Monsoon Asia and Oceania Networking Group

AI on Hi-ASAP
Online 12 October 2021

Updates of "Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)"

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Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)

- Developed under the umbrella of IGAC - Monsoon Asia and Oceania Networking Group (IGAC-MANGO), met in May 2019 to write the Science Plan; endorsed by Regional Centre for Future Earth in Asia in November 2019
- Goal
  - To provide scientific evidence to support effective policy actions to reduce air pollution levels, in particular $PM_{2.5}$, in this region by applying newly developed low-cost sensing (LCS) devices
- Current status
  - Research groups comprised of atmospheric chemists and public health professionals from 12 different areas in the Asia and the Pacific region have joined this Hi-ASAP project

Science Steering Committee (SSC) of the Hi-ASAP

Study Area	Full Name	Role	Organization
Bangladesh	Abdus Salam	Leader / AC	Department of Chemistry, University of Dhaka
	Mahbuba Yesmin	Health	Internal Medicine Department, Apollo Hospital Dhaka
Hong Kong	Kin-fai Ho	AC &Health	The Chinese University of Hong Kong
Indonesia	Puji Lestari	Leader / AC & Health	Faculty of Civil and Environmental Engineering, Institute Teknology Bandung
	Dwi Agustian	Health	Department of Public Health, Faculty of Medicine, Universitas Padjadjaran
Korea	Kiyoung Lee	Leader / AC & Health	Seoul National University
Malaysia	**Mohd Talib Latif**	Leader / AC; **Co-Chair of SSC**	School of Environmental and Natural Resource Sciences, Universiti Kebangsaan Malaysia
	Mazrura Sahani	Health	National University of Malaysia
Mongolia	Chonokhuu Sonomdagva	AC	National University of Mongolia
	Enkhjargal Altangere	Health	Public health, Ach Medical University

Study Area	Full Name	Role	Organization
Myanmar	**Ohnmar May Tin Hlaing**	Leader / AC & Health; **Co-Chair of SSC**	Environmental Quality Management Co., Ltd
Philippines	Maria Obiminda L. Cambaliza	Leader / AC	School of Science and Engineering, Ateneo de Manila University
	John Q. Wong	Health	Ateneo De Manila University
Taiwan	**SC Candice Lung**	Leader / AC & Health; **Chair of SSC**	Research Center for Environmental Changes, Academia Sinica
	WC Vincent Wang	AC	Academia Sinica
Thailand	Kim Oanh	Leader / AC	School of Environment, Resources and Development, Asian Institute of Technology
	Kraichat Tantrakarnapa	Health	Faculty of Tropical Medicine, MAHIDOL Medicine
Vietnam	Thi Hien To	Leader / AC	University of Science, Vietnam National University Ho Chi Minh City
	Tran Ngoc Dang	Health	University of Medicine and Pharmacy at Ho Chi Minh City (UMP HCMC)
Australia	Fabienne Reisen	Analysis	Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Capacity Building of Hi-ASAP in 2019-2021

- Training workshops: Advanced Institute (AI) on Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)
  - To share common methodologies and sensor technologies
  - 1st AI on Hi-ASAP was held on **August 2019**, a five-day event
  - 2nd AI on Hi-ASAP was held on **October 2020** virtually, a four-day event
  - 3rd AI on Hi-ASAP will be held on **October 2021** virtually, a five-day event
- 2019 Asia Oceania Geosciences Society (AOGS) session (July 28 – August 2, 2019, Singapore)
  - "Regional Collaborative Research on Air Pollution Sensing and Health in Asia" reported from Indonesia, Myanmar, Malaysia, the Philippines

Hi-ASAP Activities of 2021

- On-line conference session: Sustainability Research and Innovation Congress (SRI 2021), June 12-15, Brisbane, Australia
  - "Tackle Air Quality and Human Health with New Thinking and Technologies", reported from team members in Bangladesh, Indonesia, Myanmar, Malaysia, the Philippines, Taiwan, and Thailand, followed by panel discussion
- Monsoon Asia and Oceania Networking Group (MANGO) Session, 16th IGAC Scientific Conference, Online 14 September 2021
  - Recent Findings of "Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)" – a Project Endorsed by Future Earth in Asia
- MANGO Side Meeting, 16th IGAC Scientific Conference, Online 15 September 2021
  - "Health Investigation and Air Sensing for Asian Pollution (Hi-ASAP)" updates

Introduction

- Specific Aims
  - To conduct research providing policy-relevant findings to reduce $PM_{2.5}$-associated health risks at national levels

- Take advantage of the new sensor technology to tackle the health threats brought by severe $PM_{2.5}$ pollution in Asia
  - Low-cost sensing (LCS) devices are applied to evaluate $PM_{2.5}$ sources, exposures, and exposure-health relationships in high tempo-spatial resolution with much lower expenses

AS-LUNG

Integration, validation, & application of research-grade and low-cost $PM_{2.5}$ sensors

(Academia Sinica-LUNG, AS-LUNG)

■ Outdoor (attached to a light pole)

■ Indoor (palm size)

■ Portable (palm size)

Heart Rate Variability (HRV) micro-sensors in Taiwan

Publications & Major findings

- **Sensor evaluation**: Wang et al., *sensors*, 2020.6
- **Community source evaluation**: Lung et al., *Science of the Total Environment*, 2020.5
  - Qualified the major sources: traffic, restaurants, and temples
- **Indoor Air Quality** (source evaluation): Lung et al., *Indoor Air*, 2020.12
  - Qualified important indoor/exposure sources: cooking, environmental tobacco smoke, incense-burning
- **Exposure factor evaluation**:
  - Sinaga et al., *Journal of Exposure Science and Environmental Epidemiology (JESEE)*, 2020.08
  - Wang et al., Atmosphere, 2021.02
- **Exposure-health evaluation:** Lung et al., *JESEE*, 2020.11; Tsou et al., *Sensors*, 2021.02; Tsou et al., *Sensors*, 2021.07
  - HRV of the subjects were affected in the low $PM_{2.5}$ levels ($12.6 \pm 8.9 \mu g/m^3$)

Progress in different research groups

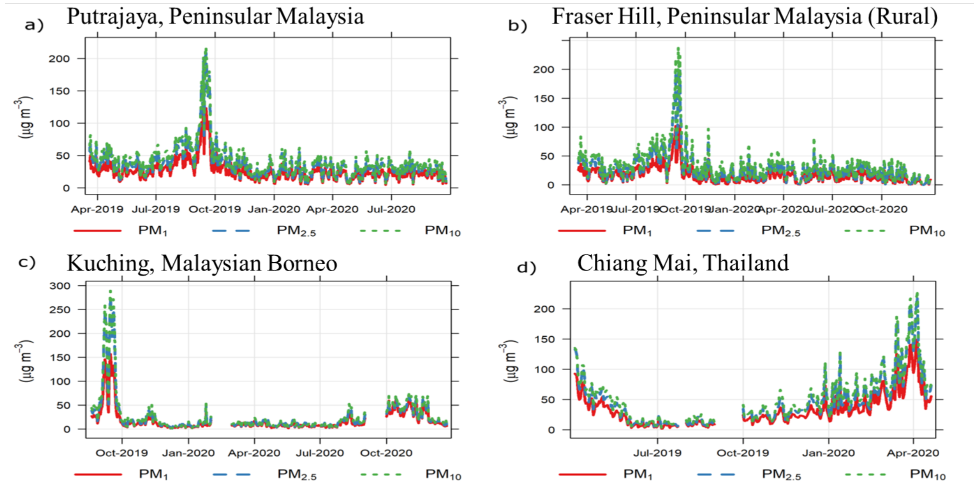
- Hong Kong (Kin-Fai HO)
  - Validate and apply a diffusion-based sensing device for CO, O_3 and NO_2

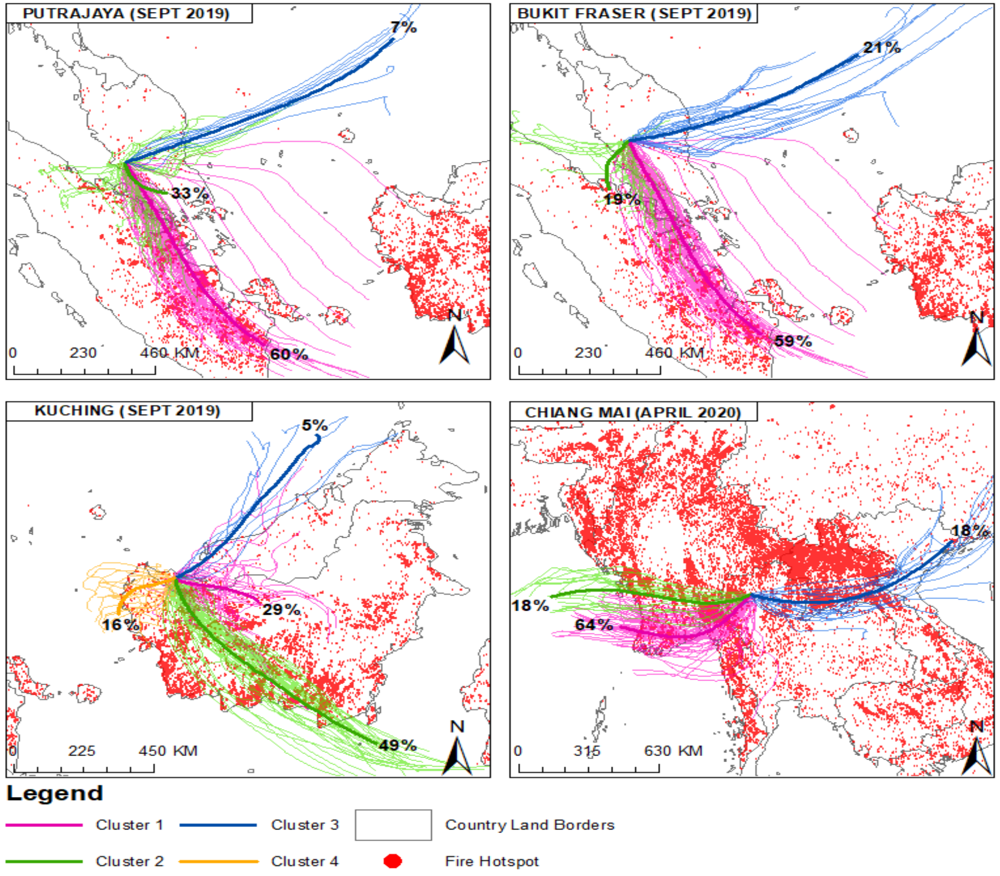
- Thailand (Kim OANH)
  - AS-LUNG-P and other instruments, street cooking
- Vietnam (Thi Hien TO)
  - AS-LUNG-P, traffic, cooking and incense-burning
- Malaysia (Mohd Talib LATIF)
  - AS-LUNG-O, ambient monitoring for biomass burning
- Myanmar (Ohnmar May Tin HLAING)
  - AS-LUNG-O, open burning in the waste disposal sites
  - AS-LUNG-P, waste disposal workers' exposures
- Bangladesh (Abdus SALAM)
  - AS-LUNG-P, 24-hour exposure patterns, traffic and cooking emissions
- The Philippines (Maria Obiminda L. CAMBALIZA)
  - AS-LUNG-P, Jeepney drivers' exposures, hotspot identification

Characteristic and Spatial-Temporal Variability of PM_{10}, $PM_{2.5}$ and PM_1 during 2019-2020 Biomass Burning Event in Southeast Asia

(authors: Murnira Othman, Haris Hafizal Abd Hamid, Royston Uning, Worradorn Phairuang, Thipsukon Khumsaeng, Zawawi Daud, Juferi Idris, Nurzawani Md Sofwan Shih-Chun Candice Lung

- To evaluate the spatio-temporal characteristic of three different sizes of PM at four different measurement sites in Malaysia and Thailand, Southeast Asia

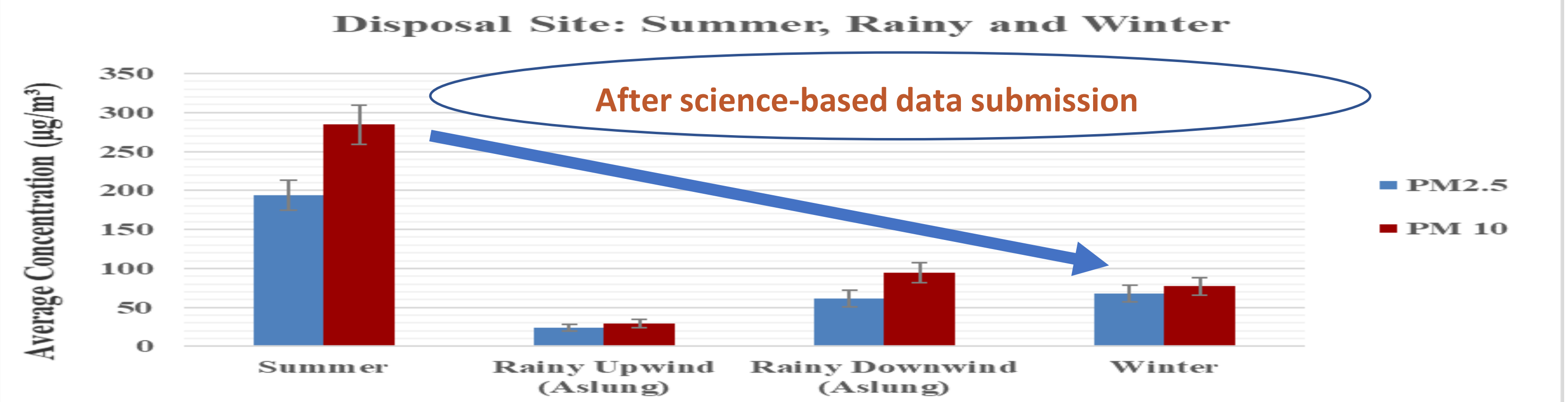




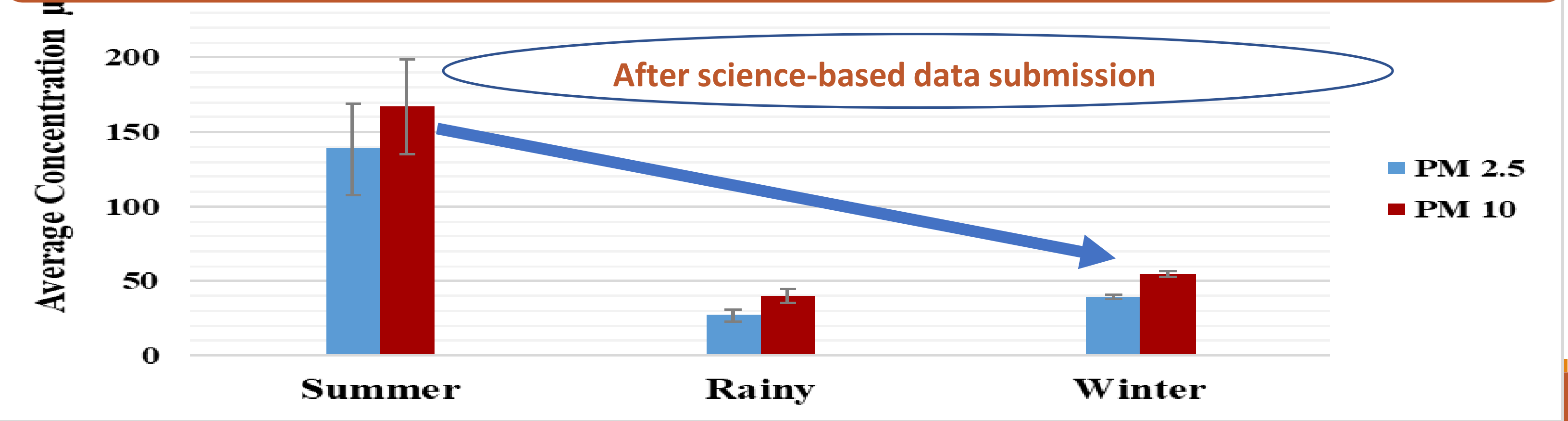
Interface between science-based data and policy action to improve the existing Mandalay City Waste Management: Ambient Air Monitoring, Air Impact Assessment, Personal PM2.5 Exposure, Health Risk Assessment, Awareness and Mitigation Measures. ***Authors: Ohnmar May Tin Hlaing, No No Lwin, Ye Naung Tun, Min Aung Myint Soe, Shih-Chun Candice Lung, Nguyen Thi Kim Oanh***

Objective: To reveal the existing air quality impact affected by opening burning at the waste disposal sites

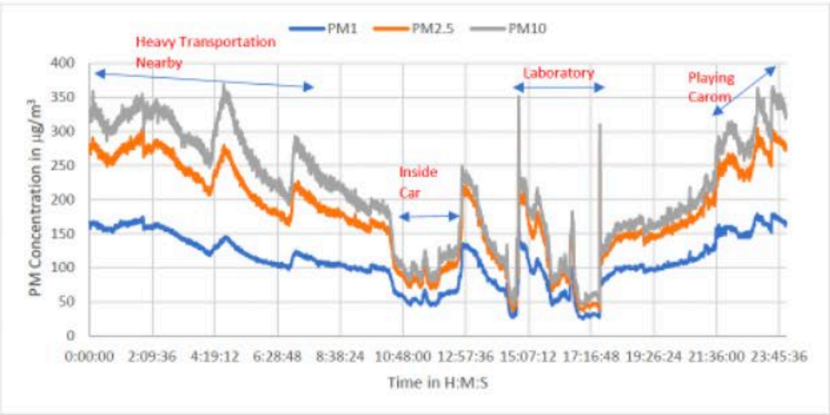
Comparison between *ambient concentration at the disposal site* between *summer, rainy and winter*

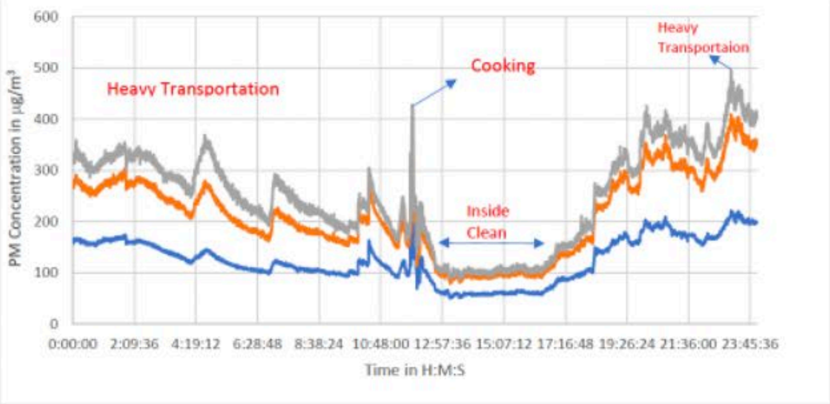


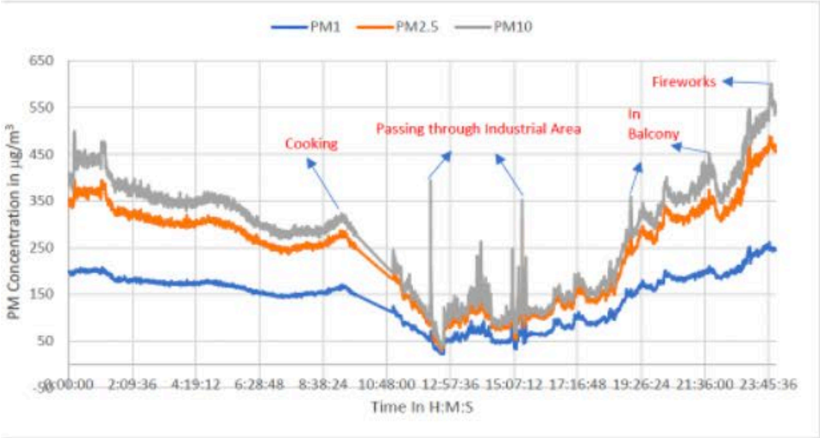
Comparison between *personal exposure at the disposal site* between *summer, rainy and winter*



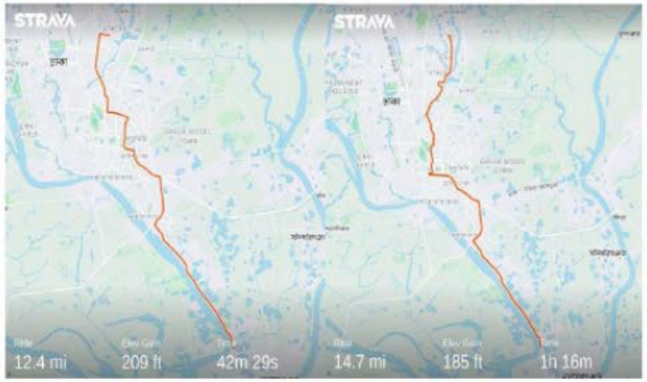
Exposure

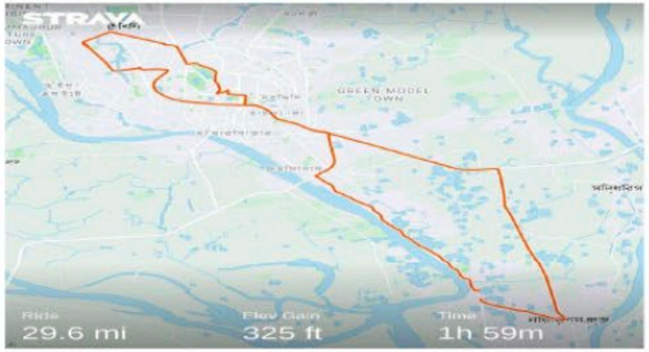






Travel Map





Environemnts

Site	Description
Residence	Very industrialized area and heavily polluted due to BSCIC and brick kilns, Fatullah, Narayanganj
Hardware market	Very densely populated with no traffic inside, kalir bazar, Narayanganj
sSuper shop	Very few people, masdair Narayanganj
Car	Four wheel drive in urban and highway routes
Rickshaw	Auto rickshaws and paddled rickshaws within the polluted Narayanganj city
Shopping mall	Bashundhara city shopping mall in Panthapath, Dhaka. Busy mall
Restaurant	Star Kabab restaurant, busy restaurant with cooking inside, Dhanmondi, Dhaka
CNG filling station	Vehicles nearby, signboard, Dhaka
Supermarket	Multistoried building, Dhanmondi, Dhaka
University research laboratory	Enclosed room with few people

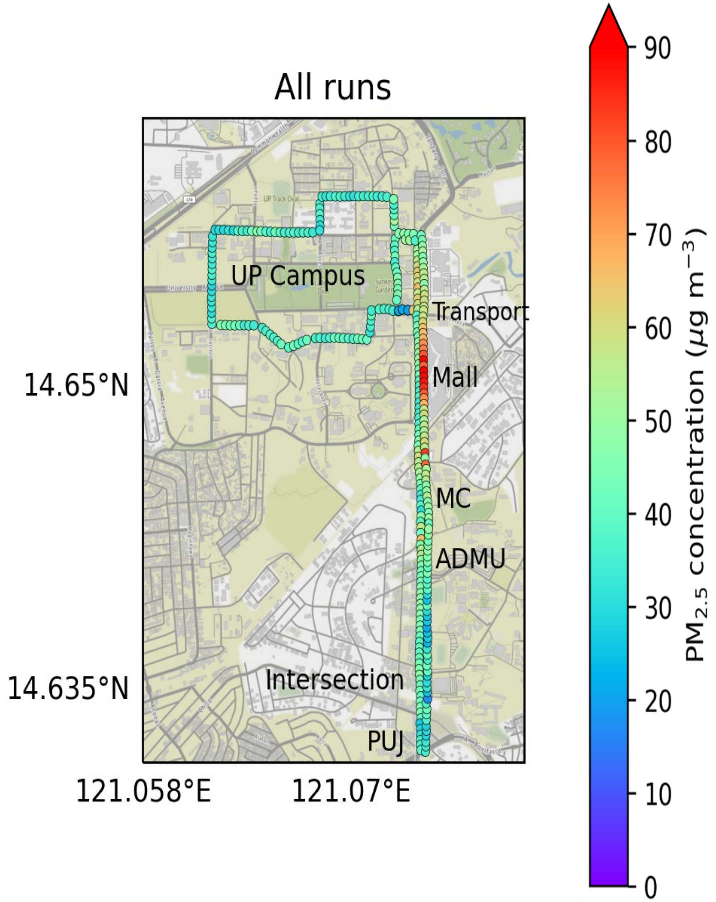
Personal Exposure Monitoring with As-Lung Sensor at different Environments in Dhaka Bangladesh

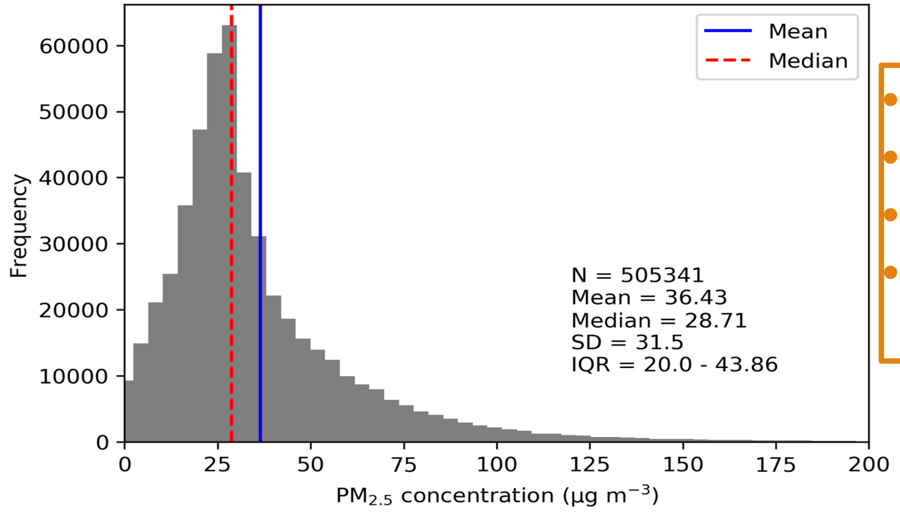
Abdus Salam et al.

Characterization of the spatiotemporal distribution of $PM_{2.5}$ in a Southeast Asian megacity: an assessment of personal exposure of a high-risk occupational group in Metro Manila, Philippines

Authors: Maria Obiminda L. Cambaliza, Melliza T. Cruz, Charlotte Kendra Z. Gotangco, Imee Delos Reyes, Gabrielle Frances Leung, Jarl Tynan A. Collado, Jose Gabriel F. Abalos, Shih-Chun Candice Lung, James Bernard B. Simpas, John Q. Wong, Rene Marlon B. Panti, Emma E. Porio, Bernell Go, Katrina Abenojar, Carlos Manalo, Grace B. Betito, Christine L. Chan, Aubrey de Francisca, Xzann Garry, Vincent Topacio

Objective: characterizing the personal $PM_{2.5}$ daily exposure of jeepney drivers





- Jeepney drivers $PM_{2.5}$ exposure
- Mean exposure: 36.4 μg/m^3
- Exposure is highly variable
- High exposures > 100 μg/m^3

- Areas with elevated levels of $PM_{2.5}$ (hotspots) include intersections in front of two campuses, a shopping mall, and a transport terminal

Path forward

- Conduct researches on source characterization, exposure assessment and exposure-health evaluation
- Combine LCS devices with filter-based measurements to evaluate aerosol compositions for source characterization
- Write joint papers
- Organize training workshop
  - 2022 workshop

Topics of joint papers

Lead author	topic	collaborator
Kim	Cooking	Hien, Salam, Candice
Talib	Biomass burning	Fabienne
Salam	24-hr exposure	Talib, Candice
Obie	Firework, Volcano- Journal of Disaster Research	Salam, Candice
Hien	Incense-burning	Candice
Ohnmar	Occupational exposure	Mazrura, Obie
Vincent & Candice	Sensor comparison	Hien, Ohnmar, Talib, Salam, Obie
Mark & Candice	Transportation	Kraichat, Hien

Any questions?

Updates for PM2.5 and health devices

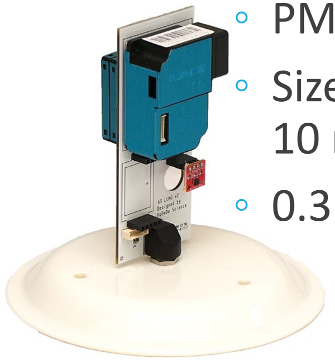
ASLung Update

PMS3003(G3)：

- PM value(ug/m3)：PM1、PM2.5、PM10

PMSA-003-C(GSA)：

- PM value(ug/m3)：PM1、PM2.5、PM10
- Size diatribution(No/0.1L)：0.3、0.5、1.0、2.5、10 micromter(μm)
- 0.3 and 0.5 are usable (Compare with EDM 180)



Outdoor

- 2 PM sensor
- 1 PM Sensor and 1 CO2

Portable

- 1 PM(G3) sensor and 1 CO2
- 1 PM(GSA) sensor and 1 CO2

Devices for health indicators

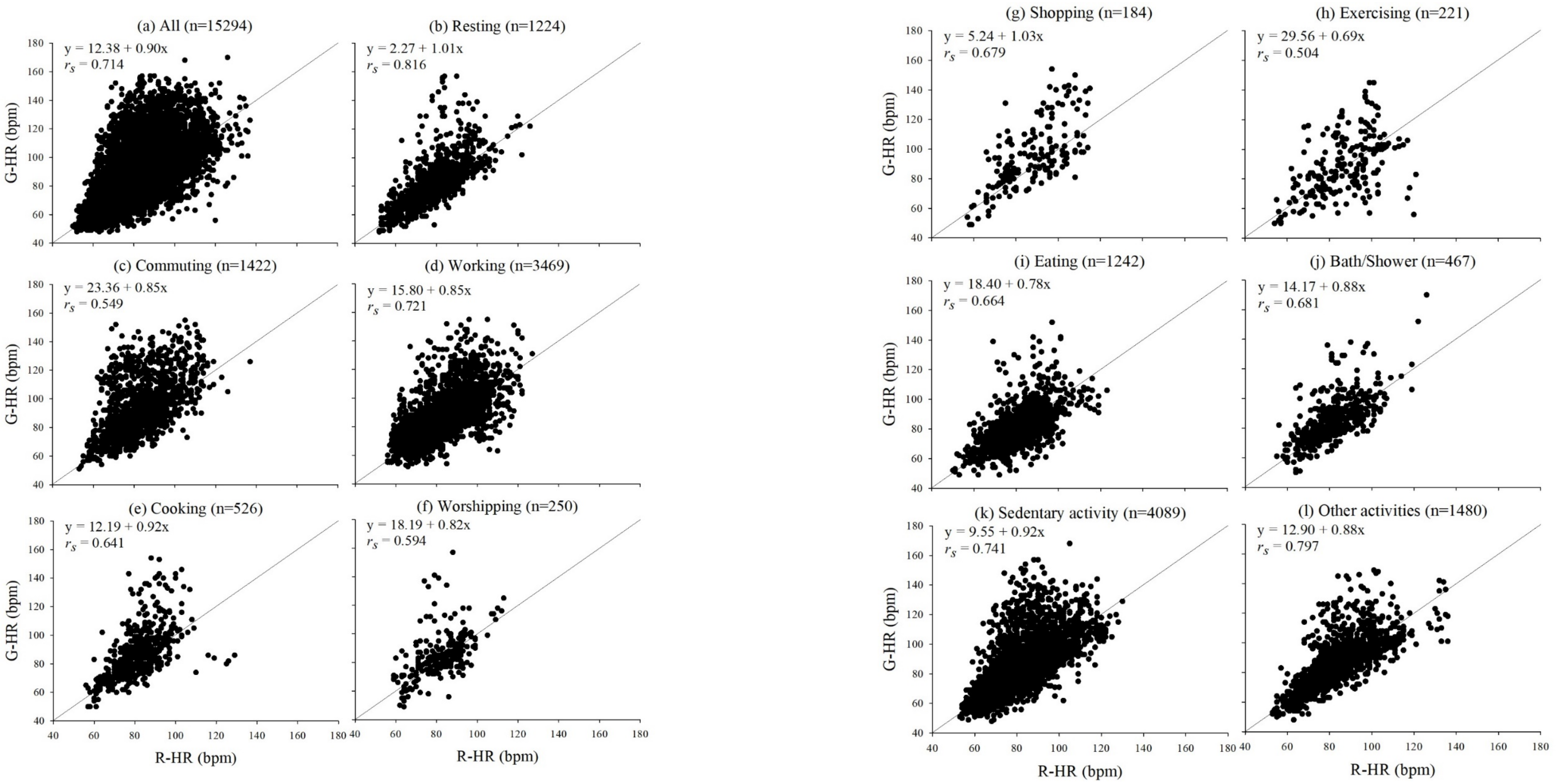
Comparison between Smart Watch and Rooti

- 49 subjects carried Garmin smart watches for 7 days
- compared with the same subjects carried Rooti for 2 days
- Garmin Forerunner® 35
  - Heart rate
  - Sleep stage: deep sleep and light sleep
  - GPS

		Garmin-HR (bpm) [a]		Rooti-HR (bpm)	
Characteristics		n	Mean ± SD (Midian)	n	Mean ± SD (Midian)
Age (years)					
40 to 64 years (27) [e]		35,846	85.7 ± 16.2 * (83.0)	7731	83.0 ± 12.4 * (83)
65 to 75 years (22) [e]		27,215	84.2 ± 16.9 (82.0)	7563	80.9 ± 12.2 (80.0)
Gender					
Male (20) [e]		24,844	85.0 ± 16.1 (82.0)	6170	83.0 ± 12.9 * (82.0)
Female (29) [e]		38,217	85.1 ± 16.8 (83.0)	9124	81.2 ± 11.9 (81.0)
Body mass index (BMI, kg/m²)					
<24 (19) [e]		25,811	82.4 ± 15.8 * (80.0)	5811	78.4 ± 11.5 * (77.0)
≥24 (30) [e]		37,250	86.9 ± 16.7 (84.0)	9483	84.1 ± 12.3 (83.0)

Tsou et al. (2021.07) Demonstrating the Applicability of Smartwatches in PM2.5 Health Impact Assessment. *Sensors*, 21(13), 4585. DOI: 10.3390/s21134585.

Comparison between Heart rate readings from Rooti and Garmin devices



Tsou et al. (2021.07) Demonstrating the Applicability of Smartwatches in PM2.5 Health Impact Assessment. *Sensors,* 21(13), 4585. DOI: 10.3390/s21134585.

Similar health damage coefficients found in regressions using Rooti and Garmin

Table 2. Associations of 5 min means of $PM_{2.5}$ concentration with R-HR[a] for 2 day monitoring (*n* = 15,294), and G-HR[b] for 7 day monitoring (*n* = 25,969).

	R-HR			G-HR		
	Coefficient [c]	**95% CI** [d]	***p*-Value**	**Coefficient** [c]	**95% CI** [d]	***p*-Value**
$PM_{2.5}$	0.229	0.127, 0.332	<0.001	0.234	0.0801, 0.389	0.003
Age	-2.50	-8.23, 3.59	0.412	-1.83	-6.47, 3.04	0.454
BMI	5.78	-0.800, 12.8	0.086	6.50	1.33, 11.9	0.013
Gender	2.03	-4.23, 8.70	0.534	-1.31	-6.12, 3.74	0.604

[a] Heart rate derived from RootiRx. [b] Heart rate derived from Garmin Forerunner 35 excluding activity intensity measurements <1100 mG. [c] Coefficients calculated as $[10^{(\beta\ IQR)}-1]$ 100%, where β denotes the effect estimate. Coefficients expressed as percent change in HR associated with each interquartile range (IQR) increase in personal $PM_{2.5}$ exposures, in models adjusted for subject, age, gender, body mass index (BMI), temperature, activity, and time of day. [d] CI, confidence interval.

Conclusion: Although Garmin devices are not medical certified, they can be applied in PM2.5 exposure-health evaluation to obtain similar health damage coefficients as those with Rooti. The advantages of low-cost and easy-to-carry allow the subjects to carry 7-days or more so that more heart rate data can be collected to achieve statistical significant findings with such large sample size

Introduction Smart Watch-Garmin Forerunner® 245

- General

HARDWARE	SPECIFICATIONS
PHYSICAL SIZE	42.3 x 42.3 x 12.2 (mm) Fits wrists with a circumference of 127-204 mm
WEIGHT	38.5 g
BATTERY LIFE	Smartwatch Mode: Up to 7 days GPS mode: Up to 24 hours
WATER RATING	5 ATM

- Health Monitoring and Sensors

SENSORS	DETAIL
GARMIN ELEVATE™ WRIST HEART RATE MONITOR	Wrist-based heart rate
PULSE OX BLOOD OXYGEN SATURATION MONITOR	Spot-check and optionally in sleep
SLEEP	Deep sleep, light sleep and rapid eye movement(REM) sleep
GPS	(GPS+GLONASS+GALILEO)
ACCELEROMETER	

Declaration of Conformity from UK

GARMIN.

Issued: 16/11/2018

Revised: 11/3/2019

UK DECLARATION OF CONFORMITY

The object of the declaration described below is in conformity with the relevant statutory requirements:

SI 2017 No. 1206 The Radio Equipment Regulations 2017

SI 2012 No. 3032 The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

ECE Regulation 10.04 Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility, Paragraphs 6.5, 6,6, 6.8, and 6.9
EN 300 328 v2.1.1 2016-11 Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques
EN 301 489-1 v2.1.1 2017-02 ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
EN 301 489-17 v3.1.1 2017-02 ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems
EN 303 413 v1.1.1 2017-06 Satellite Earth Stations and Systems (SES); Global Navigation Satellite System (GNSS) receivers; Radio equipment operating in the 1 164 MHz to 1 300 MHz and 1 559 MHz to 1 610 MHz frequency bands
EN 55032:2015/AC:2016 Class B (CISPR 32:2015) Electromagnetic compatibility of multimedia equipment – Emission requirements
EN 62368-1:2014 Audio/Video, Information and Communications Technology Equipment – Safety requirements
EN 62479:2010 Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz)

Manufactured by: Manufacturer's Address:	GARMIN International 1200 E. 151st Street Olathe, Kansas 66062 U.S.A.	&	GARMIN Corporation No.68, Zhangshu 2nd Rd., Xizhi Dist., New Taipei City 221, TAIWAN, R.O.C.
Authorised Representative:	GARMIN (Europe) Ltd. Liberty House Hounsdown Business Park, Southampton, Hampshire, SO40 9LR, U.K.		
	Information Technology Equipment (GPS smart watch)		
Type of Equipment:	Forerunner® 245, AA3568		
Model Number(s):	2,4 GHz @ 2 dBm max power		
Forerunner® 245, AA3568			

The undersigned does hereby declare that the equipment complies with the above Directives and Standards.

J S Wiltshire

Jamie Wiltshire
Quality Associate
GARMIN (Europe) Ltd.

11/3/2019

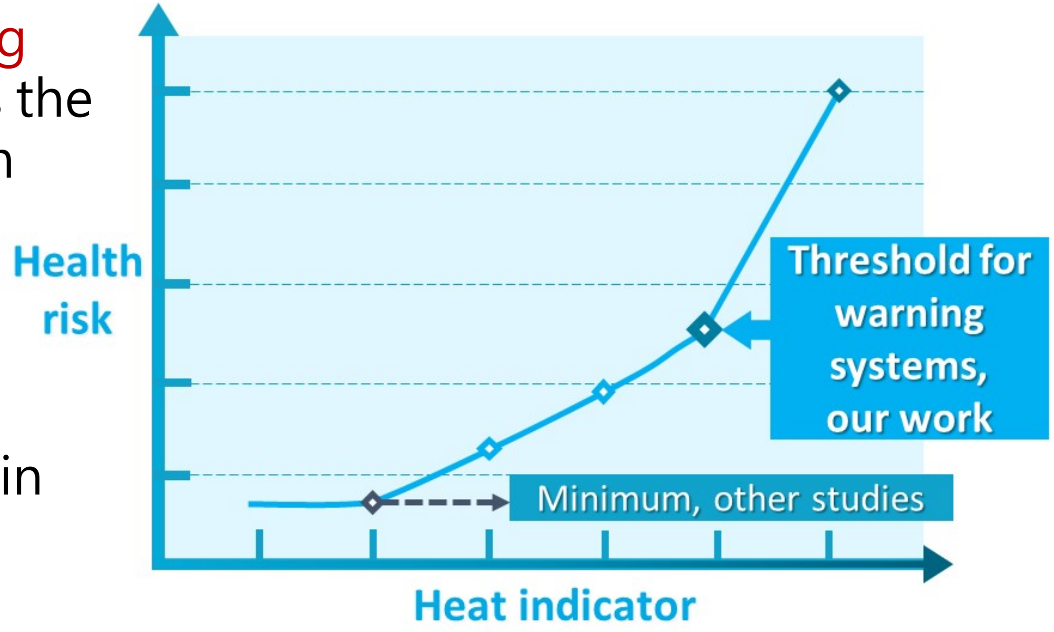
Reading for October 13

Lung et al., “Selecting thresholds of heat-warning systems with substantial enhancement of essential population health outcomes for facilitating implementation”, Int. J. Environ. Res. Public Health 2021, 18, 9506. https://doi.org/10.3390/ijerph18189506

Assessment of Thresholds of a Warning System

(Lung et al., 2021, *IJERPH*)

- Objective:
  - (1) revise statistical methods to assess the starting point of the rapid increase of heat-health risks as the appropriate thresholds for a heat warning system
  - (2) compare WBGT and temperature
- Data data:
  - Daily meteorological data for 2000-2017
  - Daily heat-related hospital and emergency visits in 2000-2017 and daily mortality counts (excluding accidents and suicides) in 2008-2014
- Statistical analysis (collaborate with a statistician) :
  - Revised generalized additive models (GAMs) with Poisson distribution



1. Replace WBGT or temperature with PM2.5
2. Replace health database with hospital data
3. Apply the same methodology to evaluate PM2.5 exposure-health relationships with AS-LUNG-O and hospital data