



USE OF LOW-COST SENSORS FOR AIR QUALITY MONITORING IN SOUTH ASIA: VIRTUAL TRAINING SERIES



FIELD LESSONS AND BEST PRACTICES FROM ALLIN-WAYRA AND REAL-WORLD SENSOR DEPLOYMENTS

From Walking Routes to Classrooms:
Applied Low-Cost Sensor Science for Air Quality



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From Walking Routes to Classrooms: Applied Low-Cost Sensor Science for Air Quality

17TH FEBRUARY 2026
ELIANI EZANI, PHD.

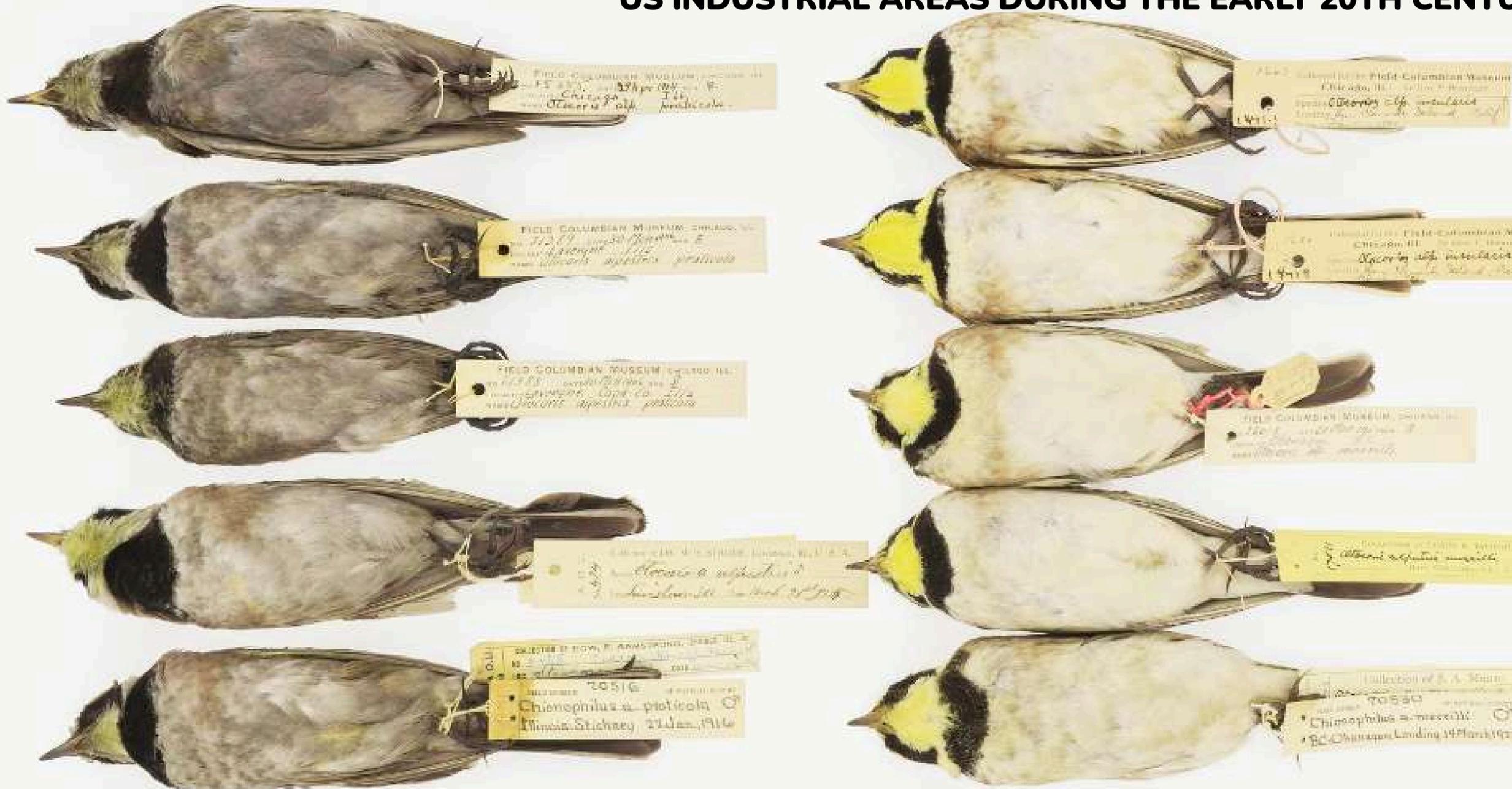
MY TALKING POINTS

- **Allin-Wayra: Why Sensor Science Needs Collaboration**
- **Field Application: Mobile PM_{2.5} Exposure Monitoring**
- **Classroom Application: STEM Air Quality Engagement**
- **Key Lessons**



When Living Things Reveal Air Pollution The Sooty Birds

A COMPARISON OF HORNED LARKS COLLECTED INSIDE AND OUTSIDE OF US INDUSTRIAL AREAS DURING THE EARLY 20TH CENTURY



WHO IS MEASURING AIR QUALITY TODAY?

slido



**MEASUREMENT IS NOW DISTRIBUTED
ACROSS MANY GROUPS**

**LOW-COST SENSORS HAVE
DEMOCRATIZED AIR MONITORING**

**BUT DISTRIBUTED MEASUREMENT
CREATES A NEW CHALLENGE**



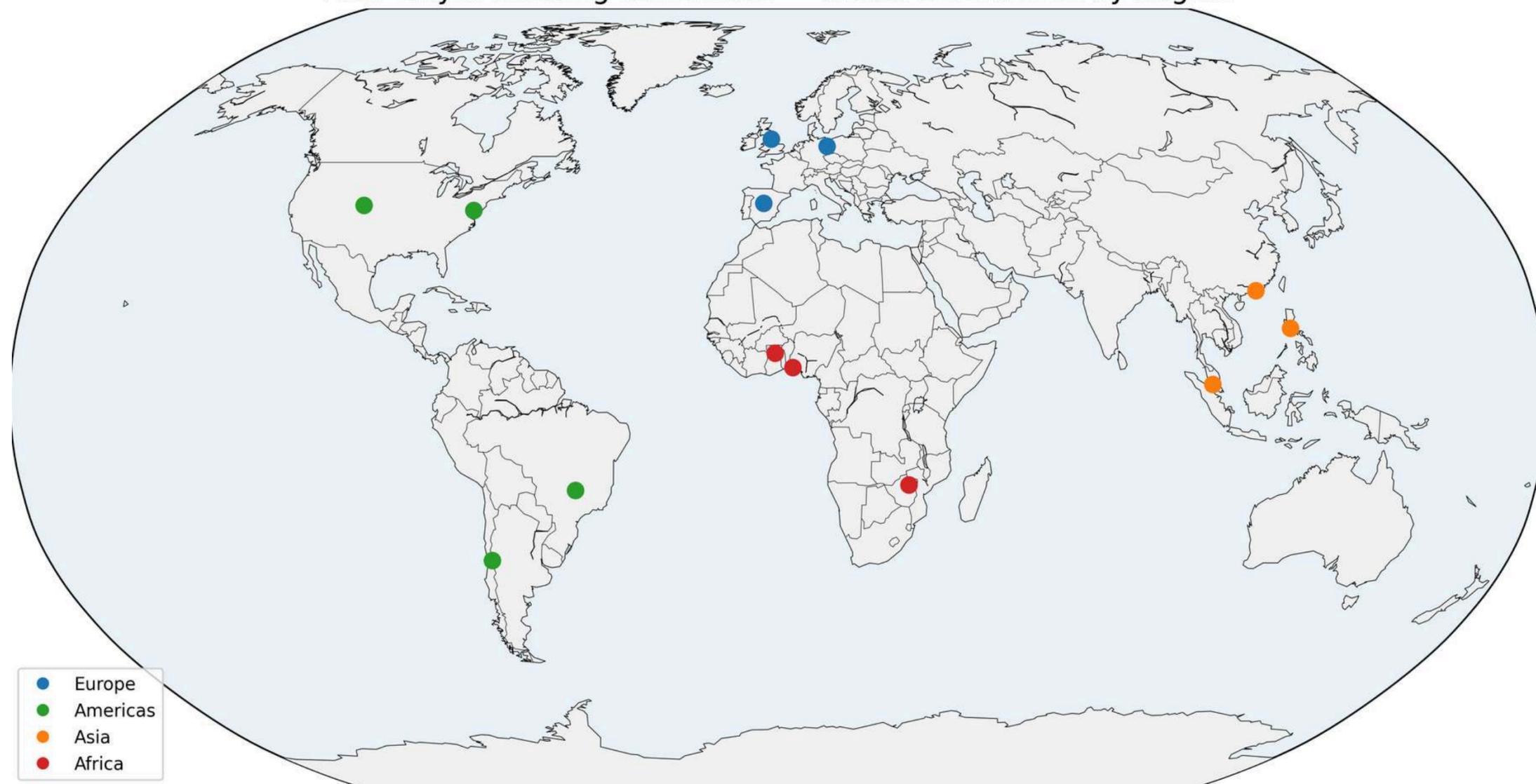
**DATA QUALITY AND
COMPARABILITY!**



ALLIN-WAYRA: ADVANCING SMALL SENSOR SCIENCE THROUGH GLOBAL COLLABORATION

- Allin-Wayra (“good air” / “winds of change”)
- IGAC activity established in 2023 to connect global small-sensor efforts and build a diverse, inclusive community of practice for responsible sensor use.

Allin-Wayra Steering Committee — Global Distribution by Region



Contact us! : allin.wayra@igacproject.org



ALLIN-WAYRA: ADVANCING SMALL SENSOR SCIENCE THROUGH GLOBAL COLLABORATION

1 Global community-of-practice coordination

2 Regional and international workshops

3 Expert webinar series

4 Conference sessions and splinter meetings

5 Co-development of open guidance resources



OPEN GUIDANCE



CITIZEN SCIENCE GLOBAL PARTNERSHIP

Particulate matter and air sensors: the citizen scientists' guide to air pollution monitoring using small sensors



Image developed using Canva

This document was prepared by the [Citizen Science Global Partnership](#) working group on Sensors for Air Quality in collaboration with the [Allin Wayra scientific community](#) at the International Global Atmospheric Chemistry Project and the [CitiQbs](#) project.

ONLINE WEBINAR & WORKSHOP

ALLIN-WAYRA CITIZEN SCIENCE GLOBAL PARTNERSHIP

DATA TO DIALOGUE: ENGAGING COMMUNITIES FOR AIR QUALITY RESEARCH AND ACTION

Date: 28th May 2025 (Wed)

Time: 13:00 - 14:00 (BST) / 12:00 - 13:00 (UTC)

Zoom Link

About the Session

Dr. Schulte will present insights from three projects:

- Breathe London:** is a hybrid air pollution monitoring network featuring a new model for translating local insight from air pollution data co-created alongside communities into policy and evidence for local decision making.
- AWAIR:** is piloting co-designed public air quality information displays in three neighbourhoods.
- The first global conference** dedicated to unpacking the communication of air quality throughout the environmental, health and public sectors. Key findings from these three initiatives are discussed while considering the diverse contexts, informational needs, and capacities that exist across the air pollution governance arena.

Mr. Raghuvansh will share an insight into Project Healthy Air, a citizen science programme that provides cost-effective, app-enabled, portable air quality sensors in schools and colleges, enabling students and teachers as citizen scientists to observe air quality for localized data and collaborate with scientists to facilitate data interpretation, visualization, and analysis, supporting scientific studies. Project Healthy Air brings real-time data into the classroom, fostering fluency in observation and data interpretation to make STEM education more impactful. The project is supported by interactive learning resources and digital technology tools to make learning more engaging. The project inspires people to take small, positive steps, such as installing green walls and planting trees, planning travel on alternative routes and scheduling outdoor activities based on AQI.

Dr. Kayla Schulte
Imperial College London

Mr. Raghuvansh Saxena
Earthwatch Institute India

openaq NRDC ALLIN WAYRA

571 Sonoma Technology

WORKSHOP VIRTUAL

Gestión de datos de calidad del aire en América Latina

¿Qué tal un sistema de gestión de datos de código abierto, inclusivo, accesible e integrado para manejar los datos de monitoreo de la calidad del aire? De eso se trata el **proyecto COMPASS!** Pero para que esto se haga realidad, **necesitamos saber cuales son tus necesidades!**

¿A quién está dirigido?
Investigadores, técnicos, profesionales y tomadores de decisión involucrados con el monitoreo del aire.

18 y 25 Junio 2025
(2h cada encuentro)

7AM Ciudad de México / Managua
8AM Lima / Bogotá / Quito
9AM Santiago / La Paz / Caracas
10AM Buenos Aires / Montevideo

Link inscripción

APOYAN ESTA INICIATIVA:

Entregaremos certificado de participación!!

ALACEA LA EC ESS IGAC AMERICAS WORKSHOP GROUP UDD

Centro de Investigación en Tecnologías para la Sociedad Facultad de Ingeniería



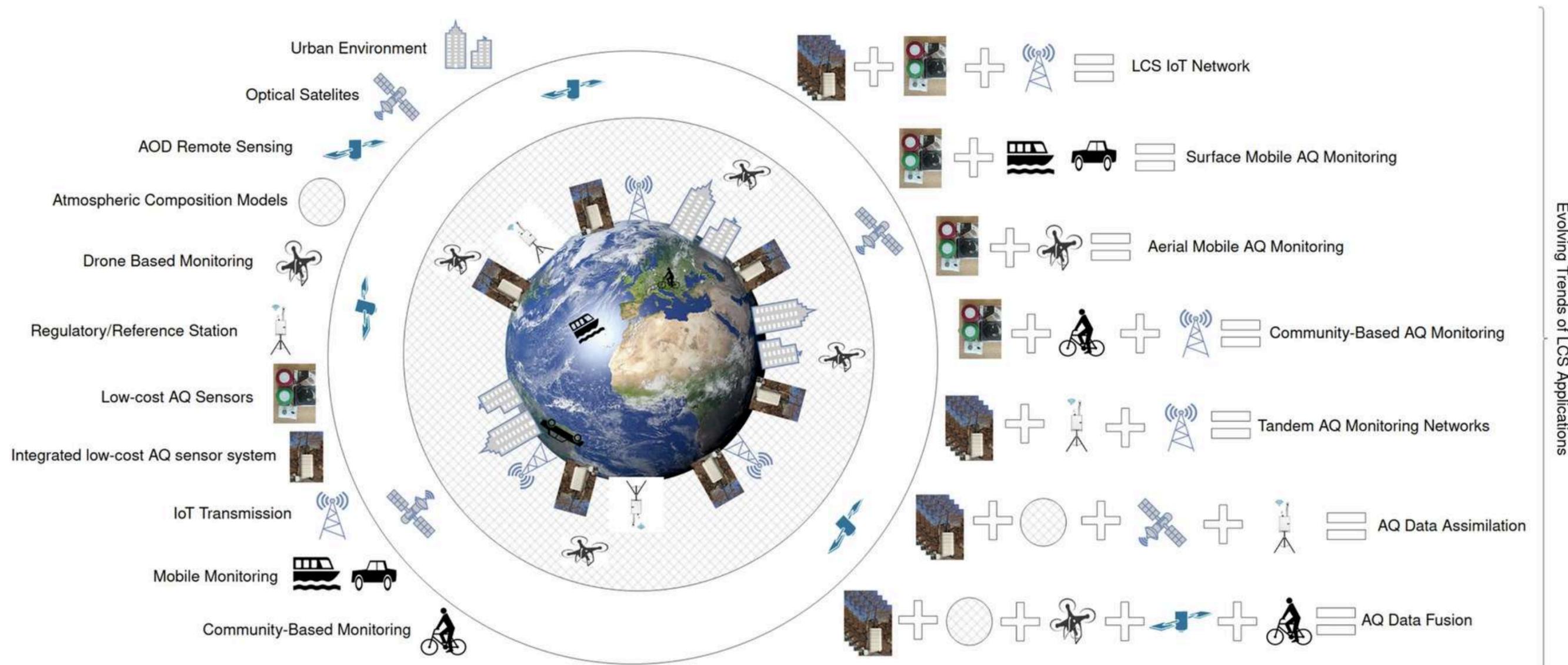
<https://doi.org/10.1038/s41612-025-01216-4>

Evolving trends in application of low-cost air quality sensor networks: challenges and future directions

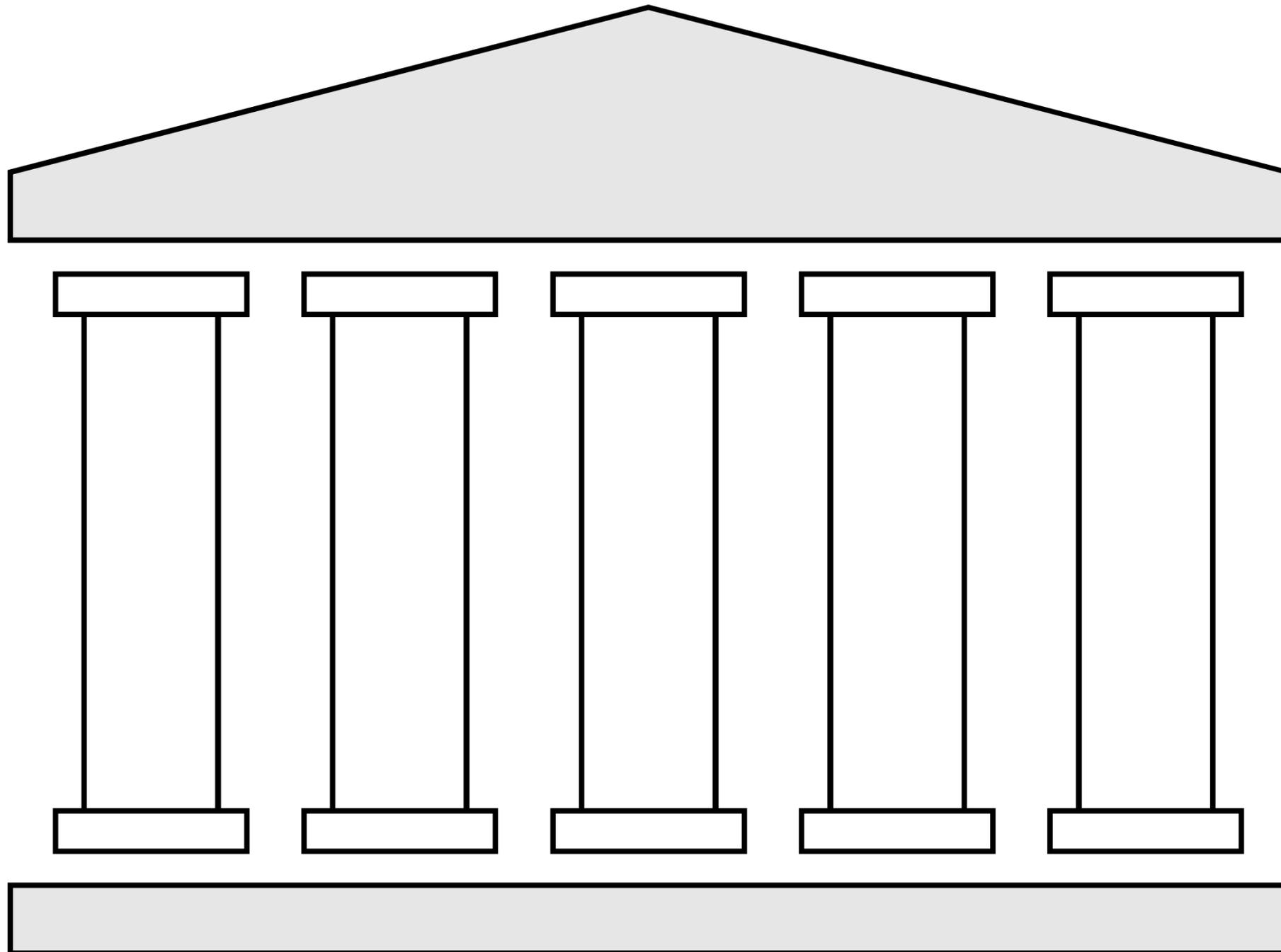
Check for updates

Evangelos Bagkis^{1,2}, Amirhossein Hassani^{2,3}, Philipp Schneider², Priyanka DeSouza^{3,4}, Shobitha Shetty², Theodosios Kassandros¹, Vasileios Salamalikis², Núria Castell², Kostas Karatzas¹, Ajit Ahlawat^{5,6} & Jibrán Khan^{7,8}

“Evolving Trends” in the application of air quality low-cost sensors (LCS) (Bagkis et al. 2025)



The 5 Pillars of Low-Cost Sensor Best Practice

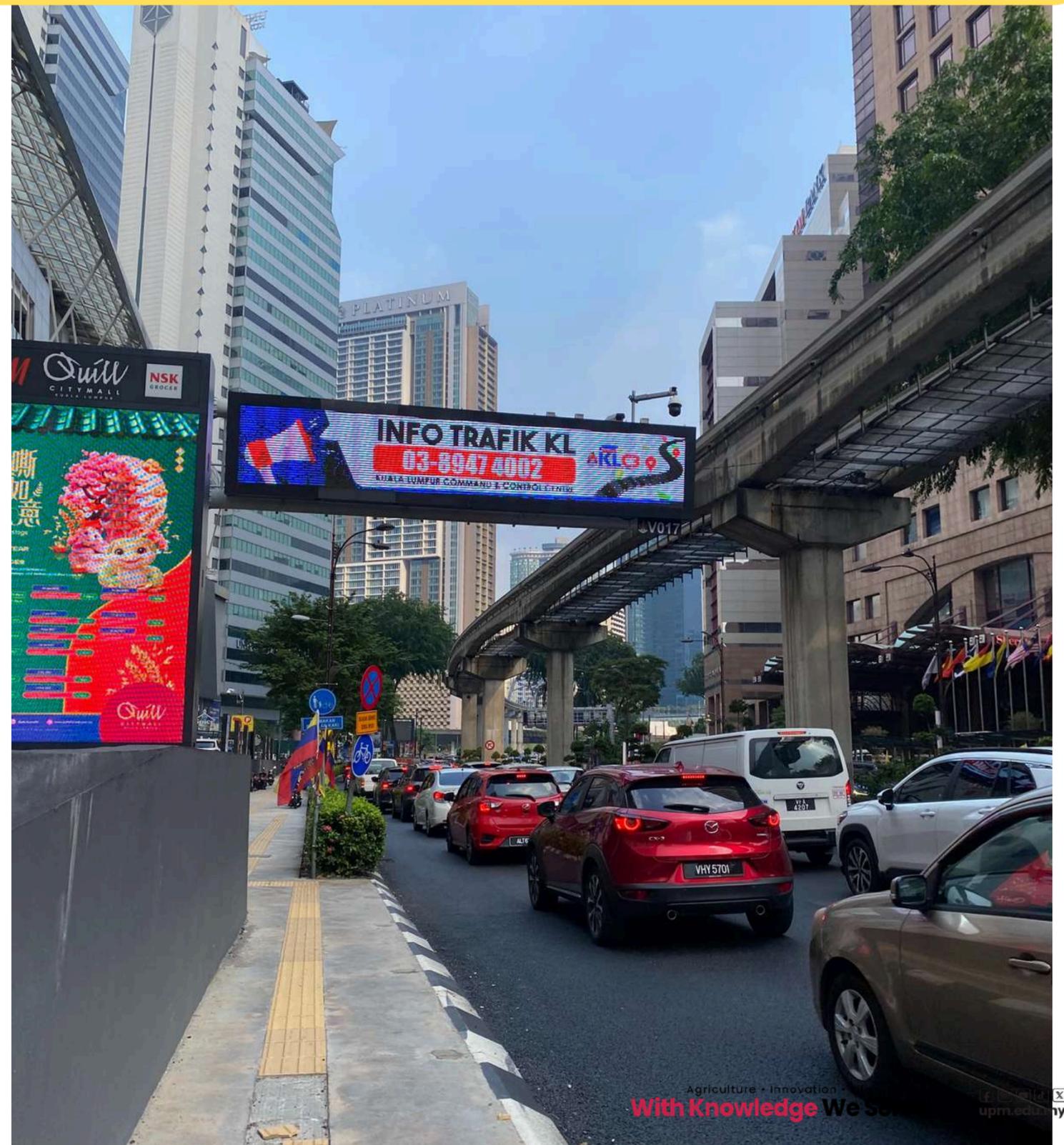


- 1. Fit for purpose**
- 2. Co-location & calibration**
- 3. Environmental correction**
- 4. QA/QC protocol**
- 5. Transparent reporting**

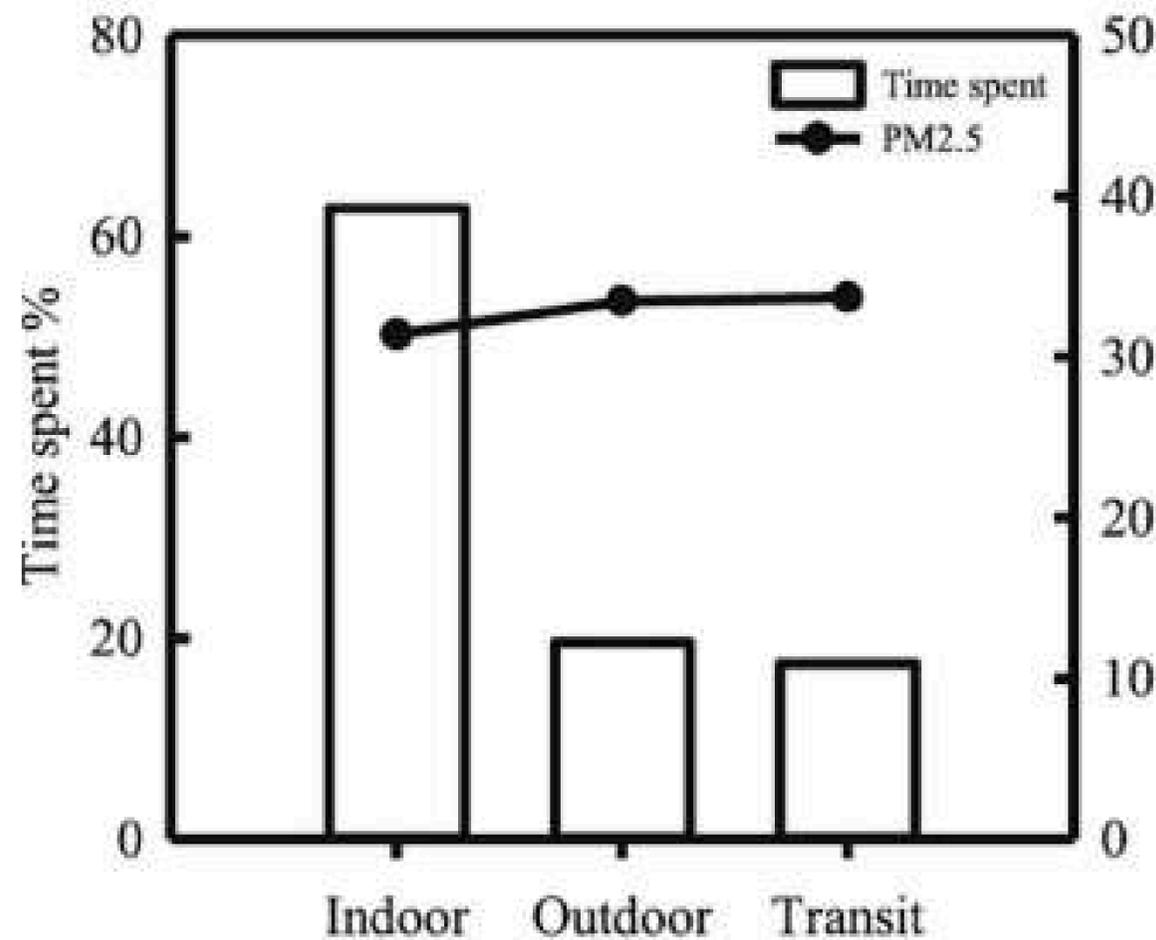
Field Application Case Study 1: Mobile PM_{2.5} Exposure Monitoring



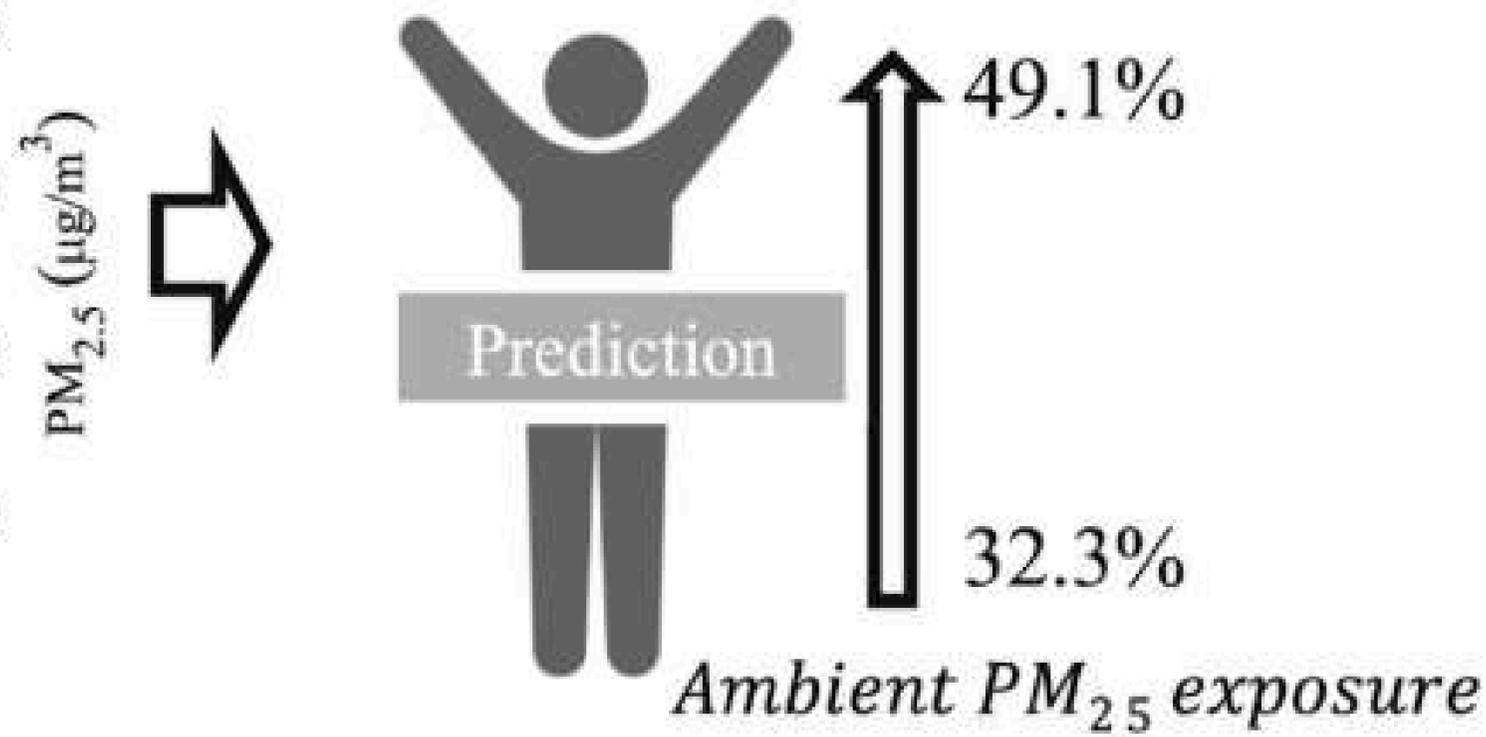
A Walk Through Kuala Lumpur.. POV from Hyperlocal Scale



PM_{2.5} Exposure across different Microenvironments



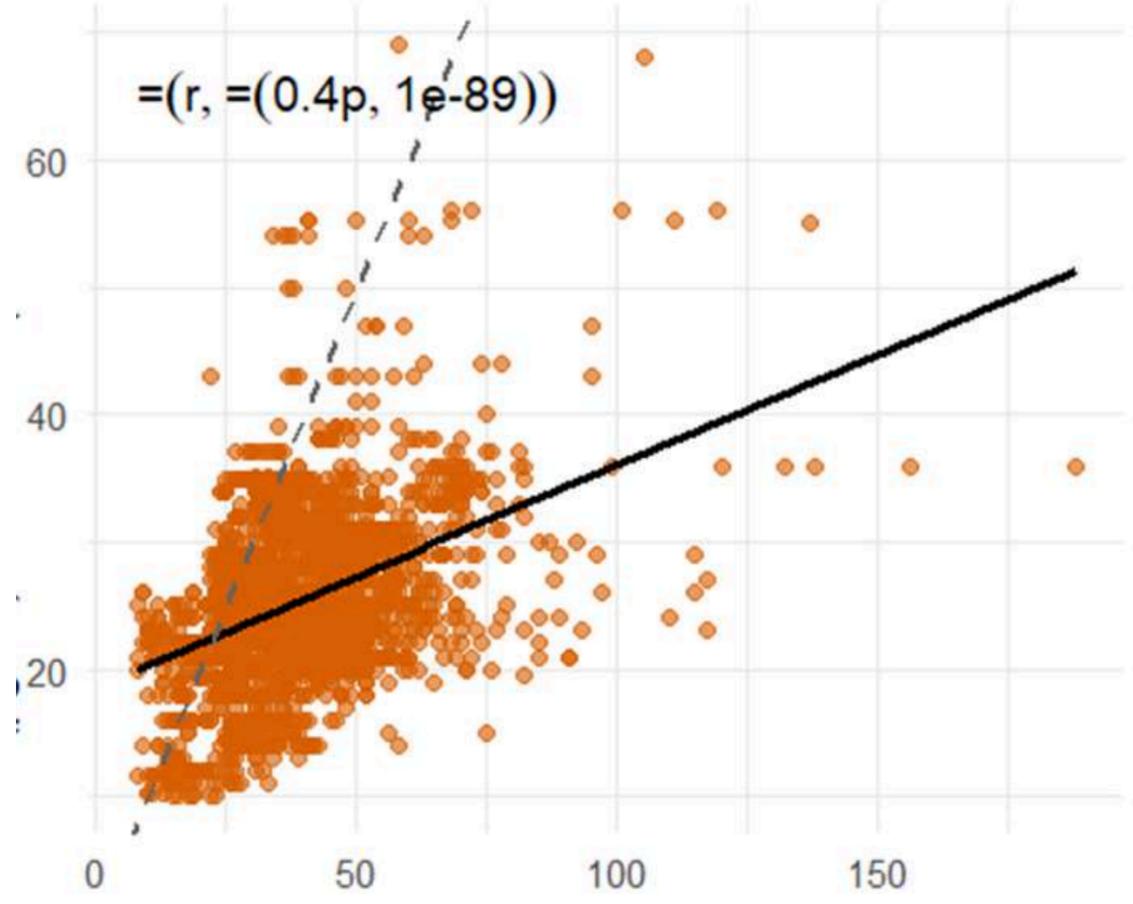
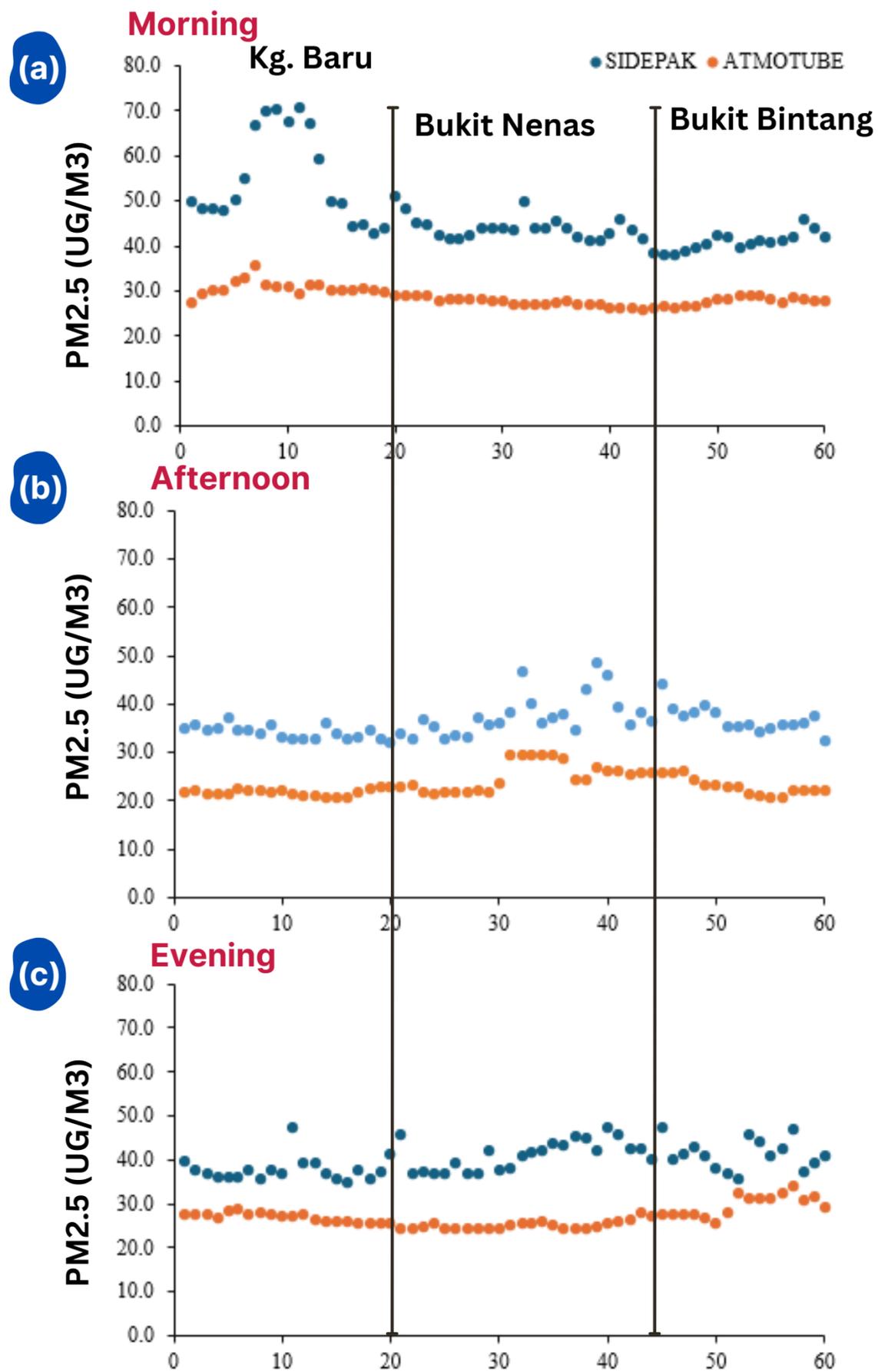
Total exposure = PM_{2.5} (indoor + outdoor + transit)



The within-subject variability dominated for personal exposure to PM_{2.5}.

Hsu et al. (2020), Environmental Pollution



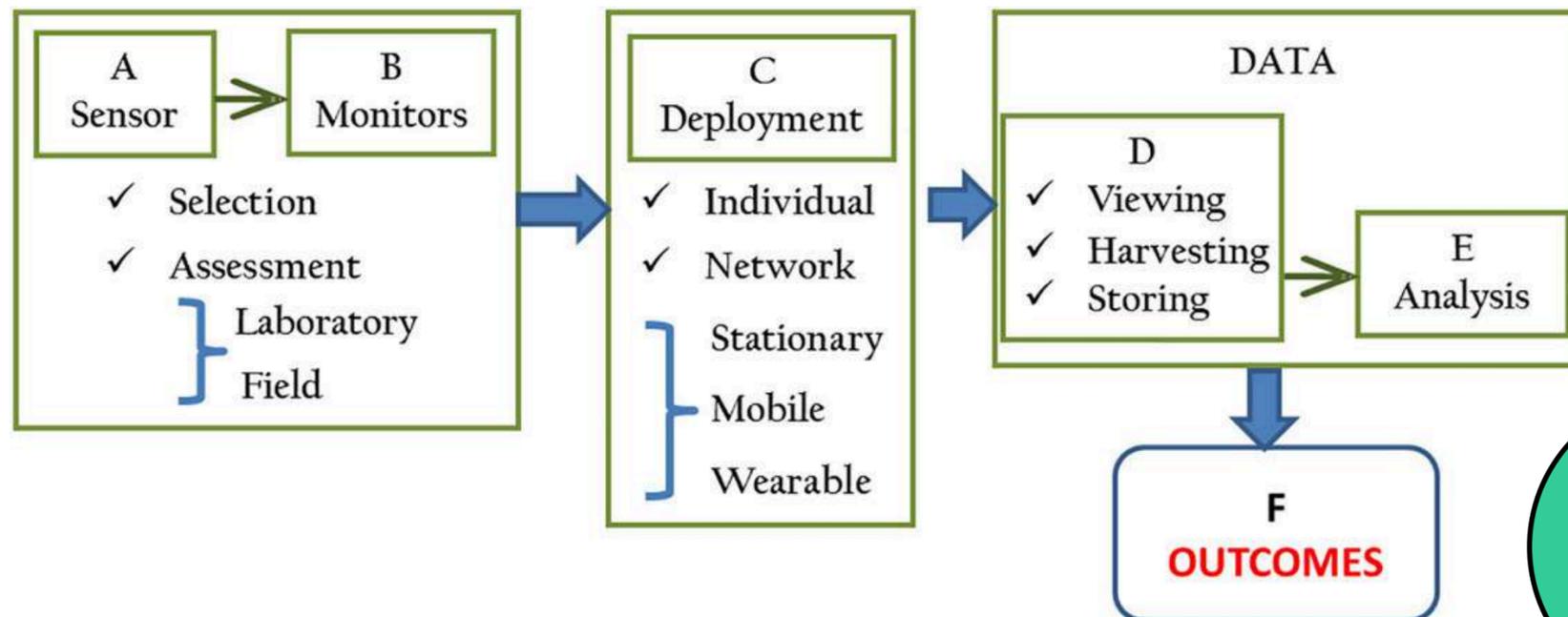


- Mobile monitoring using both research-grade (SidePak) and low-cost (Atmotube) sensors provides valuable insights into PM_{2.5} exposure among active commuters in urban environments.
- Atmotube captured general pollution trends, it underestimated PM_{2.5} concentrations by ~35% compared to SidePak and showed reduced sensitivity to short-term peaks.

Review article

Applications of low-cost sensing technologies for air quality monitoring and exposure assessment: How far have they gone?

Morawska et al. (2018)



What the Street Taught Our Sensors

1) Response time lag

- Sensors track rapid pollution changes
- Fast movement = delayed peaks

2) Inlet placement matters

- Body & bag position change airflow
- Small placement shifts → different readings

3) Humidity effects

- Strong impact in tropical conditions
- Always record environmental context

4) Spikes are signals

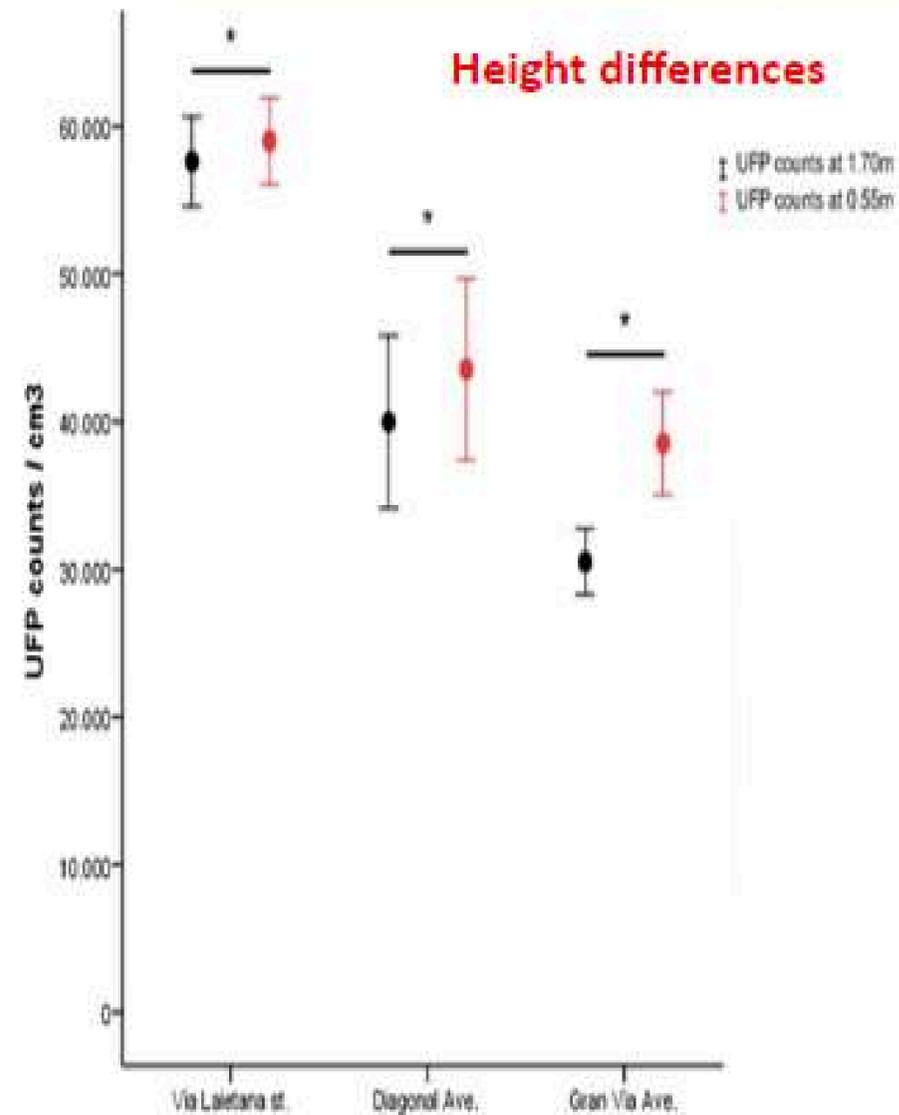
- Short peaks reveal hotspots
- Exposure patterns > absolute values



Field behavior ≠ Lab behavior

**Low-Cost Sensors Are Powerful...
But Only When Science Is Shared!**

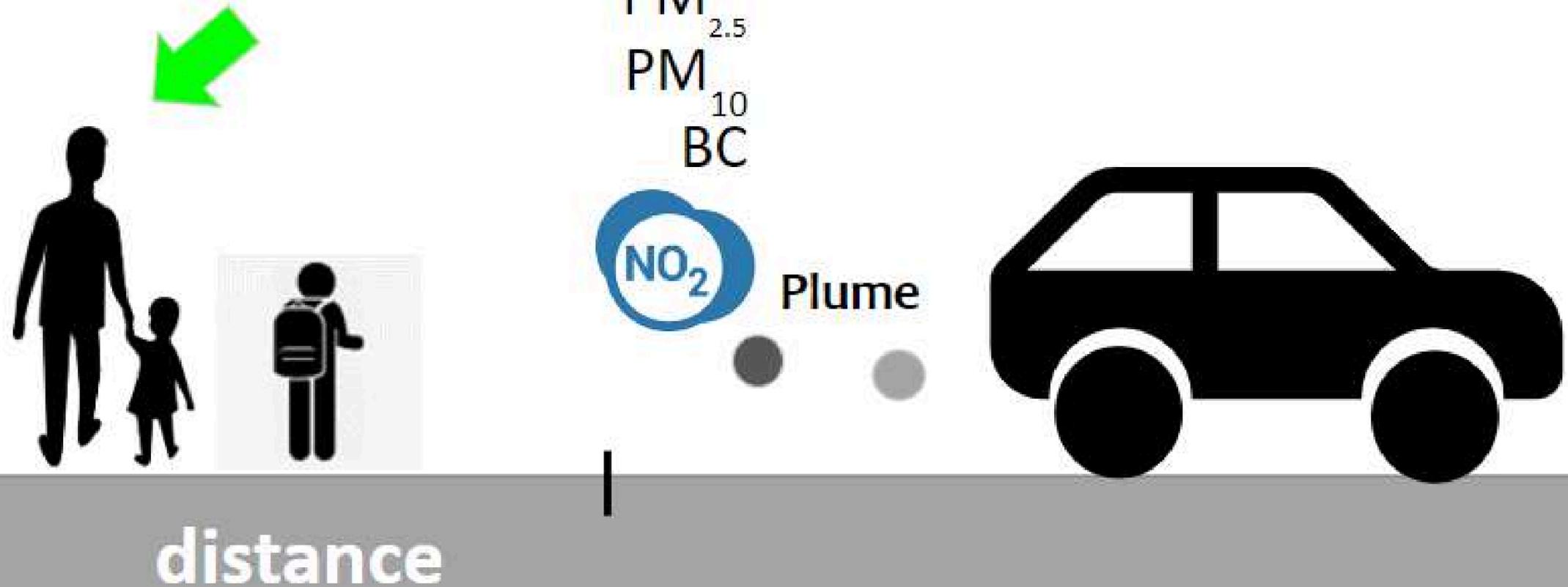
CHILDREN EXPOSURE TO AIR POLLUTION – EVERYTHING, EVERYWHERE ALL AT ONCE!



Determinants exposure to traffic-related air pollution (Batterman, 2015):

- mode of transport;
- meteorological conditions;
- proximity to traffic;
- current land use pattern (i.e., street layout, urban development, and traffic patterns).
- individual factors.

Garcia-Algar, 2015, Environmental Monitoring and Assessment



Previous Sampling Campaign



Near-road mobile monitoring - Walking route

**Total distance:
1.1 km**

**Starting point:
Residential area**

**Finishing point:
School back gate**



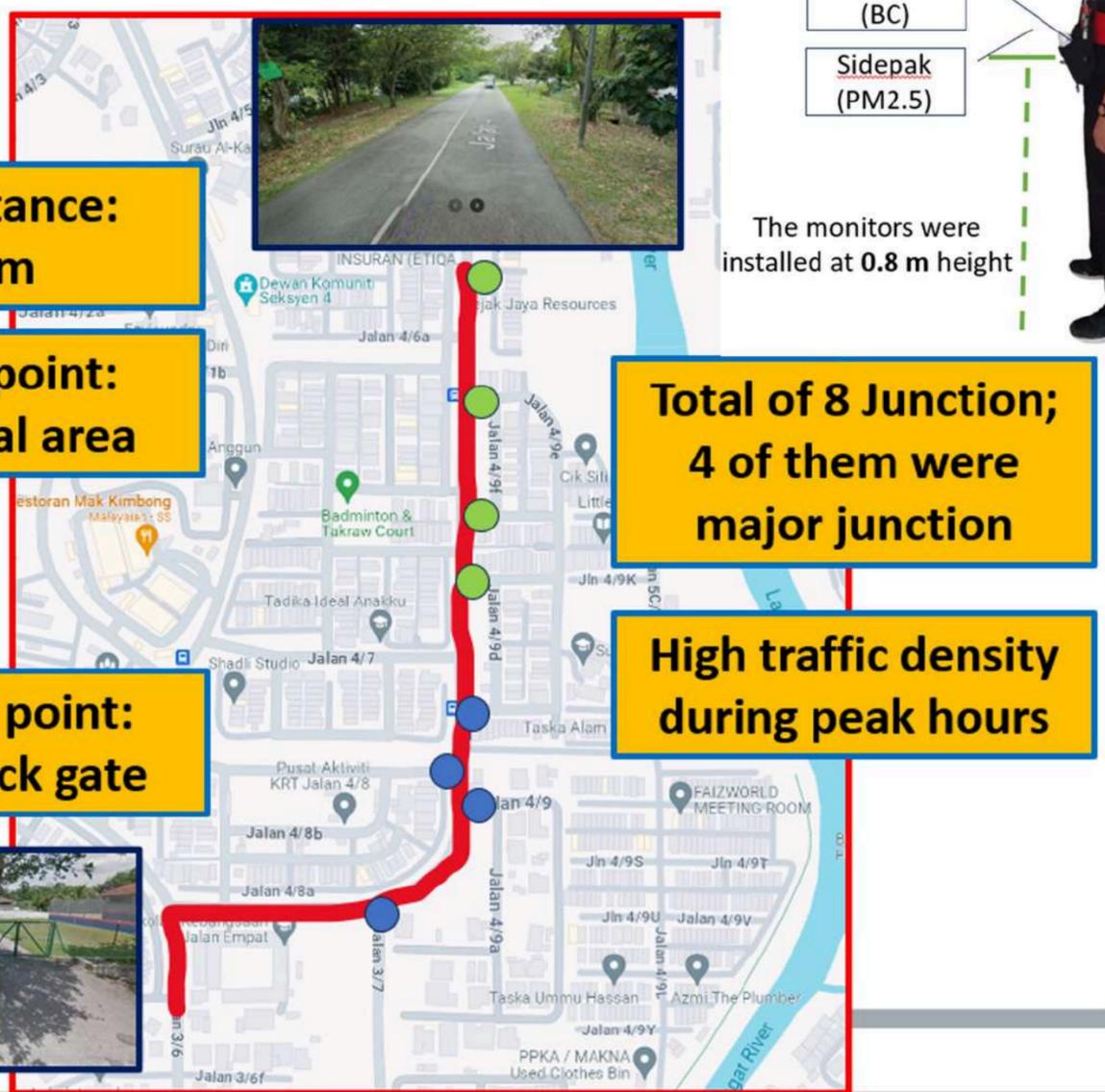
MA200 (BC)
Sidepak (PM2.5)

The monitors were installed at 0.8 m height

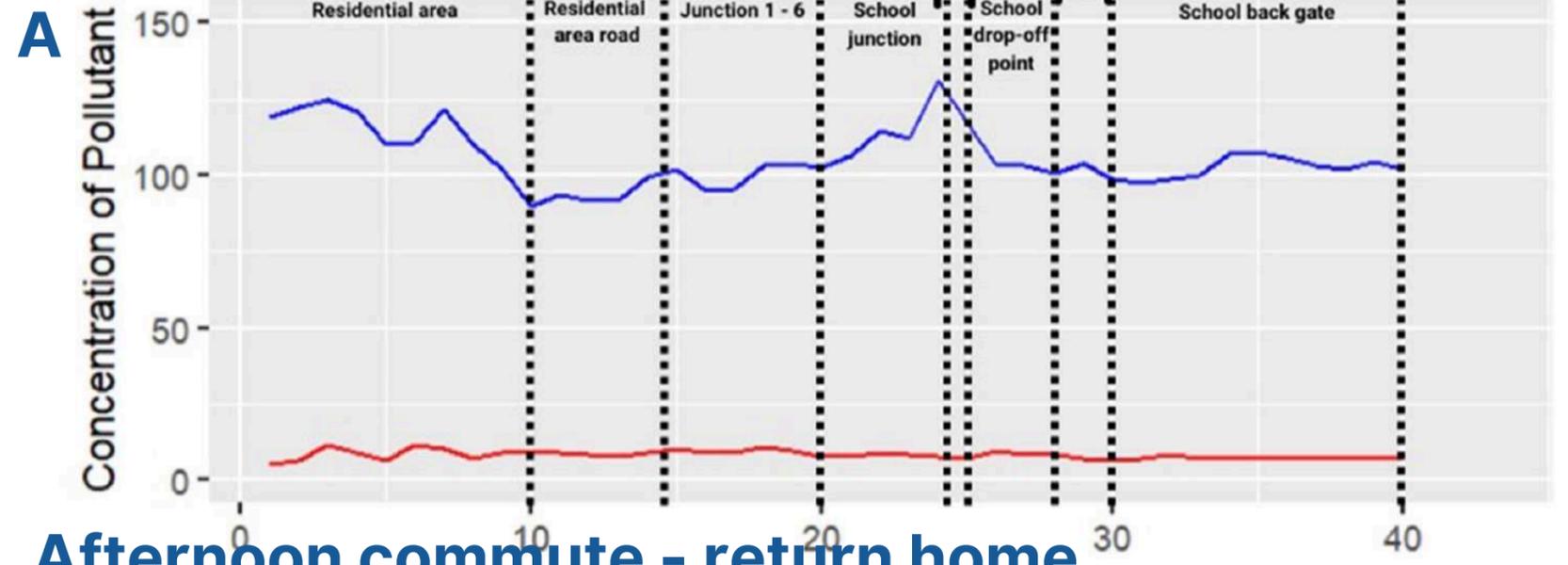


**Total of 8 Junction;
4 of them were major junction**

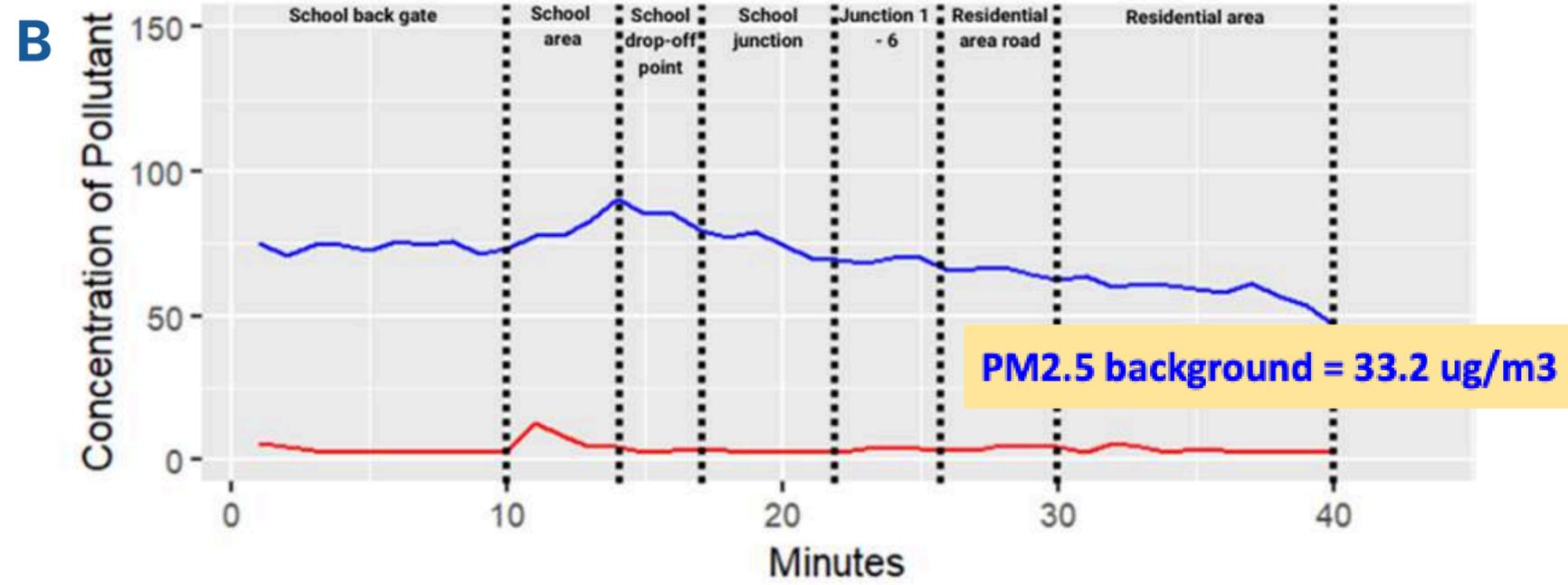
High traffic density during peak hours



Morning commute-to school



Afternoon commute - return home



Key motivation



urban science



Article

Exposure of Malaysian Children to Air Pollutants over the School Day

Eliani Ezani ¹ and Peter Brimblecombe ^{2,3,*}

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 - ² Department of Marine Environment and Engineering, National Sun Yat-sen University, Kaohsiung 80424, Taiwan
 - ³ School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK
- * Correspondence: p.brimblecombe@uea.ac.uk

Abstract: Children are sensitive to air pollution and spend long hours in and around their schools, so the school day has an important impact on their overall exposure. This study of Kuala Lumpur, Selangor and its surroundings assesses exposure to PM_{2.5} and NO₂, from travel, play and study over a typical school day. Most Malaysian children in urban areas are driven to school, so they probably experience peak NO₂ concentrations in the drop-off and pick-up zones. Cyclists are likely to receive the greatest school travel exposure during their commute, but typically, the largest cumulative exposure occurs in classrooms through the long school day. Indoor concentrations tend to be high, as classrooms are well ventilated with ambient air. Exposure to PM_{2.5} is relatively evenly spread across Selangor, but NO₂ exposure tends to be higher in areas with a high population density and heavy traffic. Despite this, ambient PM_{2.5} may be more critical and exceed guidelines as it is a particular problem during periods of widespread biomass burning. A thoughtful adjustment to school approach roads, design of playgrounds and building layout and maintenance may help minimise exposure.

Keywords: NO₂; PM_{2.5}; Kuala Lumpur; classrooms; school playgrounds; urban roads; travel to school; drop-off and pick-up zones



Citation: Ezani, E.; Brimblecombe, P. Exposure of Malaysian Children to Air Pollutants over the School Day

How can we transform scientific evidence on air pollution into hands-on learning experiences that empower young people to become informed, data-driven advocates for clean air?

Our study found that PM_{2.5} levels near school gates during pickup hours were high!
Let's investigate how students like Maurice can avoid these peaks.....

**Hi guys!
Selamat pagi!
Saya Maurice!**



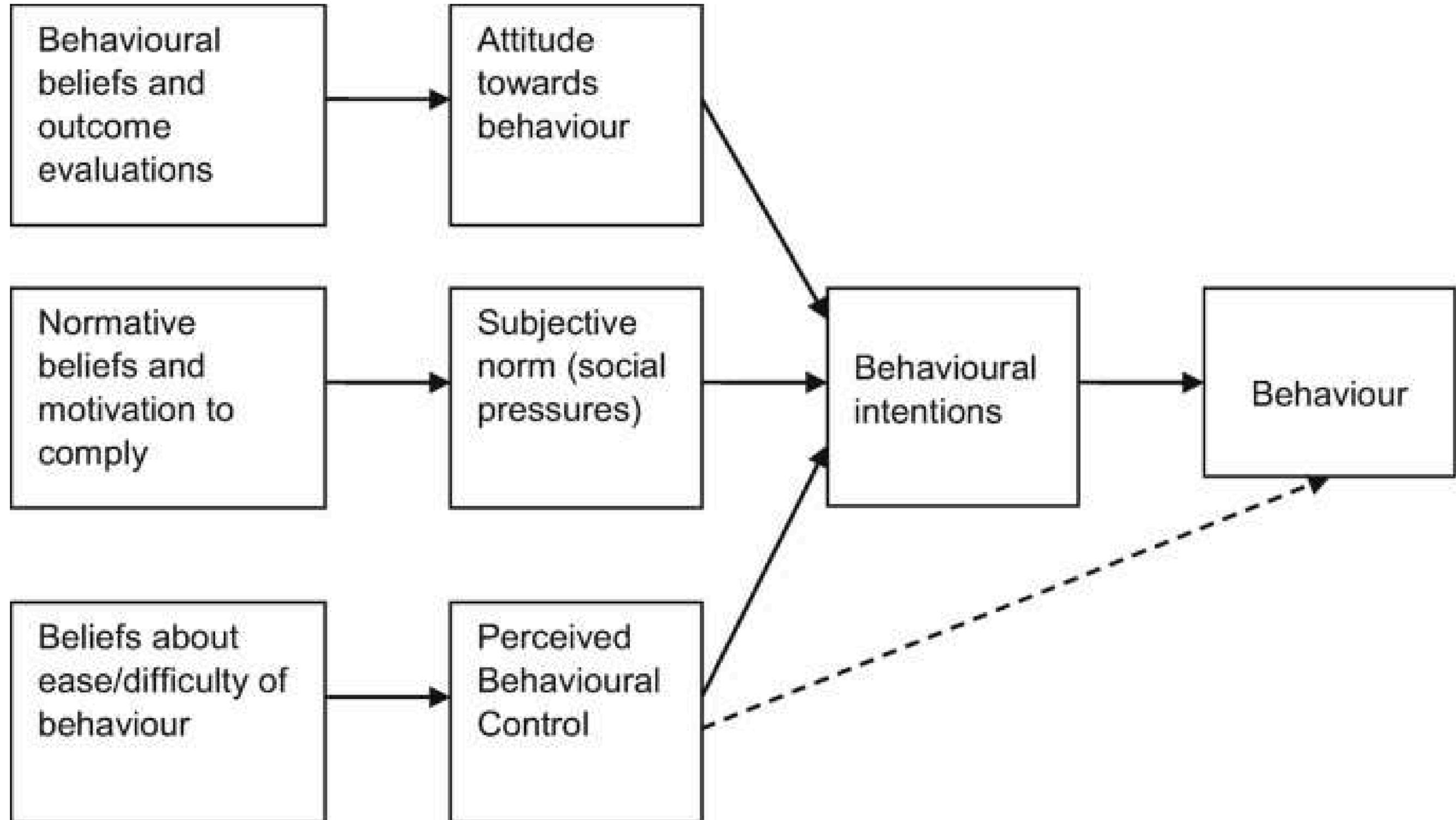
Meet Maurice – A Student Just Like Yours fictional student

Maurice lives only 500 meters from the school. Every morning, his parents drive him to school, but in the afternoon, he usually walks home on his own. Recently, Maurice has been experiencing respiratory symptoms such as coughing and shortness of breath. After a medical check-up, the doctor informed him that he is sensitive to traffic-related air pollution. Concerned about his health, Maurice wants to understand whether his school environment and walking route are contributing to his symptoms.

To help him, we invited students to become 'Air Pollution Detectives'

- tasked with investigating Maurice's daily environment and identifying the safest, cleanest route for him to take with the help of wearable low-cost sensor**

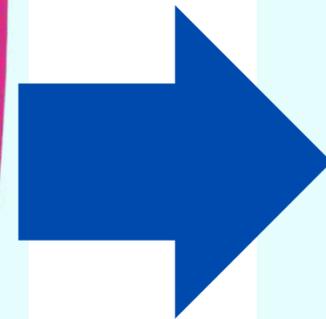
Theory of Planned Behavior (Ajzen, 1985)



Inspiration

Core Modules

Translation of Modules to the Local Situation



Analyse



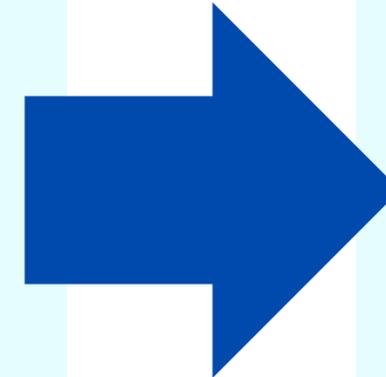
Identify



Act



Report



AIR POLLUTION DETECTIVES

Situasi:
Maurice berumur 15 tahun dan bersekolah di SMK XYZ sejak 2 tahun lalu. Maurice ke sekolah dengan menaiki kenderaan ibu bapanya dan pulang ke rumah dengan berjalan kaki. Jarak rumah Maurice ke sekolah adalah kurang dari 500 meter.

Permasalahan:
Maurice mula mengalami penyakit sesak nafas sejak akhir-akhir ini, simptom tersebut sudah lama dialaminya. Simptom tersebut akan timbul setiap kali Maurice pulang dari sekolah. Doktor telah memeriksa tahap kesihatan Maurice dan mengesyaki bahawa sistem pernafasan Maurice adalah sensitif terhadap asap di persekitarannya.

**PANGGILAN KECEMASAN!
AHLI DETEKTIF ALAM SEKITAR..
SILA BERTINDAK!**

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PENCEMARAN UDARA

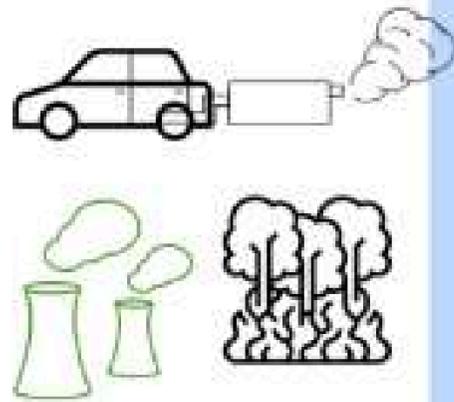
APA ITU PENCEMARAN UDARA?

Satu keadaan pencemaran yang berlaku sama ada di luar dan di dalam bangunan disebabkan oleh agen kimia, fizikal atau biologi yang boleh menyebabkan kemudaratan kepada kesihatan manusia dan perubahan iklim.

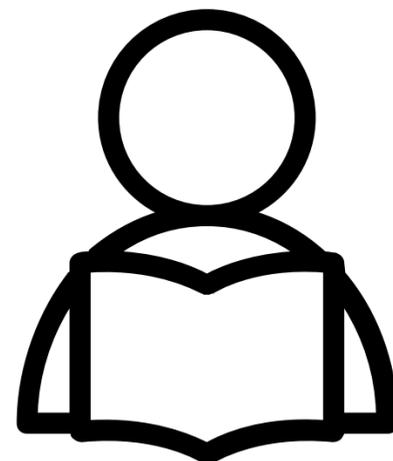
- Zarah Partikel (PM10, PM2.5)
- Gas pencemar (ozon, sulfur dioksida, nitrogen dioksida)
- Agen biologi (virus, kulat, bakteria)
- Suhu, kelembapan relatif

BAHAN PENCEMAR UDARA

SUMBER PENCEMARAN UDARA



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**86 students
aged 13-16
from non-science background**



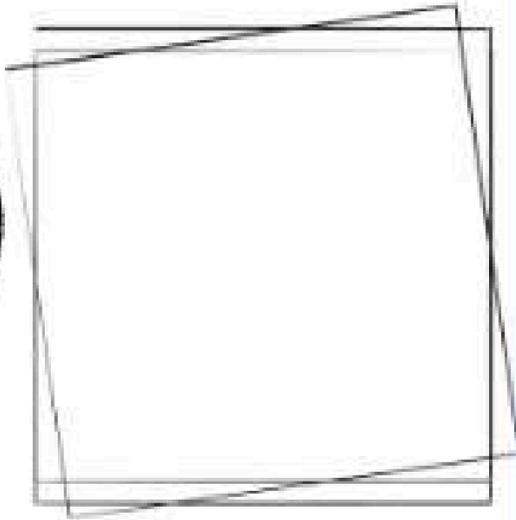
POLLUTION DETECTIVES

KUMPULAN:

ARAHAN 1

Senaraikan sumber pencemaran udara yang berkemungkinan terdedah kepada Maurice? Nyatakan sebab bagi pemilihan jawapan anda.

{10 Markah}



ARAHAN 2

Catatkan bacaan daripada gajet pengukur pencemaran udara di:

a)

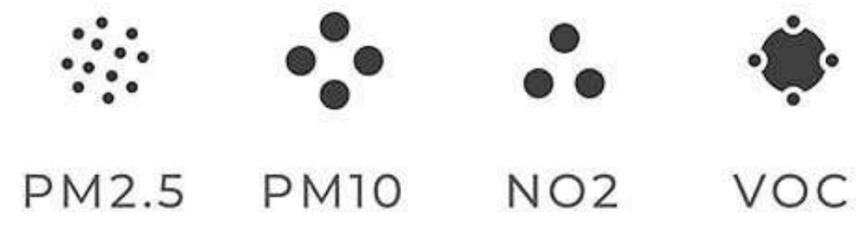
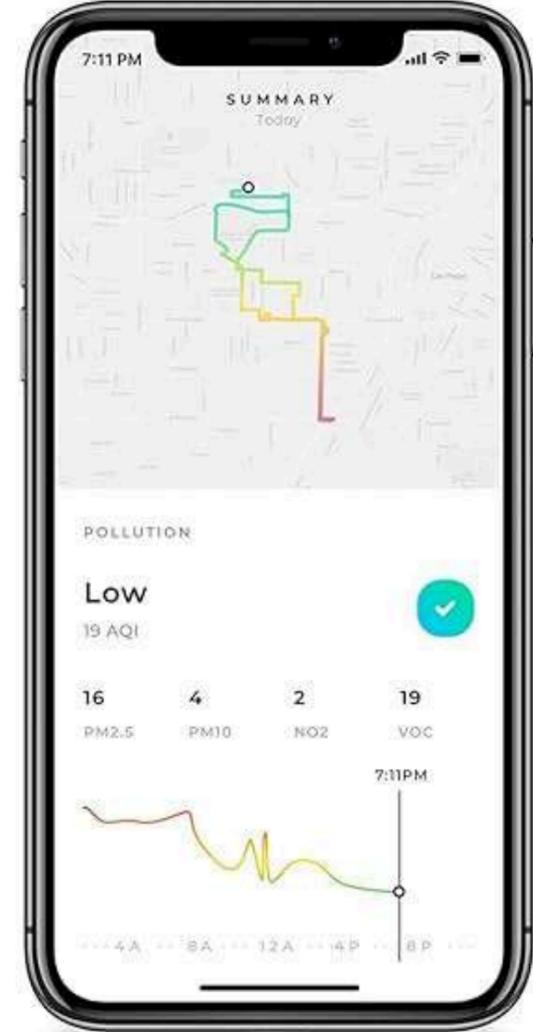
PM2.5	
Nitrogen dioksida	
Ozon	
Suhu Kelembapan Relatif	

b)

PM2.5	
Nitrogen dioksida	
Ozon	
Suhu Kelembapan Relatif	

{40 Markah}

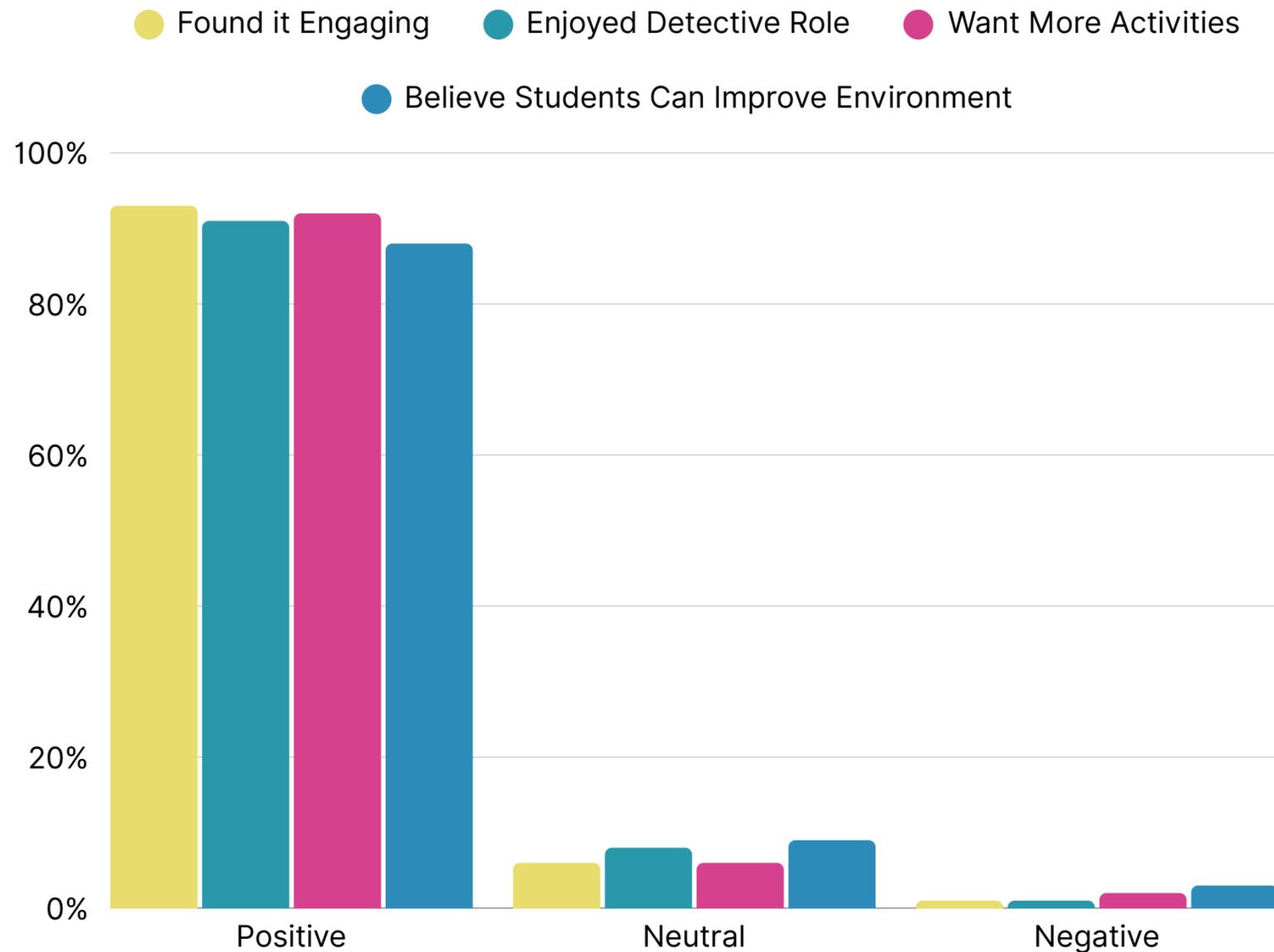
2 UNIT FLOW BY PLUME LABS



Results/Findings n=86

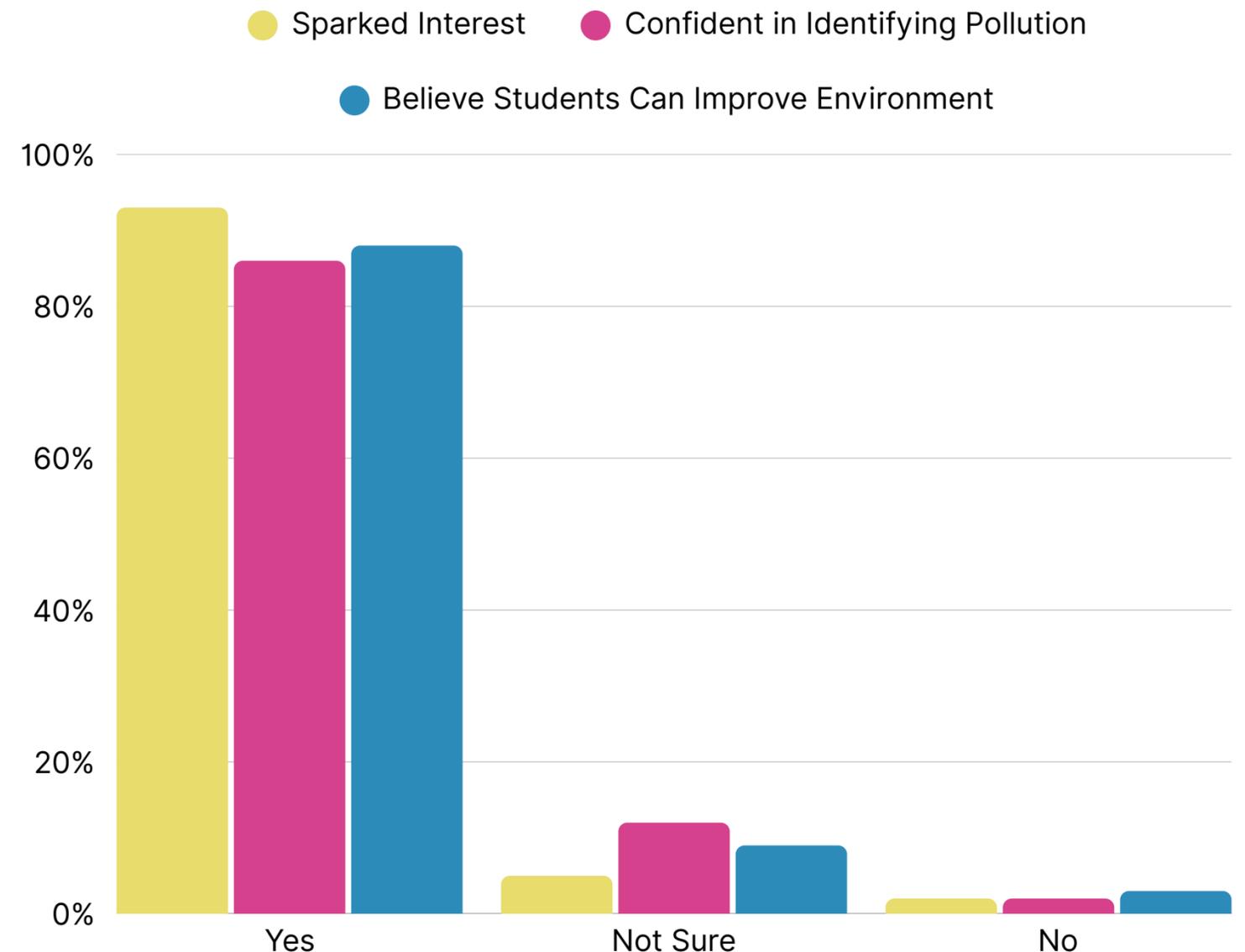
1 Student Engagement & Enjoyment

Student Engagement and Enjoyment in the "Air Pollution Detective" Activity



2 Learning Impact

Learning Outcomes from the Activity

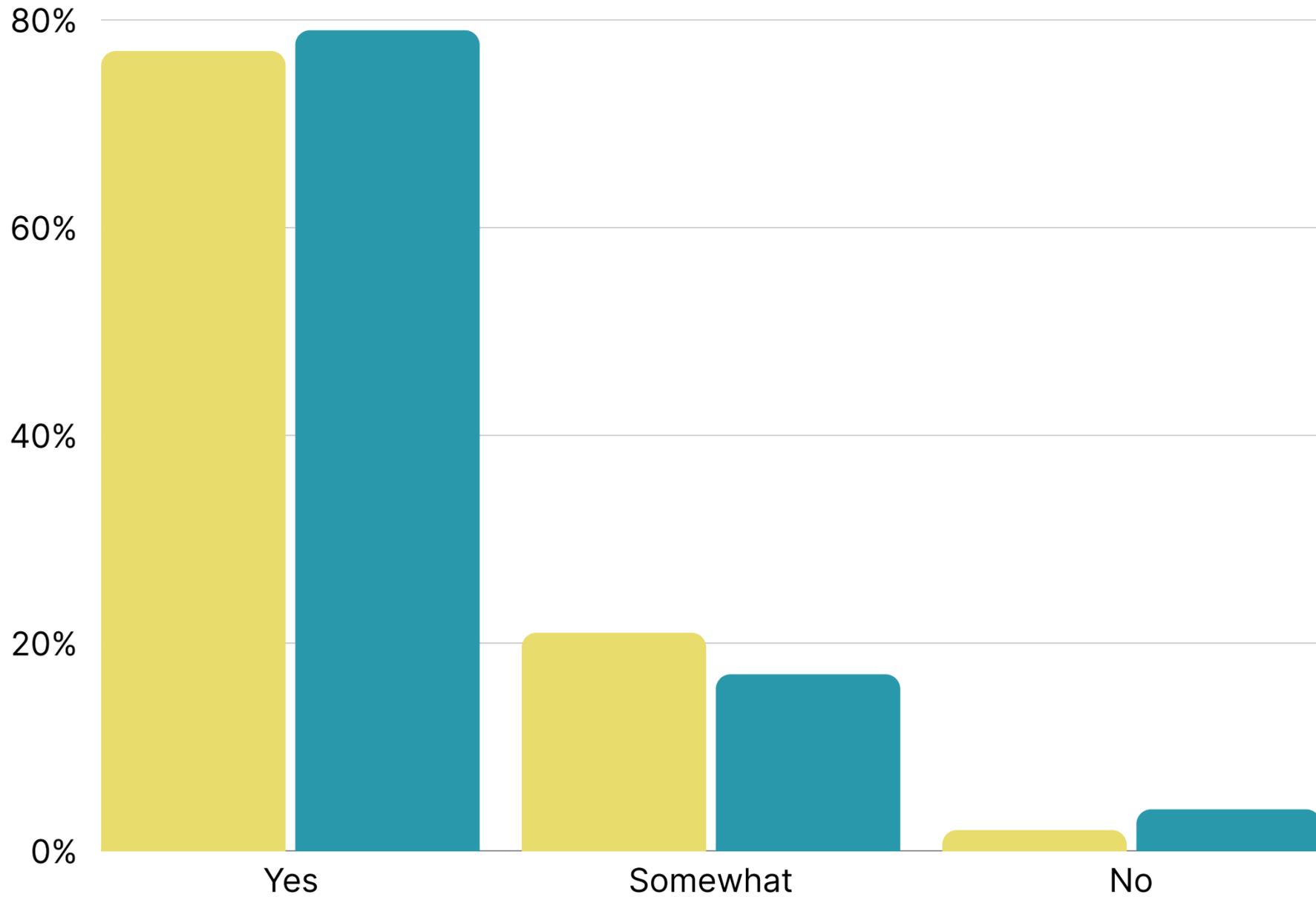


3

Sensor Usability

Hands-On Use of Low-Cost Sensors

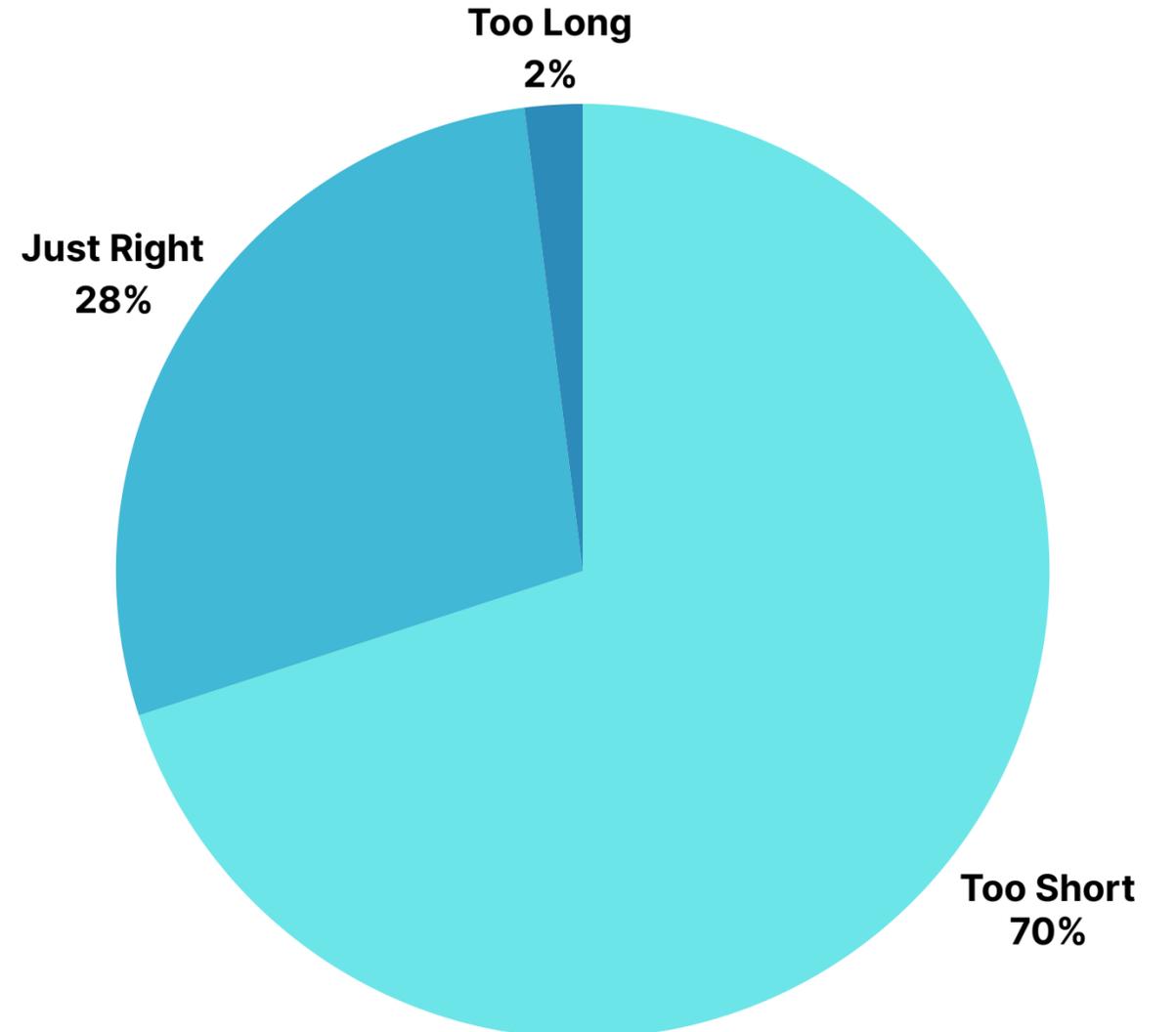
● Sensor Easy to Use ● Found Better Route for Maurice



4

Sensor Usability

Was the Time Enough?





Key-Takeaways

- Fit-for-purpose design matters more than device price
- Calibration, QA/QC, and context are not optional
- **A story-based approach with Maurice's case** --> activity more meaningful and relatable --> helped students stay **engaged** and apply what they learned to **real-life problems**
- Even with **limited time and simple sensors, students were able to collect, understand, and use air quality data to recommend safer walking routes**
- Small sensors can create big impact... but only when we pair accessibility with good science and shared best practice!

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Any question?



“We do not inherit the Earth from our ancestors, we borrow it from our children!”