LCS Monitoring for Understanding Urban Pollution Mechanisms
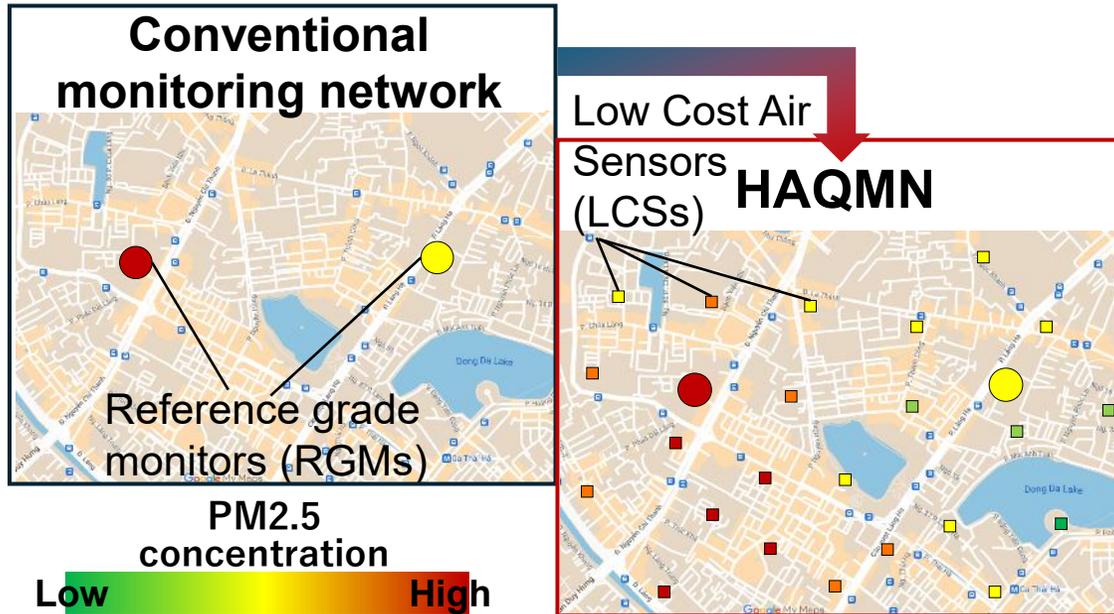
**Forum for Approaches to Air Pollution and Climate Action
17th February 2026**

**Keiichi Sato
Asia Center for Air Pollution Research**

What do LCSs reveal? What are the benefits of using LCSs?

Hybrid Air Quality Monitoring Network (HAQMN)

Reliable LCSs at many sites + RGMs

Conventional monitoring network

Low Cost Air Sensors (LCSs)

HAQMN

Reference grade monitors (RGMs)

PM2.5 concentration

Low — High

HAQMN reduces monitoring costs by using many LCSs together with a few accurate RGMs, while still keeping the measurements reliable through co-location test and cross checking.

LCSs can reveal:
- ✓ Coverage of underserved areas for air quality monitoring
- ✓ Fine-scale spatial variability and urban hotspots of air pollution
- ✓ Assess local exposure and identify vulnerable neighborhoods

Key benefits of LCSs:
- ✓ Small, lightweight devices can be installed densely in targeted areas
- ✓ Complement RGMs by providing real-world and ground-level measurements
- ✓ Help to evaluate local interventions and design more effective air quality management strategies

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EANET project "Methodology study for development of LCS hybrid air quality monitoring network (HAQMN)"

➢ Duration of project: 3 Years [2022–2024]

➢ Project is supported by Acid Deposition Monitoring Network in East Asia (EANET), Ministry of the Environment, Japan (MOEJ) and collaborated with Asian Development Bang (ADB)

➢ Research the accuracy of air quality monitoring using several types of low-cost sensors compared to a reference level monitors on a trial basis under various air quality and climate conditions in EANET participating countries.

➢ Develop practical technical documents that would support the introduction and operation of the hybrid air quality monitoring network (HAQMN) in EANET participating countries.

Disseminating the deliverables to EANET PCs
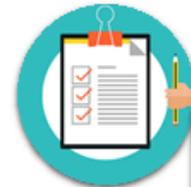
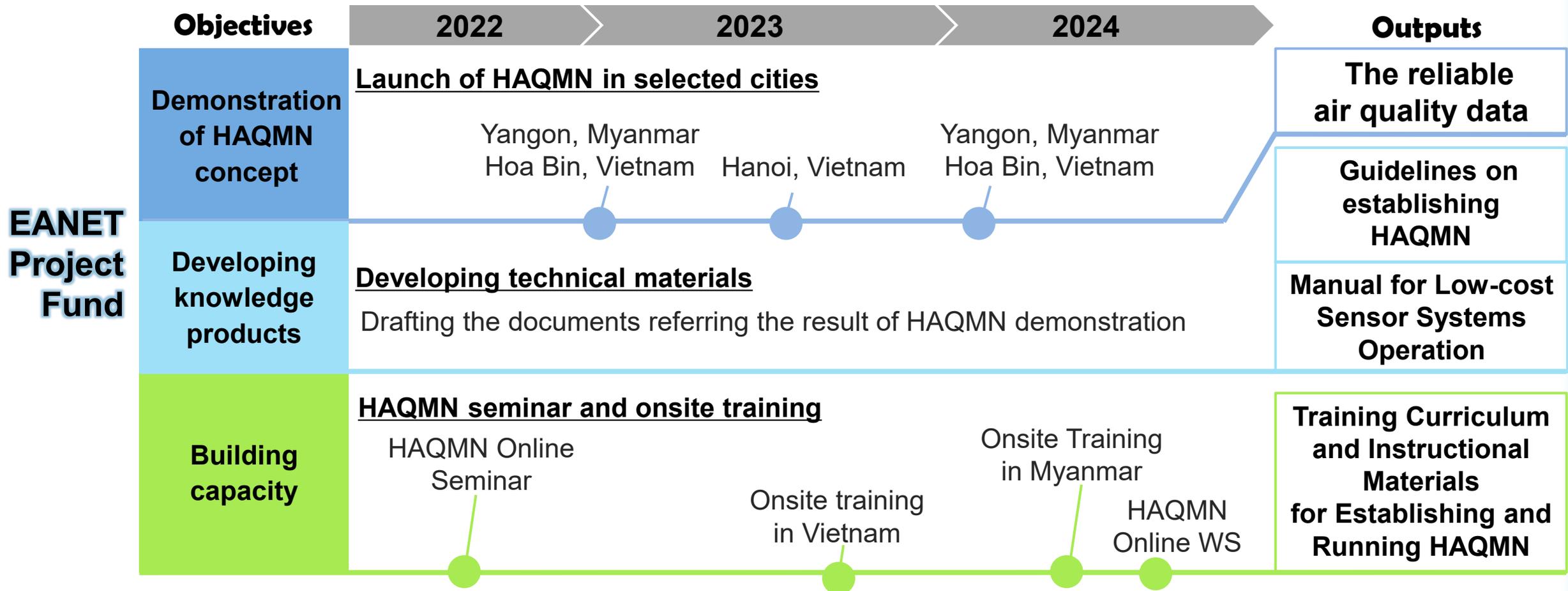HAQMN seminar and onsite training for capacity building

Developing technical materials

Launch of HAQMN in selected cities
- Parallel measurement test
- Small-scale HAQMN

Timeline of the EANET HAQMN Project from 2022 to 2024

EANET Project Fund

Objectives	2022	2023	2024	Outputs
Demonstration of HAQMN concept	**Launch of HAQMN in selected cities** Yangon, Myanmar Hoa Bin, Vietnam	Hanoi, Vietnam	Yangon, Myanmar Hoa Bin, Vietnam	**The reliable air quality data**
Developing knowledge products	**Developing technical materials** Drafting the documents referring the result of HAQMN demonstration			**Guidelines on establishing HAQMN** **Manual for Low-cost Sensor Systems Operation**
Building capacity	**HAQMN seminar and onsite training** HAQMN Online Seminar	Onsite training in Vietnam	Onsite Training in Myanmar HAQMN Online WS	**Training Curriculum and Instructional Materials for Establishing and Running HAQMN**

Demonstration of HAQMN concept: Technical studies in Myanmar and Vietnam

Recommended flowchart to operate HAQMN

Example of a) parallel test/co-location design and b) its correction model
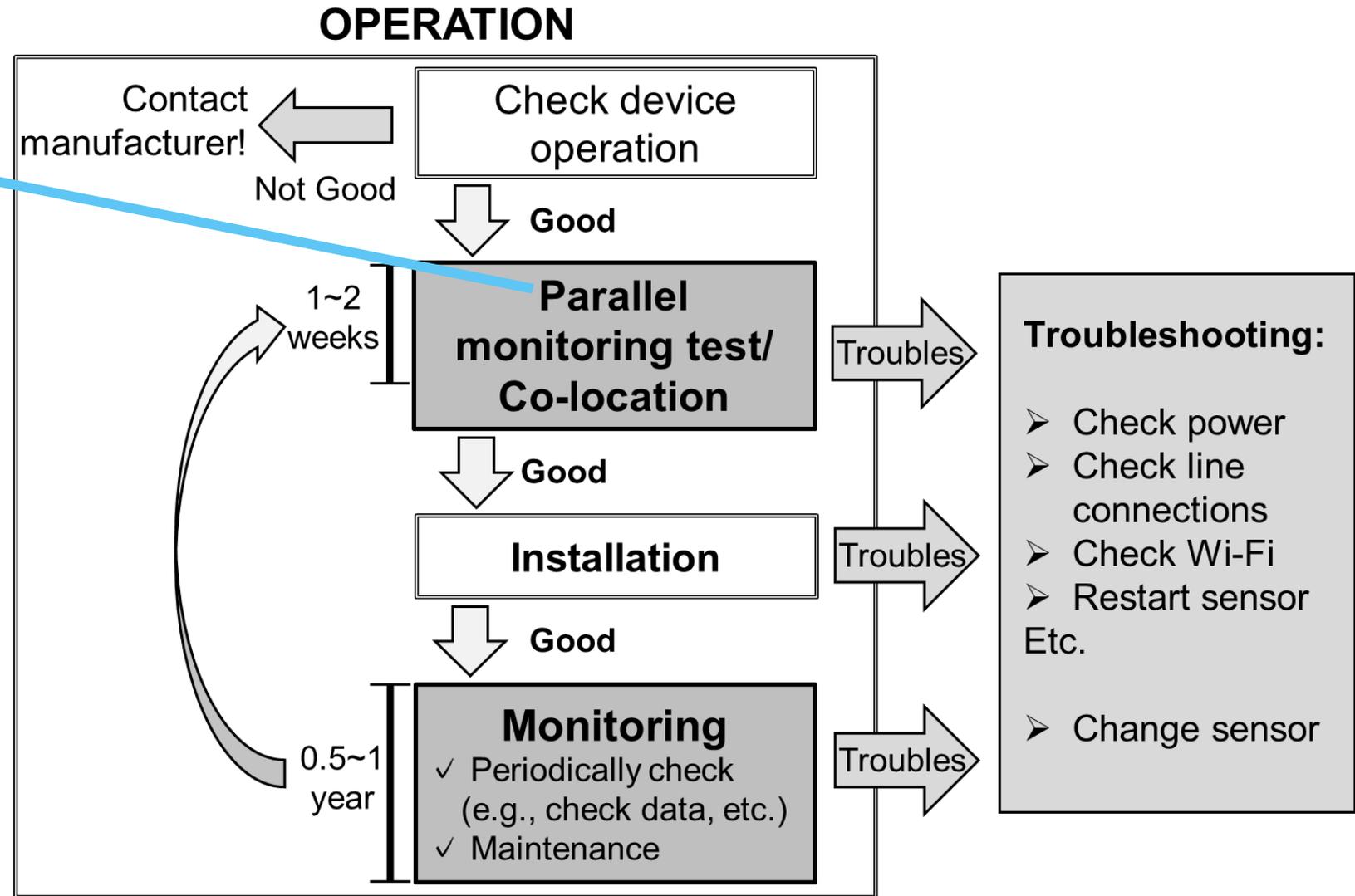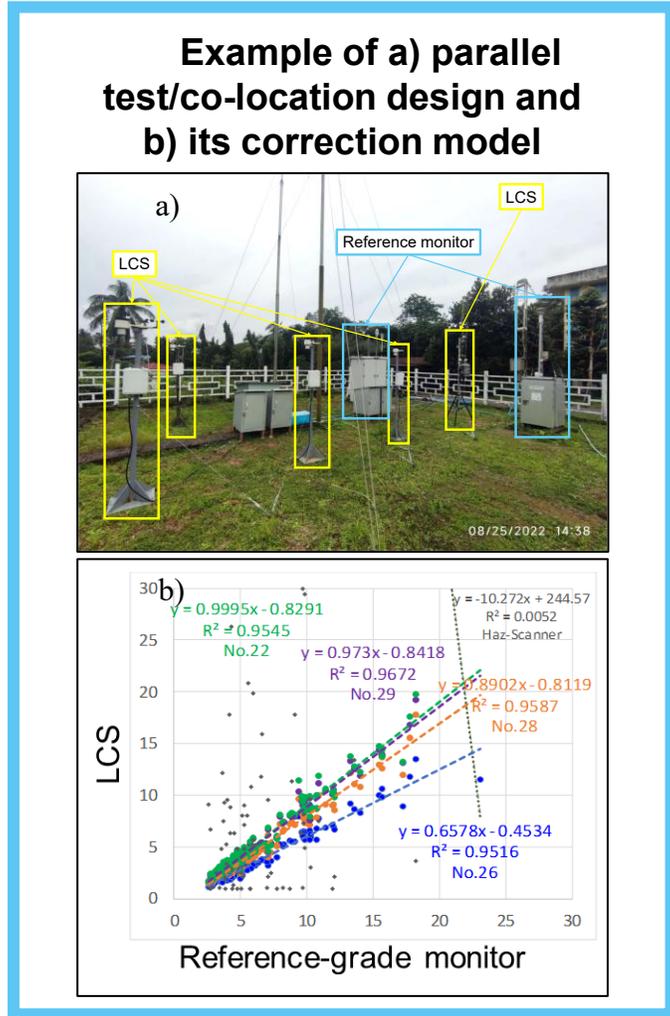
Target cities of HAQMN
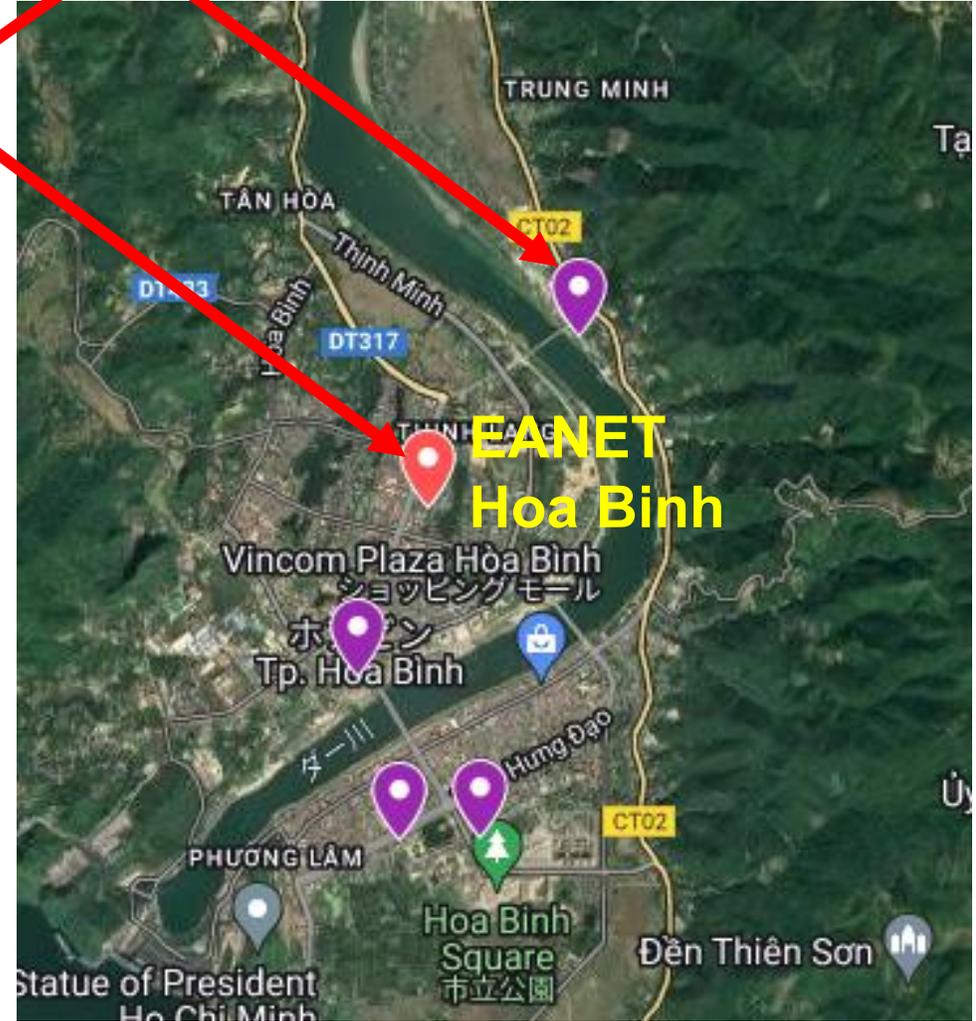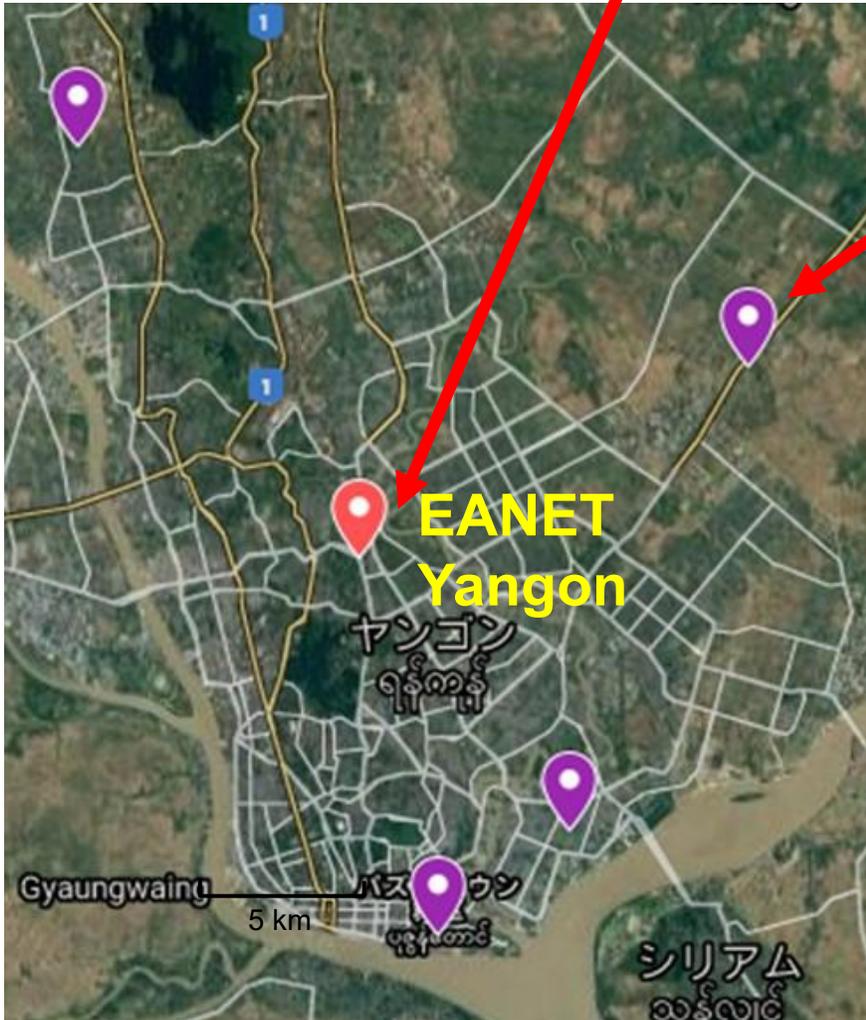
Yangon in Myanmar (from Sep. 2022)   Hoa Binh in Vietnam (from Feb. 2023)   7

EANET Yangon station implemented for parallel measurements

LCS

Installation of meteorological instrument (Need to check direction and horizontal plane)

LCS

Installation of LCS unit **(GBiot FH0, Green Blue Co., Japan)**

Reference PM2.5 monitor

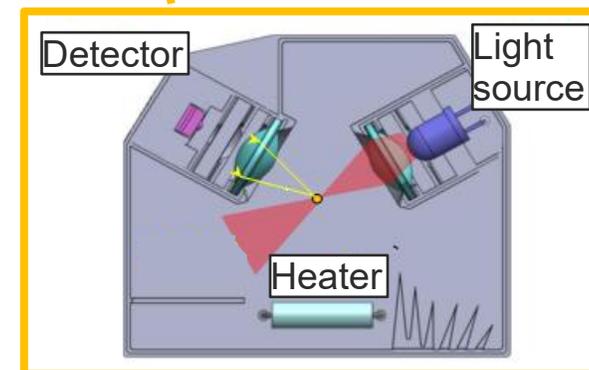β-ray $PM_{2.5}$ monitor using for EANET

Reference gas monitor

SO_2, NOx, O_3 monitor installed by local company

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# EANET Hoa Binh station implemented for parallel measurements

LCS

Reference level monitor

LCS

Small PM$_{2.5}$ sensor
(Co-developed by Nagoya Univ. and Panasonic Co., **Now available from Sibata Scientific Technology Ltd.**)
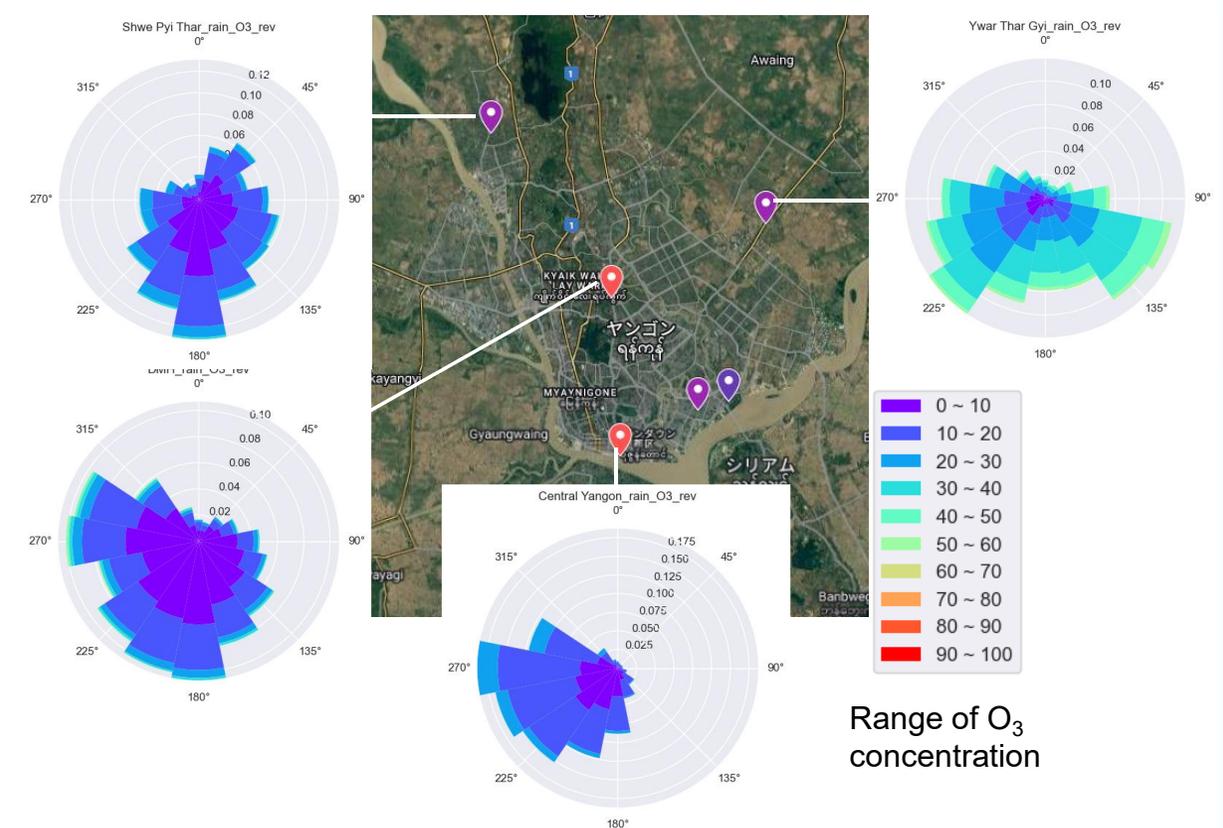
Detector

Light source

Heater

Frequency distribution of PM2.5 and O3 in Yangon

PM2.5 and O3 distribution (December 2022 to January 2023)

PM2.5

O3

Range of PM2.5 concentration
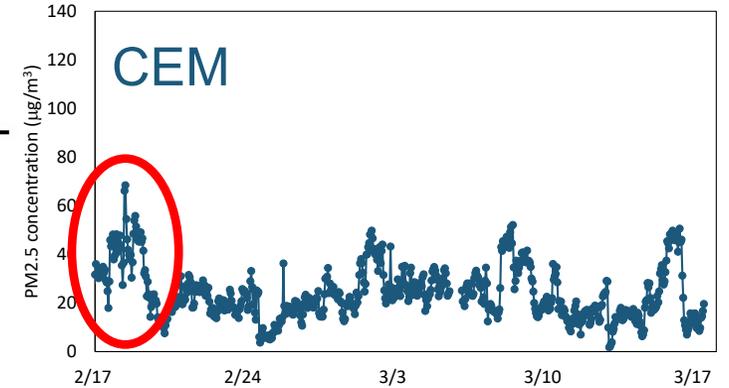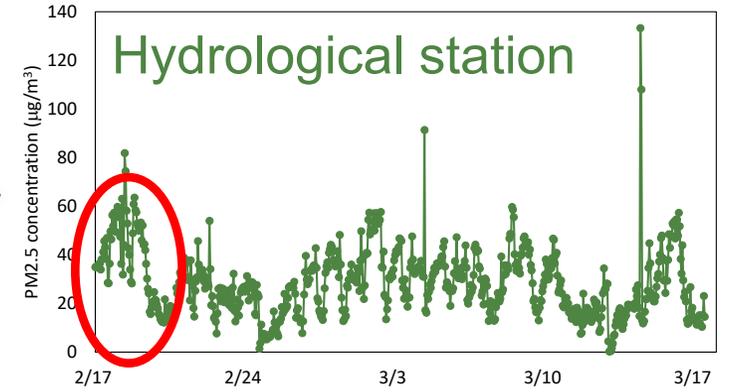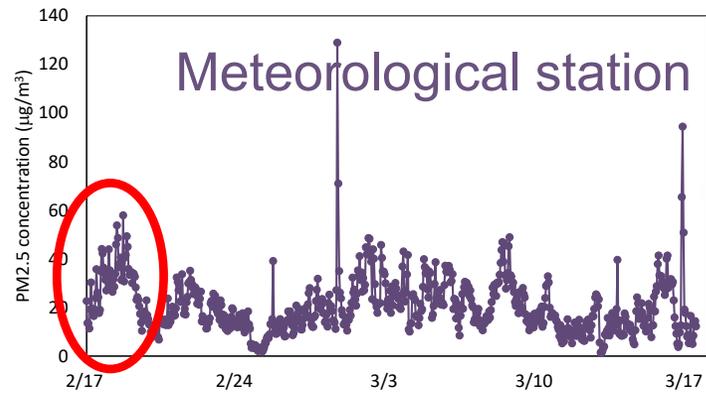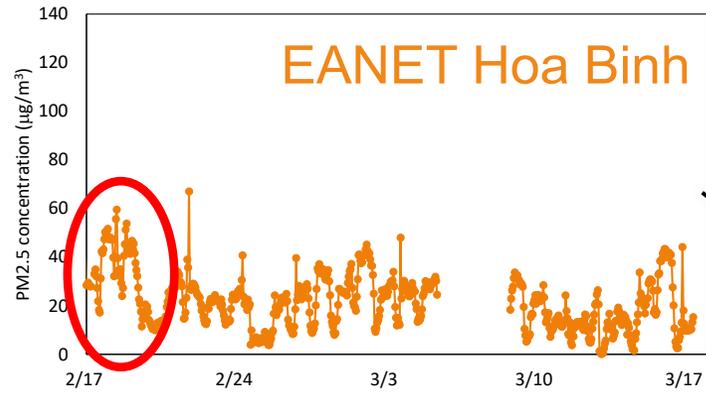
Range of O₃ concentration
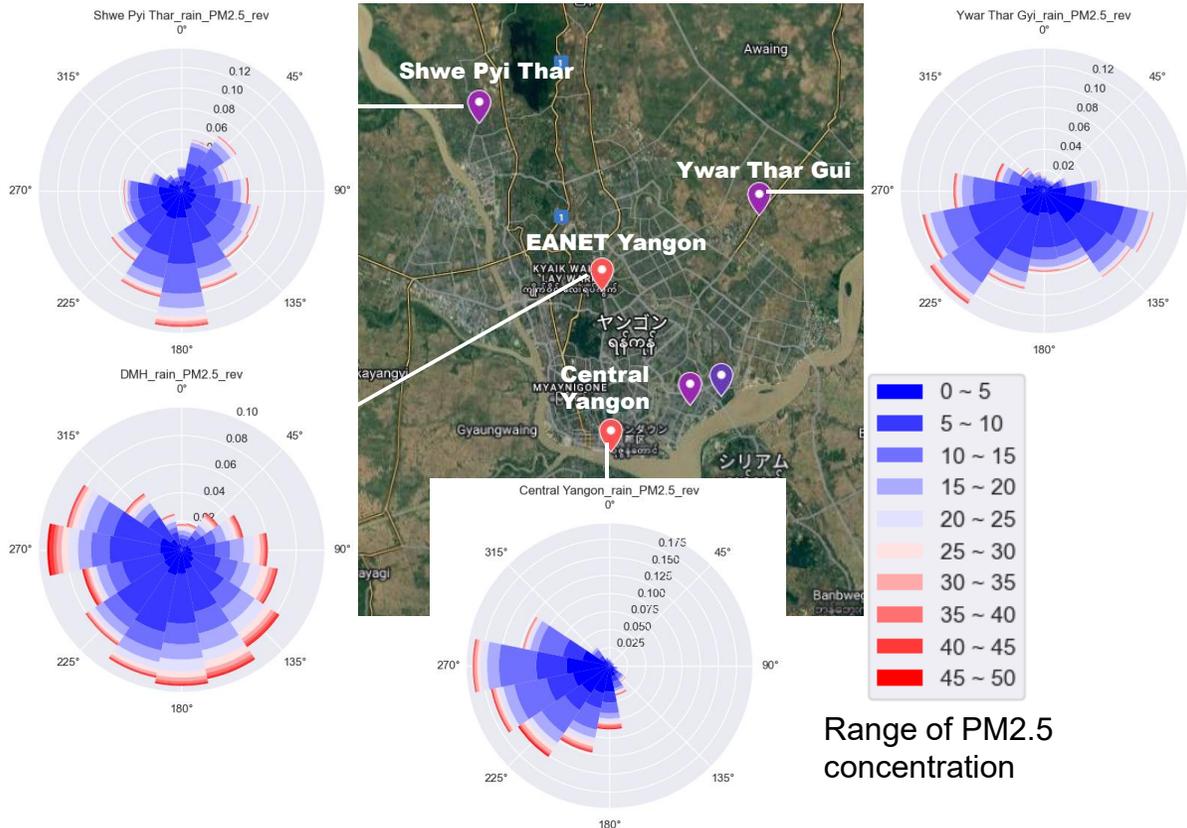
- Wind direction was dominant from south and west.
- Air concentration would be affected by emission sources in southwest direction.

Time variation of PM2.5 in Hoa Binh (February -March 2023)
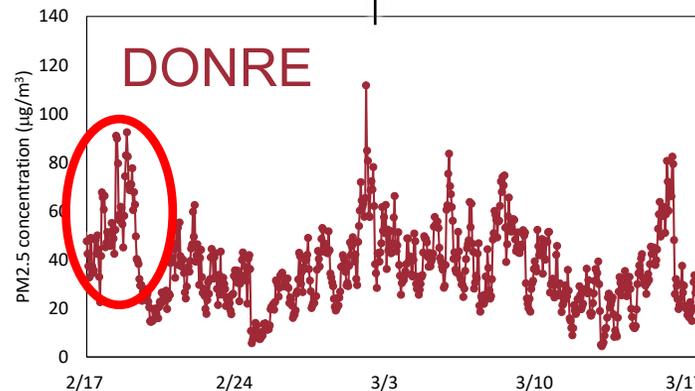
High concentration of PM2.5 was simultaneously observed at all station on February 18 and 19.

Developing knowledge products: HAQMN Guideline and LCS manual

HAQMN Guideline and LCS manual in EANET

HAQMN guideline and LCS manual are shown in EANET Web site.

https://www.eanet.asia/publications/

Existing technical manuals

support

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HAQMN Guideline   **LCS** manual
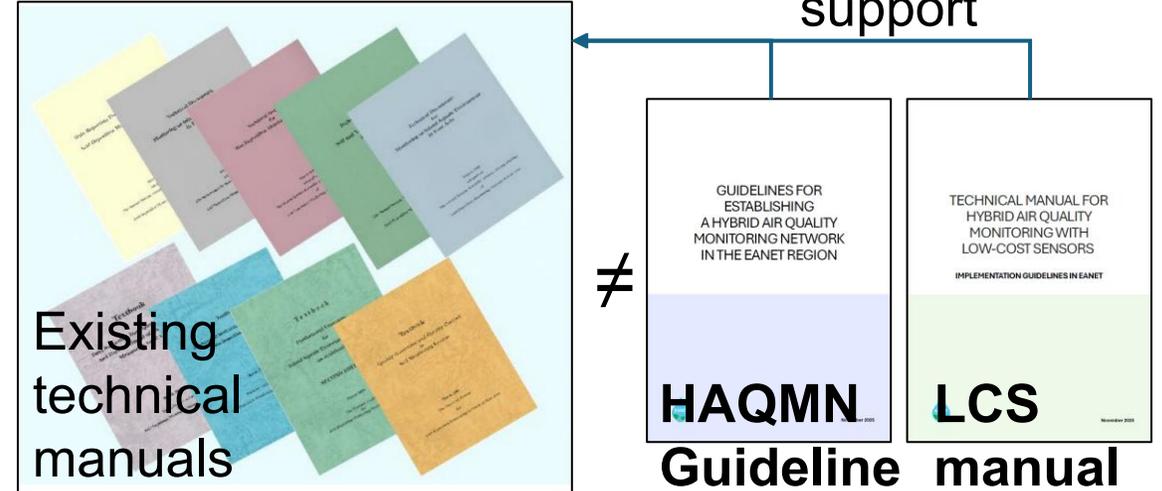
Main contents and intended audience of HAQMN Guideline and LCS manual

Documents	Main contents	Intended audience
Guidelines on establishing HAQMN	Information on deploying LCSs together with RGMs network by local and national government and research institution	Senior governmental officers who manage the air quality monitoring action plans
Technical Manual for Hybrid Monitoring with LCSs	Detailed operational procedures for LCSs (LCS assembly, maintenance, QA/QC etc.)	Especially practitioners who operate LCS and analyze the LCS data

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Building capacity:
Seminar and onsite training

EANET Training on Air Quality Monitoring Systems using Low-cost Sensors

September 6 and 7, 2023 (13:30-17:00 Vietnamese time each day)
Presentation material will be shown in the following URL
https://www.eanet.asia/eanet-training-on-air-quality-monitoring-systems-using-low-cost-sensors-lcs/

Training Program on Day 1 (6 September)

Opening Session 13:30-13:50 (UTC+7)

Time	Agenda
13:30-13:50	Opening/Orientation

Session 1: Plenary talks: Present status and efforts on LCS in Vietnam
13:50-14:20 (UTC+7)

Time	Agenda
13:50-14:20	Presentation: Presenters will introduce their present status and efforts on LCS in Vietnam
14:20-14:30	Q&A Session

Session 2: Status and efforts on LCS by ADB and US-EPA in Asian countries
14:30-15:30 (UTC+7)

Time	Agenda
14:30-15:30	Presentation: Presenters will introduce their status and efforts on LCS in Asian countries
15:30-15:50	Q&A Session
15:50-16:00	Break

Training Program on Day 1 (6 September)

Session 3: Introduction on LCS Technical studies in Vietnam and Myanmar by EANET project
16:00-16:40 (UTC+7)

Time	Agenda
16:00-16:40	Discussion: Monitoring design, parallel monitoring of LCS and reference-level monitoring equipment and preliminary analysis results of HAQMN in Vietnam and Myanmar will be presented
16:40-17:00	Q&A Session

Training Program on Day 2 (7 September)

Session 4: Demonstration on LCS operation
13:30-15:00 (UTC+7)

Time	Agenda
13:30-14:40	Demonstration: Installation of the LCS equipment, monitoring operation by using LCS equipment, and check of the real time data will be introduced
14:40-15:00	Q&A Session
15:00-15:10	Break

Session 5: Data screening and analysis obtained by LCS and HAQMN
15:10-16:50 (UTC+7)

Time	Agenda
15:10-16:10	Demonstration: Data screening and data analysis techniques, how to interpret and visualize data, and analyze trends will be introduced
16:10-16:30	Q&A Session
16:30-16:50	Wrap-up for the Way forward

Closing Session 16:50-17:00 (UTC+7)

Time	Agenda
16:50-17:00	Closing

EANET Online Workshop on the Utilization of Low-Cost Sensors for Air Quality Monitoring: Recommendations and Strategies

November 6, 2024 (13:00-16:45 Bangkok time)
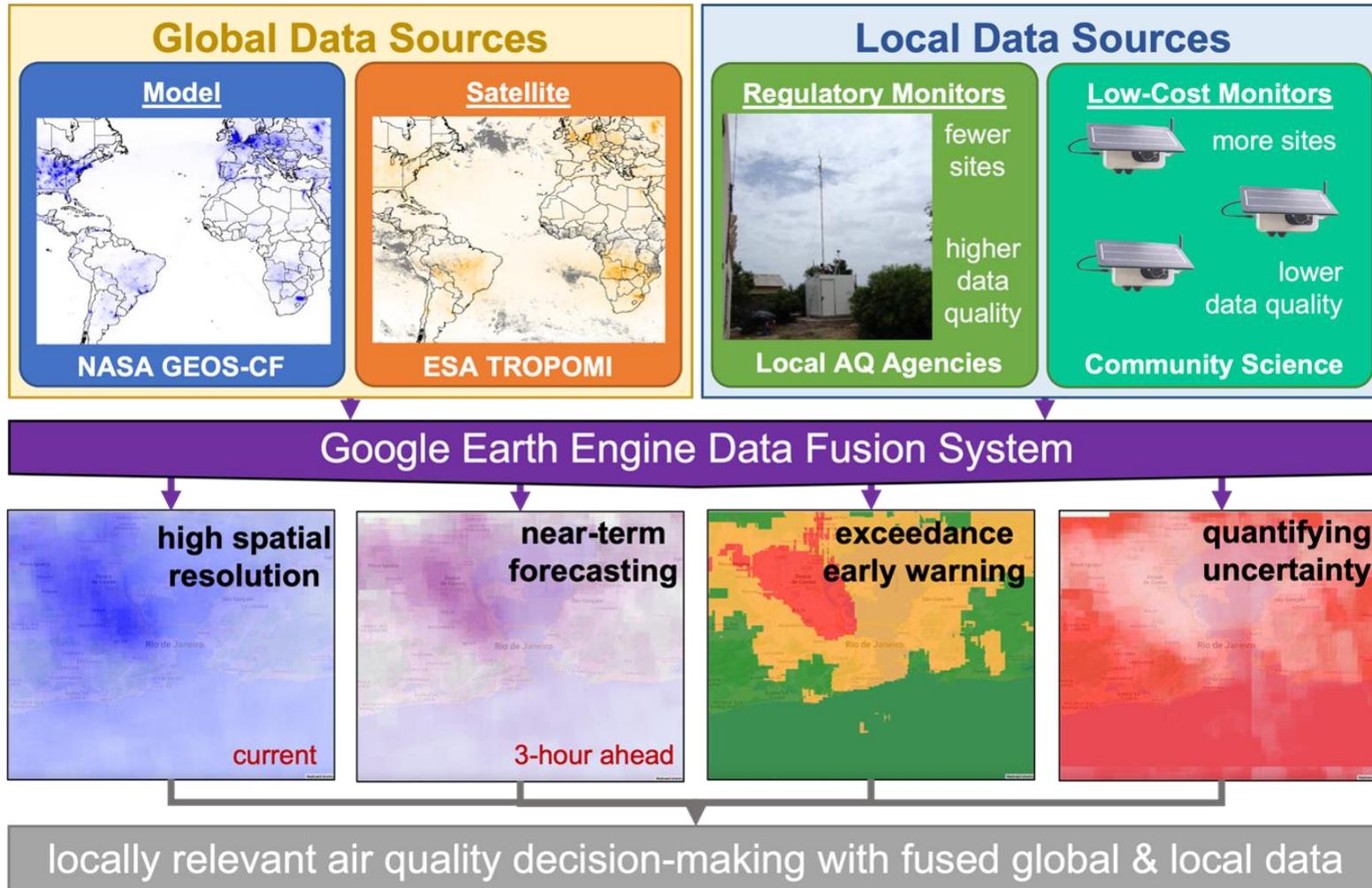Presentation material will be shown in the following URL
https://www.eanet.asia/eanet-online-workshop-on-the-utilization-of-low-cost-sensors-for-air-quality-monitoring-recommendations-and-strategies/

Workshop Program on 6 November

Opening Session 13:00-13:05 (UTC+7)

Time	Agenda
13:00-13:05	Opening Remarks

Session 1: Lesson from the preceded projects: Air quality monitoring by using a LCS network in Asian region
13:05-14:55 (UTC+7)

Time	Agenda
13:05-14:45	Presentation: Presenters will introduce their present status and efforts on LCS monitoring in the light of technical requirements, data management and visualization, citizen participation, policy involvement and business model
14:45-14:55	Break

Session 2: Report on the EANET project "HAQMN"
14:55-15:30 (UTC+7)

Time	Agenda
14:55-15:15	Presentation: Presenter will introduce the activities on the EANET LCS Project
15:15-15:20	Q&A Session
15:20-15:30	Break

Workshop Program on 6 November

Session 3: Discussions on scopes and challenges for establishing a sustainable LCS monitoring network in East Asia to strengthen efforts to improve the regional air quality
15:30-16:45 (UTC+7)

Time	Agenda
15:30-16:30	Panel discussion: Online polls regarding the key questions are made by participants to seek their needs and views. Then, the panelists make comments or recommendations on future directions of LCS monitoring in EANET.
16:30-16:45	General Q&A and summary of the workshop

Future prospective: Utilization of LCS and satellite for air quality decision making

Data fusion by using air quality model, satellite, RGMs and LCSs

Source: NASA GMAO https://gmao.gsfc.nasa.gov/science-snapshots/google-earth-engine-data-fusion-tool-to-support-air-quality-managers/

- NASA is developing a data-fusion tool that integrates air quality model, satellite, RGMs and LCSs for visualizing the spatiotemporal distribution of air pollutants.
- These analyses can contribute to health impact assessments and urban policy.

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Summary

- Low Cost Air Sensors (LCSs) can significantly strengthen urban air quality management in East Asia when they are properly integrated with reference-grade monitors (RGMs) to establish HAQMN.

- Even with limited monitoring budgets and resources, integrating RGMs, LCSs, and satellite data enables clearer understanding of urban air quality and provides actionable information for policy and public health protection.

Thank you for attention.

Supplementary Information

Design of HAQMN

Urban Hotspot :
In urban areas, LCSs are densely deployed to capture fine-scale pollution patterns and identify hotspots, with calibration from nearby RGMs to ensure data accuracy.

Community Site :
Around existing RGMs in residential zones, LCSs are added to improve resolution for assessing local pollution exposure and validating emission control efforts.

Remote sites:
In remote or ecologically sensitive areas, LCSs are used as practical alternatives to RGMs, enabling monitoring of long-range pollution transport despite limited infrastructure.
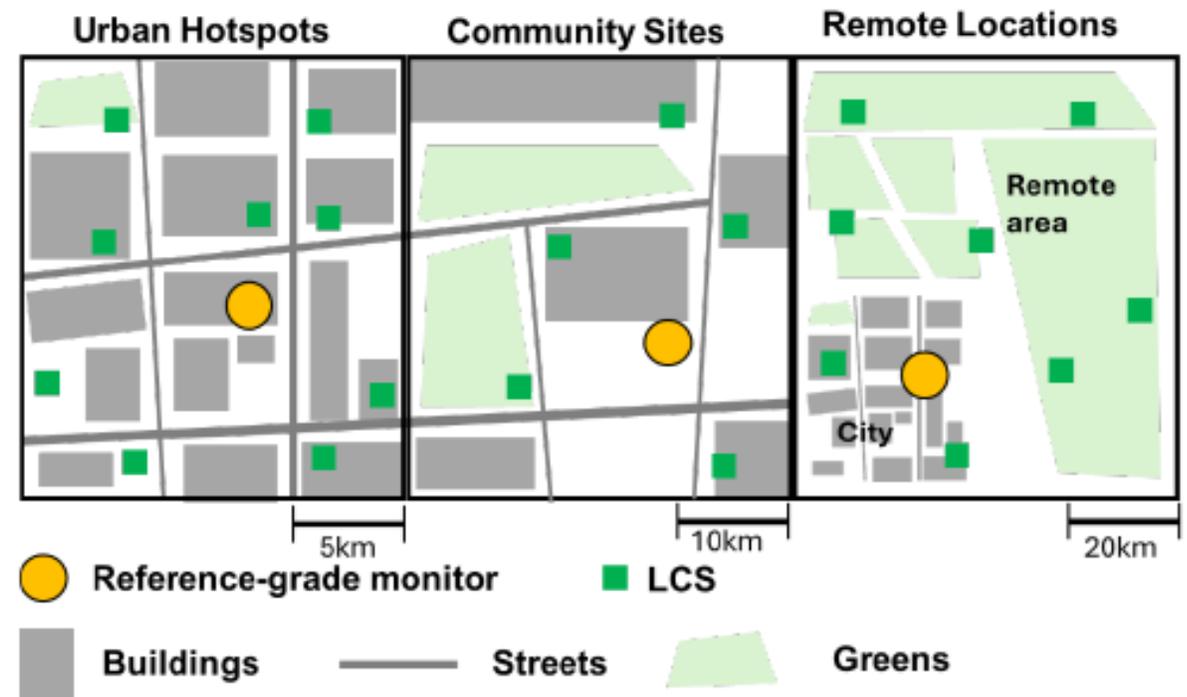
Monitored substances by LCSs

Pollutant	Priority*	Key concern	LCS Suitability	Key Considerations
$PM_{2.5}$	**High**	High concentration in Asian region, Health impact	Good (light scattering)	Affected by humidity
O_3	**High**		Moderate (EC, MOS, UV)	Cross-sensitivity with NO_2
NO_2	**High**	Traffic-related emission, Precursor of O_3	Moderate (EC, MOS, UV)	EC sensors may overestimate due to O_3 interference
SO_2	Medium	Point-source emission (e.g. Volcano)	Limited (EC only)	Better in industrial or volcanic regions
CO	Medium	Identification of mobile and biomass burning sources	Moderate (EC, MOS, NDIR)	Cross-sensitivity with NO
VOCs	**High**	Precursor of O_3	Limited (PID only)	Only Total VOCs measured; high variability

*Priority levels are indicative based on the needs of Asian countries and LCS performance.

Tier based classification of pollutants and goals

Objective	Target pollutant		
	PM$_{2.5}$	**O$_3$, NO$_2$, CO**	**Others (VOCs, SO$_2$)**
Informational Use	Tier I	Tier I	Tier I
Supplemental Monitoring	**Tier II**	≥ Tier I	≥ Tier I
Research and Regulatory Support	**Tier III**	**≥ Tier II**	-

Tier	Monitoring Purpose	MNB Requirement	Use Cases
Tier I	Informational Use	Low (±50–100%)	General spatial patterns, public awareness, education, community science
Tier II	**Supplemental Monitoring**	Moderate (±30–50%)	Hotspot Detection, spatial analysis, network optimization, urban source mapping, project evaluation
Tier III	**Research and Regulatory Support**	High (≤ 30%)	Scientific studies, exposure assessments, regulatory support

The accuracy of the sensor is usually considered via the Mean Normalized Bias (MNB).