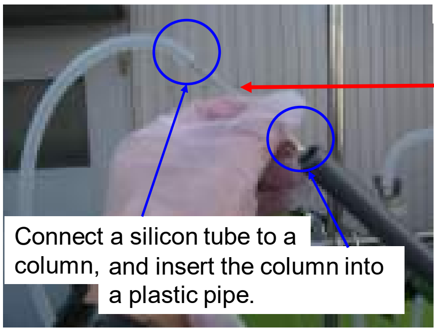
Height from ground to inlet is approximately 1.5 m.

If it is difficult to settle tent (e.g. when wind is too strong), alternatives can be used to protect mini pump.

Example: Hand Made Pump Box

7

Setting for Sampling 2

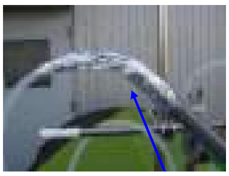


Connect a silicon tube to a column, and insert the column into a plastic pipe.

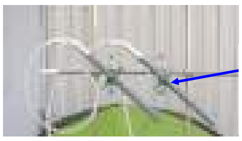
Connect a soda lime tube to a gold column.

Arrow mark

Flow direction



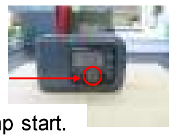
Column and plastic pipe should be covered by aluminum foil.
>Protecting from sudden rain or night dew.



Plastic pipe
>Protecting column
>Set downward

Caution:
Please postpone the sampling when it is reported to be rain within next 24 hours.

Start button



Setting finished, let's pump start.

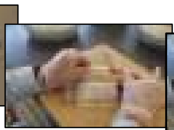
8

Travel Blank (TBL) Test
~Quality Control~

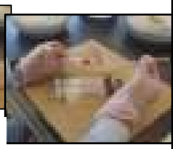
To check **contamination** on gold columns **during Transportation**

All the procedure *<u>except sampling</u>* should be carried out on least 3 gold columns.

Frequency : approximately 10% of the total number of samples at each study area.



Open a case.



Take out a column.

Bring back to the case.

TBL is called "**Field Blank**" in EPA method.

9

Aspiration Pump
(Mini Pump)

The pump should be able to aspirate at 0.5 mL/min for more than 24 hours continuously.

Example: Sampling Pump MP-Σ300 II N

- Constant Flow Rate Setting Range : 0.50-3.00 L/min.
- Point Flow Rate Range : 0.20-4.50 L/min.
- Integrated Flow Volume Displaying range : 0.0-99999 L
- Digital display: Point Flow Rate and Integrated Flow Volume.
- Electric source: Lithium Ion battery （Battery unit）or AC Adapter
- Continuous running: 50h at 0.5 L/min

Product of SIBATA SCIENTIFIC TECNOLOGY LTD. (https://www.sibata.co.jp/english/)

10

Field Note

【Example】

Checkup of progress
(not always necessary to checkup nine times.)

It is recommended to check the pump condition at least 3 times.
Example:
>Immediately after start
>Before leaving the sampling site
>Before finishing sampling

Field Note

Researcher													
Location													
Condition of Sampling start up		M/D/Y	/ /		Weather			Air temp. (℃)				Atmosphere (hpa)	
Condition of sampling end		M/D/Y	/ /		Weather			Air temp. (℃)				Atmosphere (hpa)	
Target : **Mercury**													
Sampling No. or Name													
Pump No.													
Column No.													
Sodalime No.													
Column position Info. (If necessary)													
No.	Date & Time	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)
0	(preinitiation default)												
1 (start)													
2													
3													
5													
4													
6													
7													
8													
9													
10 (end)													
Total sampling Vol. (L)													
Column No. of Travel Blank		Special instruction :											

Use 1 sheet for 1 sampling site.
(There are several columns for multiple sampling)

Ambient Temperature and Pressure

Generally, atmospheric concentration is reported as the correction value at *1 atm* , *20 °C*.

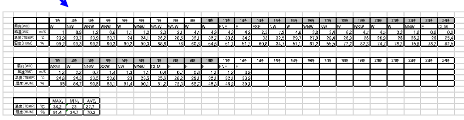
Ambient Temperature and *Pressure* are necessary to calculate the correction value.

3 ways to get the weather data
- Measure at the beginning and the end.
- Obtain from *nearest meteorological stations* or other *appropriate observation stations of hazardous substance*
- Use *portable measuring instrument*

Use the *average during the sampling period for correction.*

Example of portable measuring instrument TR-73U

Product of T&D corporation.
(https://www.tandd.com/index.html)



Example of obtained data from a meteorological station

In fact, It is not necessary to correct these data as long as you use MP-Σ300 IIN since it automatically corrects total sampling volume at 1 atm, 20 °C.
Regardless, because weather Information is important as basic data, it should be recorded.

Material 2

24 hours continuous sampling of mercury in ambient air by gold amalgamation method

The explanation of

Thermal Desorption Device

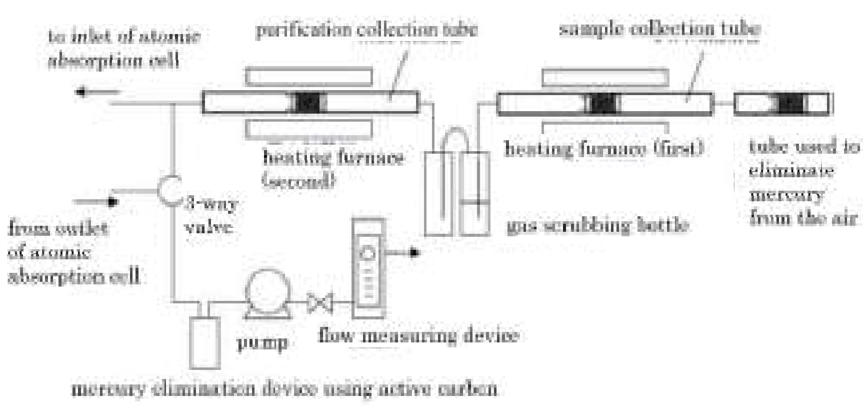
Referred Manual:
An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

Contents

Thermal Desorption Device

~ Overview ~



Cited from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

3

Thermal Desorption Device

~ Examples of manufactured products~

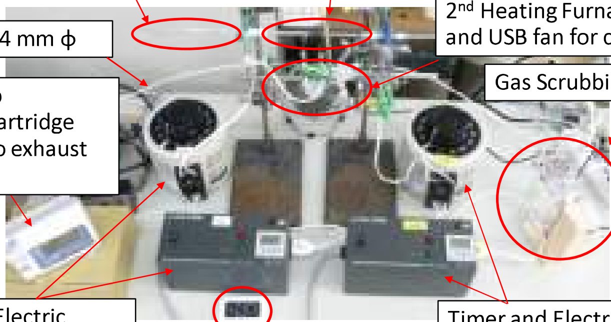
WA-5
Set of an atomic absorption spectrometer and a thermal desorption device

MA3000 (left) : Atomic absorption spectrometer
RH-MA3 (right) : Thermal desorption device (optional)

All products are produced by Nippon Instruments Corporation (NIC.)
(https://www.hg-nic.biz/)

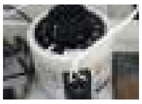
4

Thermal Desorption Device
~ Hand made ~



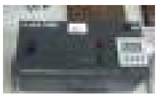
5

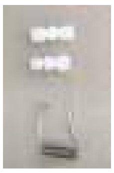
Hand made Thermal Desorption Device Materials and Equipment


Electric Transformer
Page 7


Gas Scrubber (double)
Page 8


USB fan
Page 9


Timer (Labo Clock)
Page 7


Unions
6mmϕ+6mmϕ
4mmϕ+6mmϕ

Nichrome Wire
Page 11



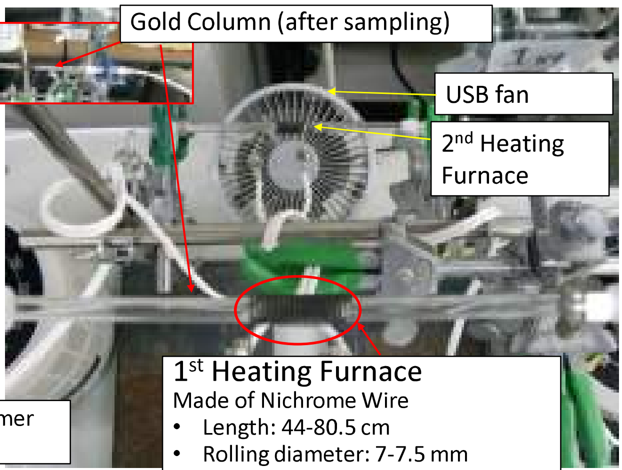
Mini Pump
(able to aspirate at 300 - 500 mL/min)
Page 10, 13


Digital Timer
Page 12

Others
>Teflon tube (o.d. 4 mm ϕ and 6 mm ϕ)
>Pressure and Chemical resistance tube (For connection Teflon tube)
>Stand and clips

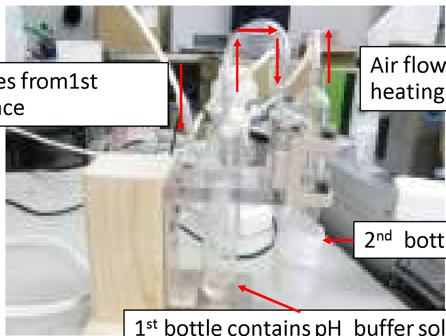
6

Hand made Thermal Desorption Device
Detail 1 : 1st heating furnace



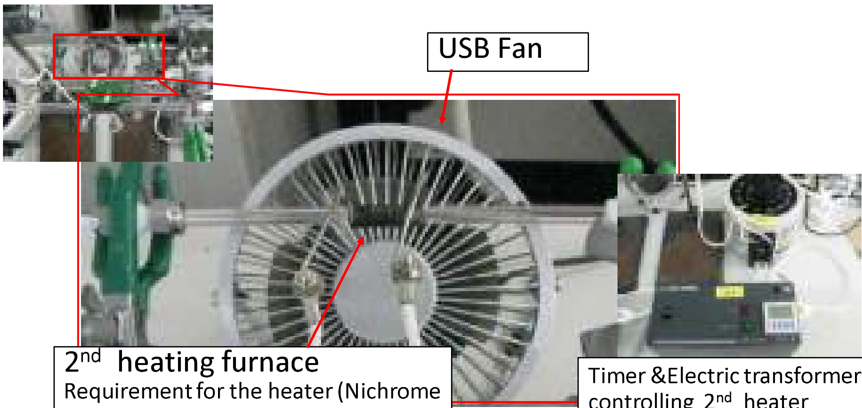
7

Hand made Thermal Desorption Device
Detail 2 : Gas Scrubbing Bottle



8

Hand made Thermal Desorption Device
Detail 3 : 2nd heating furnace

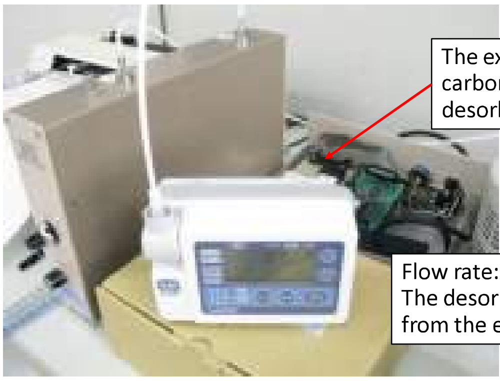


9

Hand made Thermal Desorption Device
Detail 4 : Atomic absorption spectrometer and Recorder

10

Hand made Thermal Desorption Device
Detail 5 : Aspiration Pump



The exhaust outlet has active carbon cartridge for eliminating desorbed mercury.

Flow rate: 200 -500 mL/min
The desorption gas is aspirated from the end of the line.

11

Hand made Thermal Desorption Device
Determination of Voltage and Heating Duration

Test with using thermocouple thermometer.

Adjust voltage and apply time.
Max temperature: 600-700 °C (**taking 40-60 seconds)**
Voltage: 15-25 V
These conditions differ depending on Nichrome Wire.
Start with low voltage not to break Nichrome Wire.

The condition at our Lab
Voltage: 23 V
Apply Time: 50 sec.
→ Temp. max 660 °C

12

Hand made Thermal Desorption Device Measurement Sequence

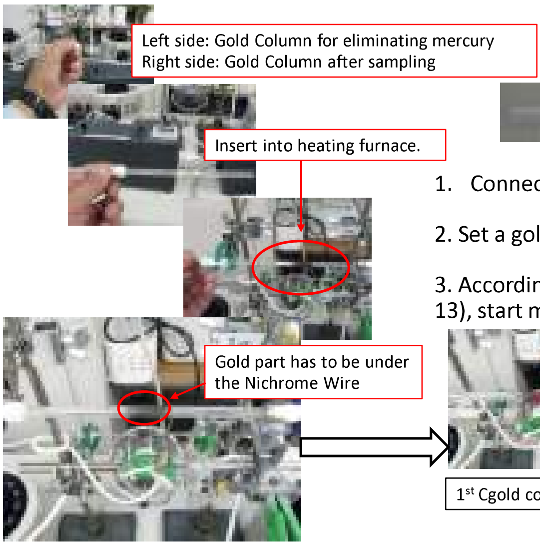
<u>Preparation</u>
- Set both Electric Transformers.
- Set both timer for transformer.
- Set the Digital Timer at 4min 30 sec.
- Set the pump at 300 mL/min, 5min.

<u>Measurement</u>
1. Set a sampling column to 1st heating furnace and confirm USB fan is turned off.
2. Turn on the pump and wait until it gets stable. (about 30 sec.)
3. Start 1st heating (Push the start key of 1st timer.)
4. Start 2nd heating (Push the start key of 2nd timer.)
5. Start the USB fan.
6. Stop the USB fan.
7. Change gold column and return to No.2

Total Sequence time	Digital Timer	
0 sec.		
30 sec.	4 min 30 sec	Since purge time is necessary, wait about 30 – 60 sec after heating.
3 min.	2 min 30 sec	
4 min.	1 min.	
5 min.	0 sec.	

13

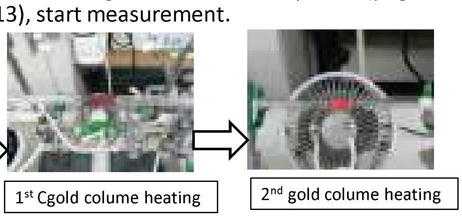
Hand made Thermal Desorption Device Measurement Procedure 1



1. Connect two gold columns.

2. Set a gold column to 1st heating column.

3. According to the decided sequence (page 13), start measurement.



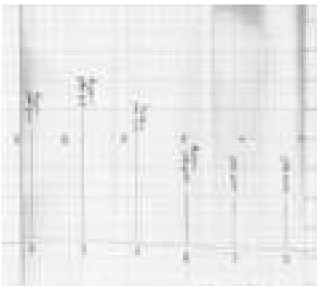
Continues to the next page.

14

Hand made Thermal Desorption Device
Measurement Procedure 2

4. Each response is recorded by a pen recorder.

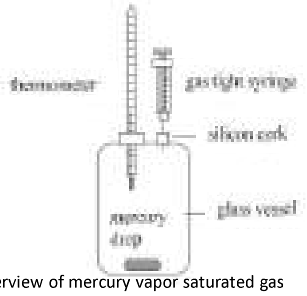
5. Measure the peak height, and write it down on a chart.
   Information on a peak should be recorded together.
   >Peak height (mm)
   >Sample name
   >cartridge No.



Later on, recorded peak height will be used for calculating concentration.

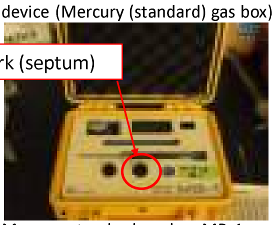
15

Hand made Thermal Desorption Device
Mercury standard 1



Overview of mercury vapor saturated gas preparation device (Mercury (standard) gas box)

Silicon cork (septum)



Mercury standard gas box MB-1
(Product of Nippon Instruments Corporation (NIC.))

"Table of Unit volume weight of mercury contained in mercury vapor saturated gas"

Unit: µg/mL=pg/µL

Table1 Unit volume weight of mercury contained in mercury vapor saturated gas

Unit: ng/mL

t °C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0	2.179	2.202	2.225	2.248	2.271	2.295	2.319	2.343	2.368	2.392
1.0	2.417	2.441	2.465	2.489	2.514	2.539	2.564	2.589	[illegible]	[illegible]
2.0	2.666	2.691	2.716	2.741	2.766	2.792	2.818	2.844	2.871	2.897
3.0	2.924	2.951	2.978	3.005	3.033	3.061	3.089	3.117	3.146	3.175
4.0	3.204	3.234	3.264	3.295	3.325	3.356	3.388	3.419	3.451	3.483
5.0	3.516	3.549	3.583	3.616	3.650	3.685	3.719	3.754	3.789	3.825
6.0	3.861	3.897	3.933	3.970	4.007	4.045	4.083	4.121	4.159	4.198
7.0	4.237	4.276	4.316	4.356	4.396	4.437	4.478	4.519	4.561	4.603
8.0	4.645	4.688	4.731	4.774	4.817	4.861	4.905	4.949	4.994	5.039
9.0	5.085	5.131	5.178	5.225	5.273	5.321	5.639	5.418	5.467	5.517
10.0	5.567	5.616	5.666	5.716	5.767	5.818	5.870	5.921	5.974	6.026
11.0	6.079	6.133	6.187	6.241	6.296	6.351	6.407	6.463	6.519	6.576
12.0	6.633	6.692	6.751	6.810	6.870	6.931	6.992	7.053	7.115	7.177
13.0	7.240	7.304	7.369	7.435	7.501	7.568	7.635	7.703	7.771	7.840
14.0	7.909	7.979	8.049	8.119	8.191	8.262	8.335	8.408	8.481	8.555
15.0	8.630	8.705	8.781	8.858	8.935	9.013	9.092	9.171	9.251	9.331
16.0	9.412	9.493	9.575	9.658	9.742	9.826	9.910	9.995	10.081	10.168
17.0	10.255	10.342	10.429	10.516	10.604	10.693	10.783	10.873	10.964	11.056
18.0	11.148	11.242	11.337	11.433	11.529	11.626	11.724	11.823	11.922	12.022
19.0	12.123	12.225	12.328	12.432	12.536	12.641	12.747	12.854	12.961	13.070
20.0	13.179	13.289	13.400	13.511	13.623	13.737	13.851	13.965	14.081	14.198
21.0	14.315	14.434	14.553	14.674	14.795	14.917	15.040	15.164	15.289	15.415
22.0	15.542	15.670	15.800	15.930	16.061	16.193	16.326	16.461	16.596	16.732
23.0	16.869	17.008	17.148	17.289	17.431	17.574	17.718	17.864	18.010	18.158
24.0	18.306	18.456	18.606	18.758	18.911	19.065	19.220	19.376	19.534	19.693
25.0	19.852	20.012	20.174	20.336	20.500	20.664	20.830	20.998	21.166	21.336
26.0	21.506	21.679	21.853	22.028	22.204	22.382	22.560	22.741	22.922	23.105
27.0	23.289	23.474	23.660	23.847	24.036	24.227	24.418	24.611	24.805	25.001
28.0	25.198	25.397	25.598	25.800	26.003	26.208	26.415	26.622	26.832	27.042
29.0	27.255	27.469	27.685	27.902	28.121	28.342	28.564	28.787	29.012	29.239
30.0	29.467	29.697	29.928	30.160	30.395	30.631	30.868	31.107	31.348	31.591
31.0	31.835	32.081	32.329	32.579	32.830	33.084	33.339	33.595	33.854	34.114
32.0	34.376	34.641	34.908	35.177	35.448	35.720	35.995	36.271	36.549	36.829
33.0	37.111	37.395	37.681	37.969	38.258	38.550	38.843	39.139	39.437	39.736
34.0	40.038	40.341	40.647	40.954	41.264	41.575	41.889	42.205	42.523	42.843
35.0	43.165	43.491	43.819	44.148	44.481	44.815	45.152	45.491	45.832	46.176
36.0	46.522	46.870	47.221	47.575	47.930	48.289	48.649	49.012	49.378	49.745
37.0	50.116	50.488	50.863	51.241	51.621	52.004	52.389	52.777	53.167	53.560
38.0	53.955	54.354	54.755	55.158	55.565	55.974	56.385	56.800	57.217	57.637

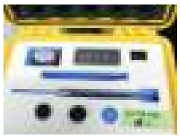
Example
Temp. :24.2 °C
→18.606 ng/mL(pg/µL)
(According to this table)
Taking Volume: 50µL
Amount=18.606*50/1000
=0.9303 ng

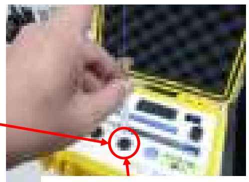
16

Hand made Thermal Desorption Device
Mercury standard 2

How to get mercury gas from a gas box

1. Set a pump.
   Flow rate: 0.5 L/min.
   Timer: 2 min.
2. Set a gold column to the pump.
3. Open the gas box and turn it on. Record the displayed temp.
4. Take mercury gas with a clean gas tight syringe. After taking out the syringe, adjust the volume.





Silicon cork (septum)

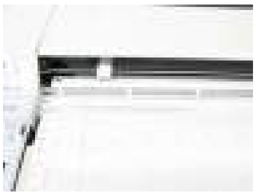
5. Start aspiration.
6. After the flow rate became under 1mL/min., inject mercury gas to a gold column.
7. Connect another gold column for eliminating mercury in surrounding air.

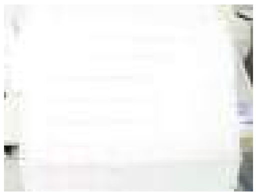
(Continues to the next page.)

17

Hand made Thermal Desorption Device
Mercury standard 3

How to take mercury gas from gas box





8. Set the gold column and measure according to page 13 – 15.

9. Record the condition and result.
>Temp of gas box (°C)
>Injection volume (µL)
>Amount of mercury (ng)
>peak height (mm)

Caution:
Each concentration of standard gas should be measured three times. On calculation, average should be used.

18

Contract Address

1334-5 Riemon, Yaizu, Shizuoka, 421-0212, Japan
Tel: +81-54-622-9552
Fax: +81-54-622-9522
E-mail: wyoshino@ideacon.co.jp
tatsuya@ideacon.co.jp

If you couldn't measure sampled columns by yourselves, please inform and send us. We'll measure them and return you results.

19

- Thank you for your attention.

20

Atmospheric Standard and Monitoring in Japan

Tatsuya Hattori
Institute of Environmental Ecology,
IDEA Consultants, Inc.

History of Air Pollution and Countermeasure Act in Japan

2

Diseases caused by Pollution in Japan

3

4 Major "KOUGAIBYO (Pollution Disease)" (1950s - 70s)

- Minamata Disease
- Niigata Minamata Disease
  - Health hazard by methylmercury pollution
- Itai-Itai Disease
  - Health hazard by cadmium pollution
- Yokkaichi Asthma
  - Health hazard by air pollution

Serious Air Pollution and Health Hazard occurred in Many Cities of Japan

Laws for Air Pollution Countermeasure

4

1962:Smoke and Soot Regulation Law
↓
1968:Air Pollution Control Law

1967:Basic Law for Environmental Pollution
↓
1993:Basic Environment Law

1969:Law concerning the Relief of Pollution-related Health Damage
↓
1973:Act on Compensation for Pollution-related Health Damage

- Legislation of Standard
- Responsibility Clarification
- Penalty for Breach
- Compensation for Sufferers

Standards, Guideline Values and Monitoring of Air Pollutants in Japan

5

Air pollutants (Continuous Monitoring Parameter in Japan)

6

Air Pollutant	• **Sulfur dioxide (SO_2)** • Nitrogen monoxide (NO) • **Nitrogen dioxide (NO_2)** • Nitrogen oxides (NO_x) • **Carbon monoxide (CO)** • **Photochemical oxidants (Ox)** • Non-Methane hydrocarbons (NMHC) • Methane (CH_4) • Total hydrocarbons (THC) • **Suspended particle matter (SPM)** • Small particle matter (<2.5μm) (PM2.5) • Suspended Particles (SP)
Weather parameter	• Wind direction • Wind Speed • Temperature • Humidity

Standards of Air Pollutants in Japan

7

	Standard
SO_2	0.04 ppm (Daily Mean) 0.1 ppm (8Hrs Mean)
CO	10 ppm (Daily Mean) 20 ppm (8Hrs Mean)
SPM	0.10 mg/m^3 (Daily Mean) 0.20 mg/m^3 (8Hrs Mean)
NO_2	0.04 ppm-0.06 ppm, or less (Daily Mean)
Ox	0.06 ppm (Hourly Mean)
PM2.5	15 μg/m^3 (Annual Mean) 35 μg/m^3 (Daily Mean)

*: Daily mean and 8hrs mean are calculated from each hourly mean of continuous measurement data

Hazardous Air Pollutants (Priority Approach Substances)

8

Environmental Standard Established (5 Substances)	• Benzene • Trichloroethylene • Tetrachloroethylene	• Dichloromethane • Dioxins (PCDDs, PCDFs and Dioxin-Like PCBs)
Guideline Value Established (9 Substances)	• Mercury and its Compounds • Acrylonitrile • Vinyl chloride (monomer) • Chloroform • 1,2-dichloroethane	• Nickel compounds • Arsenic and its compounds • 1,3-Butadiene • Manganese and its compounds
Other Substances (8 Substances)	• Acetaldehyde • Methyl chloride • Chromium and its compounds (Chromium, and Chromium(III) compounds, Chromium (VI) compounds)	• Ethylene oxide • Toluene • Beryllium and its compounds • Benzo [a] pyrene • Formaldehyde

Hazardous air pollutant: *"Substance which may damage human health in continuous exposure and can be the source of air pollution ."*

Standards and Guideline Values of Hazardous Air Pollutants in Japan

9

Environmental Standard

	Standard (Annual Mean)
Benzene	0.003 mg/m^3
Trichloroethylene	0.13 mg/m^3
Tetrachloroethylene	0.2 mg/m^3
Dichloromethane	0.15 mg/m^3
Dioxins	0.6 pg-TEQ/m^3

Guideline Value

	Guideline Value (Annual Mean)
Mercury and Its compounds	40 ng Hg/m^3
Vinyl chloride (monomer)	10 μg/m^3
Chloroform	18 μg/m^3
1,2-dichloroethane	1.6 μg/m^3
Nickel compounds	25 ng Ni/m^3
Arsenic and Its compounds	6 ng As/m^3
1,3-Butadiene	2.5 μg/m^3
Manganese and Its compounds	140 ng Mn/m^3

Atmospheric Environment Monitoring Station

10

Objectives of Monitoring (Air Pollution Control Law)

11

- To contribute to the implementation of air pollution prevention policies protecting the health of nations and living environment, obtain the;
  - ➢Status of air pollution in each area
  - ➢Status of emission source
  - ➢Existence of high concentration area
  - ➢Effectiveness of protection act
  - ➢National situation of air pollution
  - ➢National trends of air pollution

Atmospheric mercury monitoring site in Japan is mainly focused on collecting the national / regional general situation of human residents.

Number of Continuous Monitoring Station

12

- Expression for the number of monitoring station (in the standard of Japan)
  - Smaller number of
    - 1 monitoring station / 75,000 population
    - 1 monitoring station / $25km^2$ of residential area
  - (Number of continuous monitoring station is estimated by each local government)

The sufficient number of the monitoring station is adjusted by various conditions such as level of concentration, characteristics of parameter, special feature of the area, etc.

* This expression indicates the number of continuous monitoring station. The number of hazardous air pollutant (such as mercury) monitoring station is different.

Number of Continuous Monitoring Station (II)

13

	Number of Monitoring Station (FY2017)
NO_2	1254
SPM	1313
Ox	1150
SO_2	961
CO	59
NMHC	329
PM2.5	827
Total	**1464**

(*This number indicates the monitoring station for general environmental atmosphere. Other than this, there are monitoring station of automobile exhaust gas.)

Number of Monitoring Station for Hazardous Air Pollutants

14

- **1/6** of the total number of continuous monitoring station
  - Number of continuous monitoring station: Smaller number of
    - 1 monitoring station / 75,000 population
    - 1 monitoring station / 25km^2 of residential area

Classification of Monitoring Station for Hazardous Air Pollutants

15

- General Environment
  - Station where would not be affected from stable emission source or automobiles
- Surrounding Area of Fixed Emission Source
  - Station where would be affected from a stable emission source
- Roadside Area

* In some case, “Surrounding Area of Stable Emission Source” and “Roadside Area” may be overlapped.

Fixed Emission Source

16

- Emission source facility that affects the atmosphere of adjacent area to raise the concentration of hazardous air pollutants over the 1/10 of environmental standard or guideline value, etc.

For the parameter which has no standard or guideline value, 1/10 of maximum reported PRTR emission amount is applied for the determination of fixed emission source

Number of Hazardous Air Pollutant Monitoring Station

17

	Number of Monitoring Station (FY2017)				
	General	Surrounding Area of Fixed Emission Source	Roadside	Fixed Emission Source and Roadside	Total
Benzene	217	79	92	17	405
Trichloroethylene	252	38	64	4	358
Tetrachloroethylene	256	36	65	3	360
Dichloromethane	239	58	62	7	366
Mercury and its Compounds	217	20	43	1	281
Acrylonitrile	235	44	59	3	341
Vinyl chloride (monomer)	241	36	60	2	339
Chloroform	239	43	60	3	345
1,2-dichloroethane	236	44	62	3	345
Nickel compounds	201	41	37	5	284
Arsenic and its compounds	213	30	42	1	286
1,3-Butadiene	236	38	102	4	380
Manganese and its compounds	192	46	37	4	279
Acetaldehyde	193	23	95	3	314
Methyl chloride	240	35	57	2	334
Chromium and its compounds	200	32	36	4	272
Ethylene oxide	180	21	40	1	242
Toluene	214	62	90	9	375
Beryllium and its compounds	212	15	39	1	267
Benzo [a] pyrene	197	19	91	2	309
Formaldehyde	191	31	91	7	320

Monitoring Period of Hazardous Air Pollutants

18

- To evaluate health risk of general population
  - ➢It is focused on long-term Impact
- Monitoring Frequency: It should be appropriate for the correct estimate of annual mean concentration.
  - ➢Avoiding the bias of seasonal variation
  - ➢In Japan, monthly monitoring (or more) is legislated

Another condition (Height and Duration)

19

- Height of Sampling: **1.5 - 10 m** (gaseous substance)
  - ➢Height that people ordinary live
- Sampling duration: **24hours**
  - ➢To prevent the bias of diurnal variation

Monitoring Data of Atmospheric Mercury in Japan

20

Monitoring Site of Atmospheric Mercury (FY2017)

21

© OpenStreetMap contributors
Site location data is edited from the published data on "Kankyo GIS" (http://tenbou.nies.go.jp/gis/)
Satellite image is used from "Esri Imagery" in "OpenStreetMap"

Atmospheric Mercury Monitoring Data in Japan (FY1998-FY2017)

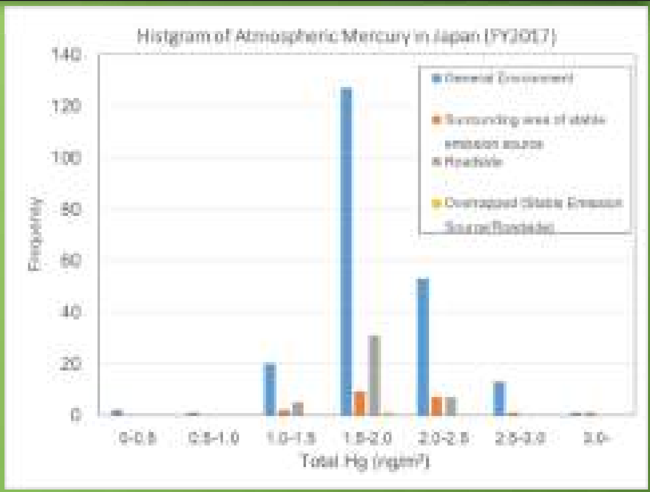
22

Fiscal Year	General Environment					Surrounding Area of Stable Emission Source					Roadside Area					Total				
	Site	Smpl	Mean	Min	Max	Site	Smpl	Mean	Min	Max	Site	Smpl	Mean	Min	Max	Site	Smpl	Mean	Min	Max
FY1998	68	816	2.8	0.86	8.6	16	192	2.8	1.2	5.0	10	120	3.3	1.7	6.7	94	1128	2.9	0.9	8.6
FY1999	127	1524	3.4	1.1	50	41	492	2.7	1.0	6.4	22	264	2.6	1.6	4.4	190	2280	3.2	1.0	50
FY2000	155	1860	2.7	0.14	15	40	480	2.8	1.2	6.3	24	288	3.1	1.0	15	219	2628	2.8	0.1	15
FY2001	157	1885	2.3	0.22	4.3	40	480	2.5	1.3	4.1	24	288	2.5	1.7	5.4	221	2653	2.3	0.2	5.4
FY2002	170	2040	2.0	0.32	3.8	44	528	2.3	1.2	3.5	30	360	2.2	1.2	5.4	244	2928	2.1	0.3	5.4
FY2003	177	2124	2.3	0.17	4.5	46	552	2.5	1.4	5.8	30	360	2.3	1.3	4.1	253	3036	2.3	0.2	5.8
FY2004	185	2220	2.3	0.94	3.8	45	540	2.6	1.3	4.6	37	444	2.4	1.5	4.0	267	3204	2.3	0.9	4.6
FY2005	212	2544	2.2	0.69	5.0	59	708	2.5	1.3	4.1	49	588	2.3	1.3	3.5	320	3840	2.3	0.7	5.0
FY2006	200	2400	2.2	0.73	4.8	57	684	2.5	1.1	4.2	45	540	2.3	1.1	3.5	302	3624	2.2	0.7	4.8
FY2007	204	2448	2.1	0.56	4.2	61	732	2.4	0.8	5.2	43	516	2.3	1.0	3.5	308	3696	2.2	0.6	5.2
FY2008	193	2316	2.1	0.73	3.8	58	696	2.2	1.5	4.4	42	504	2.2	0.1	8.7	293	3516	2.1	0.1	8.7
FY2009	193	2316	2.0	0.98	4.6	62	744	2.1	0.9	3.5	39	468	2.0	1.3	3.5	294	3528	2.0	0.9	4.6
FY2010	186	2232	2.0	0.98	4.0	58	696	2.0	0.8	3.3	36	432	2.0	0.9	3.0	280	3360	2.0	0.8	4.0
FY2011	175	2100	2.1	0.74	4.6	51	612	2.2	1.0	5.3	35	420	2.0	0.9	3.2	261	3132	2.1	0.7	5.3
FY2012	183	2196	2.0	0.82	6.1	51	612	2.1	1.2	3.6	36	432	2.0	1.2	4.0	270	3240	2.1	0.8	6.1
FY2013	174	2088	2.0	0.84	5.4	52	624	2.1	1.2	3.7	35	420	2.1	1.2	6.1	261	3132	2.0	0.8	6.1
FY2014	204	2448	2.0	0.95	4.9	24	288	2.0	1.0	2.9	32	384	1.8	1.2	2.4	260	3120	2.0	1.0	4.9
FY2015	202	2424	1.9	0.91	3.7	21	252	2.1	1.2	3.6	39	468	1.9	1.3	3.3	262	3144	1.9	0.9	3.7
FY2016	214	2568	1.9	0.78	12	18	216	2.0	1.4	4.1	39	468	1.8	1.4	2.4	271	3252	1.9	0.8	12
FY2017	217	2604	1.9	0.0021	13	20	240	1.9	1.2	3.1	43	516	1.7	1.3	2.2	281	3372	1.8	0.0021	13

*Fiscal Year in Japan: April to Next March (e.g. FY2017: Apr 2017-Mar 2018)

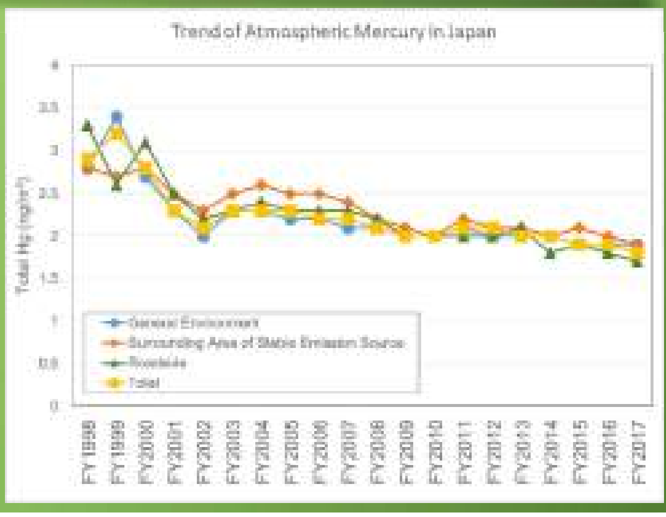
Distribution of Atmospheric Mercury (FY 2017)

23



Trend of Atmospheric Mercury in Japan

24



25

Thank you for your attention

Tatsuya Hattori: tatsuya@ideacon.co.jp
IDEA Consultants Inc.: https://ideacon.jp/en/

Material 3

24 hours continuous sampling for mercury in ambient air by gold amalgamation method

The explanation of

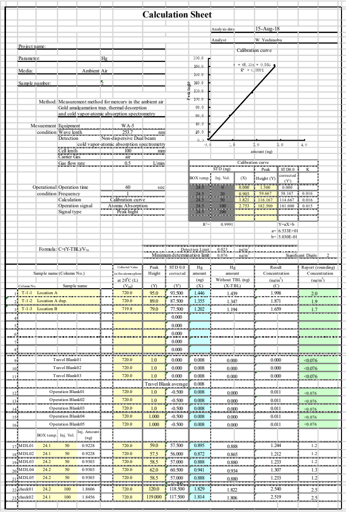
QA/QC and Calculation

Referred Manual:
An Excerpt from “Manual of Measurement Method of Hazardous Air Pollutants” (March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

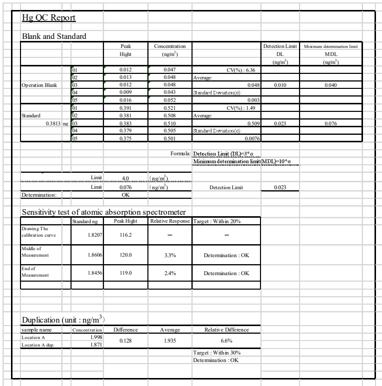
Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

Contents

Calculation sheet



Example of Calculation Sheet



Example of QC Reporting Sheet

This Excel file will be passed out to you.
Later on, please check formula in cell.

3

Required data for QC (1)

Calculation Sheet

Calibration curve

Data for calculating a calibration curve

Detection limit &
Minimum determination limit

Duplicate sampling

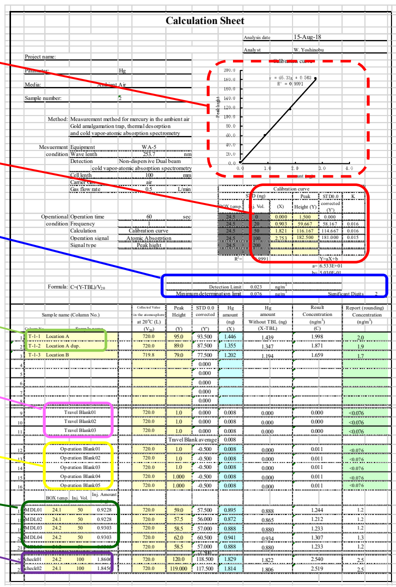
Travel Blanks 3 times

This is called " **Field Blank**" in EPA method.

Operation Blank 5 times

Std. measurement 5 times
(For calculating detection limit)

Check of Sensitivity Drift
(Sensitivity test of atomic absorption spectrometer)



4

Required data for QC (2)

QC Reporting Sheet

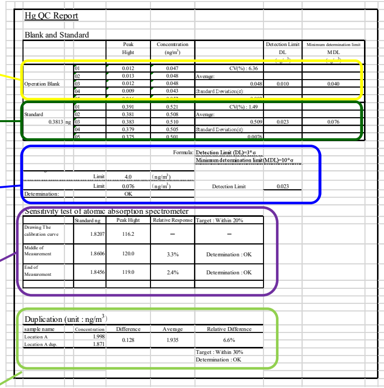
Operation Blank 5 times
& Calculation of DL & MDL

Std. measurement 5 times
& Calculation of DL & MDL

Detection limit & Minimum determination limit
(Together with comparison between Required MDL and calculated MDL)

Check of Sensitivity Drift
(Comparison of the response at the beginning and at the end.)

Comparison of duplicate samples



Hg QC Report

Blank and Standard

		Peak Hight	Concemtration (ng/m³)		Detection Limit DL	Minimum determination limit MDL
Operation Blank	01	0.012	0.047	CV(%) : 6.36		
	02	0.013	0.048	Average:		
	03	0.012	0.048	0.048	0.010	0.040
	04	0.009	0.043	Standard Deviation(σ):		
Standard	01	0.391	0.521	CV(%) : 1.49		
	02	0.381	0.508	Average:		
0.3813 ng	03	0.383	0.510	0.509	0.023	0.076
	04	0.379	0.505	Standard Deviation(σ):		
	05	0.375	0.501	0.0076		

Formula: Detection Limit (DL)=3*σ
Minimum determination limit(MDL)=10*σ

Limit	4.0	(ng/m³)		
Limit	0.076	(ng/m³)	Detection Limit	0.023
Determination:	OK			

Sensitivity test of atomic absorption spectrometer

	Standard ng	Peak Hight	Relative Response	Target : Within 20%
Drawing The calibration curve	1.8207	116.2	–	–
Middle of Measurement	1.8606	120.0	3.3%	Determination : OK
End of Measurement	1.8456	119.0	2.4%	Determination : OK

Duplication (unit : ng/m³)

sample name	Concentration	Difference	Average	Relative Difference
Location A	1.998	0.128	1.935	6.6%
Location A dup.	1.871			

Target : Within 30%
Determination : OK

Measurement Sequence (for QC)

Measurement Sequence

No	Range	Sample name
1	Low	Conditioning
2	Low	Conditioning
3	Low	Conditioning
4	Low	STD 0 μL injection
5	Low	STD 0 μL injection
6	Low	STD 0 μL injection
7	Low	STD 50 μL injection
8	Low	STD 50 μL injection
9	Low	STD 50 μL injection
10	Low	STD 100 μL injection
11	Low	STD 100 μL injection
12	Low	STD 100 μL injection
13	Low	STD 150 μL injection
14	Low	STD 150 μL injection
15	Low	STD 150 μL injection
16	Low	MDL01 _50μL
17	Low	MDL02 _50μL
18	Low	MDL03 _50μL
19	Low	MDL04 _50μL
20	Low	MDL05 _50μL
21	Low	Blank 01
22	Low	Blank 02
23	Low	Blank 03
24	Low	Blank 04
25	Low	Blank 05
26	Low	Travel Blank01
27	Low	Travel Blank02
28	Low	Travel Blank03
29	Low	Sensitivity check01 _100μL
30	Low	Location A
31	Low	Location A dup.
32	Low	Location B
33	Low	Sensitivity check02 _100μL
34	Low	Conditioning
35	Low	Conditioning

Cleaning of the line

Standards for calculation of a Calibration Curve

Standards for calculation of MDL

Operation Blanks

Travel Blanks (Field Blanks)

Checking Sensitivity Drift

Samples

Checking Sensitivity Drift

Cleaning of the line

QC 0. Baking Gold Column

Described in a manual as…

*"Heat the collection tube **at 600-700ºC for 5 minutes** with mercury free gas passing through the tube at a flow rate of 0.2-0.5 L/min. After heating, cool the collection tube with flowing gas and place it in a sealed container to prevent contamination. This procedure should preferably be performed immediately before use. When baking multiple numbers of collection tubes all at once, blank value check should be performed at a rate of at least 10% of the samples from the same baking lot."*

To remove mercury in gold columns, conduct same procedure as measurement operation twice before use. (cf. Material 2 page 14-15).

7

QC 1. Calibration Curve

At least 4 points or more (Including point 0 ng)

For example： 0, 50, 100, 150μL R^2>0.995

(cf. figure on page 3.)

Gas box temp. 24 ºC
Hg saturated gas 150μL =Hg theoretical amount 2.7459 ng

Designated* air collection volume is 0.72 m^3.
2.7459 ng/0.72 m^3≒3.814 ng/m^3

*"Manual of Measurement Method of Hazardous Air Pollutants" by MOEJ
[0.5 L/min x 24hr/1000=0.72 m^3]

Hg concentration of YOUR sample should be lower than this value.

If the Hg concentration of your sample exceeds the range of calibration curve, you need to calculate calibration curve again with increased std gas volume.

8

QC 2. Detection Limit (DL, LOD) & Minimum Determination Limit (MDL, LOQ)

Formula : DL (LOD) = 3 σ

MDL (LOQ) = 10 σ

σ : Standard Deviation of 5 times subsequent measurement of standard gas whose Hg amount equivalent to the lowest point of the calibration curve. (cf. page 4, green box)

[NOTE]
Make sure DL of Travel Blanks (pink box) and Operation Blanks (yellow box) are lower than DL (almost zero).

9

QC 3. Travel Blank (Field Blank) & Operation Blank

Travel Blank (Field Blank)

- At least three samples in a travel blank test
- Frequency: Approximately 10% of the total number of a set of samples from the same study area, period, transportation, or distance.

(cf. Material 1 page 9)

Operation Blank

- More than five samples on each measurement.

10

QC 4. Check of Sensitivity Drift
(Sensitivity test of atomic absorption spectrometer)

Measure the same amount of standard gas as the medium point of standard curve(check Std.). Calculate the Relative Response Drift as shown below and confirm the sensitivity drift is smaller than 20%. This confirmation should be done at least once every 10 samples.

Relative Response Drift< 20%

{(Peak height of the mid-point of calibration curve)-(Peak height of check Std.)} / (Peak height of the mid-point of calibration curve)*100

Refer the calculation sheet (formula in cell) .

Caution:
Inject amount should be changed according to gas box temp.
(In our lab, a gas box is placed in an incubator at 23 °C to keep the temp.)

11

QC 5. Duplicate Analysis

More than two gold columns are used for a duplicate analysis under the same conditions (from sampling to measurement). The frequency of duplicate analysis is approximately 10% of the total number of a series of samples.

Relative Variation among Replicates: Within 30 %

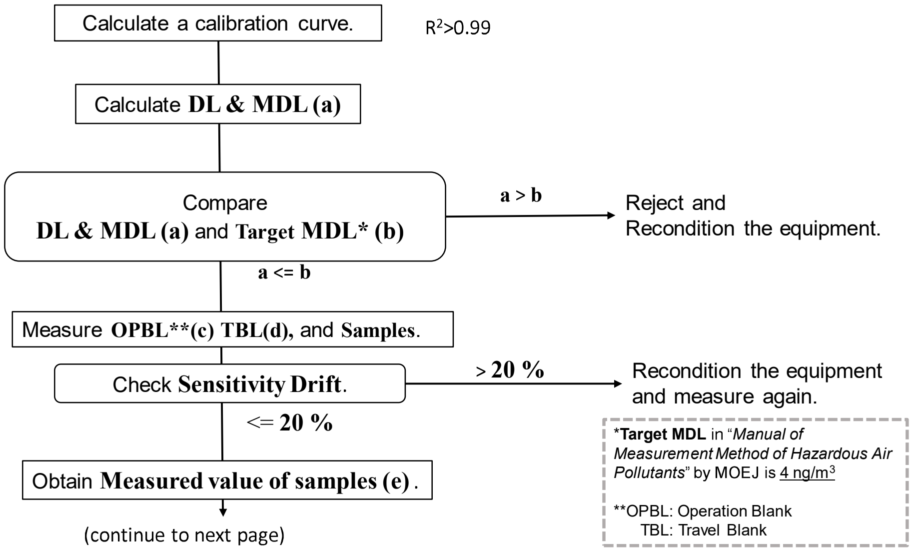
For example,

Location A : X ng/m^3
Location A dup. :Y ng/ m^3 } Average = (X+Y)/2

(X-Y)/Average x 100 **< 30 %**

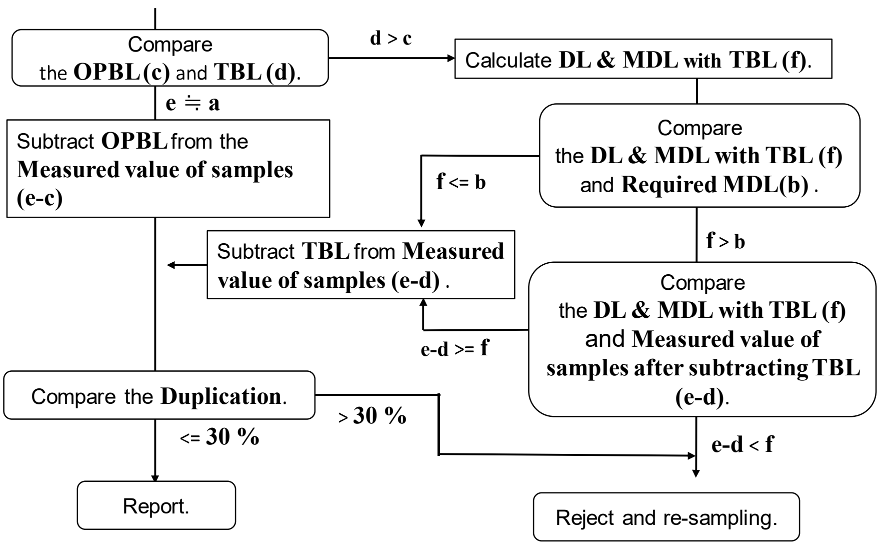
12

Flow chart for QC (1)



13

Flow chart for QC (2)



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Thank you for your attention.

15

Material 4

24 hours continuous sampling
of mercury in ambient air
by gold amalgamation method

Validation Result

in IDEA Consultants, Inc

Referred Manual:
An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants"
(March 2011, Air Environment Division, Environment Management Bureau of Water and Air Environment Fields, MOEJ)

Part 5th. Chapter 2nd.
Measurement method for mercury in the ambient air
Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

1

Contents

2

Equipment in IDEA Lab.

MA3000 (left side) : Atomic absorption spectrometer

RH-MA3 (right side) : Thermal desorption device (attachment)

Product of Nippon Instruments Inc (NIC)

Uncertainty of Mini Pump
(Sigma 300 NII)

Uncertainty of Mini Pump
(Sigma 300 NII)

No.		instantaneous flow rate of MFM	instantaneous flow rate of mini pump	Difference between MFM and mini pump
		L/min	L/min	
0	STRAT	-	-	
1	1 minute later	0.497	0.50	0.003
2	5 minute later	0.496	0.50	0.004
3	10 minute later	0.496	0.50	0.004
4	15 minute later	0.497	0.50	0.003
5	20 minute later	0.497	0.50	0.003
6	25 minute later	0.496	0.50	0.004
7	30 minute later	0.495	0.50	0.005
8	35 minute later	0.495	0.50	0.005
9	40 minute later	0.495	0.50	0.005
10	45 minute later	0.496	0.50	0.004
Average		0.496	0.50	0.004
Standard Deviation		0.00082	0	0.00082

Step1. Standard Measurement Uncertainty of Mini Pump =(SD of difference between MFM and mini pump)/(Average flow rate of Mini pump)*100 (%) =0.00082/0.50*100 = 0.164 %

Step2. Uncertainty of MFM =0.4 %
(According to calibration certificate by JQA*)
*JQA = Japan Quality Assurance Organization

Step.3 Combined Standard Uncertainty =SQRT (0.1633^2+0.4^2)= 0.432 %

The Expanded Measurement Uncertainty of Mini Pump is approximately 1 %, which is sufficiently small.

Last step. Expanded Measurement Uncertainty
(Coverage Factor : kappa =2)
=0.432 * 2 = 0.87 % (round up)

5

Coefficient of Variation

1. Daily Variation of **Slope** and **R^2** of **calibration curves**

Variation in 5 days

Date	Slope	R^2 score
13-Sep.	1.1492	0.9999
14-Sep.	1.1295	0.9995
15-Sep.	1.1506	0.9997
16-Sep.	1.1435	0.9994
17-Sep.	1.1364	0.9998
AVE.	1.1418	0.9997
SD	0.009	0.0002
CV %	**0.78**	**0.02**

Variation in a day

Date and time	Slope	R^2 score
15-Sep. 11:45	1.1506	0.9997
15-Sep. 15:02	1.1660	0.9996
15-Sep. 16:45	1.2030	0.9994
15-Sep. 18:02	1.2006	0.9996
15-Sep. 19:29	1.1965	0.9995
AVE.	1.1833	0.9996
SD	0.024	0.0001
CV %	**2.0**	**0.01**

Daily Variation is sufficiently small.

6

3

Coefficient of Variation

2. Daily Variation of **Measured Value of Actual Samples**

- Comparison of 5 days
- All the procedure (sampling to measurement) was done under same condition.

	Sampling date							
	1st day	2nd day	3rd day	4th day	5th day			
n=1	1.323	1.142	1.178	1.021	1.635			
n=2	1.270	1.057	1.140	1.052	1.576			
n=3	1.286	1.163	1.121	1.000	1.471			
n=4	1.343	1.076	1.206	0.974	1.518			
n=5	1.313	1.122	1.214	1.092	1.544	Average , maximum and minimum in each standard deviation and CV value of 5 times		
	Average, Standard Division and CV (%) of each day							
Ave.	1.307	1.112	1.172	1.028	1.549	AVE.	Max.	Min.
SD.	0.026	0.040	0.036	0.041	0.055	0.040	0.055	0.026
CV %	1.99	3.57	3.08	3.98	3.56	3.23	**3.98**	1.99

The Coefficient of Variation for 5 days was at most 3.98 %.

7

Calculation of Uncertainty

Approach 1 : 5 days Measurement of Actual Samples (cf. page 7)

All procedures (from sampling to measurement) were repeated **five times**.

As a results, we knew

"Maximum Coefficient of Variation is **3.98 %**."
(= standard measurement uncertainty)

Coverage Factor : kappa =2
3.98 * 2 =7.96

The Expanded Measurement Uncertainty of this method is approx. **8.0 %.** (round up)

8

4

Calculation of Uncertainty

Another Approach : Fishbone Diagram

Step 1. Uncertainty of a Pump

Step 2. Uncertainty of Hg adsorption and desorption

Step 3. Uncertainty of measurement

Step 4 Combined uncertainty

Step5. Expanded Uncertainty

Since step.2 and step.3 cannot be evaluated separately, step.3 is included in the calculation of step.2.

Step 1. Uncertainty of a Pump

According to manufacturer's announcement, the flow rate of the mini pump is guaranteed to be less than **5%** of the set flow rate.

If the actual values have a rectangular distribution, the uncertainty of the pump is 5/SQRT 3 = **2.9 %**

Caution :
This doesn't mean that actual flow rate differs 5% from the set flow rate. Fluctuation of the flow is up to 5% during aspiration, but the average flow rate is same as the set flow rate.
In fact, actual fluctuation is much lower than 5%. (cf. page 5)

9

Calculation of Uncertainty

Another Approach : Fishbone Diagram

Step 2&3. Uncertainty of Hg adsorption and desorption Uncertainty of measurement

Result

	Results
Added amount [ng]	1.801
Measured amount [ng]	1.713
	1.689
	1.665
	1.685
	1.763
Ave. [ng]	1.724
SD	0.055
CV [%]	**3.2**
Difference [ng]	0.077
Recovery [%]	95.7

- Mercury adsorption and desorption test:
  1. Addition of Hg standard gas to 5 blank columns
  2. Measurement of 5 columns
  3. Calculation of CV & recovery rate

Uncertainty of step 2 & 3 was **3.2 %**

10

Calculation of Uncertainty

Another Approach : Fishbone Diagram

Step 4. Combined Standard Uncertainty

=SQRT (2.9^2+3.2^2)= **4.318 %**

Step 5. Expanded Measurement Uncertainty

(Coverage Factor : kappa =2)
=4.318 * 2 = **8.64 %**
(approximately 8.7 %) (Round up)

✓ Comparison of the results from two approaches. (cf. page 8 and this page)

- 8.0 % : 5 days Measurement of Actual Samples
- 8.7 % : Fishbone Diagram

Expanded measurement uncertainty of this method **in IDEA** was proved to be **8-9%** in either approach.

11

Recovery Test

	Results	
	Hg amount (ng)	Concentration (ng/m³)
added amount	**1.801**	**2.501**
added01	3.375	4.606
added02	3.298	4.499
added03	3.239	4.414
AVE.	3.304	4.506
SD	0.068	0.097
CV %	2.07	2.14
no added01	1.546	2.066
no added02	1.644	2.202
no added03	1.660	2.224
AVE.	1.617	2.164
SD	0.061	0.086
CV %	3.80	3.95
Difference	(3.304-1.617=) **1.687**	2.342
Recovery %	(1.687/1.801*100=)**93.7**	**93.6**

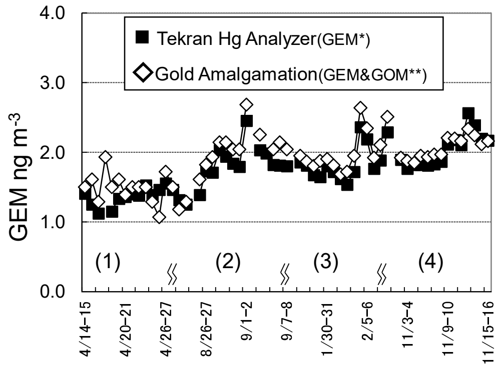
■ Recovery test:

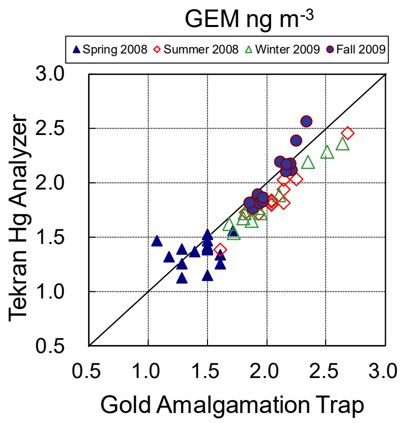
1. Actual air sampling with 3 Hg added columns and 3 blank column
2. Comparison of two groups(added & no added)
3. Calculation of recovery rate

Recovery rate was approx. **94%**

12

Comparison of Tekran and Gold amalgamation Method at Cape Hedo, Okinawa, Japan





(1) Spring: 14 -30 Apr. 2008
(2) Summer: 25 Aug. - 8 Sep. 2008
(3) Winter: 26 Jan. - 8 Feb. 2009
(4) Fall: 2 Nov. – 16 Nov. 2009

*GEM : gaseous elemental mercury
**GOM : gaseous oxidized mercury

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Gracias por su atencion

14

Survey and Monitoring Activities

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IDEA Consultants, Inc.

2

Monitoring in Minamata Convention on Mercury

3

Monitoring in Minamata Convention Articles

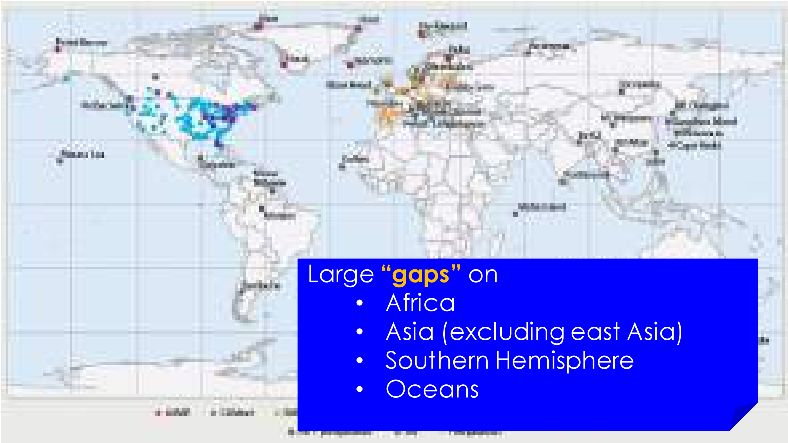
- Article 19 "Research, Development and Monitoring"
  - **1.** *"Parties shall endeavour to cooperate to develop and improve, taking into account their respective circumstances and capabilities:"*
    …
    (b) "Modelling and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media, including biotic media such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples;"
- Article 22 "Effectiveness Evaluation"
  - 2. *"To facilitate the evaluation, the Conference of the Parties shall, at its first meeting, initiate the establishment of arrangements for providing itself with comparable monitoring data on the presence and movement of mercury and mercury compounds in the environment as well as trends in levels of mercury and mercury compounds observed in biotic media and vulnerable populations."*

4

"Geographically Representative Monitoring"…?

5

Existing Global Monitoring Network(Atmosphere and Wet Deposition)



Large **"gaps"** on

- Africa
- Asia (excluding east Asia)
- Southern Hemisphere
- Oceans

UNEP Global Mercury Assessment 2013

6

Monitoring / Survey for other Articles of Minamata Convention

7

Minamata Convention

- 1. Objective
- 2. Definitions
- 3. Mercury supply sources and trade
- **4. Mercury-added products**
- 5. Manufacturing processes in which mercury or mercury compounds are used
- 6. Exemptions available to a Party upon request
- **7. Artisanal and small-scale gold mining**
- **8. Emissions**
- **9. Releases**
- 10. Environmentally sound interim storage of mercury, other than waste mercury
- **11. Mercury wastes**
- **12. Contaminated sites**
- 13. Financial resources and mechanism
- 14. Capacity-building, technical assistance and technology transfer
- 15. Implementation and Compliance Committee
- 16. Health aspects
- 17. Information exchange
- 18. Public information, awareness and education
- **19. Research, development and monitoring**
- 20. Implementation plans
- 21. Reporting
- **22. Effectiveness evaluation**

8

Minamata Convention

- 1. Objective
- 2. Definitions
- 3. Mercury supply sources and trade
- **4. Mercury-added products**
- 5. Manufacturing proces mercury or mercury co
- 6. Exemptions availabl request
- **7. Artisanal and small-**
- **8. Emissions**
- **9. Releases**
- 10. Environmentally so of mercury, other than
- **11. Mercury wastes**
- **12. Contaminated sites**
- 13. Financial resources and mechanism
- 14. Capacity-building, technical assistance and technology transfer
- 15. Implementation and Compliance
- **22. Effectiveness evaluation**

Besides Article 19 and 22, there are articles which require monitoring or survey to confirm the process and effect of the convention

4

9

Objectives of Survey/Monitoring

Example:

- High concentration area
  (Mining area, Stable emission source, Contaminated site, etc.)
  - To evaluate the exposure amount of worker/resident and Spatial tendency
    (Atmosphere, Indoor work environment)
- General residential area
  - To evaluate average and highest concentration in the general residential area
- Background area
  - To evaluate the global scale fate and transportation of mercury (e.g. long-term continuous monitoring)

10

Objectives of Survey/Monitoring

Example:

- High concentration area
  (Mining area, Stable emission source, Contaminated site, etc.)
  - To evaluate the exposure amount of worker/resident and Spatial tendency
    (Atmosphere, Indoor work environment)
- General residential area
  - To evaluate average and highest concentration in the general residential area
- Ba
  - n of

On the evaluation or assessment of the data, the survey / monitoring sites of different objectives should not be confused.

11

Which Method is Applicable?

12

Atmospheric Mercury Survey / Monitoring to…

- Fill the monitoring gaps in the global scale
- Search and evaluate the high concentration area
- Evaluate the situation of exposure of general residents

Objectives and situations are different
=The appropriate way of the survey / monitoring should be conducted

Atmospheric Mercury Survey / Monitoring

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- **Continuous active sampling – measurement on site**
- **Active sampling – analysis in laboratory**
- **Passive sampling – analysis in laboratory**

Continuous Active Sampling – Measurement on Site

14

- Actual concentration is obtained continuously (in short period)
- Speciation analysis of mercury (GEM, GOM and PBM) is possible with conventional Instrument
- Diurnal variation, daily variation is easy to be detected
- Cost of instrument is high
- Much electrical power and argon gas are necessary
- Measuring instruments have to be located in a shelter

Active sampling – Analysis in Laboratory

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- Actual concentration is obtained (periodical. Measurement in a laboratoly is necessary)
- Sampling duration is short (1 day or less)
- Instrument and apparatus is economical, and easy to carry and locate
- Using only a little electrical power (it can be provided by buttery)

Passive Sampling – Analysis in Laboratory

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- No instrument and electric power necessary on sampling (But instrument is necessary to measure the collected sample)
- Cost of material is low
- Sampler is easy to carry and locate
- Sampling duration is long
- To improve accuracy (correlation with actual concentration), relative information (e.g. temperature, wind speed) is necessary

Atmospheric Mercury Monitoring

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- Continuous active sampling – measurement on site
- Active sampling – analysis in laboratory
- Passive sampling – analysis in laboratory

- **These methods have supportive features each other**
- **Application of suitable method for the purpose / situation is recommended**

Atmospheric Mercury Survey at Waste Management Site

18

19

Environmental Model and Monitoring

20

Monitoring in Minamata Convention Articles

- Article 19 "Research, Development and Monitoring"
  - **1.** *"Parties shall endeavor to cooperate to develop and improve, taking into account their respective circumstances and capabilities:"*
    …
    *(b) "**Modelling** and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media, including biotic media such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples;"*

Monitoring Data to Contribute the Environmental Simulation Model

21

- Validation of the model
- Parameter estimation

In parameter estimation, processes and necessary parameters in a model should be considered well.

Atmospheric Monitoring Data for the Validation of a Model

22

- **To validate the output of:**
  - Concentration distribution in the Background sites
  - Seasonal Trend
  - Diurnal Variation

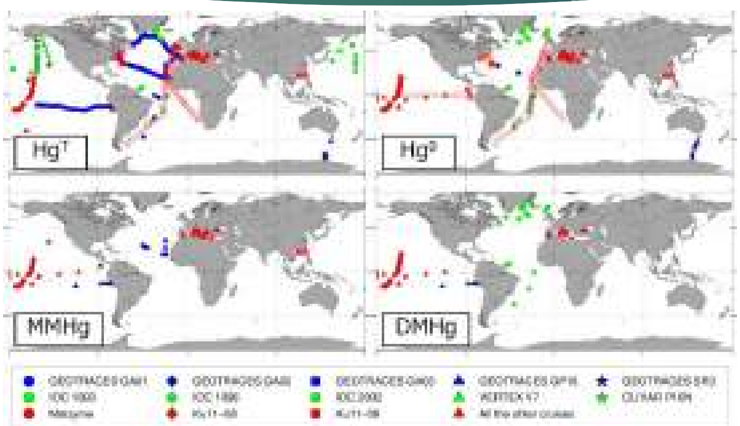
23

Other Required Monitoring Parameters Than Atmosphere

- **Deposition Amount**
  - Valuable for the validation of model process
  - Other relative parameters (atmospheric mercury concentration, climate parameters, roughness parameters, etc.) are necessary
- **Concentration of Seawater**
  - Important parameter to improve the accuracy of the model
  - Data of the area with sparse or no monitoring activity (such as Indian Ocean) is required
  - Seasonal data is not many (Insufficient to validate seasonal trend)
  - Speciation data is scarce (than total mercury)

24

Existing Ocean Survey / Monitoring Data



*: Color-filled marker: Vertical profile data
Lined-only marker: Surface data

Thank you for your attention

Tatsuya Hattori: tatsuya@ideacon.co.jp
IDEA Consultants Inc.: https://ideacon.jp/en/

Field Note

Name of researcher								
Location								
Condition at the Beginnning	M/D/Y	/ /	Weather		Air Temp. (°C)		Air Pressure (hpa)	
Condition of at the End	M/D/Y	/ /	Weather		Air Temp. (°C)		Air Pressure (hpa)	

Target : Mercury

No.	Date & Time	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)	Instantaneous flow rate	Total Vol. (L)
Sampling No. or Name													
Pump No.													
Gold Column No.													
Sodalime Tube No.													
Column position Info. (If necessary)													
0	(initial status)												
1 (start)													
2													
3													
5													
4													
6													
7													
8													
9													
10 (end)													
Total sampling Vol. (L)													
Column No. of Travel Blank	Notes :												

(Provisional Translation)

An Excerpt from "Manual of Measurement Method of Hazardous Air Pollutants" (March 2011, Air Environment Division, Environment Management Bureau of Water & Air Environment Fields, MOEJ)

Measurement method for mercury in the ambient air

Gold amalgamation trap, thermal desorption and cold vapor-atomic absorption spectrometry

1 Overview of the measurement method

Mercury in the atmosphere is collected at a constant flow rate by using a collection tube filled with collection particles. The particles are composed of diatomaceous earth particles with gold baked on their surfaces. Mercury in the atmosphere is collected as gold amalgam. During sampling, the surfaces of the collection particles may adsorb interfering gas and measured values could be compromised. In order to eliminate the influence of interfering gas, re-collect the mercury vapor generated by the collection tube attached to the thermal desorption device in the collection tube that is controlled to maintain the appropriate temperature.

The collection tube used to re-collect mercury is heated at high temperature, and desorbed atomic mercury is led to the absorption detector cell of the atomic absorption spectrometer to determine the quantity of mercury by measuring the atomic absorption at a wavelength of 253.7 nm.

With this method, analysis and collection of gaseous elemental mercury suspended in the ambient air is possible. Measurement accuracy and sampling efficiency of the other chemical forms of mercury is partly uncertain. However, because the majority exists as gaseous elemental mercury, the measured value determined by this method is considered as measured value for mercury concentration in the ambient air.

It is necessary to implement measurement quality control in order to ensure the reliability of the measured value determined by the measurement of mercury as described in this manual.

2 Reagent

(1) Standard material

Elemental mercury: more than 99% purity with assay.

(2) Diatomaceous earth particles

Thermostable diatomaceous earth particles of 500-600 μm in diameter.

(3) Gold chloride acid

Gold chloride (III) acid tetrahydrate $HAuCl_4 \cdot 4H_2O$, CASRN 1303-50-0

(4) Collection particles

Collect 3 g of diatomaceous earth particles in a beaker (50-100 mL). Then, add a solution prepared by dissolving 1 g of gold chloride (III) acid ($HAuCl_4$) to 20-30 mL of water and stir uniformly. After heating to approximately 80°C and drying by occasionally shaking, place the collection particles in a tubular furnace and heat for 30 minutes at about 800°C with air flow. (See Note 1)

1

3 Apparatus and equipment

(1) Sampling device

The sampling device is as shown in Figure 1. A collection tube, a flow control device, a pump, and a flow measuring device are connected.

It is desirable to collect samples directly within the collection tube. When, for unavoidable reasons, a conduit is used, use equipment made of clean glass or tetrafluoroethylene and/or material of equal or better property as it is less likely for mercury gas to adhere. Equipment for the sampling device should be washed thoroughly, to avoid contamination. In addition, after assembling the device prior to sampling, it should be confirmed that there are no leaks.

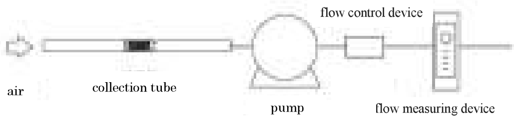


Figure 1 Overview of mercury sampling device

a) Collection tube

As illustrated in Figure 2, a quartz glass tube with a circular recess is filled in the order of quartz wool, approximately 80 mg of collection particles, and quartz wool. (See Note 1)

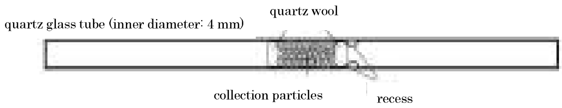


Figure 2 Example of a mercury collection tube

b) Collection tube sealed container

The container should be a glass test tube that can be hermetically sealed and stored free from mercury contamination.

c) Pump

The sealed pump, such as diaphragm type, should have a controllable gas flow rate within the range of 0.1-1.0 L/min, or be a pump of equivalent or higher performance.

d) Flow control device

The flow control device should have a controllable gas flow rate within the range of 0.1-1.0 L/min, control accuracy within ± 10% of the configuration; or, be a device of equivalent or higher performance.

e) Flow measuring device

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The flow measuring device should be able to measure to 3 decimal places of 0.001 L/min with wet gas meter, dry gas meter, float shaped area flow meter, and mass flow meter, and must be operated with high accuracy within the control range of the flow control device. A unit allowing integrated flow rate measurement is desirable, or a unit of equivalent or higher performance.

(2) Sample introduction device

a) Thermal desorption device

As illustrated in Figure 3, the used collection tube with the air sample is attached to the thermal desorption device, and the heating furnace (first) is heated to 600-700°C with a flow of mercury free air. After the vaporized gas within the mercury is washed and moisture is eliminated by introducing through a gas scrubbing bottle (see Note 2), the samples are re-collected in a collection tube (refining collection tube) attached to an atomic absorption spectrometer set to 150°C. The gas passed through the collection tube is released to the open air. Under this condition, only mercury is trapped into the collection tube and the adsorption of other interfering gas to the collection particles is suppressed. Thus, interfering substances in the mercury analysis is eliminated.

Next, after the re-collection procedure, the valve is switched to the absorption detector cell side, and the atomic mercury released by a heating of second furnace is led to the absorption detector cell of the atomic absorption spectrophotometer.

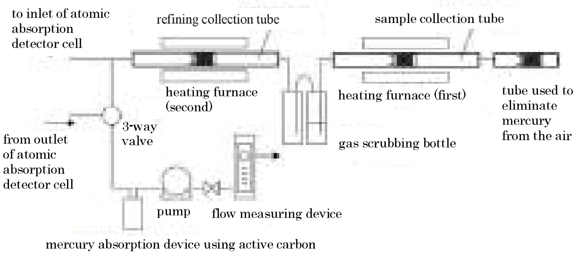

Figure 3 Example of thermal desorption device for mercury analysis

(3) Atomic absorption spectrometer

An atomic absorption spectrometer for mercury analysis or an atomic absorption spectrometer is used. This device is composed of a light source unit, an absorption detector cell unit, a wavelength selection unit, and a photometry unit.

a) Light source unit

The light source unit is a low-pressure mercury lamp or a mercurial hollow cathode lamp.

b) Absorption detector cell unit

The absorption detector cell is a plastic or glass tube (that does not absorb mercury) of 100-300 mm length with quartz glass windows at both ends.

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c) Wavelength selection unit

The wavelength selection unit for the atomic absorption spectrometer for mercury analysis is normally non-dispersive type. However, a spectrometer with a diffraction grating may also be used.

d) Photometry unit

The detector of the photometry unit is a phototube, a semiconductor detector, or a photomultiplier tube.

e) Carrier gas

The carrier gas is air, nitrogen, etc. that is mercury free.

(4) Mercury standard gas

A mercury vapor saturated gas preparation device as shown in Figure 4 is used. The device should have a structure that can be sealed after putting a few grams of elemental mercury in a glass container with thermal insulation. Also, it must be equipped with a control pressure hole for balancing the pressure within the glass vessel with the external atmospheric pressure (gas tight syringe insertion hole) and a thermometer that can measure the temperature in the glass vessel measurable to 1/10°C. The amount of mercury contained in a unit volume of mercury vapor saturated gas in the preparation device is shown in Table 1. (See Note 3) (See Note 4)

(5) Gas-tight syringe

Capacity of 10 μL - 1 mL.

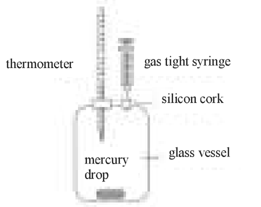


Figure 4 Overview of mercury vapor saturated gas preparation device

4

Table 1 Unit volume weight of mercury contained in mercury vapor saturated gas

Unit: ng/mL

t ℃	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0	2.179	2.202	2.225	2.248	2.271	2.295	2.319	2.343	2.368	2.392
1.0	2.417	2.441	2.465	2.489	2.514	2.539	2.564	2.589	2.614	2.640
2.0	2.666	2.691	2.716	2.741	2.766	2.792	2.818	2.844	2.871	2.897
3.0	2.924	2.951	2.978	3.005	3.033	3.061	3.089	3.117	3.146	3.175
4.0	3.204	3.234	3.264	3.295	3.325	3.356	3.388	3.419	3.451	3.483
5.0	3.516	3.549	3.583	3.616	3.650	3.685	3.719	3.754	3.789	3.825
6.0	3.861	3.897	3.933	3.970	4.007	4.045	4.083	4.121	4.159	4.198
7.0	4.237	4.276	4.316	4.356	4.396	4.437	4.478	4.519	4.561	4.603
8.0	4.645	4.688	4.731	4.774	4.817	4.861	4.905	4.949	4.994	5.039
9.0	5.085	5.131	5.178	5.225	5.273	5.321	5.639	5.418	5.467	5.517
10.0	5.567	5.616	5.666	5.716	5.767	5.818	5.870	5.921	5.974	6.026
11.0	6.079	6.133	6.187	6.241	6.296	6.351	6.407	6.463	6.519	6.576
12.0	6.633	6.692	6.751	6.810	6.870	6.931	6.992	7.053	7.115	7.177
13.0	7.240	7.304	7.369	7.435	7.501	7.568	7.635	7.703	7.771	7.840
14.0	7.909	7.979	8.049	8.119	8.191	8.262	8.335	8.408	8.481	8.555
15.0	8.630	8.705	8.781	8.858	8.935	9.013	9.092	9.171	9.251	9.331
16.0	9.412	9.493	9.575	9.658	9.742	9.826	9.910	9.995	10.081	10.168
17.0	10.255	10.342	10.429	10.516	10.604	10.693	10.783	10.873	10.964	11.056
18.0	11.148	11.242	11.337	11.433	11.529	11.626	11.724	11.823	11.922	12.022
19.0	12.123	12.225	12.328	12.432	12.536	12.641	12.747	12.854	12.961	13.070
20.0	13.179	13.289	13.400	13.511	13.623	13.737	13.851	13.965	14.081	14.198
21.0	14.315	14.434	14.553	14.674	14.795	14.917	15.040	15.164	15.289	15.415
22.0	15.542	15.670	15.800	15.930	16.061	16.193	16.326	16.461	16.596	16.732
23.0	16.869	17.008	17.148	17.289	17.431	17.574	17.718	17.864	18.010	18.158
24.0	18.306	18.456	18.606	18.758	18.911	19.065	19.220	19.376	19.534	19.693
25.0	19.852	20.012	20.174	20.336	20.500	20.664	20.830	20.998	21.166	21.336
26.0	21.506	21.679	21.853	22.028	22.204	22.382	22.560	22.741	22.922	23.105
27.0	23.289	23.474	23.660	23.847	24.036	24.227	24.418	24.611	24.805	25.001
28.0	25.198	25.397	25.598	25.800	26.003	26.208	26.415	26.622	26.832	27.042
29.0	27.255	27.469	27.685	27.902	28.121	28.342	28.564	28.787	29.012	29.239
30.0	29.467	29.697	29.928	30.160	30.395	30.631	30.868	31.107	31.348	31.591
31.0	31.835	32.081	32.329	32.579	32.830	33.084	33.339	33.595	33.854	34.114
32.0	34.376	34.641	34.908	35.177	35.448	35.720	35.995	36.271	36.549	36.829
33.0	37.111	37.395	37.681	37.969	38.258	38.550	38.843	39.139	39.437	39.736
34.0	40.038	40.341	40.647	40.954	41.264	41.575	41.889	42.205	42.523	42.843
35.0	43.165	43.491	43.819	44.148	44.481	44.815	45.152	45.491	45.832	46.176
36.0	46.522	46.870	47.221	47.575	47.930	48.289	48.649	49.012	49.378	49.745
37.0	50.116	50.488	50.863	51.241	51.621	52.004	52.389	52.777	53.167	53.560
38.0	53.955	54.354	54.755	55.158	55.565	55.974	56.385	56.800	57.217	57.637

4 Sampling

(1) Baking collection tube

With the mercury free gas at a flow rate of 0.2-0.5 L/min, heat the collection tube at 800℃ for 5 minutes. After the heating, the collection tube is cooled under flowing gas and placed in a sealed container to prevent contamination. This procedure is preferably performed immediately before use. (See Note 5)

When baking multiple numbers of collection tubes all at once, the blank value should be measured from the same baking lot at a rate of at least 10% or more of the samples with the designated method. The blank value converted to atmospheric concentration should be below the target minimum determination limit. If the blank value exceeds the target minimum determination limit, all collection tubes of the same lot, including the measured tube, should be re-baked, and the blank value checked again.

(2) Sampling

Take out the collection tube from the sealed container, and attach the side with dents (circular recess) to the sampling device (as shown in Figure 1). After confirming that there are no leaks in the entire path of the sampling, operate the pump for 24 hours with an aspiration at a flow rate of approximately 0.1-0.5 L/min.

After the sampling is over, seal the collection tube and place it in a sealed container until analysis.

Store the collection tube for the travel blank test in a sealed container, carry it in the same manner as the collection tube for the samples, except for the sampling procedure. In other words, open the plug of the travel blank collection tube during sample preparation (from when the plug of collection tube for sampling is opened until the start of sampling). Seal the collection tube for the travel blank again, and place it besides the collection tube for sampling during the sampling. After the sampling is completed, open the plug and seal it once again together with the collection tube for samplings, and store it until analysis. This travel blank test must be performed whenever contamination is suspected during transportation of the collected samples from the sampling site. Otherwise, it is not necessary to perform this procedure every time as long as it is confirmed that the prevention measures for contamination are carried out. However, in order to ensure the reliability of the sampling, the travel blank test should be thoroughly verified in advance and should be prepared to present the data when necessary. This procedure must be conducted on more than three samples that are approximately 10% of the total number of a set of samples from the same study area, period, transportation, or distance. (See Note 6)

More than two collection tubes are sampled for the duplicate analysis under the same conditions. The number of samplings for the duplicate analysis is approximately 10% of the total number of a series of samples.

5 Test procedure

(1) Setting analytical conditions of the sample introduction device, the atomic absorption spectrometer, and adjusting the equipment

Analytical conditions of the sample introduction device and the atomic absorption spectrometer are set following the example shown below.

Sample introduction device

Heating duration:	2 minutes	
Carrier gas:	air passing through the mercury collection tube	0.5 L/min

Washing solution:	diluted neutral phosphate pH standard solution (1 + 1)

Atomic absorption spectrometer

Light source:	mercury discharge tube
Wavelength:	253.7 nm
Detection method:	non-dispersive two-beam-type cold atomic absorption method

(2) Sample measurement

The thermal desorption apparatus illustrated in Figure 3 is operated as follows.

Take the collection tube with the sample out from the sealed container and attach it to the first heating furnace. Attach the purification collection tube of exclusive use, of which the blank was sufficiently reduced in advance, to the second heating furnace and keep the temperature of the furnace at 150℃. Switch the three-way valve to suction pump, then, heat the first heating furnace at 600-800℃ to vaporize the mercury while the mercury free gas flows at a constant flow rate of 0.2-0.5 L/min and re-collect mercury into the collection tube (as shown in Figure 3, the refining collection tube in the second heating furnace). Next, switch the three-way valve to absorption detector cell, guide the mercury vapor which vaporized by heating at 500-800℃ in the second heating furnace to the absorption detector cell. Mercury is measured by an atomic absorption at spectrum analysis wavelength of 253.7 nm and weight of mercury (A_s: ng) is obtained from peak height or peak area based on the calibration curve prepared in advance in (3).

(3) Creating a calibration curve

Take an appropriate amount of standard gas of mercury (0.1-10 ng of mercury) stepwise using the gas-tight syringe from the mercury vapor saturated gas preparation device, inject the gas into the collection tube of the thermal desorption-atomic absorption spectrometer (the collection tube in the first heating furnace in Figure 3), create a calibration curve based on the relationship between the absorbance obtained in (2) and the amount of mercury injected. The calibration curve is created by 5 or more different mercury injection volumes (including zero). The calibration curve is created just before the measurement. (See Note 7, Note 8)

(4) Operation blank test

For the blank test use the same baked lot tube as the sample collection tube. The operation blank value is obtained following the procedure (2). (See Note 9)

(5) Travel blank test

The weight of the mercury is measured by procedure (2) for the collection tube used for the travel blank test described in 4-(2). More than three samples are measured, and the average is considered a travel blank value (A_t: ng). (See Note 10)

(6) Sensitivity test of atomic absorption spectrometer

Standard gas is injected into the first collection tube so that the weight is close to the mid-position of the calibration curve and the sensitivity fluctuation is confirmed by carrying out procedure (2). This confirmation should be done at least once every 10 samples. When it is confirmed that the sensitivity fluctuation of the device is stable, the frequency of the sensitivity tests may be reduced within this range. However, there are risks in conducting sensitivity tests at longer intervals. Because the relationship between the cause of

abnormal values or dual measured values exceeding the standard value and the sensitivity fluctuation cannot be confirmed, all samples in the period may be re-measured or treated as missing values. In addition, when the sensitivity fluctuation exceeds 20%, all samples measured previously should be re-measured. Thus, the frequency of the sensitivity test should be set within a practical range such that re-measurement is possible, taking these risks and sample storability into account. Prior to reducing the frequency of the sensitivity test, it should be discussed sufficiently about the test in order to ensure the reliability so that a drastic sensitivity fluctuation does not occur and that the sensitivity is kept stable during a long temporal interval. Documents or data should be prepared for presentation when necessary. (See Note 11)

(7) Duplicate analysis

The mercury amount for collection tubes for the dual measurement described in 4-(2) is measured by the procedure explained in (2). (See Note 12)

6 Measurement of detection limit and minimum determination limit

Inject the standard gas which is equivalent to the lowest concentration for creating the calibration curve (near the minimum determination limit) into the baked collection tube, and obtain a measured value by conducting procedure 5-(2) (A: ng). Then, value A is substituted to (As – At) of formula (3) to calculate the atmospheric concentration. The detection limit and minimum determination limit of mercury are calculated from the standard deviation (sigma) obtained from measuring results of more than 5 samples, by using formulas (1) and (2). However, if the operation blank value exists, the operation blank value must be measured, and the calculation must be conducted by using a larger standard deviation within those of a standard gas and an operation blank value. (See Note 13)

This measurement should be carried out more than once if analytical conditions of the instruments are configured

Detection limit = 3 sigma (ng/m^3) .... formula (1)

Minimum determination limit = 10 sigma (ng/m^3) .... formula (2)

7 Calculating the atmospheric mercury concentration

The atmospheric mercury concentration is calculated using formula (3) based on the results obtained in 5-(2).

$$C = (As - At) / (V \times 293 / (273 + t) \times P / 101.3) \quad \text{formula (3)}$$

C:	mercury concentration in the atmosphere at 20℃ (ng/m^3)
As:	mercury amount of the sample (ng)
At:	travel blank value (ng)
	Operation blank value will be used if it is regarded as being equivalent to the travel blank value.
V:	collected volume measured by the flow meter (m^3)
t:	average temperature at the time of sample collection (℃) (See Note 14)
P:	average air pressure at the time of sample collection (kPa) (See Note 14)

If a wet-type integrating flow meter is used, relative humidity correction is made after calculating dry gas volume using the average water temperature (˚C) of integrating flow meter as "t" and (P-Pw) as "P". Here, Pw is a saturated water vapor pressure (kPa) at average temperature "t" at the time of the sample collection.

(Note 1) Commercial collection particles or collection tubes filled with these collection particles are readily available.
(Note 2) Water is used as washing solution. However, if acidic substance exists within the trapping material and the pH of the washing solution drops, a small amount of mercury may be dissolved into the washing solution. In such a case, it is preferable to use neutral phosphate pH standard solution diluted with water, instead of using water as the washing solution. Use after having confirmed that there is no mercury contamination in the washing solution.
(Note 3) Commercial mercury saturated gas preparation equipment is commercially available.
(Note 4) Mercury standard solution can be used. Method for preparing mercury standard solution in this case is as follows.

(1) Mercury diluted solution: take 10 mg of L-cysteine into a volumetric flask (1000 mL), add water and dissolve by shaking, add 2 mL of nitric acid, then, add water to the mark line. Prepare the dilution when it is used.

(2) Mercury standard stock solution (100 µg Hg/mL): take 67.7 mg of mercury chloride (II) ($HgCl_2$) into a volumetric flask (500 mL), dissolve in mercury diluted solution, and add additional mercury diluted solution to the mark line to make a standard stock solution. Store it in a refrigerator.

(3) Standard mercury solution (0.001-0.1 µg Hg/mL): obtain by adjusting the standard stock solution to a predetermined concentration. Dilute with mercury dilution solution when it is used.

(Note 5) The collection tube may be heated for more than 30 minutes at approximately 800˚C to reduce the blank, cooled in an atmosphere free of mercury contamination, then stored in the collection tube sealed container.
(Note 6) The travel blank value must be measured for at least three samples within a series of measurements. However, if a large variation exists in measurement results of the three samples, and may cause a large error in the measurement results by subtracting these travel blank values from the measured values, it is suggested that the travel blank test should be conducted for a necessary number of times which is deemed to be statistically meaningful.
(Note 7) If a reducing vaporization device is used, attach the collection tube to the outlet of the reduced vaporizer. The mercury standard solution is reduced, vaporized mercury is collected, and a calibration curve is made. If there is a heating furnace between the first heating furnace and the gas scrubbing bottle as shown in Figure 3, a calibration curve can be also made using a mercury standard solution. The substantial steps are as follows.

Make a standard concentration series of mercury standard solution (0.001- 0.1 µgHg/mL). Inject 100 µL of the solution into the magnetic boat or collection tube. Place it in the first heating furnace. Following procedure 5-(2), make a calibration curve based on the relationship between the mercury injection volume and the absorbance. It should be noted that contamination from the magnetic boat or collection tube should be avoided.

The calibration curve is made for standard concentration series with 5 or more stages, including zero. The calibration curve is made when a measurement is conducted.

(Note 8) The range of concentrations of the calibration curve must be changed according to the concentration level of mercury in the ambient air.
(Note 9) This operation should be performed prior to sample measurement, and the concentration in the air converted from the operation blank value is compared with the target minimum determination limit. In order to make the actual atmospheric concentration of mercury measurable, the operation blank value should be reduced as much as possible.
(Note 10) If the travel blank values of the mercury are less than or equivalent to the operation blank values, contamination during transport can be disregarded and concentration can be calculated by subtracting the operation blank value from the measured value of the sample. However, in such a case where there is contamination during transportation, the minimum determination limit (10 s: converted to the atmospheric concentration) determined from the standard deviation of the travel blank values of more than 3 samples is smaller than the target minimum determination limit, moreover, the minimum determination limit obtained from the travel blank value is larger than the target minimum determination limit, the concentration can be calculated by subtracting the travel blank value from the measured value of the sample, if only the value calculated by subtracting the travel blank value from that measured in 5-(2) is larger than the minimum determination limit drawn from travel blank value.

However, if there is contamination during transportation, the minimum determination limit drawn from the travel blank value is larger than the target minimum determination limit, and the value of subtracting the travel blank value from the value measured is smaller than the minimum determination limit drawn from travel blank value, the values are generally treated as missing data. In such case, sampling must be conducted again after eliminating the cause of contamination.
(Note 11) Differences of absorbance of making the calibration curve and sensitivity testing should be ensured to be within ± 20%, where, in fact, the range of ± 10% is preferable. If the sensitivity fluctuation exceeds ± 20%, the analytical instrument and measurement method must be adjusted, calibration curve must be made again, and the samples must be re-measured.
(Note 12) Check if the difference between the two measurements is under 30% when the concentrations are above the minimum determination limit (i.e., check if the difference between every measurement and the average is within the range of ± 15%). If the difference is large, the values are generally treated as missing data, and the sampling is carried out again after investigating the cause.
(Note 13) If the minimum determination limit is larger than target minimum determination limit, equipment and instruments should be checked and adjusted, so that it is below the target minimum determination limit. (See Note 9).
(Note 14) Data of the nearest meteorological stations or other appropriate observation agencies could be used.

SIBATA

CODE 090860-034
090860-304
090860-504
090860-104

MINIPUMP MP-ΣNⅡ Series

OPERATION MANUAL

Thank you for purchasing this product.

- This operation manual describes precautions that are important for preventing accidents as well as the procedures used to handle the product.
- To ensure safety, read this operation manual and the attached warranty thoroughly before use, and use the product correctly.
- After reading this operation manual and the warranty, keep them in a safe place where they can be referred to at any time.

Contents

Before Use

⚠ WARNING	● **This product does not have an explosive-proof structure. Do not use this product in hazardous location to prevent an explosion accident.** ● **Be sure to read this operation manual thoroughly before using the product, and be sure to use the product correctly.** ● **Keep this operation manual in a safe place where it can be referred to at any time.** ● **Be sure to familiarize yourself with, and observe, the safety precautions given in this operation manual.** ● **Observe usage procedures that are suitable for the product and that are specified in this operation manual.** Be sure to observe the above instructions. Not following these instructions may result in an accident or injury.
⚠ CAUTION	● **Do not allow water and other liquids, and gases other than air to be sucked in. Doing so might cause malfunction.** ● **Do not allow flammable gases to be sucked into this product. Doing so might cause malfunction or fire.** ● **Do not allow corrosive gases, organic solvent, chemicals or salt spray to be sucked in. Doing so might cause malfunction.**

■ About This Operation manual

- In the interests of product improvement, the contents of this operation manual may be changed without notice.
- Every effort has been made to ensure that the information contained in this operation manual is correct. If you discover any errors or omissions, however, please contact your Sibata representative.
- The copyright of this operation manual belongs to Sibata Scientific Technology Ltd.
  The reproduction of all or part of this operation manual without prior written permission from Sibata Scientific Technology Ltd. is prohibited.

■ Checking the Package

Check the contents of the package before using the product.

- **MP-ΣNⅡ Series Unit 1**
- **Suction Holder for Ultra Low Flow Rate (MP-Σ30NⅡ only) 1**
- **MANUFACTURER'S INSPECTION RESULT 1**
- **Operation manual (this document) 1**

Safety Precautions

The precautionary information that appears in this operation manual is for ensuring that the product is used safely and for preventing injury to you and other people and damage to equipment. It is all important for ensuring safety and so be sure to read it thoroughly before using the product and observe it during use.

■ About the User (Important)

This product must be operated only by persons with adequate specialist skills, training, and experience to understand the potential dangers of operating the product.
Personnel who are untrained or still undergoing training may operate the product only under guidance from a trained person or a person with specialized experience.
This operation manual was written on the assumption that the product will be operated only by users who fully understand the potential dangers of operating the product.

■ Warning Labels

In this operation manual, precautionary information is labeled. The degree of damage or injury that may occur if the product is used without consideration of the corresponding item of precautionary information is indicated by one of three labels: **DANGER**, **WARNING** and **CAUTION**. These labels indicate precautionary information that is important for ensuring safety and so be sure to observe them.

Labels Indicating Degrees of Damage or Injury

⚠ DANGER	**Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or possibly death.**
⚠ WARNING	**Indicates a potentially hazardous situation which, if not avoided, could result in serious injury.**
⚠ CAUTION	**Indicates a potentially hazardous situation which, if not avoided, may result in minor to moderate injury or equipment damage.**

⚠ DANGER

- Use only the exclusive batteries (LI-10N Battery Unit, DB-10N Dry Battery Unit) on the body of this product (Mini Pump MP-ΣNⅡ Series). Do not use other batteries. Doing so might damage this product or harm the human body.
- Connect to only the specified power adapter (QC-10N, PA-1203). Do not connect to other adapters.
- Do not use this product near highly flammable or potential fire hazards, or allow gases other than air to be sucked in. Doing so might cause explosion or fire.
- No Fires Allowed! Do not put this product into fires. Doing so might cause explosion or fire.
- Do not connect the connector electrodes with wire or other metal objects. Doing so might cause burns, battery leakage, generation of heat, or explosion.
- Charge the LI-10N using only the exclusive charger (QC-10N). Charging the battery by other methods might cause battery leakage, generation of heat or explosion.

⚠ WARNING

- Do not allow this product to be directly splashed with water. Doing so might cause electric shock or fire.
- Do not subject this product to strong impact or drop it. Doing so might cause malfunction or accidents.
- Do not leave this product inside cars in the hot sun, or install or store it in strong direct sunlight, in front of heating equipment or next to fires. Doing so might cause abnormal operation or malfunction.
- Never connect by methods other than those described in this manual, for example, by connecting to connectors using wire or other metal. Doing so might cause fire or damage the hardware.
- Never dismantle or modify this product. Doing so might cause malfunction or accidents.
- If an abnormality occurs during operation, immediately stop operation and remove the cause of the abnormality. When the abnormality is judged to be caused by this product, remove the battery and contact your Sibata agent. Do not use this product in an abnormal state or allow it to be dismantled for repair by non-service personnel. Doing so might cause malfunction or accidents.
- Do not run this product wrapped in a cloth or bedding, or enclosed in a box. Doing so might cause heat to build up, resulting in fire or malfunction.
- Do not connect the power adapter to a multi-plug power strip. Doing so might cause electric shock or fire. Before using this product on a non-specified voltage, contact your Sibata agent.
- Do not use this product when the power cable is damaged or the plug inlet on the power outlet is loose. Use in this state might cause fire or electric shock.
- Do not touch the power cable or power outlet with wet hands. Doing so might cause electric shock.
- The service life of the LI-10N is limited. Replace with a new LI-10N when battery use becomes increasingly shorter after each recharge. If this product is used beyond the LI-10N's replacement cycle, the battery might become damaged which will cause battery leakage.
- This product is made for indoor use. Do not use it in environments that may be exposed to wind and rain. Doing so might cause malfunction.
- Do not block the exhaust port. Doing so will prevent the required airflow into the product, and cause heat to build up inside, resulting in malfunction or fire.

⚠ CAUTION

- **Avoid sampling asbestos using the MP-Σ500NⅡ.**

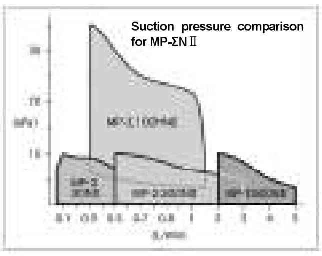
  In the context of air quality measurements for asbestos, which has become a social issue, one of the methods used is to **collect samples for 2 hours at 5 L/min.** (As per the JATI guidelines for indoor air)
  Because of the special characteristics of the filter used in this measurement method, a significant load is placed on the pump, so a pump that provides sufficient suction pressure (10 kPa or higher) must be used.
  The suction flowrate range for the MP-Σ500NⅡ is 2 L/min to 5 L/min, and at 5 L/min, the suction pressure will be 0 kPa to 3.0 kPa, which means that **the specifications range will be exceeded if the MP-Σ500NⅡ is used to collect samples for 2 hours at 5 L/min.**
  It cannot likely be used correctly under these conditions, either due to a loss of suction or a tendency to malfunction. Accordingly, if you are making measurements under these conditions, use the AIP-105 Asbestos Sampling Pump. Note that if a problem occurs when the MP-Σ500NⅡ is used under these conditions, it will not be covered under the one-year warranty.

⚠ CAUTION

- Install this product on a horizontal, stable site. Installation on an unstable location might cause abnormal operation or malfunction.
- When not using this product for a long time, remove the battery, disconnect the power adapter, and store in as cool and dry a location as possible out of the direct sunlight.
- Do not place objects on top of this product. Doing so might cause the product to tip over or deform the product, resulting in accident or malfunction.
- Take care not to nip your fingers when assembling the product, for example, when installing the battery.
- Do not wash this product with water. Doing so might cause electric shock, fire or malfunction.
- This product is exclusively for sampling air. Do not use it for purposes other than those described in this manual. Doing so might cause malfunction.
- Do not allow water and other liquids, and gases other than air to be sucked in. Doing so might cause malfunction.
- Be sure to run this product with a filter element attached to the suction holder. Also, run it with the dust collector attached to the suction port. If this product is allowed to suck in air directly (i.e. without filtering) for a long period of time, it might malfunction.
- Do not allow flammable gases to be sucked into this product. Doing so might cause malfunction or fire. Also, do not allow corrosive gases (e.g. salt spray) or chemicals to be sucked in. Doing so might cause malfunction.
- Do not insert screws or other foreign objects into the suction and exhaust ports. Doing so might cause malfunction. Should foreign objects get inside this product, immediately turn the power switch OFF, disconnect the power plug, and contact your Sibata agent.
- When disconnecting the power plug, be sure to hold the power cable by the power plug. Pulling the cable might damage it and cause electric shock or fire.
- Do not place heavy objects or step on the power cable. Doing so might cause electric shock or fire.
- The operating temperature and humidity ranges of this product are 0 to 40°C and 10 to 90% rh (no condensation), respectively. Use of this product outside of these ranges might impair its performance and service life, resulting in malfunction.
- Even when not using the LI-10N for a long time, charge it at least once every six months to prevent over discharging of its lithium cell. This prevents the LI-10N from deterioration.
- Before use, check the sheath of the power adapter cable for scratches or other abnormalities. Use in an abnormal state might cause fire or electric shock.
- Before cleaning or inspecting this product, remove the battery and the power adapter. Failure to do so might cause electric shock, electric leak or other abnormalities.
- Do not bring this product close to equipment that generates electrical noise. Also, do not install it at locations subject to string magnetic fields, or lots of dust or humidity. Doing so might damage the hardware, for example.
- Note that, should some nonconformity occur, SIBATA does not assume any liability whatsoever for compensation of data or content that could not be acquired or logged as a result, loss of data or other content, and other direct and indirect damages relating to the preceding. Periodically back up data as a precaution against malfunction or accidents.

Product Overview

The Mini Pump MP-ΣNⅡ Series is an ultra-lightweight, portable pump designed exclusively for sampling air, and features integrated flow measurement functions. Three models are available each with different flow volume ranges: the MP-Σ30NⅡ with a maximum flow rate of 0.5 L/min, the MP-Σ300NⅡ with a maximum flow rate of 3 L/min, and the MP-Σ500NⅡ with a maximum flow rate of 5 L/min, Total 4 models available including MP-Σ100HNⅡ with a maximum flow rate of 1.5L/min. The pump has a built-in mass-flow sensor, and the instantaneous flow rate and integrated flow volume measurement values are displayed digitally.
It also has a constant flow flow rate function to minimize drops in the suction flow volume accompanying increased suction pressure caused by sampling of dust, etc. It has a high suction pressure and constant suction flow rate, which means that it can be used in a wide range of applications as a pump for sampling air-borne harmful substances in work and indoor environments.



Features

- Has a built-in mass-flow sensor for directly measuring suction flow rate and displaying instantaneous and integrated flow volumes as digital values.
- Incorporates a constant flow rate function to minimize drops in the suction flow rate accompanying increased suction pressure caused by sampling of dust, etc.
- Has four timer sampling modes (manual, down timer, volume timer, cycle timer*).
- The liquid crystal display incorporates backlighting so that displayed flow rate and other values can be checked even in dark locations.
- The state of the filter element can be visually checked.
- Incorporates a measurement data log function so that the last ten measurement results can be checked on the pump. The number of logged measurement results can be increased to up to 99 by using communications software (sold separately) for uploading to a PC.
- Three power sources are supported:

Lithium-ion rechargeable cell	(LI-10N Battery Unit)	[sold separately]
Dry cell 8 × AA batteries	(DB-10N Dry Battery Unit)	[sold separately]
AC power source	(QC-10N Quick Charger)	[sold separately]
	(PA-1203 AC adapter)	[sold separately]

- The MP-ΣNⅡ series widens its constant flow rate range and lengthens its battery operating time relatively to the MP-ΣN series. (Refer details on "Main Specifications".)

* To use the cycle timer mode, communications software (sold separately) and a PC are required.

Names of Parts

MP-ΣNⅡ + LI-10N (or DB-10N)

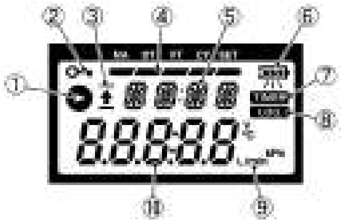
(1) Battery Unit (LI-10N or DB-10N)	(8) Charging connector (LI-10N only)
(2) Model nameplate	(9) Hook
(3) Suction port (suction holder)	(10) Slide lock
(4) Power switch	(11) Tripod mounting hole (base)
(5) Exhaust port	(12) Power source connector
(6) Rubber cover	(13) USB (Mini-B) connector
(7) Operation panel	(14) Filter check window

Operation Panel

(1) Operation display LED	(5) START/STOP key
(2) MODE key	(6) KEY LOCK key
(3) UP key	(7) LCD screen
(4) DOWN key	

The meanings of the operation display LED indications are as follows: flashing (green) - pump operating, flashing (red) - error occurred and pump operation stopped, and flashing (orange) - timer standing by or connecting to PC.

LCD Screen

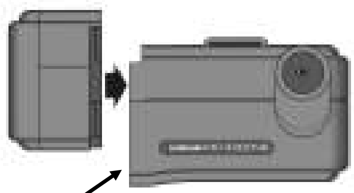


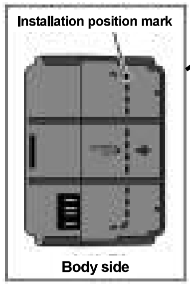
(1) Pump operation mark	(6) Battery status
(2) Key lock	(7) Timer standing by
(3) Flow volume exceeded	(8) Log check mode
(4) Mode display bar	(9) Unit
(5) Character display field	(10) Numeric display field

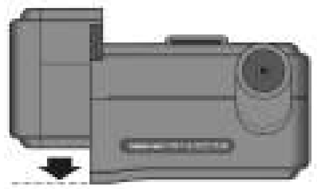
How to Install the Battery

Fit the battery into the body while referring to the mounting position mark on the body.

* **Take care not to touch the electrodes.**

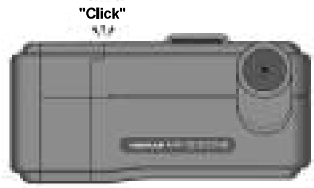






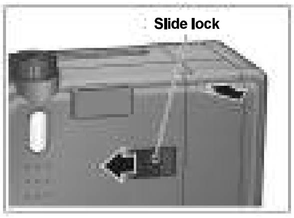
Slide the battery towards the front, and make sure that it is fully fitted in as far as it can go.
At this time, the slide lock on the back of the body prevents the battery from moving.

* **Make sure that the battery is fitted in properly.**

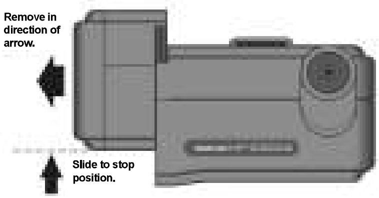


How to Remove the Battery

Before removing the battery, slide the slide lock on the back of the body as shown in the figure to unlock the lock.



With the slide lock unlocked, slide the battery towards the rear to the stop position as shown in the figure.



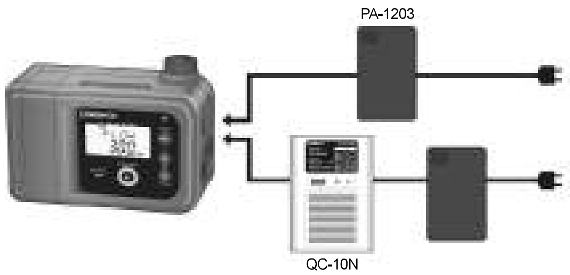
⚠ Caution
Do not slide using excessive force. The battery will come loose; but, the electrodes on the body might become damaged.

The battery can be removed towards the left when it is at the stop position.

Wiring Methods

When Used with the AC Power Source

The pump can be operated by an AC power source by connecting the QC-10N Quick Charger (sold separately) directly to the pump body. Also, the pump can be operated and the LI-10N (sold separately) charged at the same time with the LI-10N installed.
Even if the AC adapter PA-1203 (sold separately) is connected to the pump body, the body can be operated; however, the LI-10N cannot be charged.



When Using the Battery

The pump can be used by installing the LI-10N or DB-10N.

The battery status mark is displayed on the screen when the power is turned ON with the battery installed. (It is not displayed when the AC power source is connected.)

Battery status
- 70% or more power
- 30% or more power
- Less than 30%
- 0% The pump stops operating. The battery must be recharged or replaced immediately.

* When a battery other than an alkaline battery is used on the DB-10N, the battery status icon will not function properly.
* Do not remove the battery during pump operation.
* The battery can be replaced with the DB-10N installed on the pump body. However, before replacing the battery, be sure to turn the pump OFF.

If the pump is operated from the AC power source with the battery inside, the power source will automatically switch to the battery in the event of a power interruption, and measurement can be continued in this state.
In cases such as this, measurement can be performed more safely by using the Quick Charger QC-10N as the AC power source and the Battery Unit LI-10N as the battery since the battery is automatically charged after AC power is restored.

Charging Methods

The LI-10N Battery Unit (sold separately) is charged using the QC-10N Quick Charger (sold separately). As shown in the figure, the LI-10N can be charged by connecting the QC-10N to the pump body with the LI-10N installed.

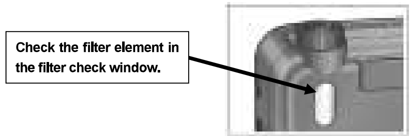
Also, the LI-10N has a charging connector. So, the battery itself can be charged by connecting the LI-10N directly to the QC-10N.

While the LI-10N is being charged, the red LED on the QC-10N will flash. When charging is completed, this is indicated by lighting the green LED. Charging time is about 6 hours.
For details, refer to the QC-10N Operation Manual.

* Be sure to use the exclusive QC-10N Quick Charger for charging the LI-10N Battery Unit. Use of other chargers might cause malfunction or abnormal overheating, resulting in ignition or explosion.
* The PA-1203 uses the same connector as that on the QC-10N. However, do not connect this to the LI-10N. The LI-10N cannot be charged even if the PA-1203 is connected.

Installation and Piping Methods

Install the pump body on a flat location. When choosing an installation site, avoid humid locations or locations that are splashed with water, locations near fire or heat generating sources, and extremely dust locations.
The pump body can also be mounted on a tripod. Insert the tripod screws into the tripod mounting hole on the base of the pump body. If a tripod with a mounting base over 40 mm is used (i.e. one that will result in a mounting footprint of 20 mm or more wide from the tripod screw at its center), the pump body sometimes cannot be installed stably.
Make sure that the filter element is attached to the suction holder. Also, replace the filter element when it becomes particularly dirty. (See page 14 "How to Install the Suction Holder.")



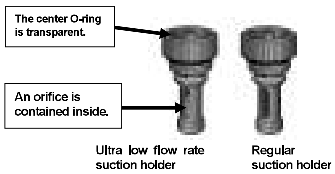
5 mm dia. and 7 mm dia. tube can be inserted onto the suction port.
* When inserting piping, take care to prevent strong force from being applied to the suction holder. Unnecessary force will damage the suction port.

Likewise, 5 mm dia. and 7 mm dia. tube can be inserted onto the exhaust port. However, pay attention to the following points:

- The piping itself sometimes acts as a load and prevents suction performance as indicated in the specifications from being achieved.
- The flow volume on the exhaust side cannot be controlled. Treat indicated flow volume values for reference only.

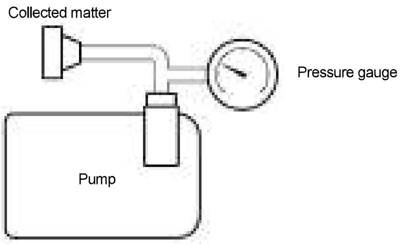
During Ultra Low Flow Volume Measurement (supported only on MP-Σ30NⅡ)

When measuring under a flow rate of 0.150 L/min or less, use the ultra low flow rate suction holder that is provided.



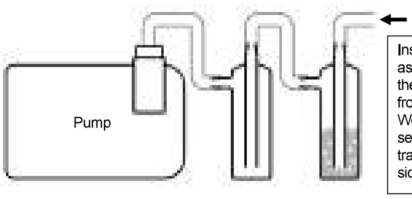
Suction Pressure

A load (suction pressure) is applied to the pump by collected matter in the dust collector installed on the suction port.
On each of the pump models, the maximum suction pressure is determined by respective flow rate. (See page 36 "Main Specifications.") Exceeding the specification range will cause malfunction; however, this pump does not have a function for measuring suction pressure. So, we recommend measuring the suction pressure of collected matter in advance referring to the diagram below.



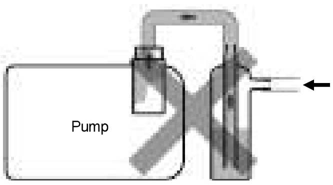
When Using an Impinger

In use of mini pumps that use an impinger, liquid will be sucked into the pump body if the piping is connected in the wrong way, which will result in malfunction. Install piping referring to the following diagram.



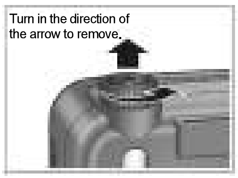
Install piping on the pump as shown in the figure on the left to prevent liquid from being sucked directly. We also recommend setting up a multi-stage trap on the pump suction side.

Never set up piping in such a way that liquid is sucked in directly as shown in the figure on the left.

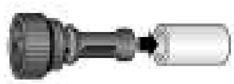


How to Install the Suction Holder

The suction holder can be removed from the suction port by turning it counterclockwise.



The filter element in the suction holder can be replaced by pulling lightly.



Be sure to insert the filter element into the suction holder before installing the suction holder. Turn the suction holder clockwise to install.

* Turn the suction holder in as far as it will go. It may cause air leakage if the holder is not turned in firmly. However, do not overtighten the suction holder. Doing so might prevent it from being removed again or cause malfunction. <u>Tightening the suction holder hard does not necessarily result in improved air tightness.</u>

Preparing for Operation

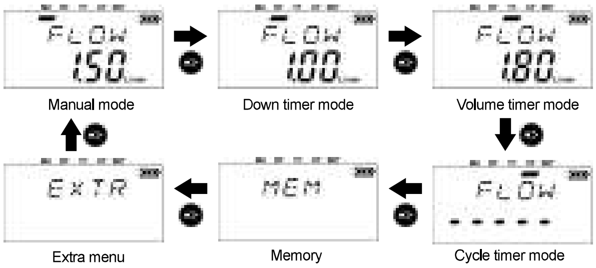
Make sure that the wiring and piping have been properly connected.
Turn ON the power switch on the side of the pump body.
The version and flow rate conversion temperature value are displayed on screen, and the screen changes as follows.

* When using the pump for the first time, the manual mode screen will be displayed. Normally, the screen for the mode used in the previous measurement is displayed.
* The battery status mark is not displayed when the pump is operated from the AC power source.

Each press of the MODE key switches the screen cyclically as follows: manual mode →down timer mode → volume timer mode → cycle timer mode → memory → extra menu.

Each press of the MODE key switches the segment to light on the mode display bar at the top of the LCD screen to indicate the current mode.

MA: manual mode
DT: down timer mode
VT: volume timer mode
CY: cycle timer mode
SET: setup in progress (Not displayed using only the MODE key.)



The mode display bar is not lit in the memory and extra menu screens.

Operation Modes

This pump has the following four operation modes.

(1) Manual mode operation (See page 17.)

Pressing the START/STOP key starts and stops pump operation.
The only setup item provided is instantaneous flow rate.

(2) Down timer mode operation (See page18.)

Pressing the START/STOP key operates the pump for the preset time.
Three setup items are provided in this mode: instantaneous flow rate, sampling start time and sampling time (end time).

(3) Volume timer mode operation (See page 20.)

Pressing the START/STOP key starts pump operation at the preset time. Pump operation ends when the preset integrated flow volume value is reached.
Three setup items are provided in this mode: instantaneous flow rate, sampling start time and sampling end integrated flow volume.

(4) Cycle timer mode operation (See page 22.)

To use this mode, communications software (sold separately) and a PC are required.
In this mode, the pump can be operated automatically in accordance with the setup details preset on the PC. Setups for up to five measurements can be registered in advance.
For details, refer to the communications software operation manual.

In the explanations for each of the following modes, it states that the operation display LED flashes. However, the LED can also be set up not to flash. (See page 29.)

Manual Mode

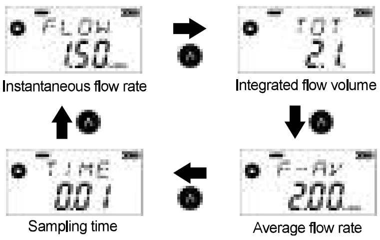
LED display conventions | Flashing | Lit

Press the MODE key until the MA segment of the mode display bar lights.
The instantaneous flow rate setting is displayed initially in this screen.
The integrated flow volume and other setup items are sometimes displayed by using the UP/DOWN key. (See page 26 "After Ending Operation.")

In the manual mode, only the flow volume is set.

Holding down the MODE key in this screen causes the SET segment of the mode display bar to light and the flow rate value to flash. In this state, the flow volume can be set.
Change the numeric value by pressing the UP/DOWN key to set the flow rate.
After setting the flow rate, press the START/STOP key. The flow rate value lights and the SET segment of the mode display bar goes out to indicate that setup is complete.

Pressing the START/STOP key again starts pump operation.
During pump operation, the operation display LED flashes (green), the pump operation mark lights, and the instantaneous flow rate is displayed.



Pressing the UP key during pump operation switches the screen cyclically as follows: integrated flow volume → average flow rate → sampling time → instantaneous flow rate. Pressing the DOWN key switches the screen in the reverse direction.

Holding down the KEY LOCK key during pump operation displays the key icon as in the figure on the right and disables use of the START/STOP key.

* The above items can be checked by using the UP/DOWN key.
To cancel the key lock, hold down the KEY LOCK key again. The key icon goes out and the key lock is canceled.

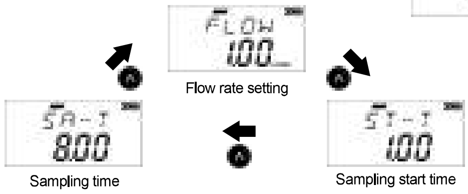
When the START/STOP key is pressed, pump operation stops, and the integrated flow volume screen is displayed.

* If an error occurs, the error No. is displayed and the operation display LED flashes (red).
For details, see page 26 "After Ending Operation."

Down Timer Mode

LED display conventions | Flashing | Lit

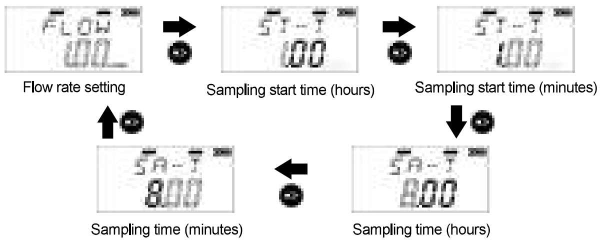
Press the MODE key until the DT segment of the mode display bar lights.
The flow volume setting is displayed initially in this screen.



Pressing the UP key switches the screen cyclically as follows: sampling start time → sampling time → instantaneous flow rate setting. Pressing the DOWN key switches the screen in the reverse direction. The integrated flow volume and other setup items are sometimes displayed by using the UP/DOWN key. (See page 26 "After Ending Operation.")
Pressing the MODE key in any of the screens changes the mode to the volume timer mode.

In the down timer mode, only three items are set: instantaneous flow rate, sampling start time, and sampling time.

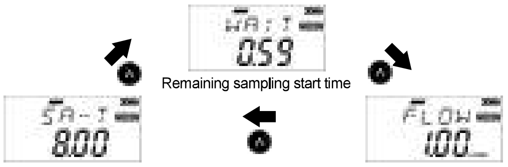
Hold down the MODE key at any of the flow rate setting, sampling start time or sampling time setup items. The SET segment of the mode display bar lights, and the display value flashes to indicate that the value can be set.
Change the numeric value by pressing the UP/DOWN key to set the flow rate.



Each press of the MODE key in the setup screen switches the screen cyclically as follows: flow rate setting → sampling start time (hours) → sampling start time (minutes) → sampling time (hours) → sampling time (minutes) → flow rate setting.
After entering each of the settings, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.

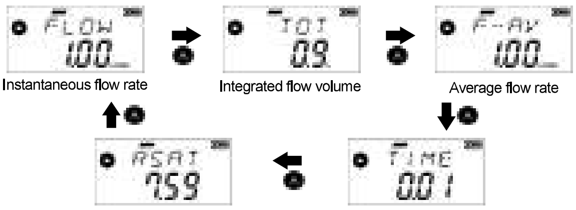
Pressing the START/STOP key again starts pump operation in the down timer mode.
The operation display LED flashes (orange), the "timer standing by" icon is displayed on screen, and the remaining sampling start time is displayed.

* If the START/STOP key is pressed when the start time is set to "0.00", pump operation starts immediately.



Pressing the UP key switches the screen cyclically as follows: flow rate setting → sampling time → remaining sampling start time. Pressing the DOWN key switches the screen in the reverse direction.

Pump operation starts when the remaining sampling start time reaches "0.00".
During pump operation, the operation display LED flashes (green), the pump operation mark lights, and the instantaneous flow rate is displayed.



Pressing the UP key during pump operation switches the screen cyclically as follows: integrated flow volume → average flow rate → sampling time → remaining sampling time → instantaneous flow rate. Pressing the DOWN key switches the screen in the reverse direction.

Holding down the KEY LOCK key during pump operation displays the key icon and disables use of the START/STOP key.

* The above items can be checked by using the UP/DOWN key.
To cancel the key lock, hold down the KEY LOCK key again. The key icon goes out and the key lock is canceled.

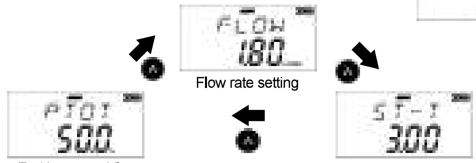
When the preset sampling time is reached, pump operation stops and the integrated flow volume screen is displayed.
For details, see page 26 "After Ending Operation."

* Pump operation can be forcibly stopped by pressing the START/STOP key.

Volume Timer Mode

LED display conventions: Flashing / Lit

Press the MODE key until the VT segment of the mode display bar lights.
The instantaneous flow rate setting is displayed initially in this screen.

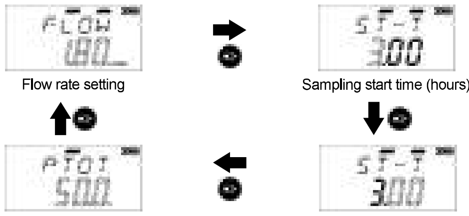


Pressing the UP key switches the screen cyclically as follows: sampling start time → volume timer → flow rate setting. Pressing the DOWN key switches the screen in the reverse direction.
The integrated flow volume and other setup items are sometimes displayed by using the UP/DOWN key. (See page 26 "After Ending Operation.")
Pressing the MODE key in any of the screens changes the mode to the cycle timer mode.

In the volume timer mode, only three items are set: flow rate, sampling start time, and end integrated flow volume (volume timer).

Hold down the MODE key at any of the flow rate setting, sampling start time or volume timer setup items. The SET segment of the mode display bar lights, and the display value flashes to indicate that the value can be set.

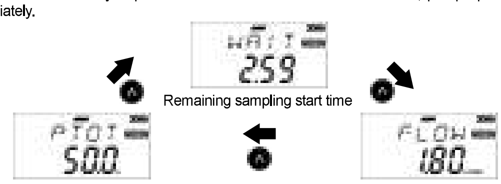
Change the numeric value by pressing the UP/DOWN key to set the flow volume.



Each press of the MODE key in the setup screen switches the screen cyclically as follows: flow rate setting → sampling start time (hours) → sampling start time (minutes) → volume timer → flow rate setting.
After entering each of the settings, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.

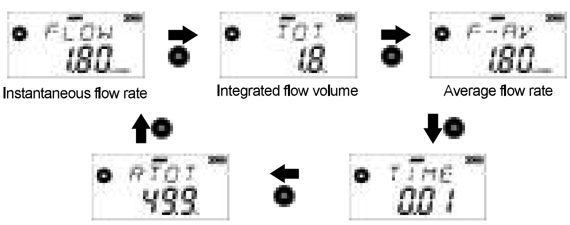
Pressing the START/STOP key again starts pump operation in the volume timer mode.
The operation display LED flashes (orange), the "timer standing by" icon is displayed on screen, and the remaining sampling start time is displayed.

* If the START/STOP key is pressed when the start time is set to "0.00", pump operation starts immediately.



Pressing the UP key switches the screen cyclically as follows: flow volume setting → volume timer → remaining sampling start time. Pressing the DOWN key switches the screen in the reverse direction.

Pump operation starts when the remaining sampling start time reaches "0.00".
During pump operation, the operation display LED flashes (green), the pump operation mark lights, and the instantaneous flow rate is displayed.



Pressing the UP key during pump operation switches the screen cyclically as follows: integrated flow volume → average flow rate → sampling time → remaining integrated flow volume → instantaneous flow rate. Pressing the DOWN key switches the screen in the reverse direction.

Holding down the KEY LOCK key during pump operation displays the key icon and disables use of the START/STOP key.

* The above items can be checked by using the UP/DOWN key. To cancel the key lock, hold down the KEY LOCK key again. The key icon goes out and the key lock is canceled.

When the preset integrated flow volume is reached, pump operation stops and the integrated flow volume screen is displayed.
For details, see page 26 "After Ending Operation."

* Pump operation can be forcibly stopped by pressing the START/STOP key.

Cycle Timer Mode

The cycle timer mode can be set only from the PC. Communications software (sold separately) is also required.
Press the MODE key until the CY segment of the mode display bar lights.
The flow rate setting is displayed initially in this screen.

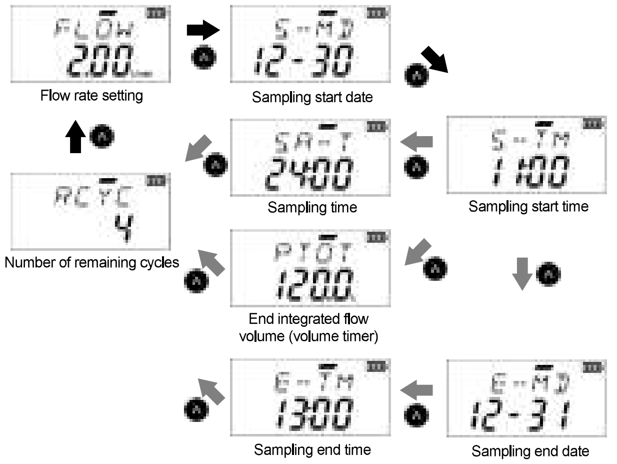
When cycle operation has not been set, the display will be as shown on the right, and the various setting values will not be displayed.

The cycle timer mode allows complex pump operation to be set using communications software (sold separately) on a PC.
The sampling start setting involves only setting of the time. The sampling end time setting, however, involves setting of three conditions, each of the time, duration (i.e. how many minutes later) and the volume timer.
Setups comprising the above settings for up to five measurements can be registered.

⚠ Caution

In the cycle timer mode, though the time setting is the sampling start condition, <u>sampling is not started automatically.</u>

Sampling is started on condition that the pump is turned ON (power is being supplied to the pump) and that the screen is set to the "sampling standing by" screen by pressing the START/STOP key.
Note that pump operation cannot be started simply with the pump turned ON.
Also, the cycle timer mode is designed to automatically move to the next cycle if cycle operation is not started within two minutes of the preset time. Note also that the pump will not operate according to the preset settings in this case.



Pressing the UP key switches the screen cyclically as follows: sampling start date → sampling start time → sampling end conditions (3 conditions settable: duration, time and volume, each with a different screen) → number of remaining cycles → flow rate setting. Pressing the DOWN key switches the screen in the reverse direction.
The integrated flow volume and other setup items are sometimes displayed by using the UP/DOWN key. (See page 26 "After Ending Operation.")
Pressing the MODE key in any of the screens changes the mode to memory.
The cycle timer mode can be set only on the PC. So, holding down the MODE key will not change the screen to the setup screen.

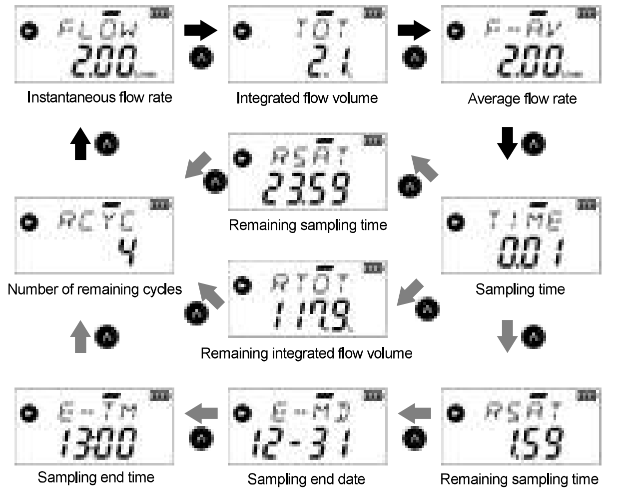
Pressing the START/STOP key starts pump operation in the cycle timer mode.
The operation display LED flashes (orange), the "timer standing by" icon is displayed on screen, and the remaining sampling start time is displayed.

Note that cycle operation can start only from this screen!!

* "WAIT" starts flashing when the remaining time counts down to two minutes. If the START/STOP key is pressed to cancel pump operation in this state ("WAIT" flashing), this cycle is not performed and operation moves to the next cycle.

Pressing the UP key switches the screen cyclically as shown above: flow rate setting → sampling start date → sampling start time → sampling end conditions (3 conditions settable: duration, time and volume, each with a different screen) → number of remaining cycles → remaining sampling start time. Pressing the DOWN key switches the screen in the reverse direction.

Pump operation starts when the remaining sampling start time reaches "0.00".
During pump operation, the operation display LED flashes (green), the pump operation mark lights, and the instantaneous flow rate is displayed.



Pressing the UP key switches the screen cyclically as follows: integrated flow volume → average flow rate → sampling time → remaining time or integrated flow volume up to sampling end conditions → number of remaining cycles → instantaneous flow rate. Pressing the DOWN key switches the screen in the reverse direction.

Holding down the KEY LOCK key during pump operation displays the key icon and disables use of the START/STOP key.

* The above items can be checked by using the UP/DOWN key.
  To cancel the key lock, hold down the KEY LOCK key again. The key icon goes out and the key lock is canceled.

When the preset sampling end conditions are reached, pump operation stops and the integrated flow volume screen is displayed.
For details, see page 26 "After Ending Operation."

* Pump operation can be forcibly stopped by pressing the START/STOP key.

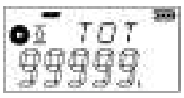
Numeric Value OVER Display

The following caution screens are displayed when the integrated flow volume, sampling time and instantaneous flow rate exceed fixed numeric values during operation in their respective modes.

Integrated Flow Volume

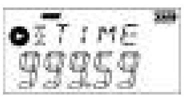
When integrated flow volume exceeds 9999.9 L (on the MP-Σ30NⅡ, 999.99 L) the OVER icon flashes, and displayed one digit increases. (9999.9 L → 10000 L, on the MP-Σ30NⅡ, 999.99 L → 1000.0 L)

When the integrated flow volume exceeds the maximum display volume 99999 L (on the MP-Σ30NⅡ, 9999.9 L), the numeric value flashes without being incremented beyond this value. The mini pump continues to operate, however, numeric values are not incremented and the integrated flow volume cannot be measured. The average flow rate in this instance also cannot be measured.



Sampling Time

When the sampling time exceeds 999 hours and 59 minutes, the OVER icon and numeric value flash. The mini pump continues to operate, however, numeric values are not incremented beyond this value and the sampling time cannot be measured.



Instantaneous Flow Rate

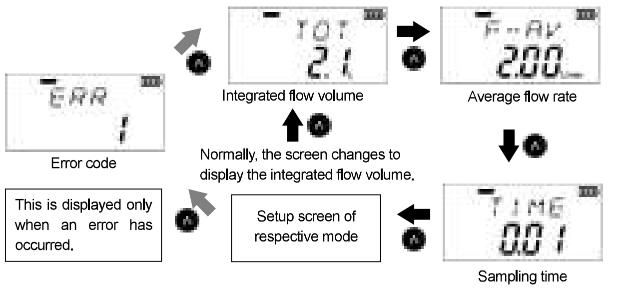
When the instantaneous flow rate exceeds the maximum display value, the OVER icon and numeric value flash. Numeric values are not incremented beyond this value.

Maximum display values for instantaneous flow rate

MP-Σ30NⅡ	0.750 L/min
MP-Σ300NⅡ	4.50 L/min
MP-Σ500NⅡ	6.00 L/min
MP-Σ100HNⅡ	2.50 L/min

After Ending Operation

When the START/STOP key is pressed, pump operation stops, and the integrated flow volume screen is displayed.
* If an error occurs, the error No. is displayed and the operation display LED flashes (red).



Pressing the UP key switches the screen cyclically as follows: average flow volume → sampling time → setup screen of respective mode → integrated flow volume. Pressing the DOWN key switches the screen in the reverse direction.

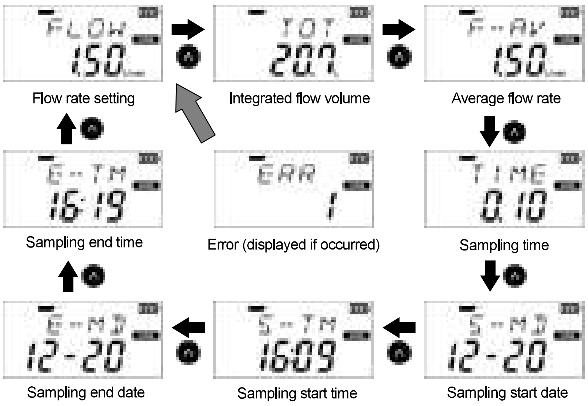
The (error code), integrated flow volume, average flow rate, and sampling time are collectively called the "last data," and are displayed only in the operation mode that measurement was last performed.
(For example, when operation was last performed in the down timer mode, the last data is displayed only in the down timer mode and not in other modes, such as the manual mode.)
The last data is the same as LOG 0 in the memory function described on the following page.
Pressing the UP/DOWN key returns the screen to flow volume setting or other regular screens.

If an error code is displayed, see page 34 "Errors."

Memory

Press the MODE key until the MEM screen is displayed.
In this screen, you can view past data (logs) by pressing the START/STOP key.

"LOG 0" is displayed in the initial screen. Logs for the last ten measurements (to LOG 9) can be viewed provided that logs are stored in memory.
The date on this screen is the date when the pump was first operated.
* If logs are not stored in memory even after pump operation, contact your Sibata agent.

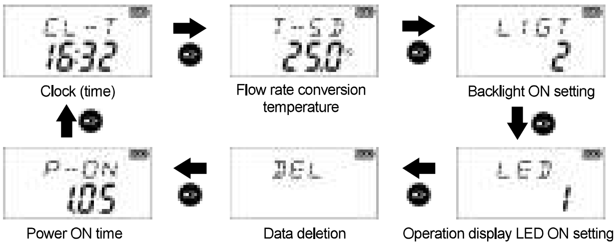


Pressing the UP key in each log screen switches the screen cyclically and returns to the log screen as follows: flow rate setting → error (displayed if occurred) → integrated flow volume → average flow rate → sampling time → sampling start date → sampling start time → sampling end date → sampling end time. Pressing the DOWN key switches the screen in the reverse direction.
Which mode the pump was operated in can be checked by the mode display bar at the top of each screen.
Pressing the MODE key at any respective position advances the screen to the next log screen.
Pressing the START/STOP key in any of the above screens returns the screen to the MEM screen.
Up to 10 logs can be checked on the mini pump body. However, up to 99 logs can be viewed on a PC by using communications software (sold separately).
The last data displayed after pump operation stops is LOG 0.

Extra Menu

LED display conventions — Flashing — Lit

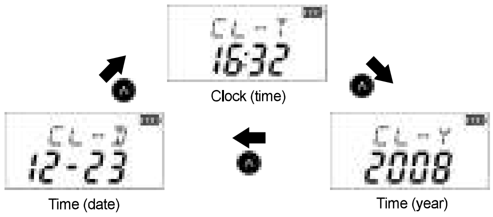
Press the MODE key until the EXTR screen is displayed.
In this screen, you can enter the extra menu if you press the START/STOP key, and the clock (time) is displayed.



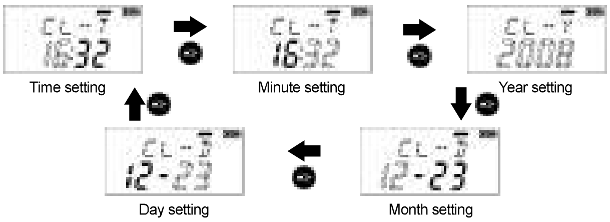
Pressing the MODE key switches the screen cyclically: flow rate conversion temperature → backlight ON setting → operation display LED ON setting → data deletion → power ON time → clock (time).

Clock

Pressing the UP key in the clock (time) screen switches the screen cyclically: year → date → time.
Pressing the DOWN key switches the screen in the reverse direction.
Pressing the MODE key in any of the screens changes the screen to the flow volume conversion temperature.

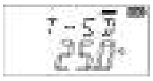


The clock can be set by holding down the MODE key in the respective screen. In the setup screen, the SET segment of the mode display bar lights and the value that can be set flashes. Set the value by using the UP/DOWN key.



Pressing the MODE key changes the screen cyclically as follows: time → minutes → year → month → day → time. In each of the relevant screens, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.
* If the time deviates greatly or cannot be set after the clock is set, contact your Sibata agent.

Flow Rate Conversion Temperature



The flow rate conversion temperature is displayed. The default temperature is 25.0°C. Holding down the MODE key causes the SET segment of the mode display bar to light and the value to flash.
The value can be switched between 20.0°C and 25.0°C by pressing the UP/DOWN key. In each of the relevant screens, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.

Backlight ON Setting

The backlight ON condition can be set. The default is 2.
Holding down the MODE key causes the SET segment of the mode display bar to light and the value to flash. The value can be changed in the range 0 to 2 by pressing the UP/DOWN key.

0: OFF at all times
1: ON at all times
2: Backlight turns OFF if no buttons are pressed for 30 seconds.
(The number of seconds can be set at "Backlight ON Time" on page 32.)

In each of the relevant screens, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.

Operation Display LED ON Setting

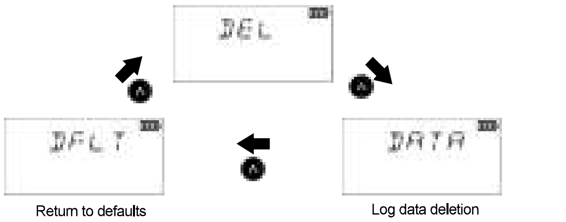
The operation display LED can be set ON or OFF. The default is 1.
Holding down the MODE key causes the SET segment of the mode display bar to light and the value to flash. The value can be switched between 0 and 1 by pressing the UP/DOWN key.

0: OFF (LED does not turn ON at any item.)
1: ON

In each of the relevant screens, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.

Data Deletion

The log data (memory) on the mini pump can be deleted and settings can be returned to their defaults.
Pressing the UP key after entering the DEL screen switches the screen cyclically as follows: log data deletion → return to defaults → DEL screen. Pressing the DOWN key switches the screen in the reverse direction.
Pressing the MODE key in any of the screens changes the screen to the power ON time.



DATA indicates that all registered log data are to be deleted.
DFLT indicates that all pump settings are to be returned to their defaults.
In each of the relevant screens, hold down the MODE key to scroll "PUSH START KEY". In this screen, pressing the MODE key cancels the operation.
Press the START/STOP key to execute the operation.

When "END" is displayed, this indicates that deletion is completed.
* Note that logs or settings cannot be restored once they have been deleted.
* When settings have been returned to their defaults, the flow volume calibration value (see page 32 "Calibration") is also returned to its default.
* Do not turn OFF the pump while data is being deleted. Doing so might cause malfunction.

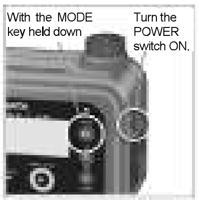
Note that, should some nonconformity occur, SIBATA does not assume any liability whatsoever for compensation of data or content that could not be acquired or logged as a result, loss of data or other content, and other direct and indirect damages relating to the preceding. We recommend using communications software (sold separately) to periodically back up data as a precaution against malfunction or accidents. We also recommend preliminary operation checks and other periodic inspection.

Power ON Time

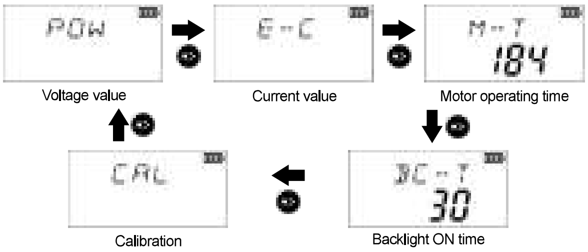
The time elapsed since the mini pump was turned ON is displayed.
Only the MODE key is functional in this screen.

Submenus

Submenus are provided so that you can make setups in more detail.
To enter submenus, turn the pump ON with the MODE key held down. The POW screen will be displayed.
The following items can be checked and set.



Pressing the MODE key with POW (voltage value) displayed switches the screen cyclically as follows: current value → motor operating time → backlight ON time → calibration → voltage value.



Voltage Value

Pressing the START/STOP key operates the pump for ten seconds. The voltage during pump operation is displayed.

* The flow volume at this time is the flow volume set in the manual mode. (See page 17 "Manual Mode.")

Current Value

Pressing the START/STOP key operates the pump for ten seconds. The current consumption during pump operation is displayed. Current is displayed in mA units.

* The flow volume at this time is the flow volume set in the manual mode. (See page 17 "Manual Mode.")

Motor Operating Time

This is the total operating time of the pump. The motor's service life is about 2,000 hours of operation. After 2,000 hours of operation is exceeded, consider performing maintenance on the pump.

* 2,000 hours of operation is only a guideline. This figure may become shorter depending on the operating environment.

Backlight ON Time

The time up to when the backlight turns OFF out after a button on the control panel is pressed can be set. (See page 29 "Backlight ON Setting.") The default is 30 seconds.
Holding down the MODE key in this screen causes the SET segment of the mode display bar to light and the value to flash. In this state, the value can be set. Change the value by using the UP/DOWN key. After changing the value, press the START/STOP key. The display value lights, and the SET segment of the mode display bar goes out to indicate that setup is complete.

Calibration

Calibration with suction holder connected to suction port in order to do highly precise measurement. Using Sibata's bubble film flow meter BF-200/BF-600 Series as a standard flow meter allows easier correction. Refer to the instruction of bubble film flow meter BF-200/BF-600 Series for more detail.

BF-200/ BF-600 Series and communications software with USB cable(Sold separately) allows the automatic operation as below:

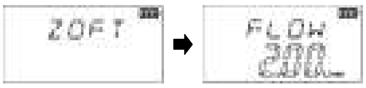
Pressing the UP/DOWN key after entering the CAL screen enters the flow volume calibration mode.

* **Calibration here is 1-point calibration. So, accuracy will deviate with other flow rate. To return to the original calibration value, set the defaults. (See page 30"Data Deletion.")**

Press the START/STOP key in the FADJ screen. The flow rate conversion temperature is displayed flashing. The value can be switched between 20.0°C and 25.0°C by pressing the UP/DOWN key. Pressing the MODE key in this screen cancels calibration and returns to the FADJ screen.

After setting the flow rate conversion temperature, press the START/STOP key. The flow volume is displayed flashing. Set the flow rate to be calibrated by pressing the UP/DOWN key.

Pressing the START/STOP key offsets the flow rate to zero and starts pump operation. The operation display LED flashes (red), the pump operation icon flashes, and no other operations are accepted for one minute. When the operation display LED starts flashing (green) and the pump operation icon stops flashing and lights, perform measurement using a standard flow meter.



When measurement is completed, press the START/STOP key to stop pump operation.
Match the flow rate value to the number indicated on the standard flow meter by pressing the UP/DOWN key.

When the above calibration procedure is finished, press the START/STOP key. "END" is displayed and the screen returns to the FADJ screen.

* There is no need to calibrate the flow rate each time that the pump is used.

* Do not turn the pump OFF during calibration. Doing so might cause malfunction.

Errors

Immediately stop operation if an error occurs during pump operation.
If an error occurs, the error No. is displayed and the operation display LED flashes (red).

1: The difference between the set flow rate and the instantaneous flow volume displays has reached or exceeded ±20%.

2: The power voltage has fallen below 6 V.

3: The motor current consumption has reached or exceeded 500 mA.

These errors are also stored in the log.

With ERR2, the power source sometimes is interrupted and the display goes out. When the power is turned back ON in this case, the operation display LED will flash (red) and "ERR2" will be displayed. In this state, press any button. The regular screen will be displayed and operations can be performed. If the power is turned OFF without pressing any button and the power is turned back ON again, "ERR2" will be displayed again.

Troubleshooting

Symptom	Cause	Remedy
No display after power ON	Battery is not connected.	Install LI-10N Battery Unit or DB-10N Dry Battery Unit, or run on an AC power source.
	Battery power of LI-10N Battery Unit has dropped.	Charge LI-10N with QC-10N Quick Charger.
	DB-10N Dry Battery Unit has no batteries inside.	Insert 8 new AA batteries inside at specified positions.
	The batteries inside DB-10N Dry Battery Unit are running low.	
	The AC adapter plug is disconnected during use on an AC power source.	Connect the QC-10N (AC adapter provided) or PA-1203 AC adapter correctly into the 100 to 240VAC power outlet. Also, check the connector on the MP-ΣN Ⅱ side.
Display appears however pump does not operate or pump operation is strange.	Liquid is being sucked in. (See note * below.)	Repair and adjustments are required. Contact your Sibata agent.
	Battery power is low, and is displayed on screen. (when LI-10N Battery Unit is used)	Replace or charge battery, or run on an AC power source.
Pump operates, but flow rate does not increase or stabilize.	Filter element is clogged.	Replace filter element.
	Exclusive suction holder is not used (MP-Σ30N Ⅱ only).	When measuring under 0.150 L/min or less, use provided ultra low flow rate suction holder.
	Sampling tube is broken.	Replace tube. Change how tube is connected.
	There is an obstacle on exhaust side.	Remove obstacle.
	Suction pressure is outside specification range.	See if suction pressure is within specification range. (See pages 13 and 36, 37)
Pump stops during sampling.	Check the error No. displayed on screen. ERR1: Difference between set flow rate and displayed instantaneous flow rate has reached or exceeded ±20%. ERR2: Power voltage has fallen below 6 V (due to power failure or disconnection of electric plug from the power source.) ERR3: Motor current consumption has reached or exceeded 500 mA.	Remove cause of error according to error No., and retry use. If problem is not solved, contact your Sibata agent.
Internal clock setting fails even though internal clock has been set.	Clock time deviates considerably, or the time registered by the memory function is a strange value.	Repair and adjustments are required. Contact your Sibata agent.
No logs in memory.	Logs are not stored in memory even after pump operation.	Repair and adjustments are required. Contact your Sibata agent.
Backlight does not turn ON.	The backlight is set not to turn ON.	Refer to backlight ON setting in extra menu (See page 29).
Operation display LED does not turn ON.	The operation display LED is set not to turn ON.	Refer to operation display LED ON setting in extra menu (See page 29).

* A frequent problem is the impinger connected in reverse. Pay attention to orientation when connecting piping. (See page 13 "Installation and Piping Methods, When Using an Impinger.")

Main Specifications

Pump Unit

Item Code	090860-034	090860-304
Model	MP-Σ30N Ⅱ	MP-Σ300N Ⅱ
Operable Flow Rate Range	0.050 to 0.500 L/min	0.50 to 3.00 L/min
Display Range of Instantaneous Flow Rate	0.000 to 0.750 L/min	0.00, 0.20 to 4.50 L/min
Constant Flow Rate Ranges	0.1 L/min: 0 to 10.0 kPa 0.2 L/min: 0 to 9.0 kPa 0.3 L/min: 0 to 9.0 kPa 0.4 L/min: 0 to 8.0 kPa 0.5 L/min: 0 to 7.0 kPa	0.5 L/min: 0 to 10.0 kPa 1.0 L/min: 0 to 7.0 kPa 2.0 L/min: 0 to 6.0 kPa 3.0 L/min: 0 to 5.0 kPa
Accuracy of Constant Flow Rate	Within ±5% of the set flow rate	
Range of Integrated Flow Volume Setting (Volume Timer)	0.00 to 999.99 L	0.0 to 9999.9 L
Display Range of Integrated Flow Volume	0.00 to 9999.9 L	0.0 to 99999 L
Display Range of Set Time	0.00 to 999.59 (time: minute)	
Time Setting / Display	Year / month / day, hour : minute	
Built-In Flow Meter	Mass-flow sensor	
Pump Type	Double diaphragm type	
Material	Pump head: ABS / POM / TPU, diaphragm: EPDM, valve: EPDM, case: PC	
Mode	Manual, down timer, volume timer, cycle timer	
Display	Liquid crystal display device (with backlighting)	
Communications (USB)	Loading and setting by exclusive communications software	
Suction / Exhaust Port Diameter	O.D. 6 mm and 8 mm (tube used: I.D. 5 mm dia. and 7 mm dia.)	
Range of Operating Temperature / Humidity	0 to 40 °C 10 to 90% rh (no condensation)	
Electric Power Source	Lithium-ion rechargeable battery (sold separately), AA dry batteries (optional), AC adapter (optional)	
Operating Time (when a lithium-ion rechargeable battery is used in a no-load state)	over 60 hours	1.0 L/min: over 50 hours 2.0 L/min: over 45 hours 3.0 L/min: over 35 hours
Operating Time (when AA alkaline dry cells are used in a no-load state)	over 30 hours	1.0 L/min: over 25 hours 2.0 L/min: over 22 hours 3.0 L/min: over 17 hours
Dimensions	145 W × 67 D × 95 H mm (excluding protrusions, including lithium-ion rechargeable battery)	
Weight	0.65 kg (including lithium-ion rechargeable battery)	
Accessories	Suction holder for ultra low flow rate (for MP-Σ30N Ⅱ only)	

* The above stated operable flow rate range, constant flow rate range, and accuracy of constant flow rate are for 1 atmospheric pressure. It may be short of the stated performance when it is high altitude and low atmospheric pressure.

* The operating time is the case for at 25°C. The life of the battery varies depending on the ambient temp., usage record, and suction pressure.

* When the MP-Σ30N Ⅱ is used at flow rates lower than 0.1 L/min, the instantaneous flow rate displayed may deviate momentarily.

Pump Unit

Item Code	090860-504	090860-104
Model	MP-Σ500N Ⅱ	MP-Σ100HN Ⅱ
Operable Flow Rate Range	2.00 to 5.00 L/min	0.30 to 1.50 L/min
Display Range of Instantaneous Flow Rate	0.00, 0.50 to 6.00 L/min	0.00, 0.10 to 2.50 L/min
Constant Flow Rate Ranges	2.0 L/min: 0 to 10.0 kPa 3.0 L/min: 0 to 8.0 kPa 4.0 L/min: 0 to 5.0 kPa 5.0 L/min: 0 to 3.0 kPa	0.3 L/min: 6 to 35 kPa 0.5 L/min: 5 to 30 kPa 0.7 L/min: 4 to 25 kPa 1.0 L/min: 3 to 22 kPa 1.5 L/min: 3 to 10 kPa
Accuracy of Constant Flow Rate	Within ±5% of the set flow rate	
Range of Integrated Flow Volume Setting (Volume Timer)	0.0 to 9999.9 L	
Display Range of Integrated Flow Volume	0.0 to 99999 L	
Display Range of Set Time	0.00 to 999.59 (time: minute)	
Time Setting / Display	Year / month / day, hour : minute	
Built-In Flow Meter	Mass-flow sensor	
Pump Type	Double diaphragm type	
Material	Pump head: ABS / POM / TPU, diaphragm: EPDM, valve: EPDM, case: PC	
Mode	Manual, down timer, volume timer, cycle timer	
Display	Liquid crystal display device (with backlighting)	
Communications (USB)	Loading and setting by exclusive communications software	
Suction / Exhaust Port Diameter	O.D. 6 mm and 8 mm (tube used: I.D. 5 mm dia. and 7 mm dia.)	
Range of Operating Temperature / Humidity	0 to 40 °C 10 to 90% rh (no condensation)	
Electric Power Source	Lithium-ion rechargeable battery (sold separately), AA dry batteries (optional), AC adapter (optional)	
Operating Time (when a lithium-ion rechargeable battery is used in a no-load state)	2.0 L/min: over 36 hours 3.0 L/min: over 30 hours 4.0 L/min: over 24 hours 5.0 L/min: over 18 hours	1.0 L/min: over 48 hours (at 3kPa)
Operating Time (when AA alkaline dry cells are used in a no-load state)	2.0 L/min: over 18 hours 3.0 L/min: over 15 hours 4.0 L/min: over 12 hours 5.0 L/min: over 9 hours	1.0 L/min: over 24 hours (at 3kPa)
Dimensions	145 W × 67 D × 95 H mm (excluding protrusions, including lithium-ion rechargeable battery)	
Weight	0.65 kg (including lithium-ion rechargeable battery)	

* The above stated operable flow rate range, constant flow rate range, and accuracy of constant flow rate are for 1 atmospheric pressure. It may be short of the stated performance when it is high altitude and low atmospheric pressure.

* The operating time is the case for at 25°C. The life of the battery varies depending on the ambient temp., usage record, and suction pressure.

LCD Screen Indications and Meanings

Regular Screens		
CLD-D	Current date	Displays the date of the internal clock.
CLD-T	Current time	Displays the time of the internal clock.
CLD-Y	Current year	Displays the year of the internal clock.
DATA	Log deletion screen	Displays deletion of all logs.
DEL	Deletion screen	Displays log deletion and setting of defaults.
DFLT	Default settings	Indicates the fact that you are returns settings to their defaults.
E-MD	Measurement end date	Displays the date at the end of sampling.
END	End	Indicates the fact that data deletion has ended.
ERR	Error No.	Displays the error and details of the error by an error No.
E-TM	Measurement end time	Displays the time at the end of sampling.
EXTR	Extra menu	Menu for entering various setup menus (e.g. clock setting).
F-AV	Average flow volume	Displays the average flow rate during sampling.
FLOW	Flow rate setting, instantaneous flow rate	Displays the set flow rate before measurement and the instantaneous flow rate during measurement.
LED	Operation display LED setting	Displays the LED ON setting.
LIGT	Backlight ON setting	Displays the backlight ON setting.
LOG 0-9	Log No.	Displays each log by a No. in the log screen.
MEM	Past log menu	Menu for entering the log menu
PC--	PC connection screen	Indicates that you are connecting to the PC by a USB cable.
P-ON	Power ON time	Displays the time that the pump was turned ON.
PTOT	Volume timer setting	Displays the integrated flow volume set by the volume timer.
RCYC	Remaining number of cycles	Displays the remaining number of cycles (remaining number of measurements) by the cycle timer.
RSAT	Remaining measurement time	Displays the remaining time up to end of measurement.
RTOT	Remaining measurement volume	Displays the remaining integrated flow volume up to end of measurement.
SA-T	Set sampling time	Displays the sampling start time.
S-SMD	Measurement start date	Displays the sampling start date in the cycle timer mode.
S-TM	Measurement time	Displays the sampling start time in the cycle timer mode.
ST-T	Pump operation start time	Displays the preset sampling start time.
TIME	Actual sampling time	Displays the actual sampling time.
TOT	Integrated flow volume	Displays the actual integrated flow volume value.
T-SD	Flow volume conversion temperature display	Displays the temperature conversion value of the flow volume.
VER	Version information	Displays the version information of this product.
WAIT	Remaining measurement start time	Displays "measurement standing by" and the remaining time up to start of measurement.
Submenus		
BC-T	Backlight OFF time setting	Indicates that you are setting the time until the backlight is turned OFF.
CAL	Calibration screen	Screen for entering the calibration mode
E-C	Current value	Displays the current consumption
END	End	Indicates that calibration has ended.
FADJ	Flow rate calibration screen	Displays flow rate calibration.
FLOW	Calibrated flow rate, instantaneous flow rate	Displays the flow rate during calibration, and the instantaneous flow rate during pump operation.
M-T	Motor operating time	Displays the continuous motor operating time of this product.
POW	Battery voltage	Displays the battery voltage.
TCAL	Flow rate conversion temperature setting at	Displays the flow rate conversion temperature setting at flow rate calibration.
ZOFT	Zero offset	Indicates that zero offset is being performed at flow rate calibration.

Options (Including Consumables)

- LI-10N Battery Unit [Item Code: 080860-010]
- DB-10N Dry Battery Unit [Item Code: 080860-011]
- QC-10N Quick Charger [Item Code: 080860-110]
- PA-1203 AC adapter [Item Code: 080000-1203]
- Suction port set for MP-ΣN/MP-ΣNⅡ [Item Code: 080860-002]
- Soft case for MP-ΣN/MP-ΣNⅡ [Item Code: 080860-003]
- Data communication cable with software package MP-ΣN/MP-ΣNⅡ for English version [Item Code: 090860-0045]
- VFE-3 Filter Elements (packet of 5) [Item Code: 080860-001]

Maintenance

To sustain the flow volume precision of this product, we recommend periodic inspection (charged).
We recommend inspection at our company once every year.
Also, replace the filter element periodically.

Warranty and Repair

This product shall be repaired free-of-charge should it malfunction within one year of purchase. When asking for repair, be sure to directly contact the dealer of purchase.
Consumables provided with this product fall outside of the scope of this Warranty. Repair of the product itself also shall fall outside of the scope of this Warranty if any of the following causes it to malfunction:

- Faults or damage resulting from incorrect use
- Faults or damage resulting from repairs or modifications implemented by parties other than Sibata
- Faults or damage resulting from fires or natural disasters, such as earthquakes
- Faults or damage occurring after purchase due to relocation, movement, falling, or vibration
- Faults or damage resulting from the use of consumable items not specified by Sibata
- Any case in which the date of purchase has not been entered on the warranty, the warranty has not been stamped, or the warranty items have been corrected

■ Requesting the Repair of Products Used in Environments Exposed to Asbestos (Request)

In order to prevent harm to customers and repair staff due to asbestos exposure, we would like your cooperation when you request the repair of products that have been used in environments exposed to asbestos. Please read the following before requesting repairs.

1: Remove any asbestos from the product before sending it for repairs. After removing asbestos, place the product and any accessories in a double-sealed, transparent, waterproof material (such as a strong plastic bag) and pack it in a box. When sealing the bag, make sure that the product serial number and the number of accessories can be confirmed from the outside.

2: Write "AS" clearly in the "Fault Description and Request Details" column of the "Repair Request Form." If there is no such description with the product, you may be asked by our sales representative to confirm whether there was any asbestos exposure.

3: When the product to be repaired is sent to us by courier, then, in addition to the model number, add "AS" to the "Comments" or "Description" section of the invoice. This measure is to prevent damage to the sealed bag when the package is unpacked with a cutter.

Note: The above request is applicable to all similar products related to asbestos measurement.

Disclaimer

Should some nonconformity occur during use of this product, SIBATA does not assume any liability whatsoever for compensation of data or content that could not be acquired or logged as a result, loss of data or other content, and other direct and indirect damages (loss of business profit, interruption of business, etc.) relating to the preceding.
SIBATA guarantees repair of production malfunctions under fixed conditions. However, SIBATA does not offer any compensation for loss of or damage to data stored on the product. When asking SIBATA for repair or other services, make a backup of any required data. SIBATA does not assume any liability whatsoever for any damages that may occur accompanying loss or discarding of data due to infringement of precautions described in this manual or neglect to back up data on the part of the customer.
For details of repair after the Warranty has expired, contact your Sibata agent. The product shall be repaired for a fee only if SIBATA judges that repair shall restore its functions, and its functions can be sustained in the future only in accordance with specified methods of use.
When returning this product for repair, fill in the Trouble Notification Sheet and send this sheet together with this product. (See page 41 " Trouble Notification Sheet.")

Disposal of the Product

Dispose of the product in accordance with the disposal laws and regulations of your respective local governing body. The pump body is made almost entirely from plastic (PCB and ABS).
The LI-10N Battery Unit should, if possible, be disposed of by a recycle vendor since it is a lithium-ion rechargeable cell.

Inquiries

If you have any questions about this product, or if there is any other way in which we can be of assistance, contact your Sibata representative.

14.08.05H(03)

Trouble Notification Sheet

This sheet is to be filled with information required for the smooth checking and repair of pump malfunctions. Please fill in this sheet in as much detail as possible. Also, attach this sheet when asking for repair. Please fill in the cautions when sending the pump for repair and required cleaning details.

Mini Pump MP-ΣNⅡ Series Trouble Notification Sheet

If the pump malfunctions, make a copy of this sheet, fit it in and contact your Sibata agent.
Entry Date: (y/m/d)

[Product Conditions of Use]
Model □: MP-Σ30NⅡ □: MP-Σ300NⅡ □: MP-Σ500NⅡ □: MP-Σ100HNⅡ
Serial No. Date of Purchase: (y/m/d)
Start of Use: (y/m/d)
Frequency of Use □: Every day □: ___ days/week □: ___ days/month □: ___ hours/day
Operating Environment Temperature (measured temperature, if possible): ( )°C to ( )°C
Number of Installed Units: __ units Application:

[Symptoms of Malfunction]
Frequency of Occurrence □: Every time □: Occasionally □: Rarely □: Other
( )
Start of Malfunction □: Since purchase □: Within a month □: Within a week
□: Other
( )
Symptoms: (Write in as much detail as possible.) Ex: Backlight does not turn ON even by pressing a key.

[Check Items] (Please choose your answer.)

- Does the LCD display turn ON when the power to the pump body is turned ON? (Yes ・ No)
- Is the filter element particularly dirty? (Yes ・ No)
- Is water or other liquid being sucked in? (Yes ・ No)
- Are there any signs or scratches on the pump body indicating that it has been dropped or impacted? (Yes ・ No)

[Work Check Items When Asking for Repair]
□: Make a copy of the Trouble Notification Sheet, fill it in and send it together with the pump.
□: If there is the risk that harmful substances (e.g. asbestos) have been sucked into the pump, put this Trouble Notification Sheet in an envelope, and stick this to the outside of the box. Also, be sure to clearly indicate the presence of such substances on the Trouble Notification Sheet. (In case of asbestos sampling, please follow the " ■ Requesting the Repair of Products Used in Environments Exposed to Asbestos (Request) " on page 39.)

SIBATA SCIENTIFIC TECHNOLOGY LTD.
1-1-62, Nakane, Soka, Saitama, 340-0005 Japan
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URL : http://www.sibata.co.jp/english/

Note) Shape, dimensions, specifications, and other product information are subject to change without notice in the interest of product improvement to the extent that product functions and applications will not be impaired.

Atmospheric Mercury Monitoring Workshop 2019
for Establishing a Multi-media Mercury Monitoring Network
in Asia-Pacific

Program

Day 1 (Monday, 12th August)

Time	Program
9:00-9:30	Registration
9:30-10:30	Presentation ● Mercury monitoring method of ambient air by gold amalgamation trap ➢ Method outline ➢ Survey and sampling ➢ Measurement
10:30-10:45	Coffee Break
10:45-12:15	Demonstration / Experiment ● Ambient air sampling ➢ Setting sampling equipment (Gold Trap)
12:15-13:30	Lunch
13:30-15:30	Demonstration / Presentation ● Measurement of ambient air sample ➢ Attachment devices for conventional AAS devices ● AAS with hand-made application device ● Measurement by AAS (calibration curve creation)
15:30-15:45	Coffee Break
15:45-17:30	Presentation ● Atmospheric Standards and Monitoring in Japan

Day 2 (Tuesday, 13th August)

Time	Program
9:00-10:30	Demonstration / Experiment ● Ambient air Sampling ➢ End of Sampling ➢ Recording (field note) ➢ Preparation Procedure (apparatus and instruments)
10:30-10:45	Coffee Break
10:45-12:15	Demonstration / Experiment ● Measurement by AAS ➢ Measurement of Collected Air Samples
12:15-13:30	Lunch
13:30-14:30	Presentation / Demonstration ● Data Calculation ● QA/QC Parameter in Atmospheric Monitoring
14:30-15:30	Presentation ● Survey and Monitoring Plan
15:30-15.45	Coffee Break
15:45-17:30	Discussion / Closing

Day 3 (Wednesday, 14th August) : APMMN meeting

Day 4 (Thursday, 15th August): APMMN meeting

Day 5 (Friday, 16th August): APMMN meeting

Thermo Recorder
TR-73U

User's Manual

Thank you for purchasing our product.
Carefully read this instruction manual before using this unit.

2016.11 16504480009 8th Edition

Important Notices and Disclaimers

In order to properly use this product, please carefully read this manual before using. T&D Corporation accepts no responsibility for any malfunction of and/or trouble with this product or with your computer that is caused by the improper handling of this product and will deem such trouble or malfunction as falling outside the conditions for free repair outlined in the attached warranty.

- All rights of this manual belong to T&D Corporation.
- It is prohibited to use, duplicate and/or arrange a part or whole of this manual without the permission of T&D Corporation.
- Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries.
- Windows Vista is either a registered trademark or trademark of Microsoft Corporation in the United States and/or other countries.
- All registered trademarks, company names, product names and logos mentioned herein are the property of T&D Corporation or of their respective owners.
- Specifications, design and other contents outlined in this manual are subject to change without notice.
- Please follow the safety precautions outlined in this manual carefully.
- We cannot guarantee nor are we responsible for safety if this product is used in any manner other than was intended.
- On-screen messages in this manual may vary slightly from the actual messages.
- Please notify the shop where you purchased this product or T&D Corporation of any mistakes, errors or unclear explanations in this manual.
- T&D Corporation accepts no responsibility for any damage or loss of income caused by the use of our product.
- This product has been designed for private or industrial use only.
- It is not for use in situations where strict safety precautions are necessary such as in connection with medical equipment, whether directly or indirectly.
- We are not responsible for any malfunction or trouble caused by the use of our product or by any problem caused by the use of measurement results of our unit. Please be fully aware of this before using our product.
- This manual cannot be reissued, so please keep it in a safe place.
- Please read the warranty and provisions for free repair carefully.

Compliance Information

Radio, EMC and Safety Regulations

This device complies with Part 15 of the Federal Communications Commission (FCC) rules. Operation is subject to the following two conditions: (1)This device may not cause harmful interference, and (2)this device must accept any interference received, including interference that may cause undesired operation.

FCC Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Caution

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Table of Contents

Safety Precautions and Instructions

To ensure safety obey all of the following warnings

The following items should be strictly obeyed for the safe usage of this unit, and for protecting yourself and other people from bodily harm and/or damage to property. Before using make sure to carefully read, understand and follow the safety rules and precautions for our products as outlined below.

Explanation of Symbols

Explanation of Warning Symbols

⚠WARNING	These entries are actions that absolutely under no circumstance should be taken. The taking of such an action may cause serious personal physical damage or death.
⚠CAUTION	These entries are actions that if taken may lead to physical injury or damage to persons or things.

Explanation of Picture Symbols

△	Denotes an important warning or caution. Inside or near the symbol may appear another symbol giving details. (EX: Be careful of electrocution)
⃠	Denotes a forbidden action. Inside or near the symbol may appear another symbol giving details. (EX: Do not use in wet areas.)
●	Denotes an action that you must take. Inside or near the symbol may appear another symbol giving details. (EX: Unplug power plug from outlet)

	⚠ WARNING
●	When installing and using this product, make sure to follow all warnings and directions from your computer manufacturer.
⃠	Do not take apart, repair or modify the main unit. Doing so may cause fire or electrocution.
●	If water or a foreign body enters into this unit, immediately remove the batteries and stop using. Continued use may cause fire or electrocution.
⃠	Do not use this unit in wet or humid places, such as a bathroom. It may cause a fire or other trouble including malfunction.
●	Store main units, sensors, batteries and communication cables out of the reach of children. It is dangerous to touch or swallow batteries.
⃠	If any smoke or strage smells are emitted from the unit, immediately remove the batteries and stop using. Continued use may cause fire or electrocution.
△	This device is designed to measure and record temperature and humidity. Do not use it for any other purpose than to measure and record temperature and humidity.

	⚠CAUTION
⃠	This unit is not water-resistant. If the unit gets dirty, wipe it with a clean cloth and a mild detergent.
⃠	Do not expose the unit to harmful gases or chemicals. It may cause corrosion and/or other danger to the unit and to people handling the unit.
●	Do not use batteries other than specifies. Doing so may cause fire or damage.
△	Battery terminals may provide insufficient contact due to age or vibration. This may lead to data loss.
●	Condensation may occur if the units is moved from one environment to another where the difference in temperature is great. Use the unit in an environment where the ambient temperature is great. Use the unit in an environment where the ambient temperature is from -10 to 60°C and the humidity is 90%RH (no condensation) or less.
△	To prevent damage to the unit from static electricity, remove static electricity from your body by touching metal aroung you (door knob, window frame) before touching the unit. Static electricity may cause not only damage to the unit, but may cause breaks in or a loss of data.
●	If the unit will not be used for period of time, for safety reasons please remove the battery. If left in the unit, it may leak and lead to malfunctioning.
△	Please take extra caution when plugging in and pulling out the USB plug while another USB device such as CD-RW/HDD is in operation. It may cause problems to your CD-RW or other device.
●	We shall not guarantee the operation of our device if you have connected it to your computer using a USB hub or a USB extension cable.
△	Batteries used under low pressure conditions may leak and cause a malfunction.
⃠	Please do not insert your fingers or any foreign objects into any of the devices' jacks.
⃠	Do not use any other batteries than those that are specified in this User's Manual. It may cause a fire or other trouble including malfunction.

Do not use or store the Thermo Recorder in any of the following places. Doing so may cause electrocution, fire and/or other adverse effects to the device and/or your computer.

-Areas exposed to direct sunlight
This will cause the inside of the device to become overheated and may cause fire, deformation, and/or other damage including malfunction.
-Areas prone to strong magnetic fields
This may cause damage including malfunction.
-Areas exposed to water leakage
This may cause electrocution or other damage incluing malfunction.
-Areas exposed to excessive vibration
This may cause injury, malfunction, damage or loss of proper electrical contact.
-Areas near fire or exposed to excessive heat
This may cause damage including malfunction and deformation.
-Areas prone to smoke, duct and dirt
This may cause damage including malfunction.

Cautions about using the Sensors

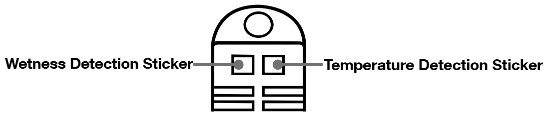
Cautions about using the temperature-humidity sensor TR-3100

The sensor can measure temperature within the range of 0 to 50°C and humidity within the range of 10 to 95%RH. Only use the sensor within these ranges.
If extremely severe temperature changes occur, the humidity measurements may appear abnormal. Once the sensor's temperature becomes stable, the measurements will return to normal.
This sensor is not waterproof. Do not get wet.
When measuring with the temperature-humidity sensor in an environment of 0 to 50°Cand less than 30%RH, the measurements may sometimes fluctuate. This is not abnormal.

Cautions about using the Sensors

[Handling the temperature-humidity sensor]

- The service life of humidity sensors can vary greatly depending on operating environment.Periodic calibration may be required.
  During use the temperature-humidity sensor will accumulate impurities (dirt) on the surface of the sensor is being used in a bad environment (smoky or dusty places) it may be necessary to change the sensor sooner.
- When the temperature-humidity sensor is not being used, please place it in the attached vinyl bag with the drying agent included and store it in a cool dark place with a temperature of between 5 to 25°C and a humidity of below 30%RH.
- Attached to the temperature-humidity sensor are two stickers: a wetness detection sticker and a temperature detection sticker. If either of the stickers shows abnormality, you should change the old sensor to a new one immediately.



-Wetness Detection Sticker

Informs you that the sensor has been wet.

Normal
Under normal conditions, black dots will appear on a white

Abnormal
Under abnormal conditions, it will turn to red.

-Temperature Detection Sticker

Informs you that the sensor measured a temperature measurement over 60°C.

60 **Normal**
Under normal conditions, the number 60 will lightly appear on a pinkish white background.

60 **Abnormal**
Under abnormal conditions, the number 60 will clearly appear on a red background.

About Thermo Recorder TR-73U

Outline

TR-73U Thermo Recorder is a data logger capable of measuring, displaying and recording temperature, humidity, and barometric pressure data. TR-73U has a total of three channels: one temperature, one humidity, and one barometric pressure channel. The data recorded into the TR-73U units can then be downloaded quickly via USB cable to your computer whereby with our exclusive software you can easily process the data into graphs, tables, save to files and/or print it out.
Moreover, it is possible to connect more than one unit at the same time.

Basic Functions

-Barometric Pressure Measuring Range : 750 to 1100 hPa

The TR-73U with the internal barometric pressure sensor can measure and record in a range of 750 to 1100 hPa.

-Temperature Measuring Range: 0 to 50°C (with supplied temp-humidity sensor)

The TR-73U with the internal temperature sensor can measure and record in a range of -10 to 60°C, but by purchasing one of our optional temperature sensors it is possible to measure and record in the wider range of -40 to 110°C.
Please take a look at our full range of optional sensors to find one to match your application. (T&D Website: HOME > PRODUCTS > TR-73U > Options)

-Humidity Measuring Range : 10 to 95%RH

The TR-73U with the sensor included in this package can simultaneously measure and record temperature in a range of 0 to 50°C and humidity in a range of 10 to 95% RH.

-Amount of Recorded Data : 8000 readings x 3 channels

One channel can record and hold up to 8000 measurement readings.
At the longest recording interval of 60 minutes, recording can continue consecutively for 1 year.

-10 Months of Operation with just 1 AA Alkaline Battery

Our low energy consumption design gives you ten months of continuous operation with only one AA alkaline battery.
This gives you the freedom to use the data loggers in places where they can be left alone for long periods of time, such as, in transportation or warehouse.

NOTE:

- Battery life varies depending upon the type of battery, the measuring environment, the frequency of communication, and the ambient temperature in which it is used. Specifications and explanations used in this User's Manual are based on operations carried out with a new battery and are in no way a guarantee of your actual battery life.
  Also, if the recording interval is less than 10 seconds, battery life will be much shorter.

-Battery Life Warning Display

When the battery power becomes low, a battery life warning signal will appear in the unit's LCD display.
If the battery power becomes even lower the unit will automatically go into sleep mode in order to protect the data.

-15 Recording Intervals

Select from 15 recording intervals (from 1 second to 1 hour) to meet your needs.
Select from 2 Recording Modes
One-time Mode : When the number of recorded readings reaches 8000, [FULL] will appear in the unit's LCD display and recording will automatically stop.
Endless Mode : When the number of recorded readings reaches 8000, the oldest data readings will be overwritten and recording will continue.

-Current Readings Monitoring Display

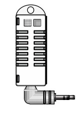
With our exclusive software, you cannot only monitor the current measurements at a set interval, but can view those measurements in a continually changing graph.
You can simultaneously display the current measurements and corresponding graphs for the number of units you have connected.

-Adjustment Function

By entering the adjustment values beforehand with the provided software, it is possible to view and record the adjusted measurement values.
There are two methods of adjustment: adjusting by one point or adjusting by two points.
Adjustment for differences will be based upon the following simple equation Y=aX+b.
X equals the measured value and Y equals the value after adjustment.

Package Contents

Thermo Recorder TR-73U x 1



Temperature-Humidity Sensor
TR-3100 x 1

T&D Recorder for Windows
Software CD-ROM x 1

User's Manual (Warranty) x 1

Software User's Manual x 1

USB Communication Cable
US-15C x 1

AA Alkaline battery x 1

Before Using…

Important Notes about the Installation Procedure of T&D Recorder for Windows.
In order to use a USB connection to communicate between the TR-73U and a PC, it is necessary to install the software and the USB driver.

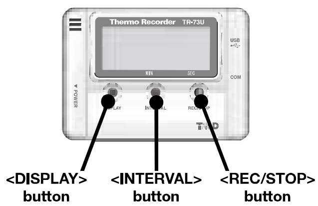
Before connecting the TR-73U to the computer with a USB cable, make sure to first install the software.
When you connect the TR-73U to the computer before installing the software, the following message may appear. In that case, click [Cancel] and disconnect the USB cable.

For details about making TR-73U Unit Settings or about Downloading Data, see the explanation in the Software User's Manual and/or the Software “Help”.

Part Names and Functions

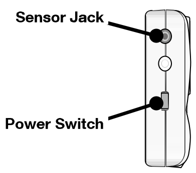
Part Names and Functions

FRONT

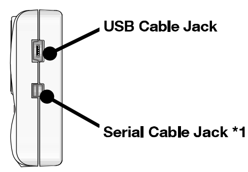


DISPLAY : Pressing this button will change the LCD Display Mode.
INTERVAL : Pressing this button will display the currently set recording interval.
REC/STOP : Pressing this button will start or stop recording.

LEFT SIDE

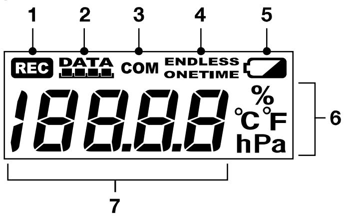


RIGHT SIDE



1: Not supported in TR-73U.

LCD Display



1. Recording Mark

The recording condition will appear.
ON : Recording in progress.
BLINKING : Waiting for programmed start.

2. Data Capacity Scale

After every 2000 readings the scale will be marked from left to right.

3. COM Mark

This will appear when data is being sent or received.
ON : USB cable is connected.
BLINKING : In communication with computer.

4. Recording Mode

One-time Mode : When the number of recorded readings reaches 8000, [FULL] will appear in the unit's LCD display and recording will automatically stop.
Endless Mode : When the number of recorded readings reaches 8000, the oldest data readings will be overwritten and recording will continue.

5. Battery Life Warning Signal

When the battery power becomes low, a mark will appear on the LCD of the main unit. If the battery power becomes even lower, [SLP] will appear and normal operations will stop. Please change the battery as soon as the Battery Warning Mark appears.

IMPORTANT:

- If the main unit remains in sleep mode for about 1 month without a change of battery, or if the battery is left out of the unit for more than 2 minutes, all recorded data will be lost.

6. Unit of Measurement

The unit of the measurement for the display will appear.

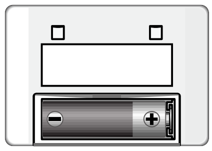
7. Measurements and Messages Area

Current measurements or operational messages such as [FULL] or [SLP] will appear.

Installing the Battery

1. Remove the battery cover form the back of the unit.

2. Insert 1 AA alkaline battery, making sure that the + and – are in the correct direction.
****Always use a new battery.***



3. Replace and close the battery cover.

[Changing the Battery]

1. When battery power becomes low, a battery life warning signal will appear in the unit's LCD display.
If, at this time you change the battery, recording will continue uninterrupted and all data will be saved for downloading.

2. If the battery is not changed and power becomes even lower, [SLP] will appear in the LCD display.
The unit will automatically go into sleep mode in order to protect the data and all normal operations will stop.
If you change the battery at this point, it is still possible to download all saved recorded data.

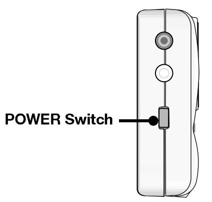
3. If the battery is further left unchanged, the display will automatically shut off.
If all battery power is lost, all data will be lost as well.

NOTE:

- If a unit is left without a battery for more than 2 minutes, all data will be lost, so please work quickly when changing the battery.

Turning ON the Power

1. By holding in the POWER switch at the left side, the unit will turn on.



[Turning OFF the Power]

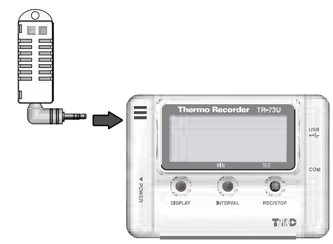
By holding in the POWER switch, the unit will turn off.

- During recording, the power cannot be turned off. Please stop recording first and then turn off the power.
- Even if the power has been turned off, the recorded data will be saved. However, if the battery power is totally lost, all data will be lost, so please download data as soon as possible to avoid losing any necessary data.

Connecting the Sensors

Connect the Sensor

****To avoid poor connections, be sure to push the sensor connector securely into the jack.***
**** When using the temperature-humidity sensor in environments where the temperature is 0 to 15 and humidity under 30 RH, there may occur changes in measurement readings. This is not a malfunction.***



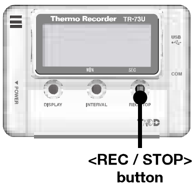
NOTE:

- If a sensor extension cable is being used with the data logger connected by USB to your computer, electromagnetic waves may cause large errors in measurements.
- For details about handling the temperature-humidity sensor, please refer to page 9 "Cautions about using the Sensors" of "Safety Precautions and Instructions"

Starting Recording from Main Unit Button

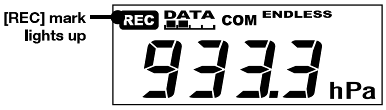
By pressing the <REC/STOP> button on the main unit you can start a recording session immediately.

*** If you wish to make changes to the device name, channel name, recording mode or to any other recording conditions, you must make those settings by connecting the device to your computer.***



Start Recording

Press in the <REC/STOP> button on the front of the unit until the [REC] mark appears in the display. When displayed, recording has begun.

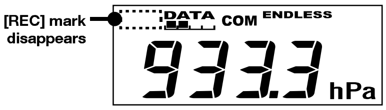


NOTE:

- By starting a new recording session, all data currently saved in the unit will be erased.
- Even if the unit is waiting for a programmed recording to start via the provided software, by pressing the <REC/STOP> button until the [REC] mark appears, you can start a new recording session immediately.

Stop Recording

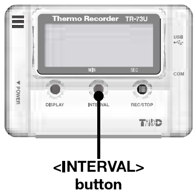
You can stop a recording session by pressing the <REC/STOP> button until the [REC] mark disappears from the display. When it has disappeared, recording has stopped.



Setting Recording Interval from Main Unit Button

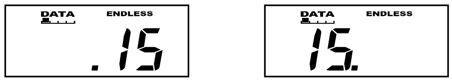
You can make or change recording interval settings from the <INTERVAL> button on the front of the TR-73U main unit.

*** During recording or while waiting for a programmed recording to start via the provided software, there are not settings to be made.***



1. Press in the <INTERVAL> button on the front of the device until the recording interval appears in the display.

2. With each pressing of the <INTERVAL> button the recording interval time will change.
   Press until the desired setting appears.
   *Recording Interval : 1,2,5,10,15,20,30 seconds 1,2,5,10,15,20,30,60 minutes



15 seconds **15 minutes**

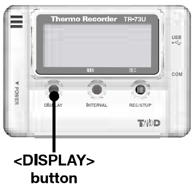
3. When the desired recording interval appears, stop pressing the <INTERVAL> button.
   Within a few seconds, the current measurement readings will return to the display and the setting will be finished.

   *** By pressing the <INTERVAL> button during recording or while waiting for a programmed recording to start via the provided software, the currently set recording interval will be displayed.***

Changing the LCD Display Mode from Main Unit Button

You can make or change the LCD display settings from the <DISPLAY> button on the front of the TR-73U main unit.

1. By pressing the <DISPLAY> button on the front of the unit, you can change the screen display.



2. If the LCD display shows three channels' readings alternatively, it will show one channel as a fixed display by pressing the button.
   By pressing the button again, the LCD display pattern will be set for displaying three channels alternatively.
   If the display has been set for a fixed channel, with each pressing of the button the channel display will change.

Specifications

Device Type	TR-73U		
Sensor	TR-3100 (External) (*1)		Barometric Pressure Sensor (Internal)
	Thermistor	Polymer Resistance	
Measurement Channels	Temperature 1ch	Humidity 1ch	Barometric Pressure 1ch
Units of Measurement	°C, °F	%RH	hPa
Measurement Range	0 to 50°C (Supplied Sensor) -40 to 110°C (Optional Sensor)	10 to 95 %RH	750 to 1100 hPa
Accuracy	Avg. ± 0.3°C [0 to 50°C]	±5 %RH [at 25 °C, 50 %RH]	±1.5 hPa
Measurement Resolution	0.1°C	1 %RH	0.1 hPa
Responsiveness	Response Time (90%): Approx. 7 min.		4 seconds or 40 seconds if recording interval is 10 sec. or more.
Logging Capacity	8,000 data sets (One data set consists of readings for all channels in that type of unit.)		
Recording Interval	Select from 15 choices: 1, 2, 5, 10, 15, 20, 30 sec. or 1, 2, 5, 10, 15, 20, 30, 60 min.		
Recording Mode	Endless (Overwrite oldest data when capacity is full) or One Time (Stop recording when capacity is full)		
Communication Interfaces	USB Communication, Serial Communication (RS-232C) (*2)		
Power	AA Alkaline Battery (LR6) x 1		
Battery Life (*3)	Approx. 10 months		
Dimensions	H 55 mm x W 78 mm x D 18 mm		
Weight	Approx. 40 g		
Operating Environment	Temperature: -10 to 60 °C Humidity: 90 %RH or less (no condensation)		

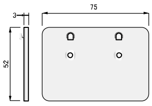
Software	T&D Recorder for Windows (TR-5, 7xU)
Compatible OS (*4)	Microsoft Windows 10 32/64 bit Microsoft Windows 8 32/64 bit Microsoft Windows 7 32/64 bit Microsoft Windows Vista 32 bit (SP1 or later)
Display Languages (*5)	English
Other	The Microsoft .NET Framework 3.5 SP1 is required.

*1: It is also possible to measure temperature with the internal sensor. However, the measurement range is restricted to the operating environment for the whole device.
*2: Customers wishing to write their own software, please contact your local distributor for the serial communications protocol specifications. (Note: Optional serial communication cable TR-07C is also required.)
*3: Battery life varies depending upon the ambient temperature in which it is used, the recording interval, the frequency of communication, and the battery performance. All estimates are based on operations carried out with a new battery and are in no way a guarantee of actual battery life.
*4: For installation, it is necessary to have Administrator (Computer Administrator) rights.
*5: We recommend using an operating system in the same language as the display language. Operation in different languages is not guaranteed.
The specifications listed above are subject to change without notice.

Optional Accessories

TR-07K2 Wall Attachment

Wall Attachment
Included:
screws x 2 double-sided tape x 1



US-15C USB Communication Cable

Cable Length
about 1.5 m

Product Support

For support, please contact the distributor from which you purchased the product.

A list of distributors can be found at:

http://www.tandd.com/about_tandd/contactus/

Product Information

Product information can be found at:
http://www.tandd.com/product/

Thermo Recorder TR-73U
User's Manual

T&D CORPORATION
817-1 Shimadachi, Matsumoto, Nagano 390-0852, Japan
Website : http://www.tandd.com/
FAX : +81-263-40-3152 E-mail : support@tandd.com

Thermo Recorder TR-73U Warranty

Warranty Period	1 year from date of purchase
Date of Purchase	
Customer's name Address Phone No.	
Distributor's name Address Phone No.	
Object of Repair	Main Unit (excluding accessories.)
Method of Repair	Send in for Repair

Provisions for Free Repair

1. If the unit does not work properly despite the fact that the customer used it properly and in line with the manual, the unit shall be repaired free of charge through the distributor which sold the unit.
2. If the customer requests free repair because of trouble within the warranty period, bring or send the unit along with the warranty to the distributor.
3. If you have moved after purchasing, or there are difficulties contacting the distributor from which you purchased the unit, please contact T&D directly for service.
4. Free repair is not available in the following cases even though it is within the warranty period:
   1. Trouble or damage was caused by careless operation, natural disaster, fire, public pollution, or use of a power source other than specified.
   2. If repair, adjustment, disassembly or modification of the unit has been carried out by a person other than a T&D authorized engineer.
   3. Trouble or damage was caused by transportation, movement or dropping of the unit after purchase.
   4. Failure to submit the warranty or failure to fill in all items required in the warranty.
5. The warranty cannot be reissued.

This warranty only promises customers free repair within the period and conditions clarified in this warranty. Therefore, the customer's legal rights will not be limited by this warranty. For further information on repair and other service questions after the termination of the warranty period, contact your distributor.