

# Overview of the Asia Pacific Mercury Monitoring Network (APMMN)

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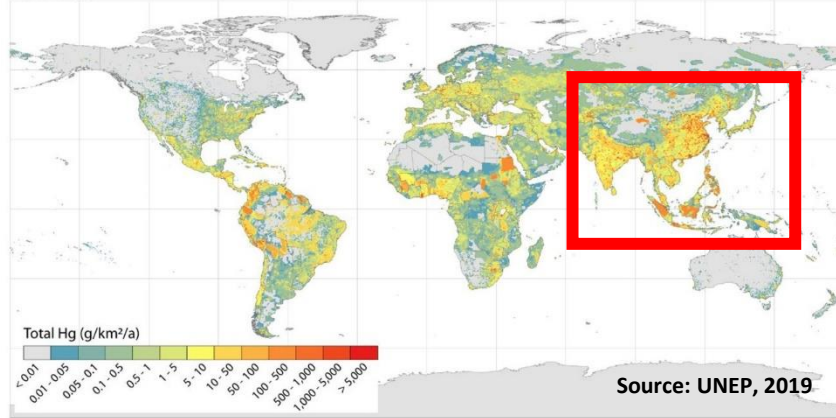
**<sup>2</sup>U.S. Environmental Protection Agency, USA**

**<sup>3</sup>National Atmospheric Deposition Program, USA**

# Asia Is the Largest Source Region

2015

All sectors

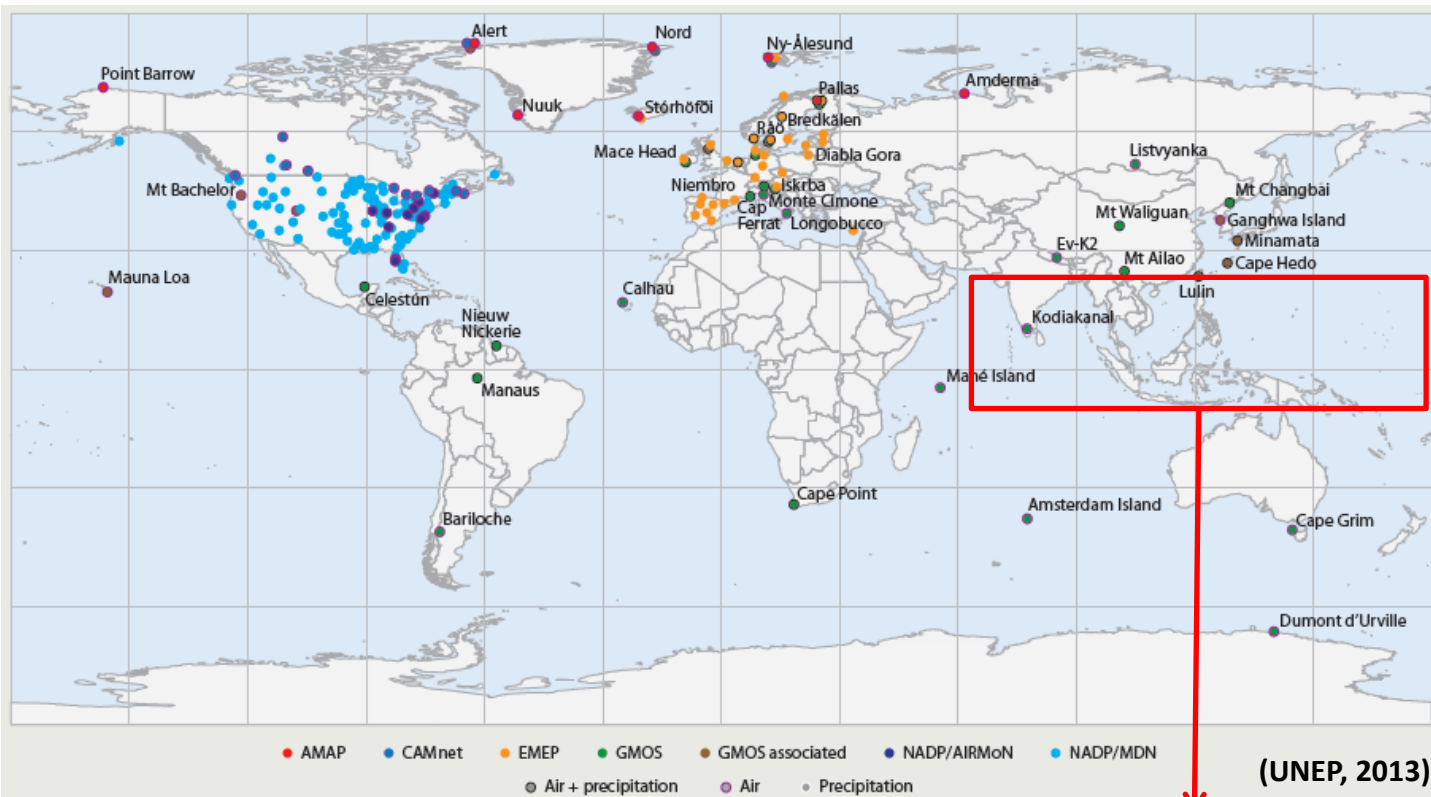


▼ Quantities of mercury emitted to air from anthropogenic sources in 2015, by different sectors in different regions.

	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	3.57	4.07	1.15	0.0	8.79 (6.93-13.7)	0.4
Central America and the Caribbean	5.69	19.1	6.71	14.3	45.8 (37.2-61.4)	2.1
CIS & other European countries	26.4	64.7	20.7	12.7	124 (105-170)	5.6
<b>East and Southeast Asia</b>	<b>229</b>	<b>307</b>	<b>109</b>	<b>214</b>	<b>859 (685-1430)</b>	<b>38.6</b>
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	27.0	7.63	5.77	0.0	40.4 (33.8-59.6)	1.8
South America	8.25	47.3	13.5	340	409 (308-522)	18.4
<b>South Asia</b>	<b>125</b>	<b>59.1</b>	<b>37.2</b>	<b>4.50</b>	<b>225 (190-296)</b>	<b>10.1</b>
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

Country	Emissions (tonnes)
<b>China</b>	<b>536.8</b>
<b>India</b>	<b>205.9</b>
<b>Indonesia</b>	<b>156.8</b>
Philippines	32.5
Vietnam	18.1
Japan	15.0
Myanmar	13.2
Thailand	11.6
Malaysia	8.3
Mongolia	7.0
Taiwan	7.0
Korea	6.9
Cambodia	4.2
Laos	3.0
Singapore	1.6
Sri Lanka	1.6
Nepal	1.2

# But Atmospheric Hg Monitoring Is Limited



**Long-term or background atmospheric Hg monitoring activities in SE and S Asia and the Pacific Island countries are very limited.**

# Asia Pacific Mercury Monitoring Network (APMMN)



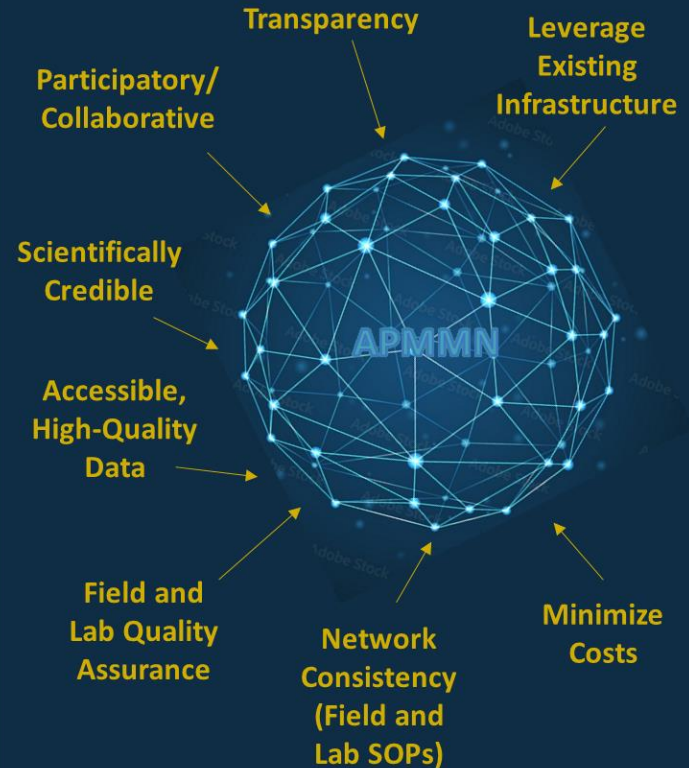
Asia Pacific Mercury  
Monitoring Network

- APMMN was established to fill in regional data gap.
- A cooperative effort to systematically monitor [mercury in air and rainwater](#) throughout the Asia-Pacific Region since 2016, but planning began in 2012 with a series of meetings and workshops.
- APMMN involves many different and voluntary groups, including environmental ministries and federal government agencies, academic institutions, and scientific research and monitoring organizations.

# APMMN Objectives

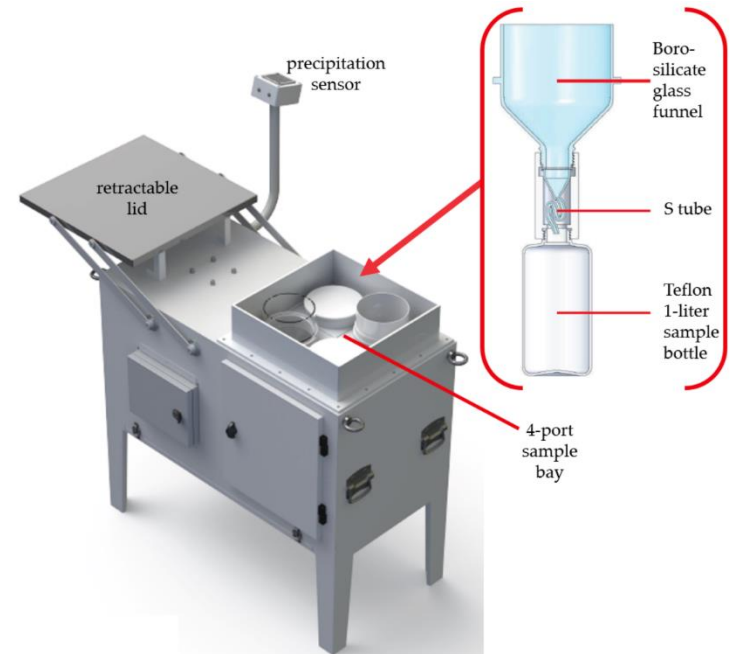
- Determine **status and trends** in concentrations of atmospheric mercury, and wet, dry, and total deposition
- Develop a **robust dataset** for modeling and assessment
- Assist partner countries in **developing monitoring capacity**
- **Share data** and monitoring information

## Network Design Principles



# Approach

- Automated wet deposition sampler provided by Taiwan MOENV
- Site operator and lab staff training
- Samples shipped to National Central University(NCU), Taiwan for Hg analysis
- Data reported back to partner countries



**APMMN Wet Deposition Sampler**

**Chemical Analysis:** Cold vapor atomic fluorescence spectroscopy (CVAFS) at National Central University, Taiwan

**Mercury Forms:** Total mercury wet deposition and precipitation concentrations

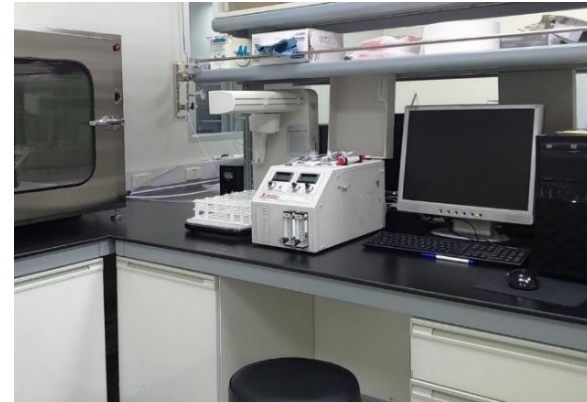
**Sampling Frequency:** One week; Tuesday – Tuesday schedule

**Meteorology:** Precipitation depth measured onsite (best) or as close as possible to the sampler (within 5 km)

**Site Types:** Regionally representative; urban, remote, rural areas with estimated high levels of mercury and deposition; sensitive ecosystems

# Center for Environmental Monitoring and Technology

- To support the operation of APMMN, Taiwan MOENV funded the establishment of the **Center for Environmental Monitoring and Technology** on NCU campus in 2016
  - Rainwater sample Hg analysis
  - Meetings and workshops
  - Capacity building
  - Technology transfer

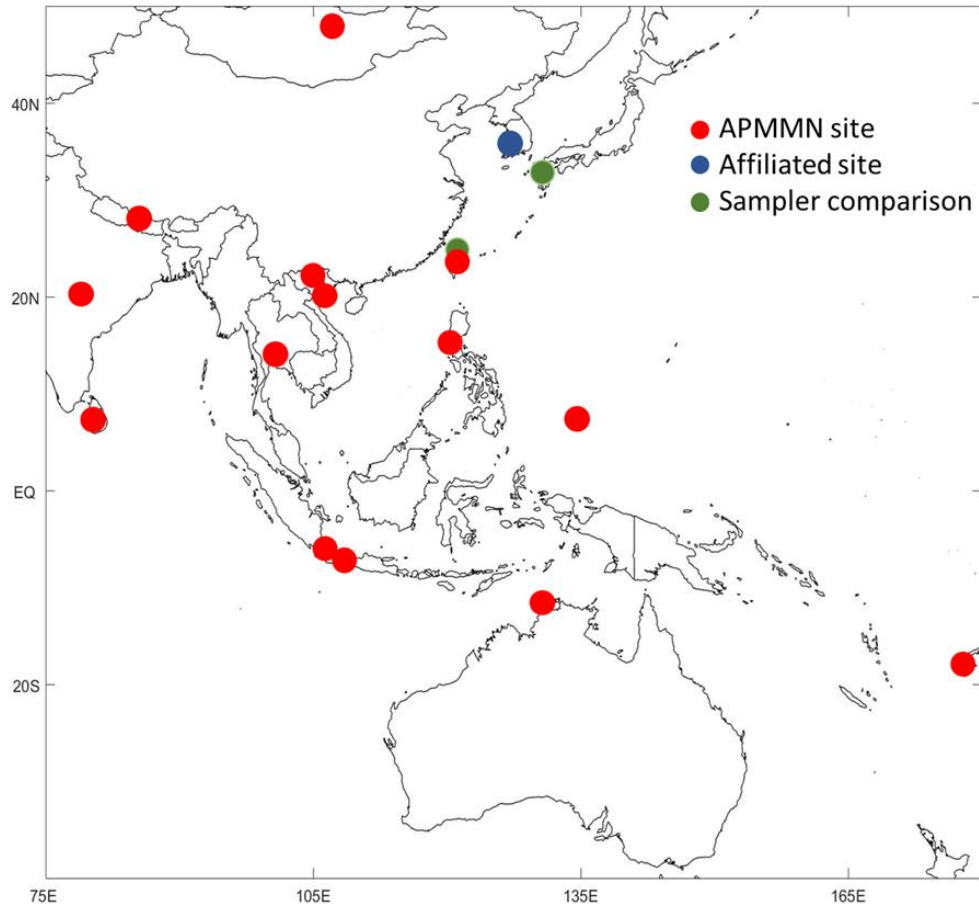


# The Most Recent APMMN Site Setup in Palau in 2023

- Sampler arrived Palau in 2020, but the site setup was delayed due to the COVID-19 pandemic.
- Sampler installed on the roof of Environmental Quality Protection Board (EQPB) Building on July 28, 2023.



# APMMN Site Map



- **15 APMMN sites**
  - **Australia**
  - **Fiji**
  - **India**
  - **Indonesia**
  - **Korea**
  - **Mongolia**
  - **Nepal**
  - **Palau**
  - **Philippines**
  - **Sri Lanka**
  - **Taiwan**
  - **Thailand**
  - **Vietnam**
- **2 sampler inter-comparison sites**
  - **NCU, Taiwan**
  - **NIMD, Japan**

# Wet Deposition Samples Received and Analyzed

Year	2016-17	2018-19	2020	2021	2022	2023	Sum
Number	279	336	175	266	282	289	1627

Year	Total Hg Concentration <sup>1</sup> (ng L <sup>-1</sup> )		
	Mean±S.D	Minimum	Maximum
2016–17	8.6±8.7	0.4	59.3
2018–19	12.2±12.7	0.3	97.8
2020	19.4±21.3	1.5	99.8
2021	17.8±17.5	0.3	97.4
2022	21.4±19.8	1.3	95.2
2023	25.3±23.3	0.7	94.7

<sup>1</sup>Concentrations greater than 100 ng L<sup>-1</sup> are not included because of QA/QC concern.

# Partners Meetings and Workshops in 2012-2019



# APMMN Partners Meetings in 2020-2022 (Virtual)



# APMMN Partners Meeting in Taipei, Taiwan in 2023



# Capacity Building and Training

## Training workshop in Taiwan (May 2017)



## Training workshop in Taiwan (June 2019)



# Capacity Building and Training

## Advanced Training at NCU (2018-2019)

**March 2019  
(Indonesia)**



**April 2019  
(Philippines  
and Sri Lanka)**



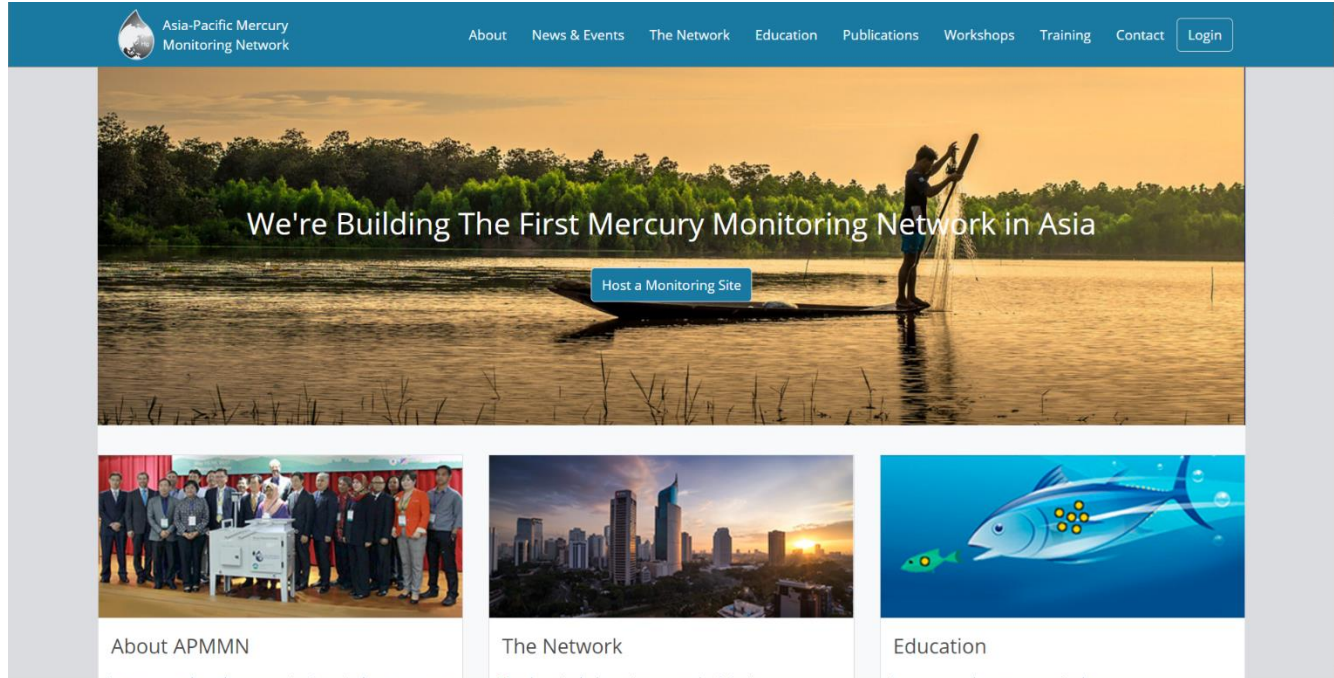
# Capacity Building and Training

## Training Overseas (2018-2023)

Country	Date
Philippines	June 2018
Indonesia	May 2019
Indonesia	August 2019
Fiji	November 2019
Vietnam	December 2019
Palau	July 2023



# APMMN Website



The screenshot shows the homepage of the Asia-Pacific Mercury Monitoring Network (APMMN) website. The header is a dark blue bar with the APMMN logo on the left and a navigation menu on the right. The main content area features a large banner image of a person in a boat on a lake at sunset, with the text "We're Building The First Mercury Monitoring Network in Asia" and a "Host a Monitoring Site" button. Below the banner are three columns of content: "About APMMN" with a group photo, "The Network" with a city skyline, and "Education" with a fish illustration.

Asia-Pacific Mercury Monitoring Network

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We're Building The First Mercury Monitoring Network in Asia

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About APMMN

The Network

Education



[apmmn.org](http://apmmn.org)

# An Article Introducing the APMMN



*Communication*

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

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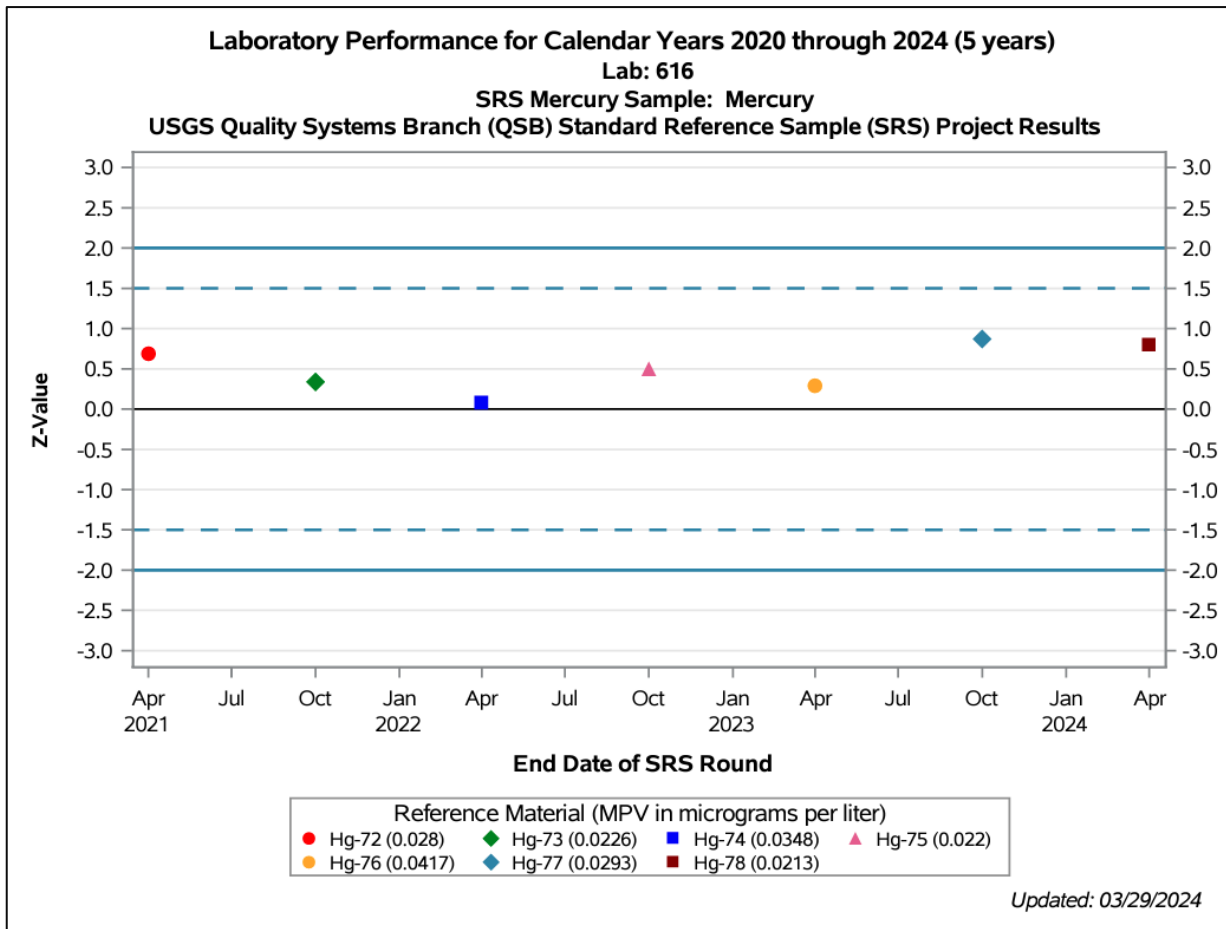
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Atmosphere 2019, 10(9), 481; <https://doi.org/10.3390/atmos10090481>

# USGS Standard Reference Sample (SRS) Program



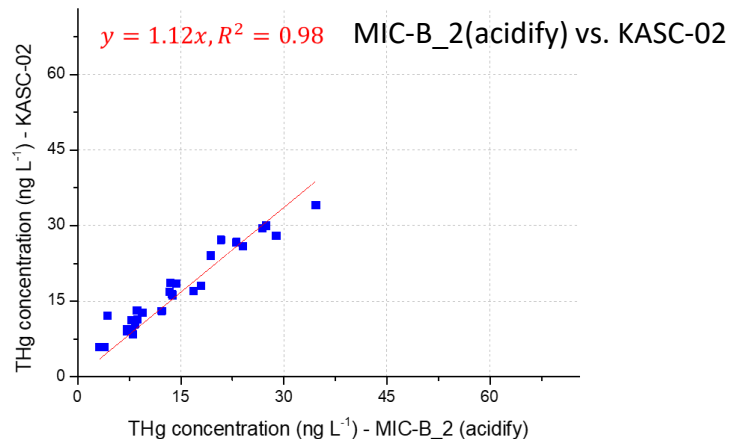
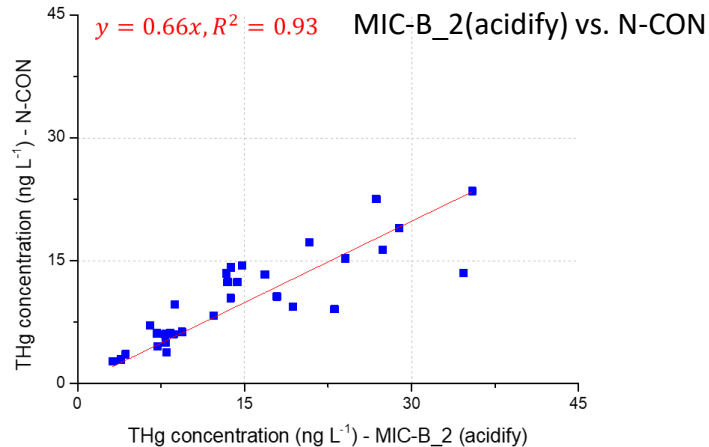
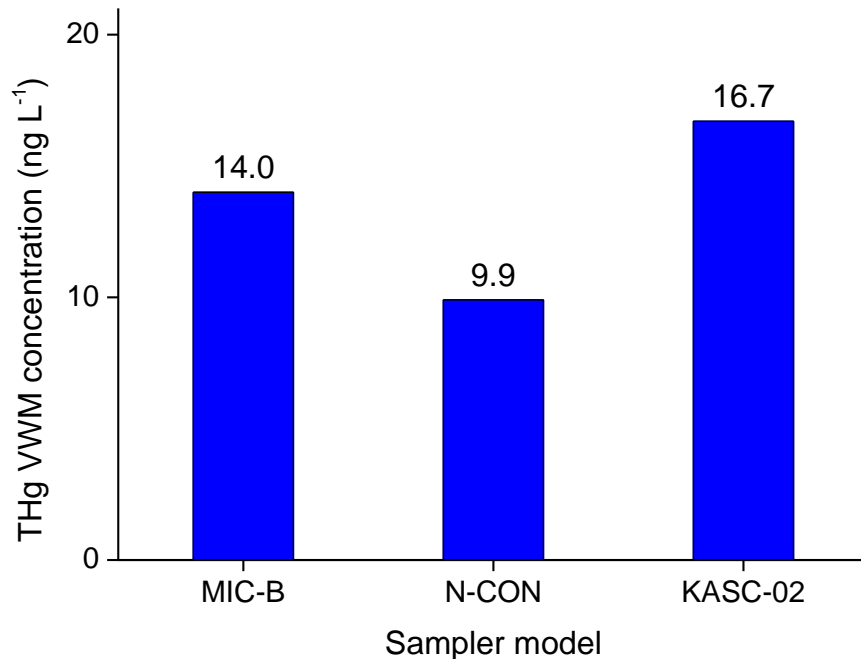
# Inter-comparison of Various Wet Deposition Samplers

- There is no “standard” wet deposition sampler.
- APMMN uses MIC-B type sampler, whereas NADP/MDN uses N-CON sampler. Japan uses KASC-02 sampler.
- Inter-comparison study conducted to study the influences of sampler types on rainwater Hg measurement.
- Inter-comparison study conducted on NCU campus to study the influences of the following factors on rainwater Hg measurement:
  - Sampler types
  - Acid pre-charge
  - Bottle size (Overflow)



# Hg Conc. of Wet Samples by Different Samplers

May 2023 - April 2024

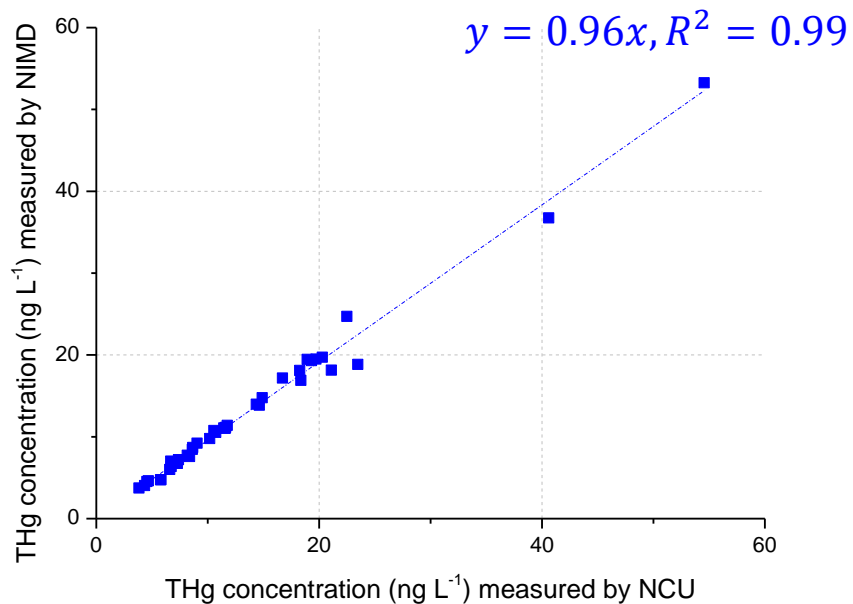


# Analytical Laboratory Inter-comparison

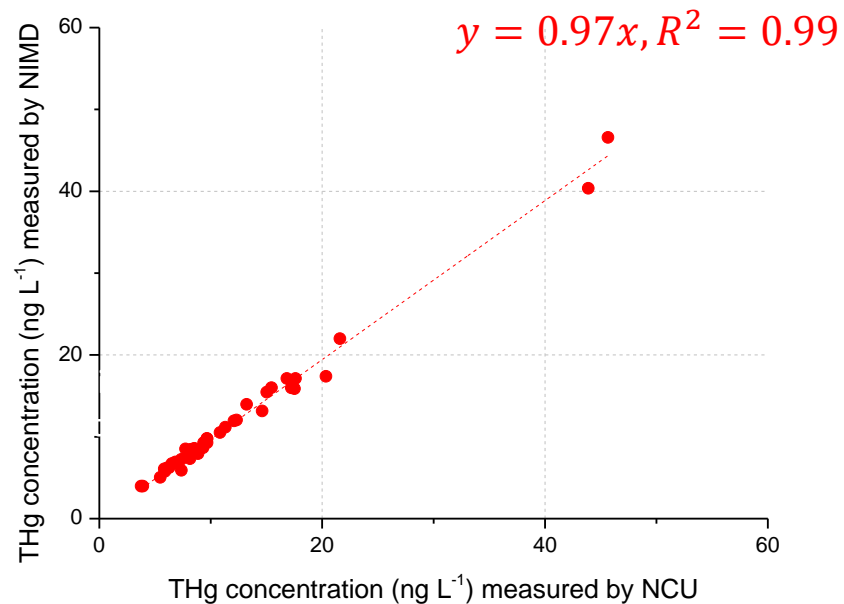
January – December 2022

Sampling Site: NCU

## KASC-02

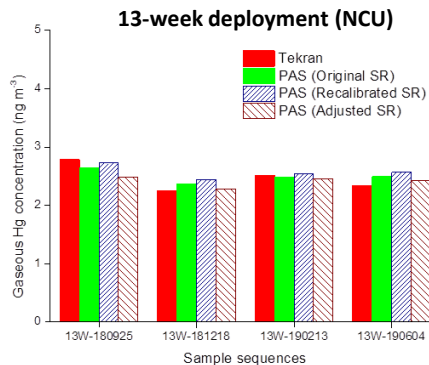
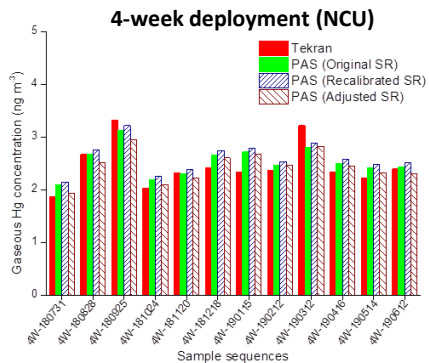


## MIC-B



# Passive Air Sampler(MerPAS) 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.



# Pilot Study of MerPAS Application in APMMN

<b>GEM concentrations (ng m<sup>-3</sup>)</b>					
	<b>2023Q1</b>	<b>2023Q2</b>	<b>2023Q3</b>	<b>2023Q4</b>	<b>2024Q1</b>
<b>Mongolia</b>	<b>1.9</b>	<b>1.8</b>	<b>1.7</b>	<b>2.3</b>	<b>-</b>
<b>Indonesia</b>	<b>4.2</b>	<b>8.6</b>	<b>8.8</b>	<b>10.7</b>	<b>-</b>
<b>Sri Lanka</b>	<b>-</b>	<b>-</b>	<b>1.3</b>	<b>1.9</b>	<b>-</b>
<b>Nepal</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>26.2</b>
<b>LABS, Taiwan</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1.5</b>	<b>1.4</b>
<b>NCU, Taiwan</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2.2</b>	<b>2.3</b>

# Future Plans

- 1. Bring in new partners and expand existing wet network**
  - Deploy new mercury wet deposition collectors
- 2. Continue training and network organizational development**
  - Annual Partners Meeting and training, site visits
- 3. Network atmospheric mercury monitoring stations**
  - Explore networking operating atmospheric mercury monitoring systems into one harmonized network in the Indo-Pacific region
  - Considering a **manual active/passive measurement** of atmospheric Hg in network
  - **Working closely with Japan on gaseous Hg monitoring**
- 4. Data acquisition, management and distribution**
  - QA/QC
  - Developing a database; update website where data will be distributed

**THANK  
YOU!**

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