Air quality sensor data towards Clean Air Action Planning in Manila, Philippines

ASIA BLUE SKIES PROGRAM

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Clean Air Asia:
leading the regional mission for improved air quality in Asian cities

AIR QUALITY AND CLIMATE CHANGE PROGRAM

- Ambient Air Quality and Emission Standards
- Emission Inventories and AQ Modeling
- Air Quality Communication
- Clean Air Action Plans
- Stationary Sources

SUSTAINABLE TRANSPORT PROGRAM

- Clean Fuels and Vehicles
- Green Freight and Logistics
- Low Emissions Urban Development

Training & Workshops
Hands-on Work

CAPACITY BUILDING

INFORMING FOR ACTION

Data gathering & analysis
Knowledge products
Awareness raising

POLICY GUIDANCE

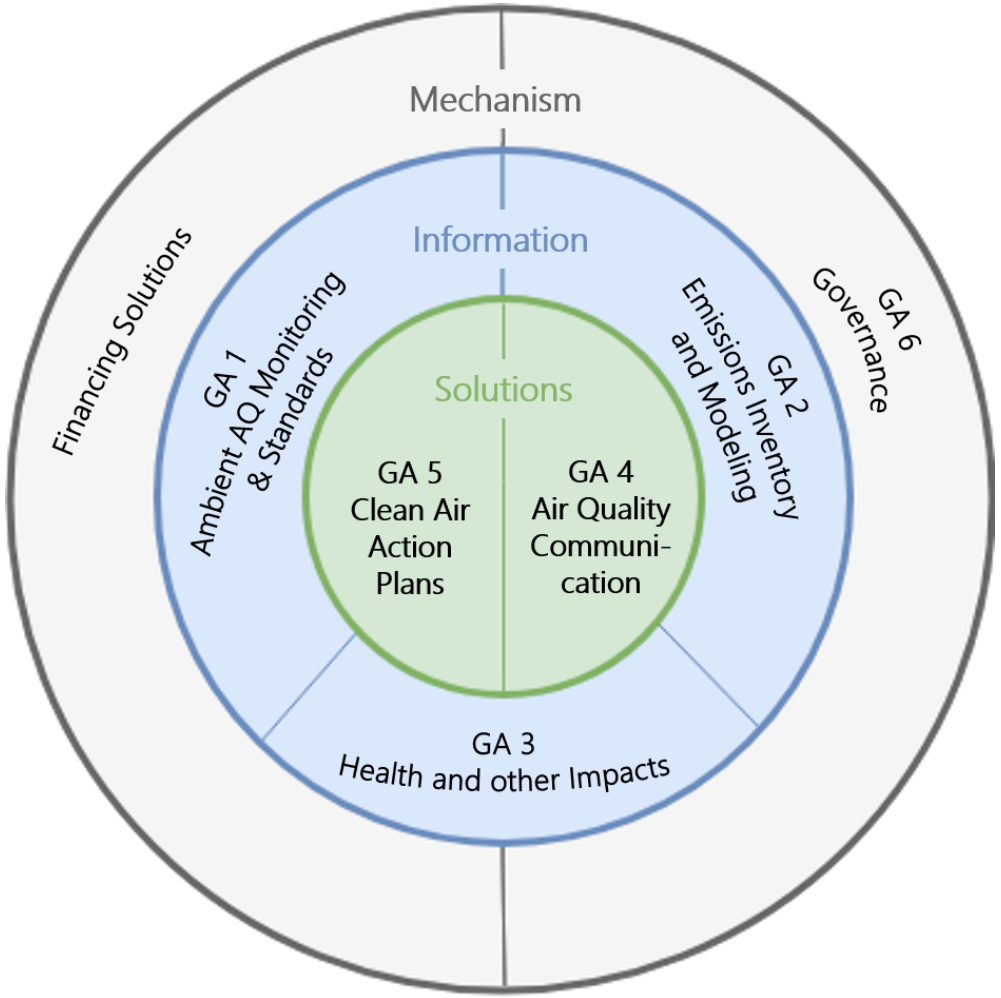
Science-based

www.cleanairasia.org

The Asia Blue Skies Program

Photo from Rappler (2020)

What do cities do to manage air pollution?



GUIDANCE FRAMEWORK FOR BETTER QUALITY IN ASIAN CITIES

KNOWLEDGE BASE

- **Level of pollution**
- **Sources of Pollution**
- **Impacts**

SOLUTIONS

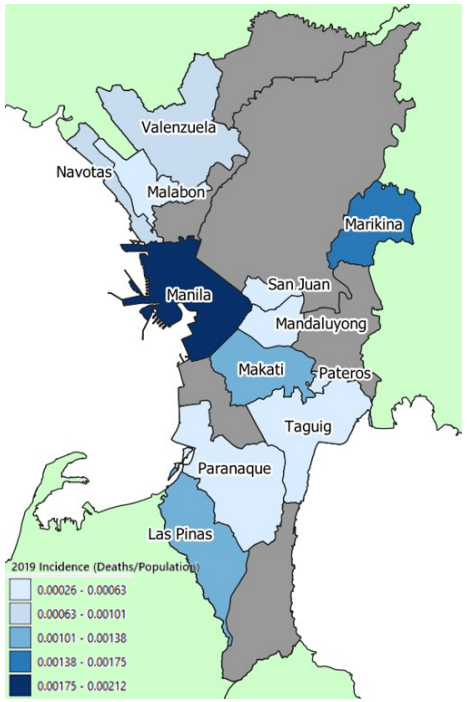
- **National: policies and frameworks**
- **Local: Clean Air Action Plans, measures**
- **Individual**

Institutionalized through CLEAN AIR ACTION PLANS

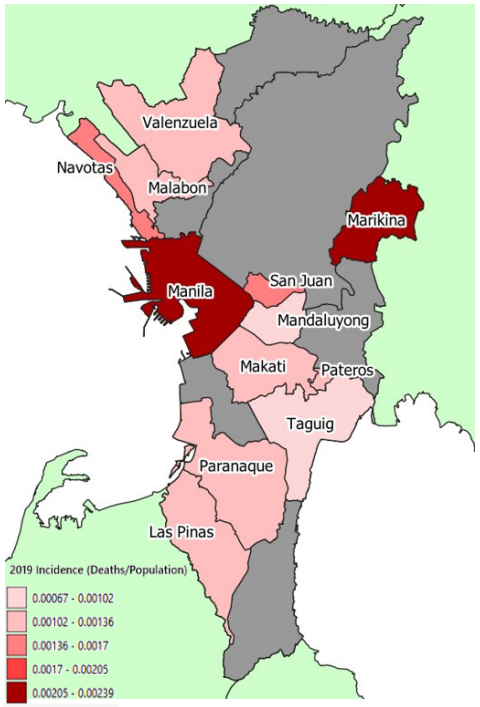
Motivation: Health impacts of air pollution

Prior to the pandemic, City of Manila has **high incidence of respiratory-related morbidity and mortality cases**

- More than half of the ten leading causes of deaths and illnesses in the city can be worsened by air pollution

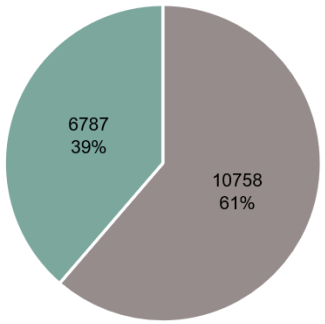


Deaths due to Pneumonia/ Bronchopneumonia in Metro Manila in 2019 (Source: Department of Health, 2020)

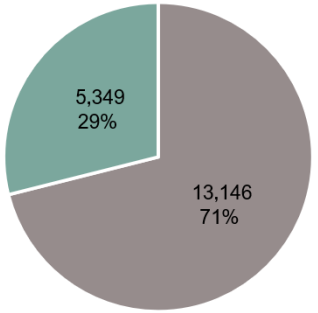


Deaths due to Heart Diseases in Metro Manila in 2019 (Source: Department of Health, 2020)

2018 Mortality Cases in City of Manila



2019 Mortality Cases in City of Manila



Respiratory cases/can be worsened by air pollution

Mortality cases not related to air pollution

- National insurance (PhilHealth) claims in Manila health facilities on 2019:

Cerebrovascular	Php 81.5 million
Respiratory	Php 54 million
COPD	Php 4.5 million
Ischemic Heart Disease	Php 4.5 million
Cardiovascular	Php 3.2 million
Lung Cancer	Php 3 million

Majority (74%) of the claims are for patients 45 y/o and above.

Improving the air quality in the city can contribute to improving the health of its citizens (and reducing hospital costs).

Baseline Air Quality Monitoring towards AQM

Freedom Triangle
(near Manila City Hall, Taft Ave.)

Very busy roadside
Jan 21, 2020 to present

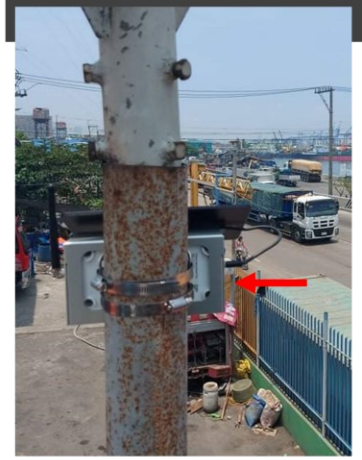
Rizal Park
(near the Rizal Shrine)

Open area, green space
Feb 4, 2020 to present

Mendiola
(corner Concepcion Aguila St.)

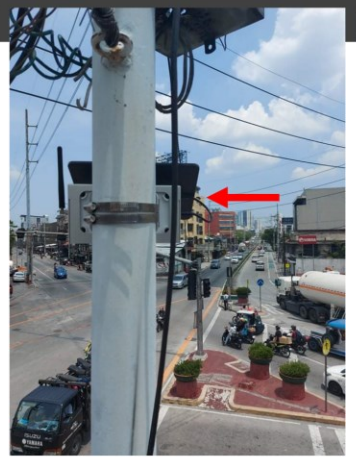
School zone
Feb 4 to Aug 27, 2020

Port Area
(Radial Road 10, Manila Port)



Very busy roadside
Jun 1, 2021 to present

Aurora Boulevard
(corner Retiro, Dimasalang St.)

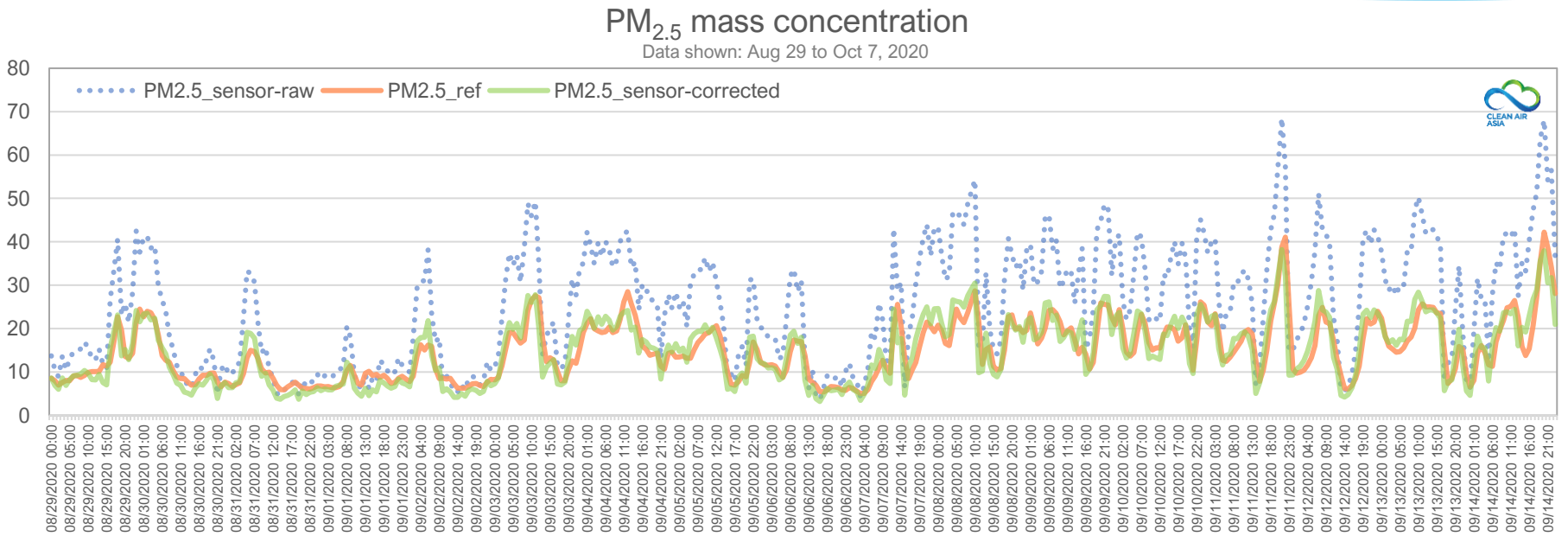


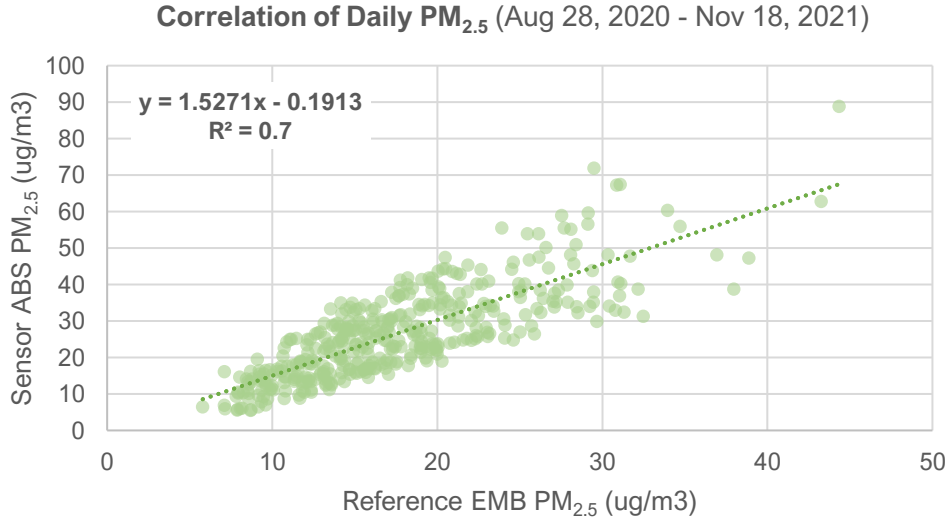
Very busy intersection
Jun 1, 2021 to present

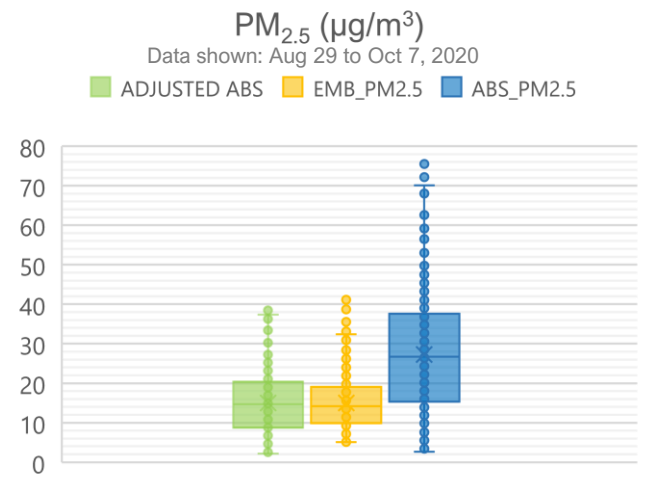
Fabella Hospital
(In Santa Cruz, Manila)

Outdoor/indoors (ward)
Nov 26/Dec 30, 2021 to present

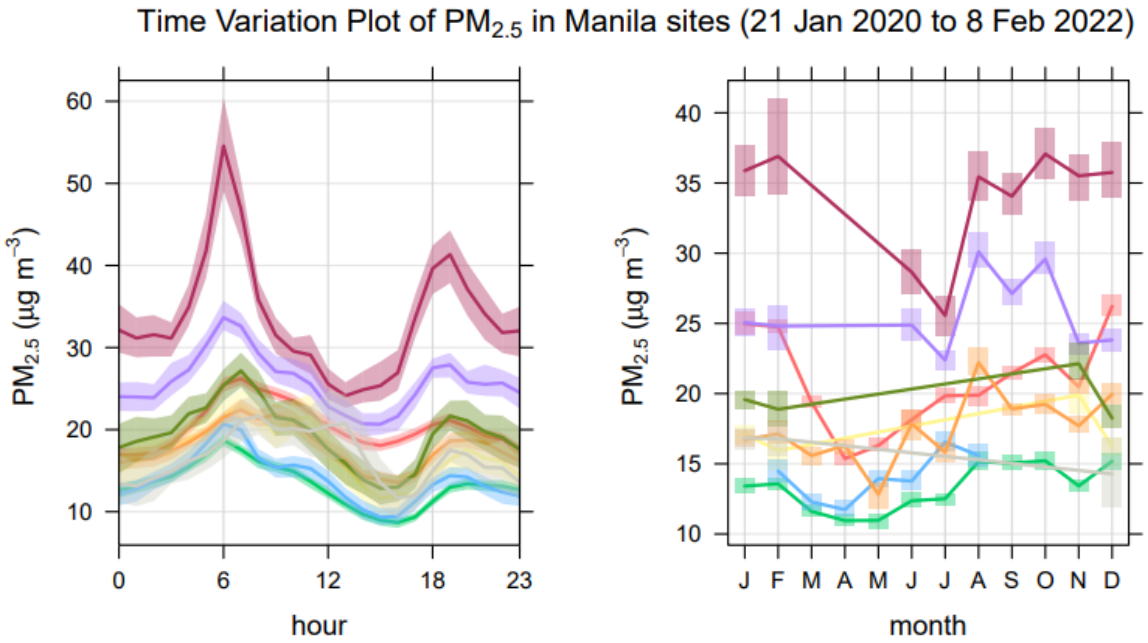
Collocation with DENR EMB Reference Monitor







Hourly, daily, weekly, and monthly $PM_{2.5}$ trends in Manila



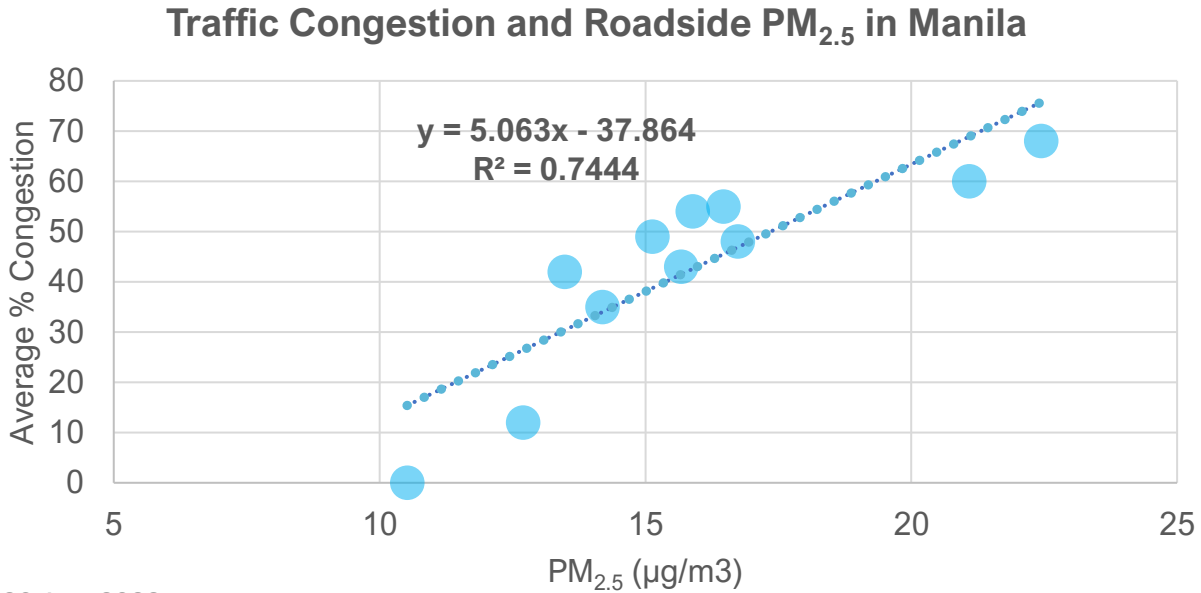
Port Area (heavy duty trucks to and from the Manila port pass through)

Aurora Intersection (busy road in the middle of residential, commercial areas)

- $PM_{2.5}$_freedom
- $PM_{2.5}$_dps
- $PM_{2.5}$_rizal
- $PM_{2.5}$_mendiola
- $PM_{2.5}$_mehan
- $PM_{2.5}$_port
- $PM_{2.5}$_aurora
- $PM_{2.5}$_fabella.outdoor
- $PM_{2.5}$_fabella.indoor

- **Highest period averages** were observed in January and December; Peak hours from 6-8 AM and 6-7 PM
- in the Port area and Aurora roadside (**heavy traffic sites with diesel trucks**) with **UNHEALTHY AQI**

- During the March-April 2020 COVID-19 strict lockdown, the measured lower roadside $PM_{2.5}$ was in congruence with observed lower traffic volume



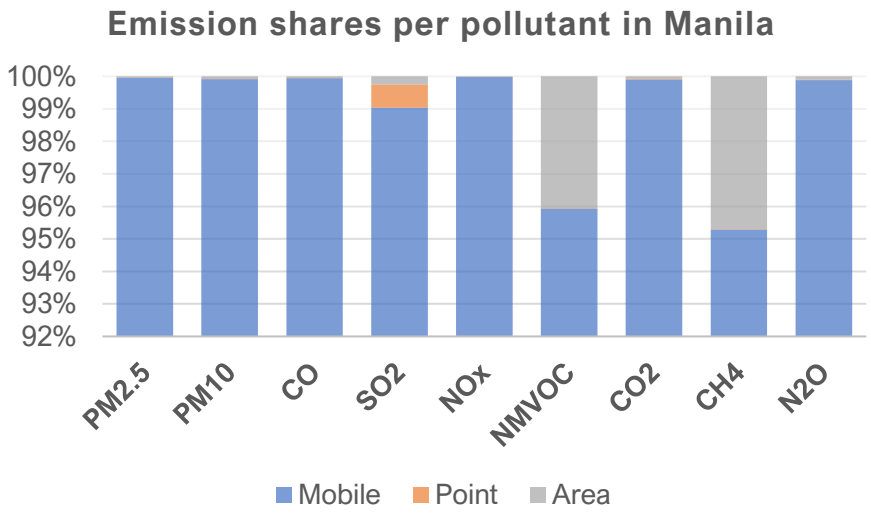
Average daily $PM_{2.5}$ in Manila

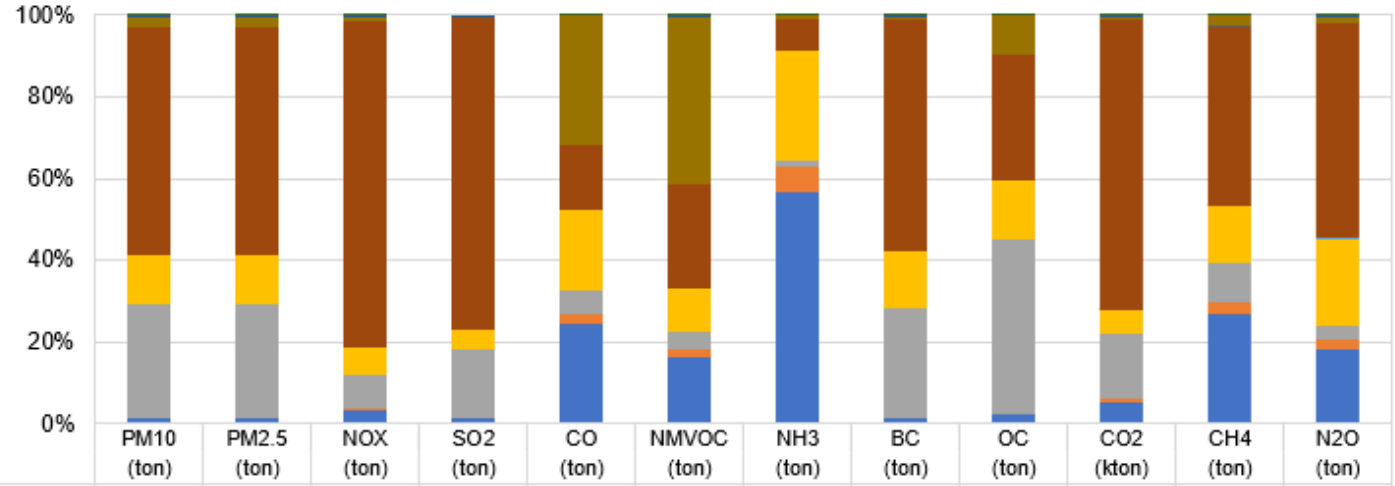
Legend	Comply with WHO 2021	Comply with WHO 2005	> Comply with DENR	> Exceed WHO, DENR
$PM_{2.5}$ Ave. Conc.	WHO 2021 AQG	WHO 2005 AQG	DENR EMB NAAQGV	
Daily	15	25	35	

*Data covers Jan 2020-Feb 2022

Emissions Inventory in Manila

Mobile sources dominate the emissions share in the city, especially from *heavy-duty trucks*
- **most of the emissions can thus be controlled through management of the transport sector**





	PM10 (ton)	PM2.5 (ton)	NOX (ton)	SO2 (ton)	CO (ton)	NMVOC (ton)	NH3 (ton)	BC (ton)	OC (ton)	CO2 (kton)	CH4 (ton)	N2O (ton)
Three wheeler	0	0	0	0	16	8	0	0	0	0	0	0
Jeepney	115	115	3,098	0	730	266	1	57	9	666	35	10
Motorcycle	660	660	4,939	0	174,058	43,238	22	93	433	787	375	21
Trailer	23	23	709	0	136	42	0	14	2	201	11	1
Truck	14,853	14,853	459,285	35	87,848	26,885	233	9,277	1,411	130,121	6,848	810
Buses	9	9	190	0	53	16	0	5	1	24	1	-
Mini Buse	2	2	37	0	10	3	0	1	0	5	0	-
UV	4	4	48	0	141	14	1	3	1	23	3	0
SUV_Van	3,204	3,204	37,783	2	111,000	11,235	779	2,239	665	11,000	2,159	330
LCV	7,355	7,355	47,851	8	30,394	4,485	42	4,406	1,977	29,007	1,527	56
Taxi	37	37	1,919	0	14,345	1,839	177	22	10	1,043	452	30
PC	347	347	17,964	1	134,259	17,213	1,654	209	92	9,636	4,180	282

Road segments with the greatest number of heavy-duty trucks contribute the highest emissions

AQ sensor data in road segments with high volume of heavy-duty trucks also recorded the highest $PM_{2.5}$ concentrations

Our approach to Clean Air Action Planning (from Data to Action)

KNOWLEDGE BASE

SOLUTIONS

AIR QUALITY MONITORING
- **Level of pollution**

- Baseline air quality levels in monitoring sites
- Air quality targets
- Highlights contribution of roadside emissions to ambient air quality

EMISSIONS INVENTORY
- **Sources of Pollution**

- Applicable emission sources
- Priority sources based on emissions contribution
- Baseline emissions

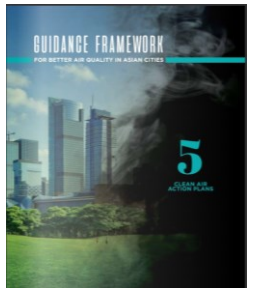
HEALTH MAPPING
- **Impacts**

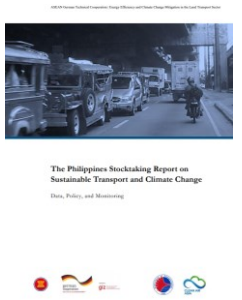
- Priority districts for exposure reduction
- Baseline PhilHealth incidences

CITY PROFILE, ACTIVITIES, TRENDS
- **Local conditions and air pollution drivers**

Informs targeting of pollution control measures

Monitoring and evaluation framework for pollution control measures





Quantifying the benefits of transport measures

LEAP Integrated Benefits Calculator

The Long-range Energy Alternatives Planning System with Integrated Benefits Calculator

- **LEAP-IBC: informs prioritization of measures and for developing mitigation action plans**
- Scenarios modelled related to transport

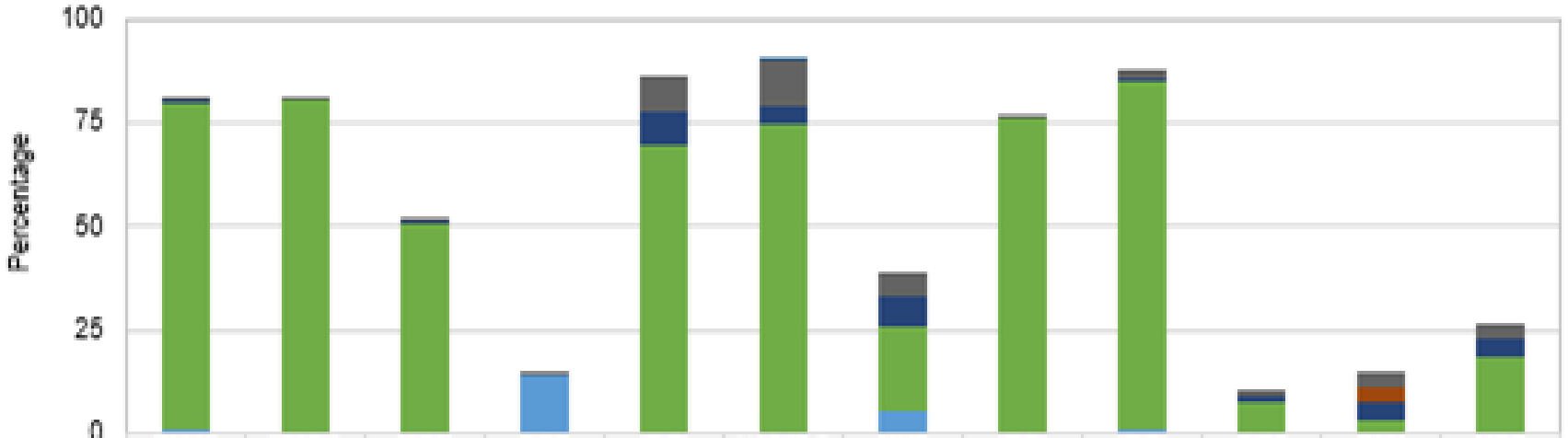
Scenario	Description
TRANS_EU4	100% of vehicles **comply with Euro4** standards by 2030
TRANS_PUB	20% of VKT of PC, MC **converted to public transport** by 2030
TRANS_EV	21% of VKT of PC, MC, buses, minibuses, jeepneys, and three wheelers **converted to electric vehicles** by 2030

Basis

- Existing vehicle fleet share
- Gradual government shift
- EV Roadmap of PH

% Emissions Reduction (BAU vs year 2030)

- For PM related species (i.e., PM_{10}, $PM_{2.5}$, OC and BC) and NO_X, the **TRANS_EU4 (complying with Euro 4 standards) can lead to emissions with 75.6% - 83.9%, and 50.2% reduction**, respectively



	PM10	PM2.5	NOX	SO2	CO	NMVOC	NH3	BC	OC	CO2	CH4	N2O
2030 TRANS_PUB	0.8	0.8	0.8	0.0	9.0	10.3	6.1	0.4	2.5	1.3	3.6	3.7
2030 TRANS_EV	0.4	0.4	1.0	0.0	7.8	5.0	7.1	0.3	0.6	1.6	4.1	4.4
2030 TRANS_EU4	79.5	79.9	50.2	0.0	69.4	74.0	20.3	75.6	83.9	7.1	2.9	17.9

- Population weighted annual $PM_{2.5}$ conc. in Manila was 33 µg/m^3 in 2019
  - Under BAU, it will increase to 38 µg/m^3 by 2030
  - If all measures are implemented, $PM_{2.5}$ could decrease (36 µg/m^3 by 2030) – avoiding a total of > **16,000 avoided premature deaths** from 2020-2030 **(32 billion USD in associated economic benefits**)

WAY FORWARD: Policy recommendations on transport and implementation

ACCELERATING EURO 4 ADOPTION
(inspection and maintenance for old vehicles, low sulfur fuels, DPF installation)

TRAFFIC DEMAND MANAGEMENT
(parking management, congestion charge zone, peak management)

PROMOTION OF PUBLIC TRANSPORT AND NMT
(increased public transport capacity, infrastructure development supporting public transport and NMT, subsidy for public transport)

PROMOTION OF E-VEHICLES
(charging infrastructure, battery reuse/recycling, tax exemptions)

1. Operationalizing the Manila City Clean Air Action Plan

- Formation of a **Transport Core Group** for coordination and implementation of transport measures
- Strengthening **inspection and maintenance of Manila DPS vehicles** as the first step in enforcing Euro IV compliance
- Community engagement and continuation of AQ monitoring

2. Continued capacity building trainings for the City of Manila

including traffic and transport management

3. Air quality communication in support of the CAAP implementation

Key takeaways and lessons learned

PARTNERSHIPS = PROGRESS

- Partnerships and collaborations lead to more efficient use of resources
- Measures must be aligned with the goals of the stakeholders
- Capacity building of partners pushes sustainability of efforts

DATA IS KEY

- Comprehensive data collection and analysis is essential in
  - Justifying the need for urgent action
  - Identification of priority measures
  - Guiding decision-making with high level of certainty

Real-time air quality data from the sensor network increased engagement, proactiveness and action from the local government and stakeholders in the implementation of measures to improve air quality

Thank you!

TEAM MEMBERS: Precious Benjamin, Dang Casanova, David Ecal, Dana Babela, Erika Macapagal, Lai Nguyen Huy, Thao Pham
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