

Oman Environment Forum 2020

Muscat, Oman

10 January 2022

Clean Air Actions to Mitigate PM_{2.5}: Thailand's Experience

Dr. Supat Wangwongwatana



**Faculty of Public Health
Thammasat University**



Clean Air Actions in Thailand

Outline

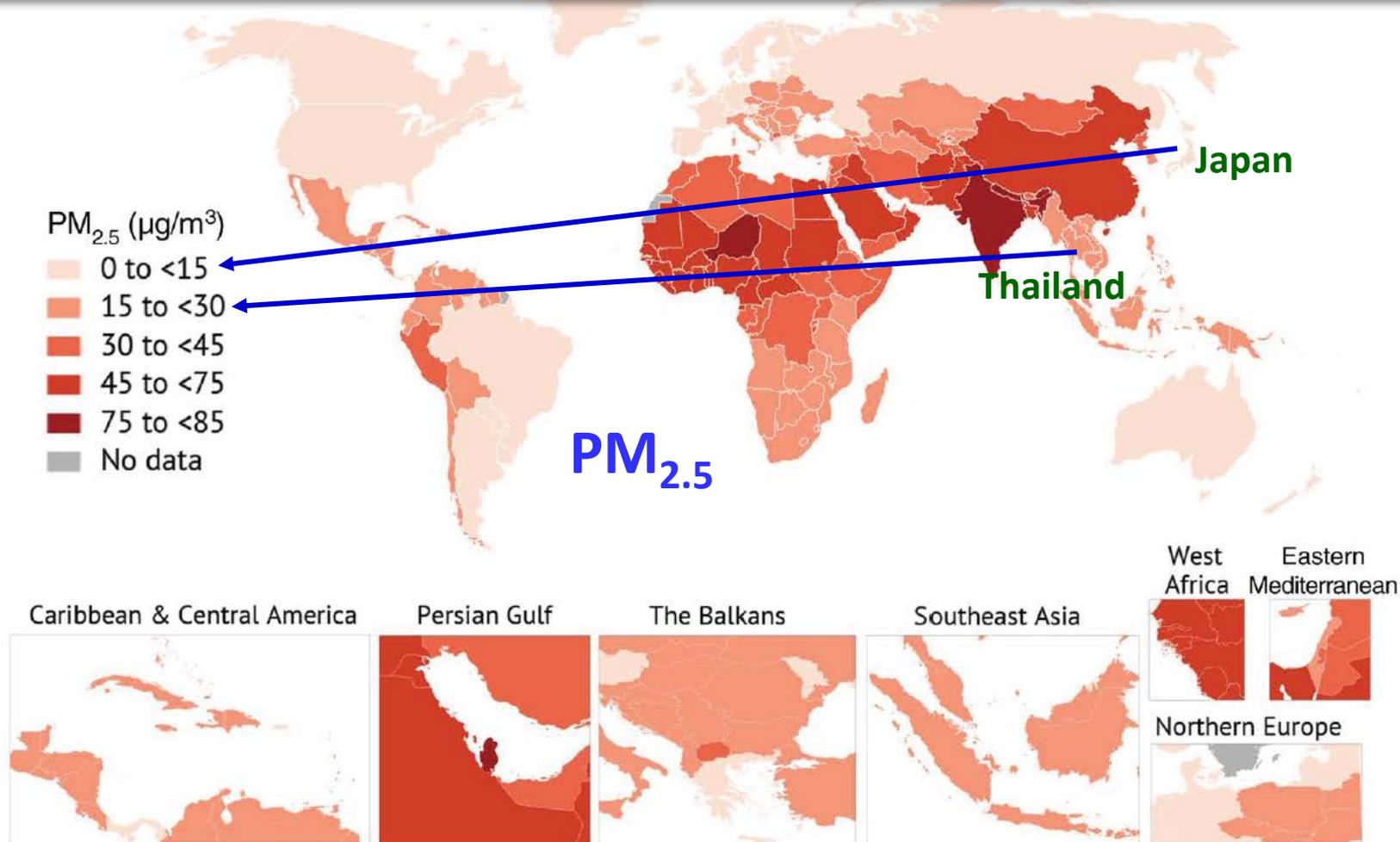
- **State of Global Air Quality**
- **State and Trends of Thailand Air Quality**
- **State of Problems and Sources of Air Pollution**
- **Process in Developing Clean Air Action Plan**
- **Clean Air Actions in Thailand**
- **Evaluation of Success**

State of Global Air Quality

STATE OF GLOBAL AIR / 2020

A SPECIAL REPORT ON GLOBAL EXPOSURE TO AIR POLLUTION AND ITS HEALTH IMPACTS

Global map of population-weighted annual average PM_{2.5} concentrations in 2019



Visit stateofglobalair.org to explore data for your country or region.

Top 10 countries with the highest population-weighted annual average PM_{2.5} exposures in 2019

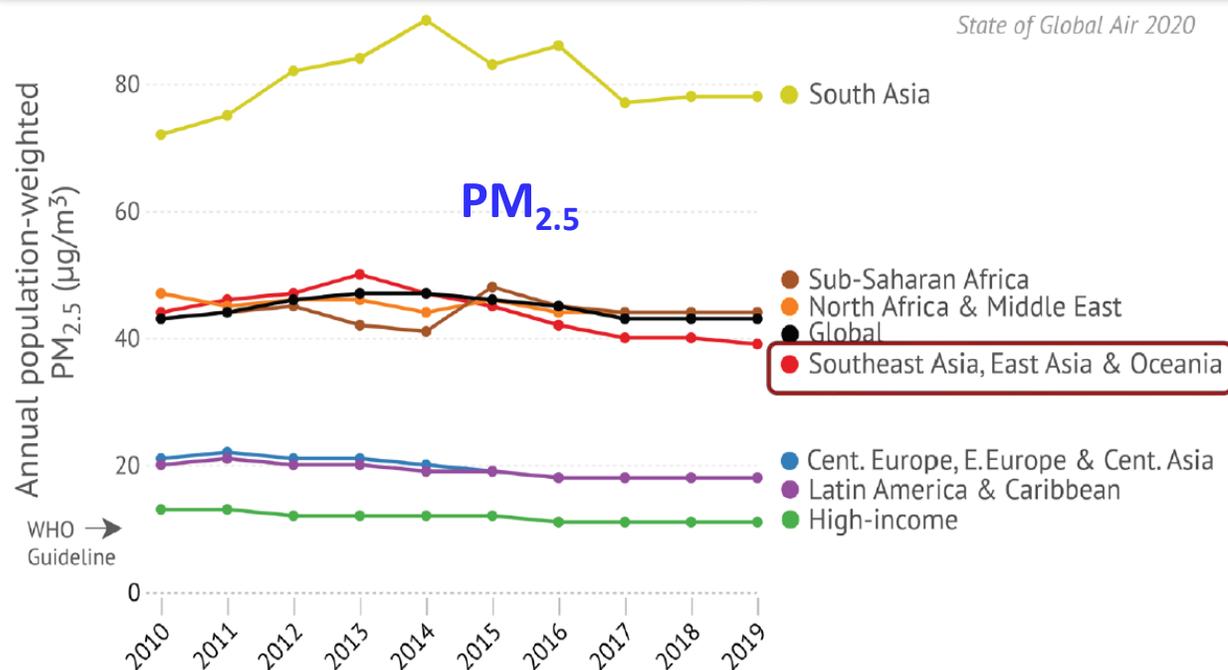
Country	PM _{2.5} Concentration (µg/m ³)	95% Uncertainty Intervals*
India	83.2	76.1 to 90.7
Nepal	83.1	62.9 to 107
Niger	80.1	42.2 to 145
Qatar	76.0	59.2 to 96.6
Nigeria	70.4	45.4 to 105
Egypt	67.9	47.8 to 92.8
Mauritania	66.8	37.6 to 108
Cameroon	64.5	43.8 to 92.6
Bangladesh	63.4	55.1 to 73.8
Pakistan	62.6	49.9 to 77.5

* The 95% uncertainty intervals are a measure of scientific uncertainty. They reflect a range of values, from the 2.5th to the 97.5th percentile of a possible distribution of values, within which the true concentration is likely to fall.

STATE OF GLOBAL AIR / 2020

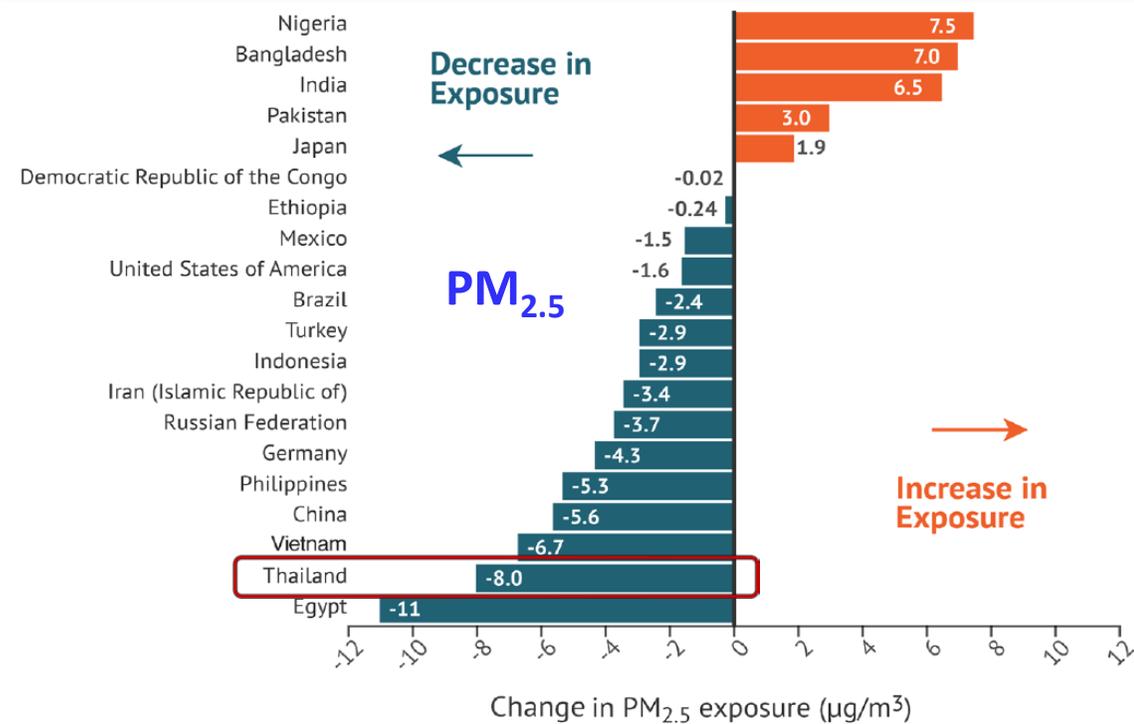
A SPECIAL REPORT ON GLOBAL EXPOSURE TO AIR POLLUTION AND ITS HEALTH IMPACTS

Trends in population-weighted annual average PM_{2.5} concentrations in different regions, 2010-2019



Visit stateofglobalair.org to explore data for your country or region.

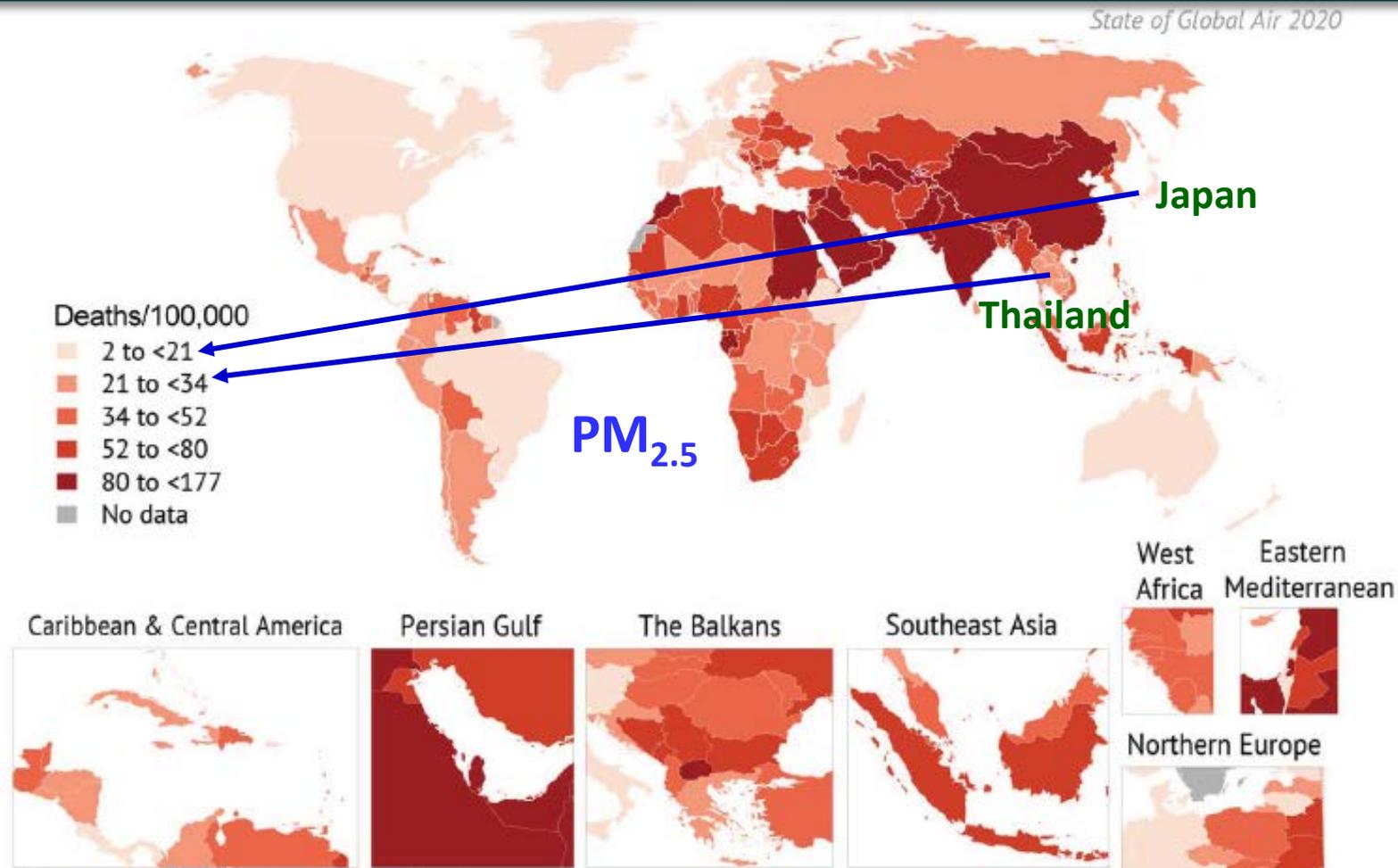
Change in population-weighted annual average PM_{2.5} exposure in the 20 most populous countries, 2010-2019



STATE OF GLOBAL AIR / 2020

A SPECIAL REPORT ON GLOBAL EXPOSURE TO AIR POLLUTION AND ITS HEALTH IMPACTS

Global map of age-standardized rates of death attributable to PM_{2.5} in 2019

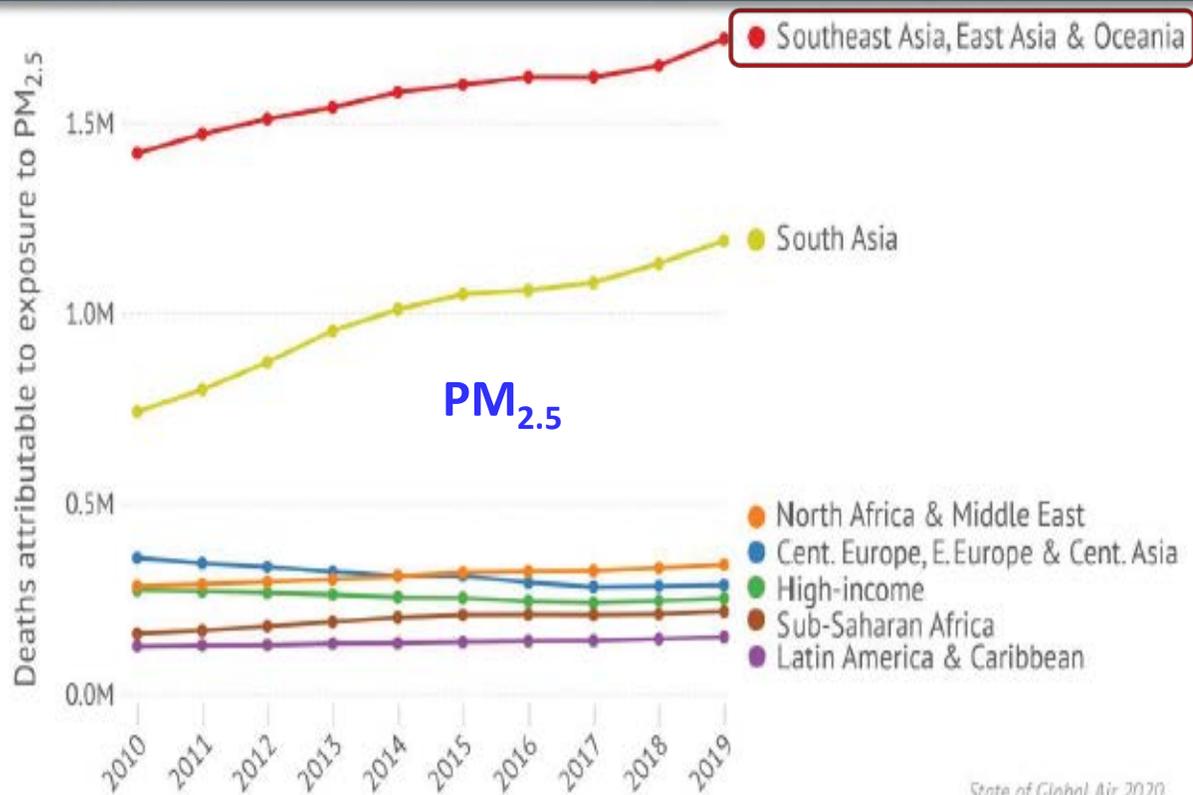


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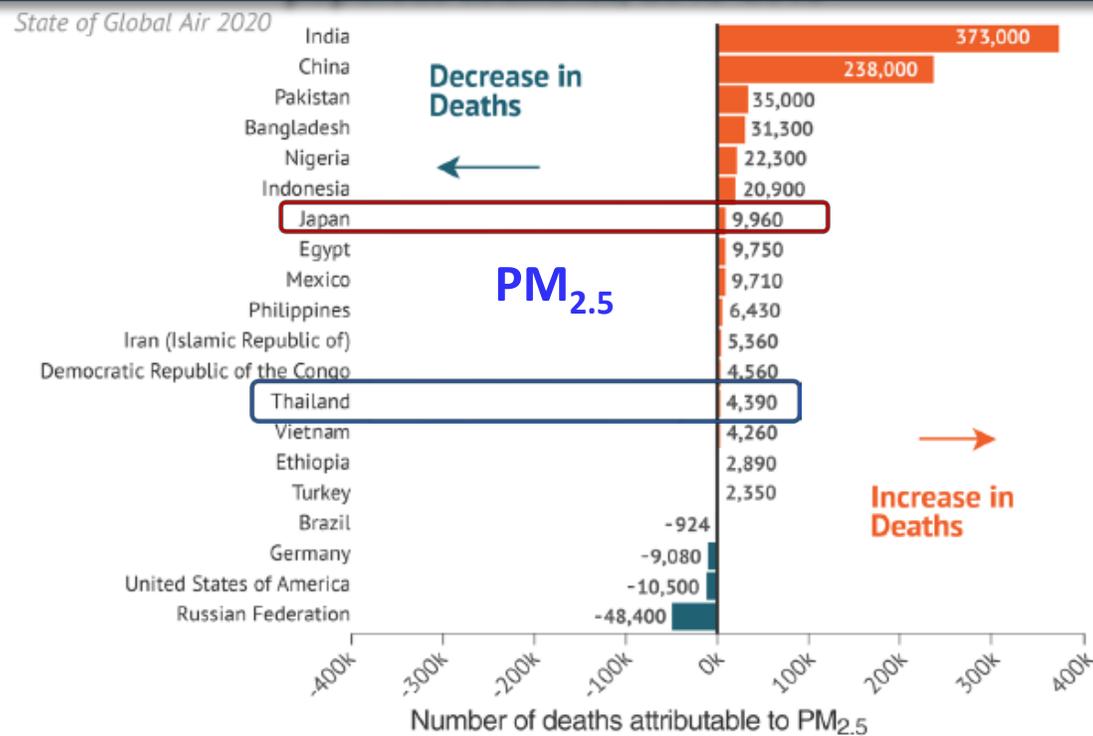
STATE OF GLOBAL AIR / 2020

A SPECIAL REPORT ON GLOBAL EXPOSURE TO AIR POLLUTION AND ITS HEALTH IMPACTS

Trends in total deaths attributable to PM_{2.5} in different regions, 2010-2019



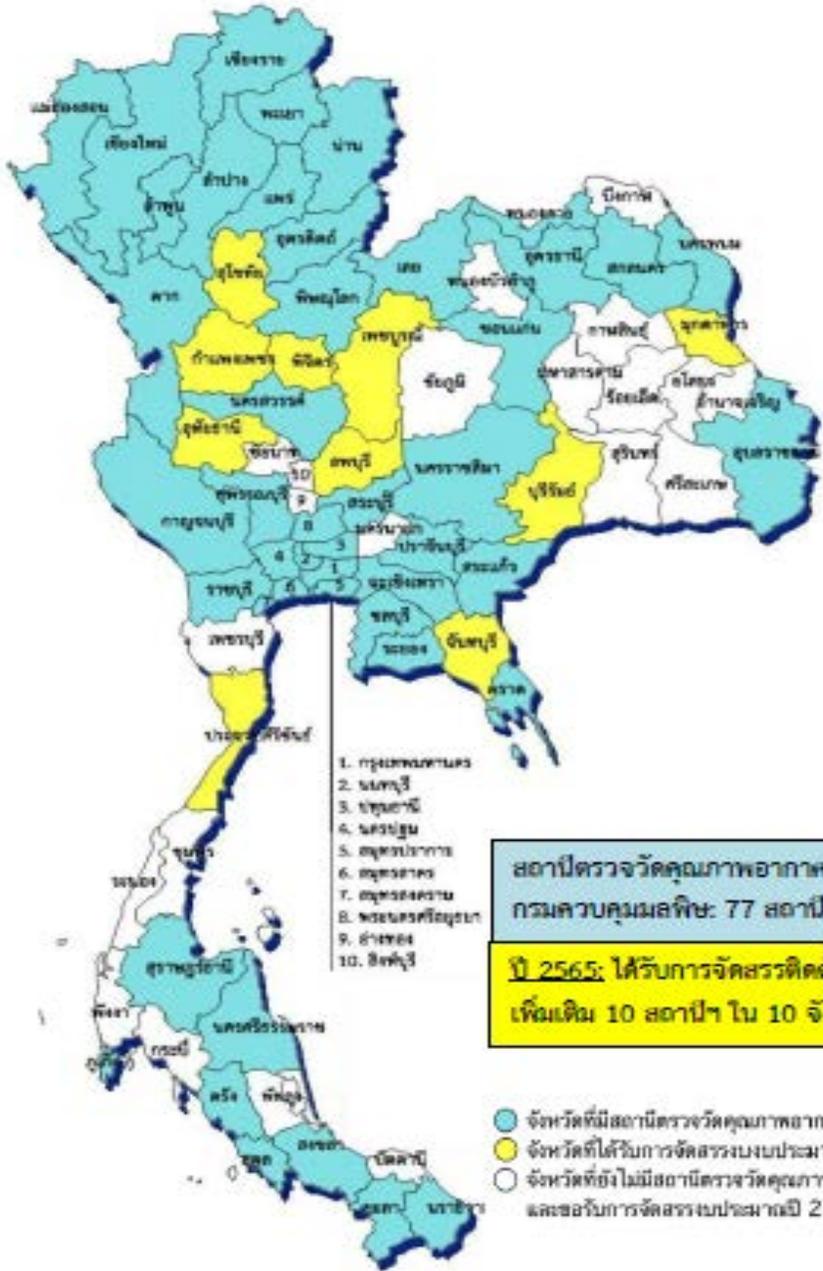
Change in total deaths attributable to PM_{2.5} in the 20 most populous countries, 2010-2019



Visit stateofglobalair.org to explore data for your country.

State of Thailand Air Quality

Thailand Air Quality Monitoring Network (PCD) in 2021



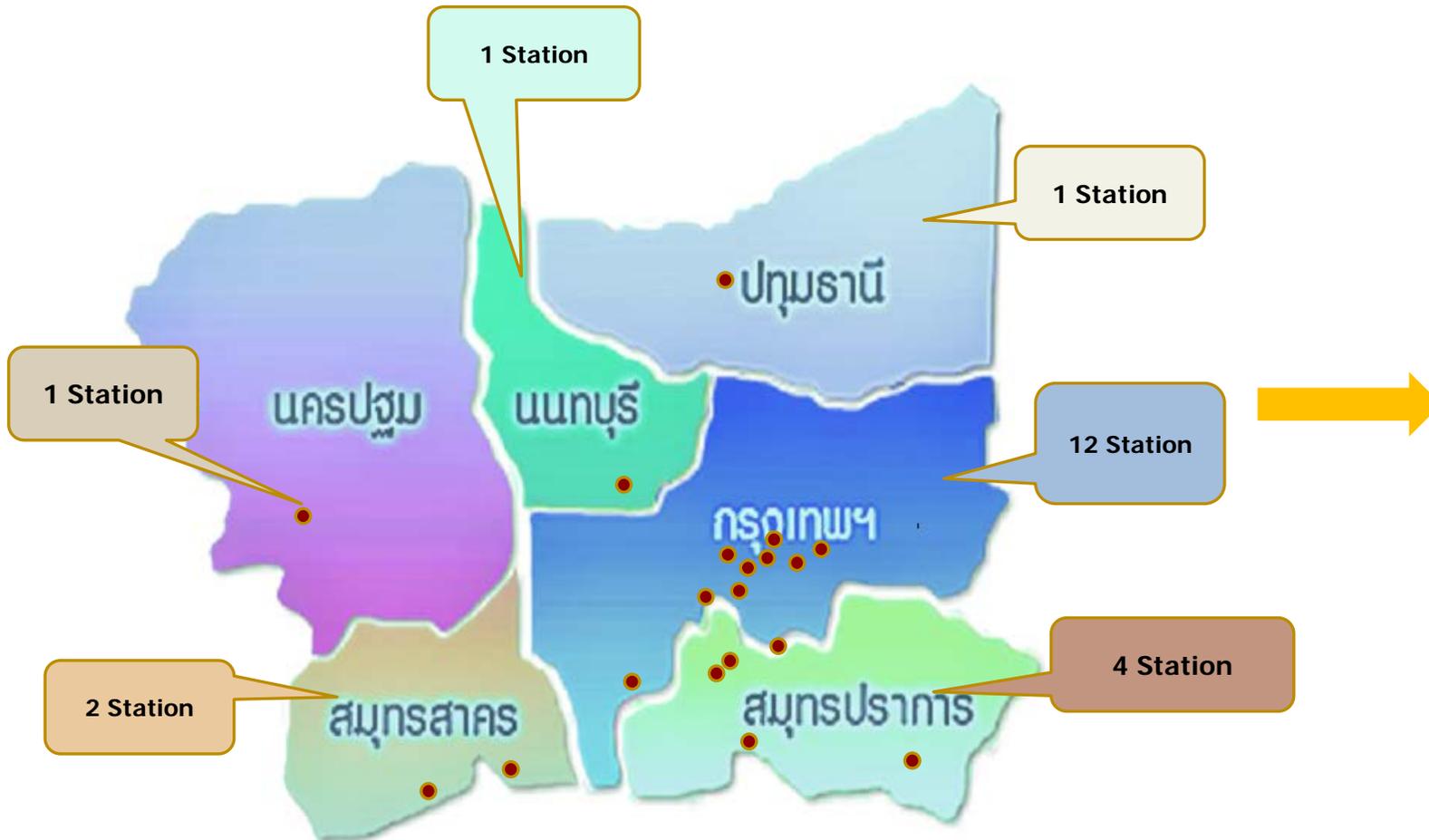
สถานีตรวจวัดคุณภาพอากาศ
 ครอบคลุมพื้นที่: 77 สถานี 46 จังหวัด
 ปี 2565: ได้รับการจัดสรรติดตั้งสถานี
 เพิ่มขึ้น 10 สถานี ใน 10 จังหวัด

- จังหวัดที่มีสถานีตรวจวัดคุณภาพอากาศ
- จังหวัดที่ได้รับการจัดสรรงบประมาณ ปี 2565
- จังหวัดที่ยังไม่มีสถานีตรวจวัดคุณภาพอากาศ และขอรับการจัดสรรงบประมาณปี 2566

- Automated air quality monitoring stations
 - 77 stations in 46 provinces
 - Monitored parameters: PM_{2.5}, PM₁₀, O₃, CO, NO₂, SO₂ and meteorological parameters such as wind speed, wind direction, temperature, humidity, solar radiation, and precipitation.
- Air quality monitoring mobile units: 9 units
- Outdoor standalone PM_{2.5} monitors



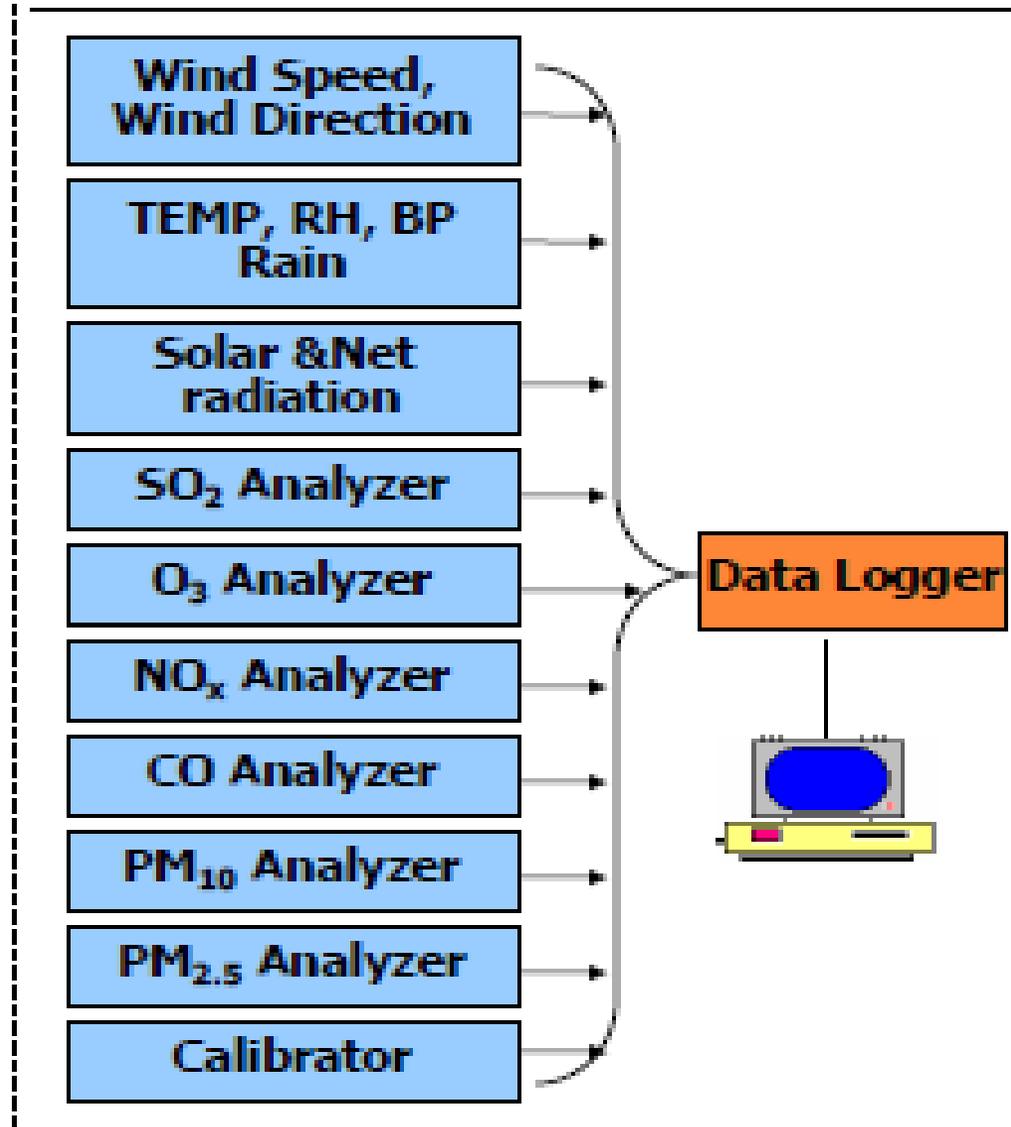
PM_{2.5} Monitoring Network in BMR – PCD



Years	PM _{2.5} Monitoring Stations
2011	1
2012	1
2013	1
2014	2
2015	3
2016	5
2017	6
2018	19 (Bangkok and Vicinity)
2020	21 (Bangkok and Vicinity)
	68 (Nationwide)
2021	21 (Bangkok and Vicinity)
	77 (Nationwide)

Diagram of Ambient Air Quality Monitoring Station and Data Transmission System

REMOTE STATION

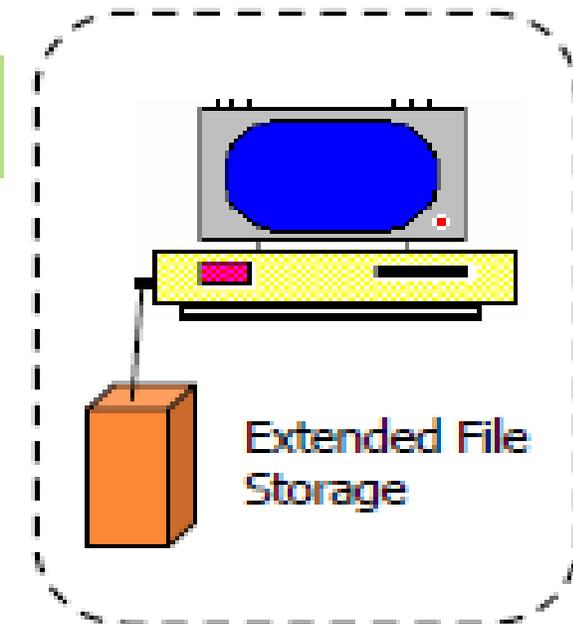


The central processing computer for data storage and analysis

Local Telephone Service



Internet
GPRS



State of Air Pollution in Bangkok in 2020

General Area

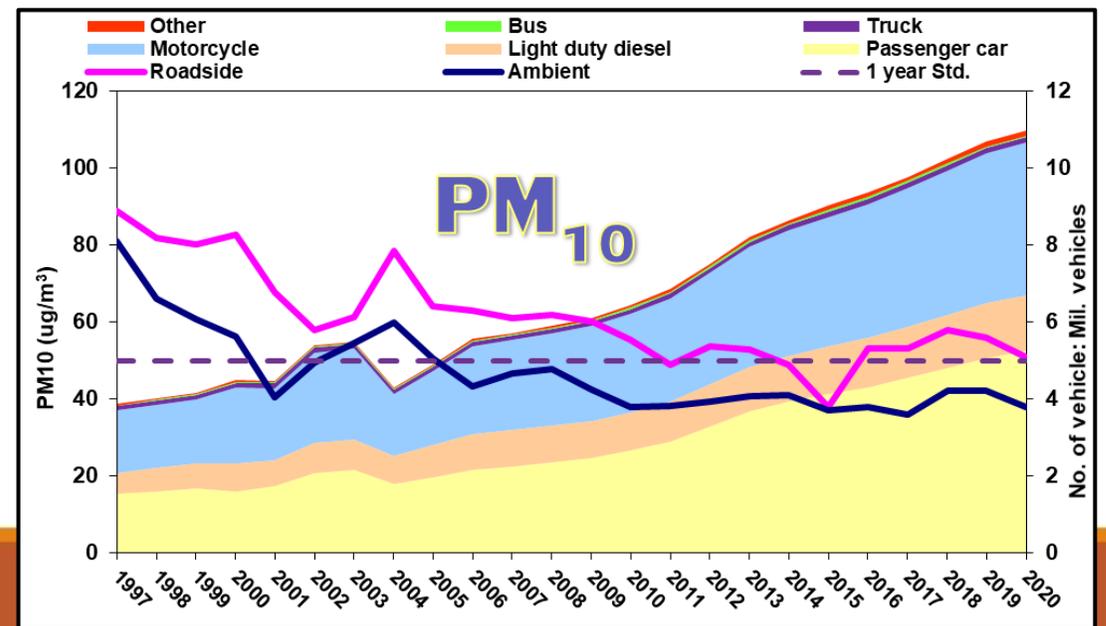
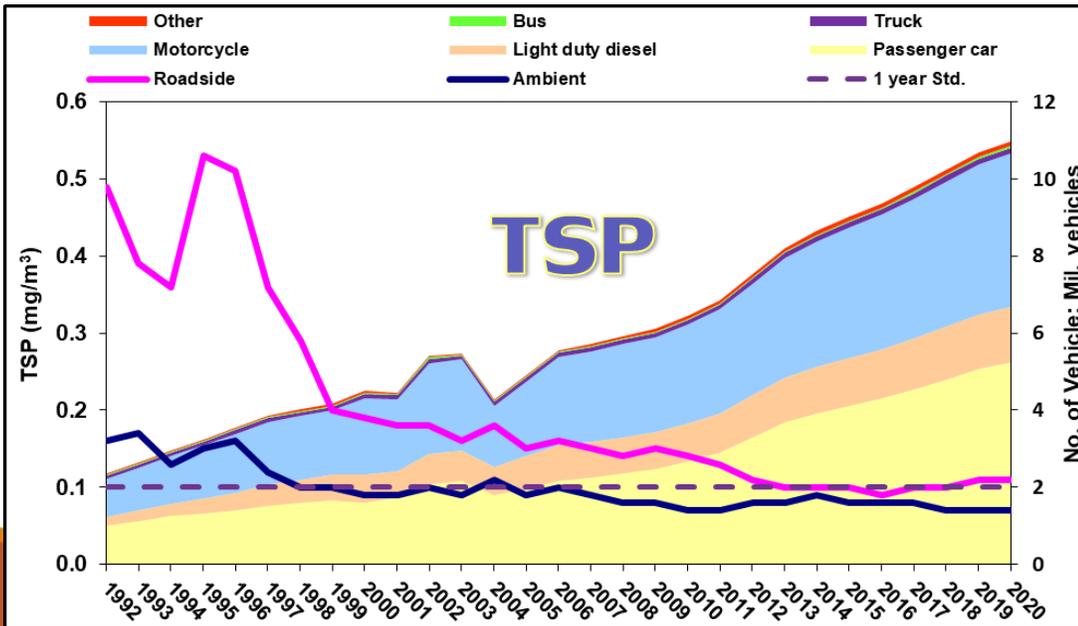
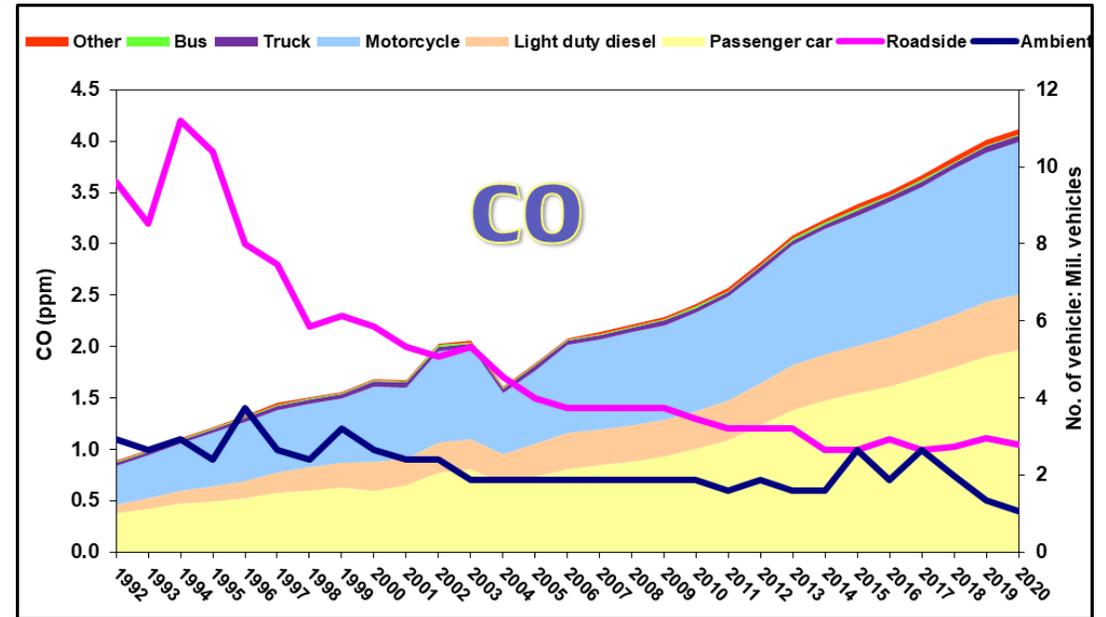
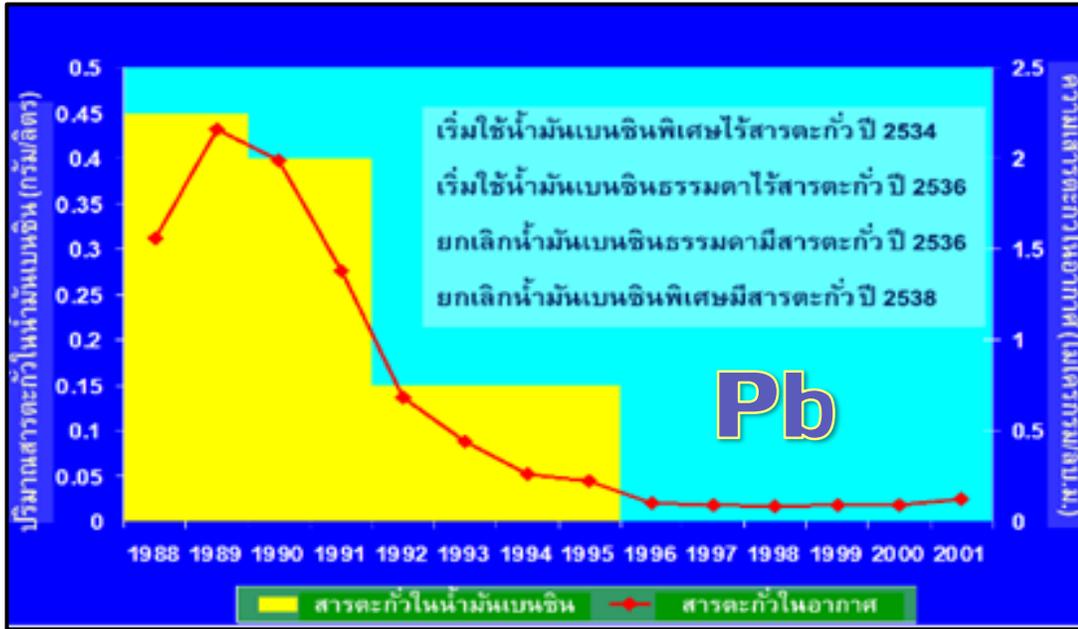
Pollutants	Range	95 Percentile	Standards	Exceeding Standards	Average 1 Year	Annual Avg. Standards
TSP (24-hr) mg/m ³			0.33		0.08	
PM ₁₀ (24-hr) μg/m ³	10-145	81	120	10/2534 (0.39)	38	50
PM _{2.5} (24-hr) μg/m ³	3-100	49	50	104/2526 (4.12)	21	25
Pb (monthly) μg/m ³						
CO (1-hr) ppm	0.00-2.40	0.99	30	0/15407 (0.0)	0.44	
CO (8-hr) ppm	0.0-1.78	0.91	9	0/16102 (0.0)	0.44	
O ₃ (1-hr) ppb	0-138	65	100	25/17502 (0.14)	26	
O ₃ (8-hr) ppb	0-105	56	70	201/18236 (1.10)	26	
SO ₂ (1-hr) ppb	0-9	3	300	0/6917 (0.0)	1	0.04
SO ₂ (24-hr) ppb	0-4	3	120	0/302 (0.0)	1	0.04
NO ₂ (1-hr) ppb	0-108	39	170	0/25998 (0.0)	15	0.03

State of Air Pollution in Bangkok in 2020

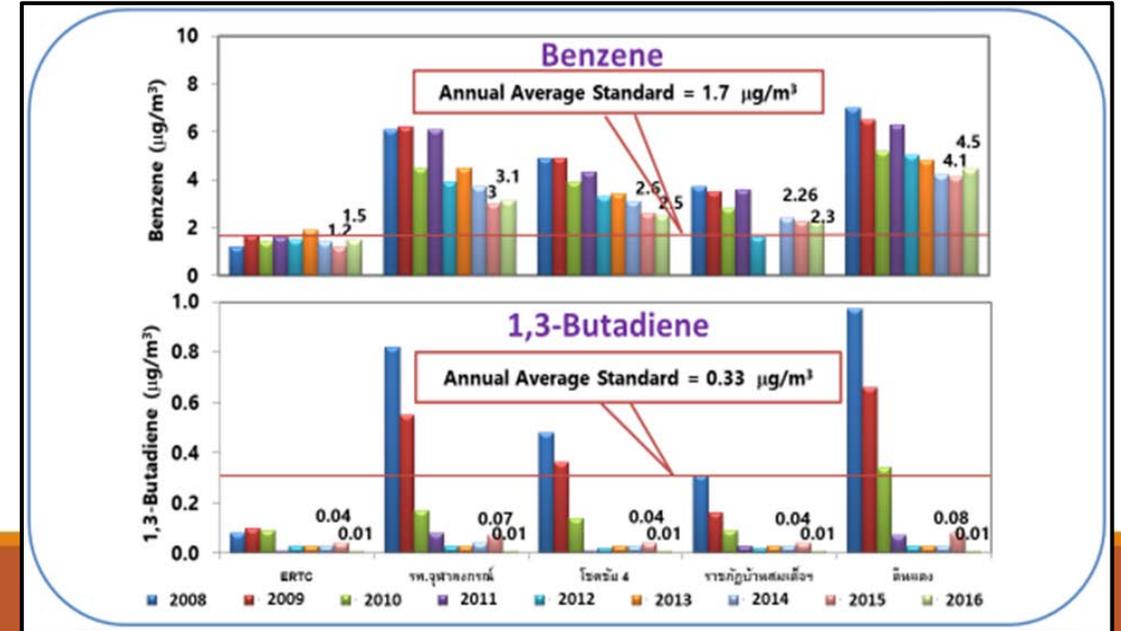
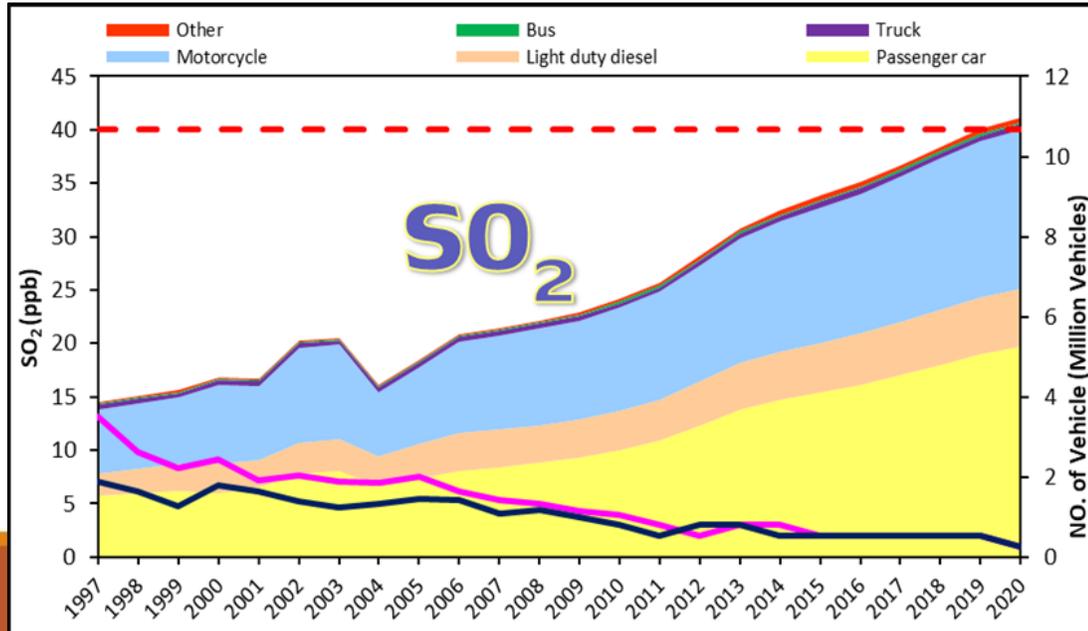
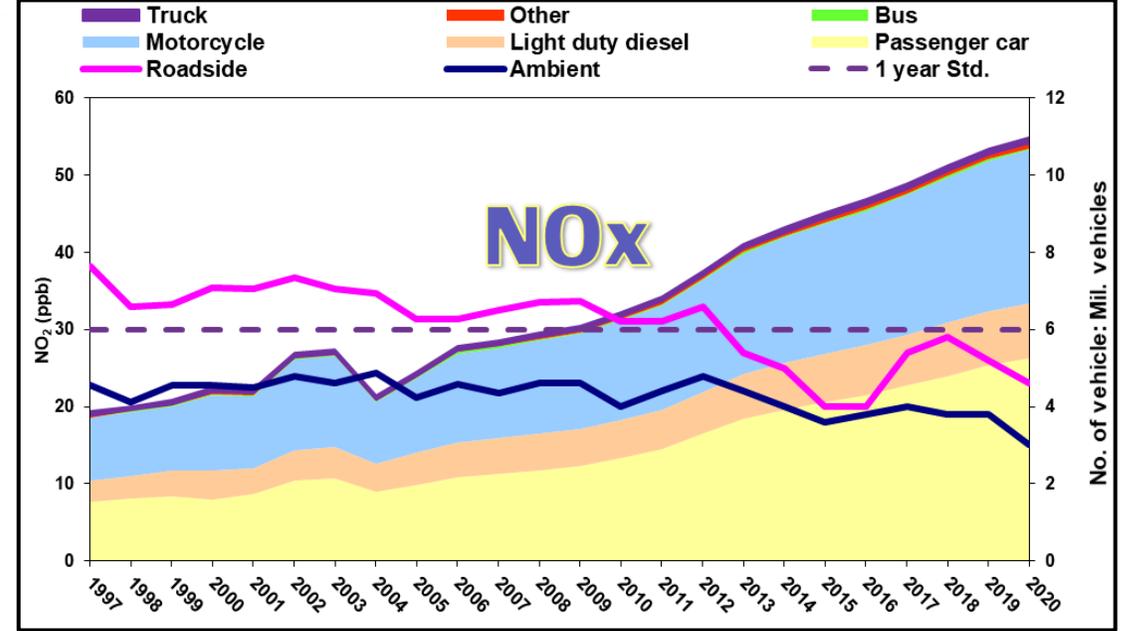
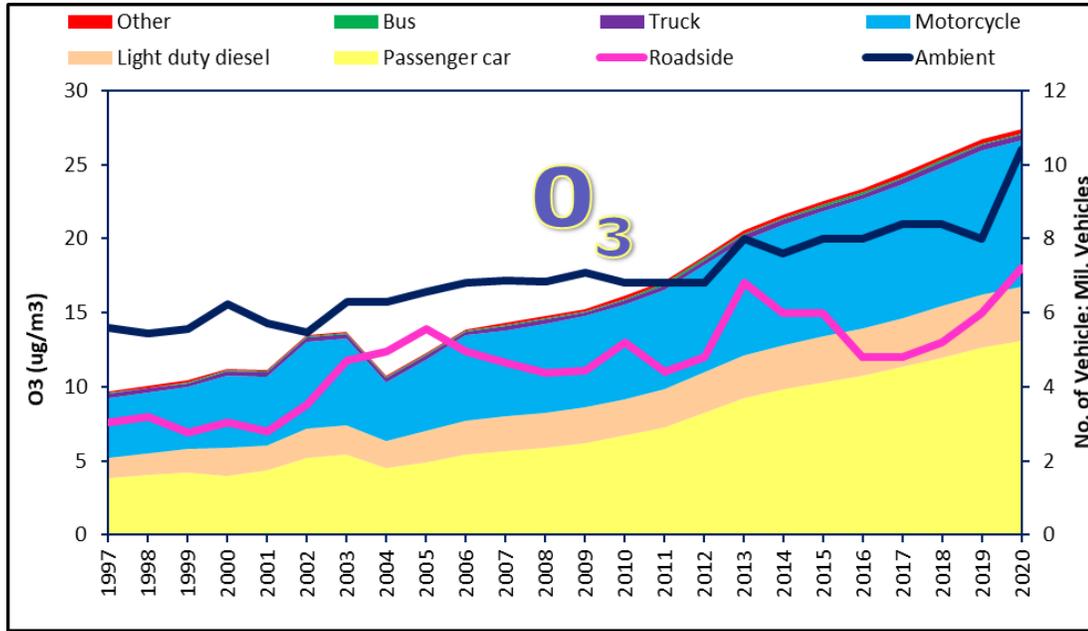
Roadside Area

Pollutants	Range	95 Percentile	Standards	Exceeding Standards	Average 1 Year	Annual Avg. Standards
TSP (24-hr) mg/m ³						
PM ₁₀ (24-hr) μg/m ³	12-179	98	120	23/1816 (1.27)	51	50
PM _{2.5} (24-hr) μg/m ³	4-112	57	50	154/1808 (8.52)	26	25
Pb (monthly) μg/m ³						
CO (1-hr) ppm	0.00-7.81	2.03	30	0/28314 (0.0)	1.05	
CO (8-hr) ppm	0.00-6.42	1.86	9	0/29625 (0.0)	1.05	
O ₃ (1-hr) ppb	0-108	48	100	4/15540 (0.03)	18	
O ₃ (8-hr) ppb	0-91	43	70	29/16204 (0.18)	18	
SO ₂ (1-hr) ppb	0-9	3	300	0/4866 (0.0)	1	0.04
SO ₂ (24-hr) ppb	0-3	2	120	0/212(0.0)	1	0.04
NO ₂ (1-hr) ppb	0-124	55	170	0/31982 (0.0)	23	0.03

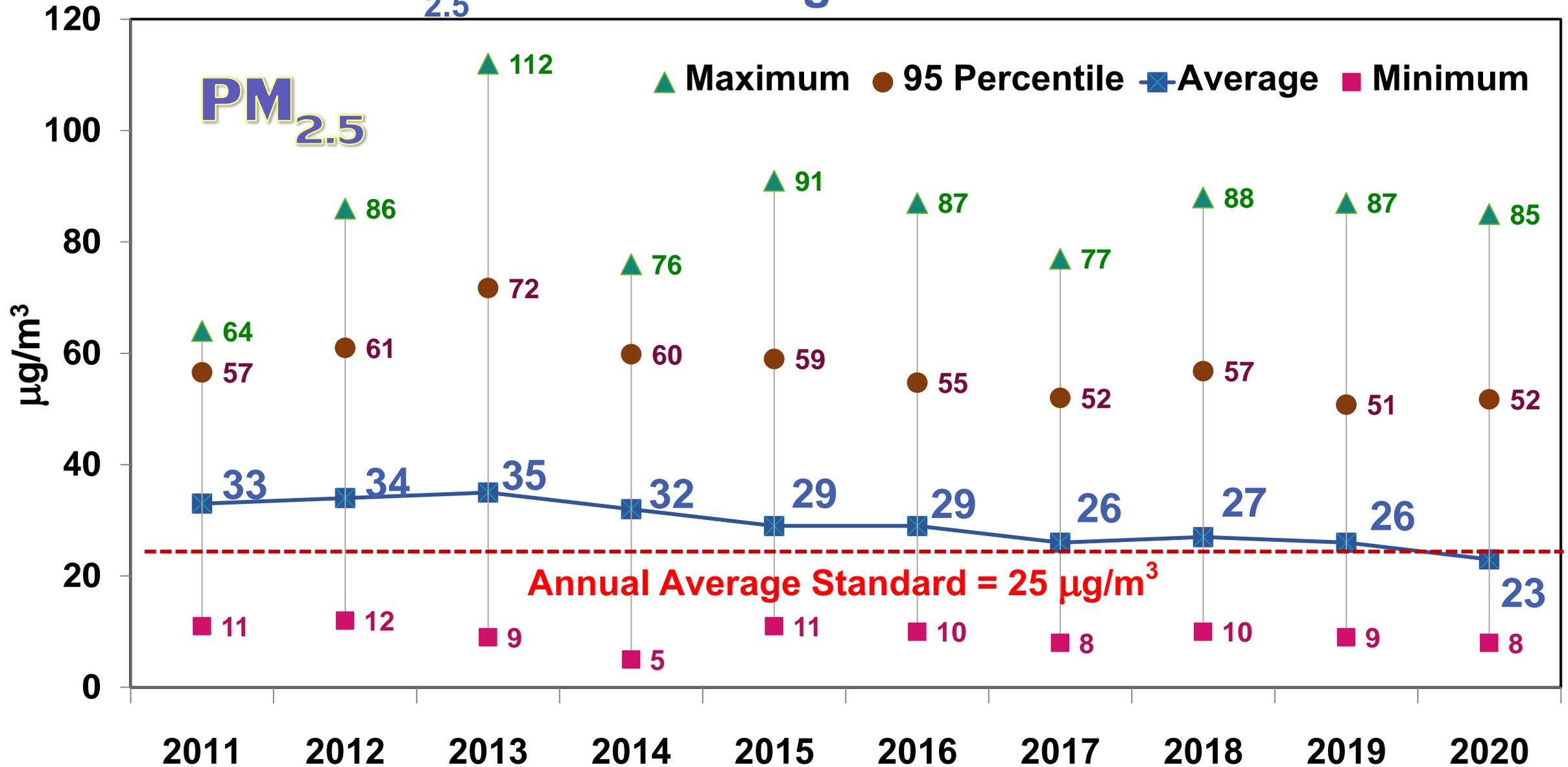
Trends of Air Quality in BMA



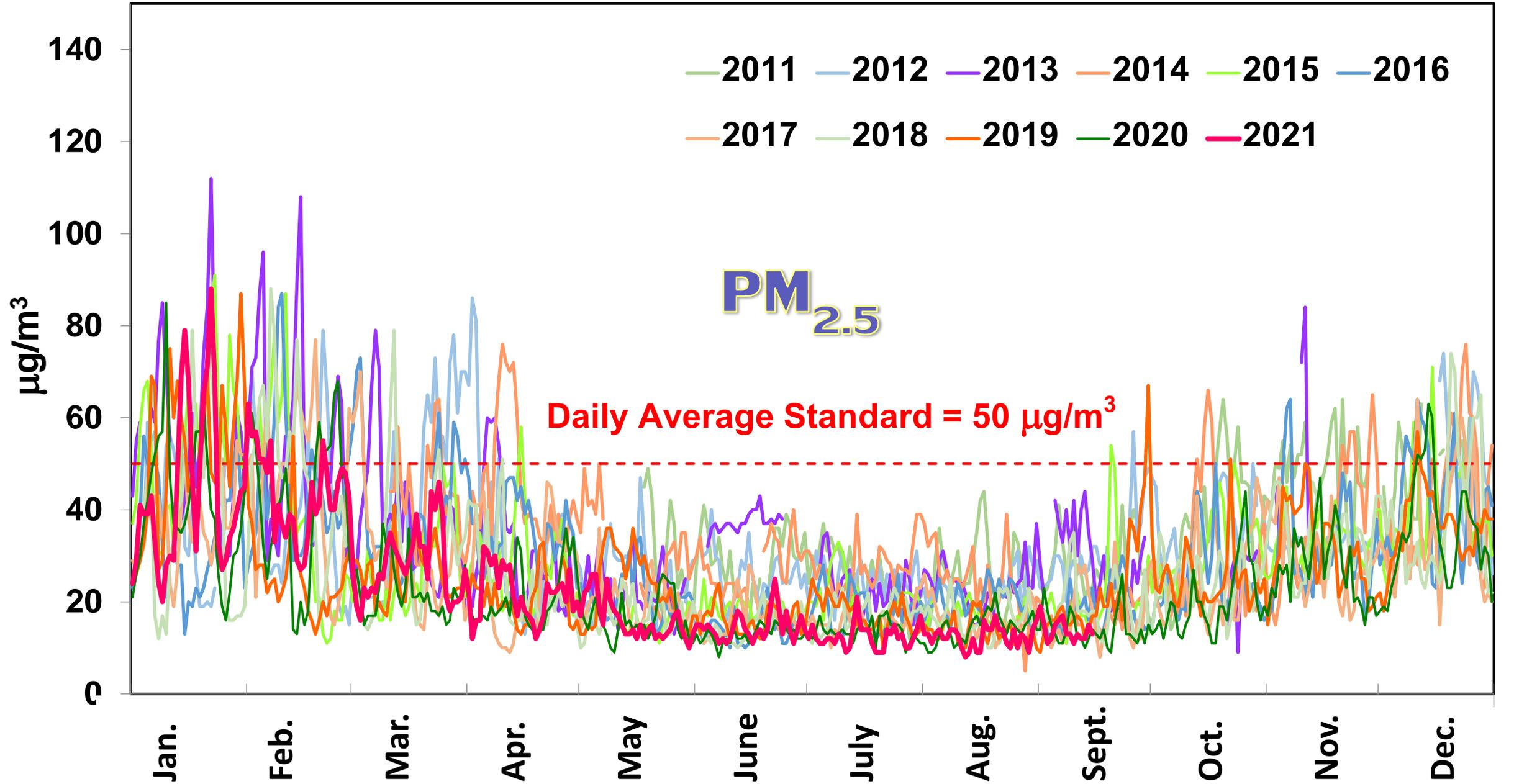
Trends of Air Quality in BMA



PM_{2.5} Levels in Bangkok 2011 - 2020

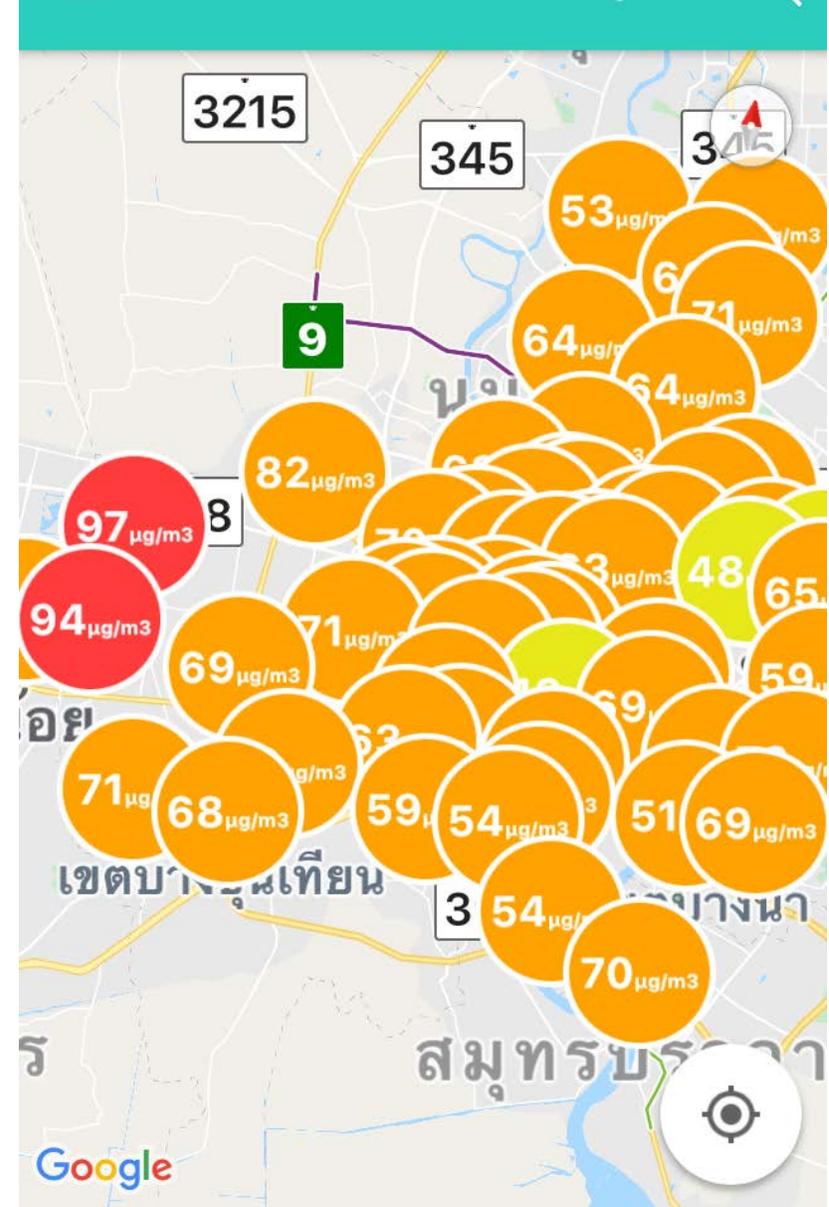
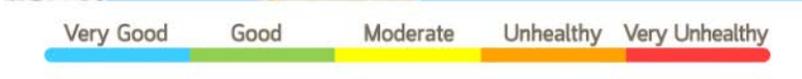
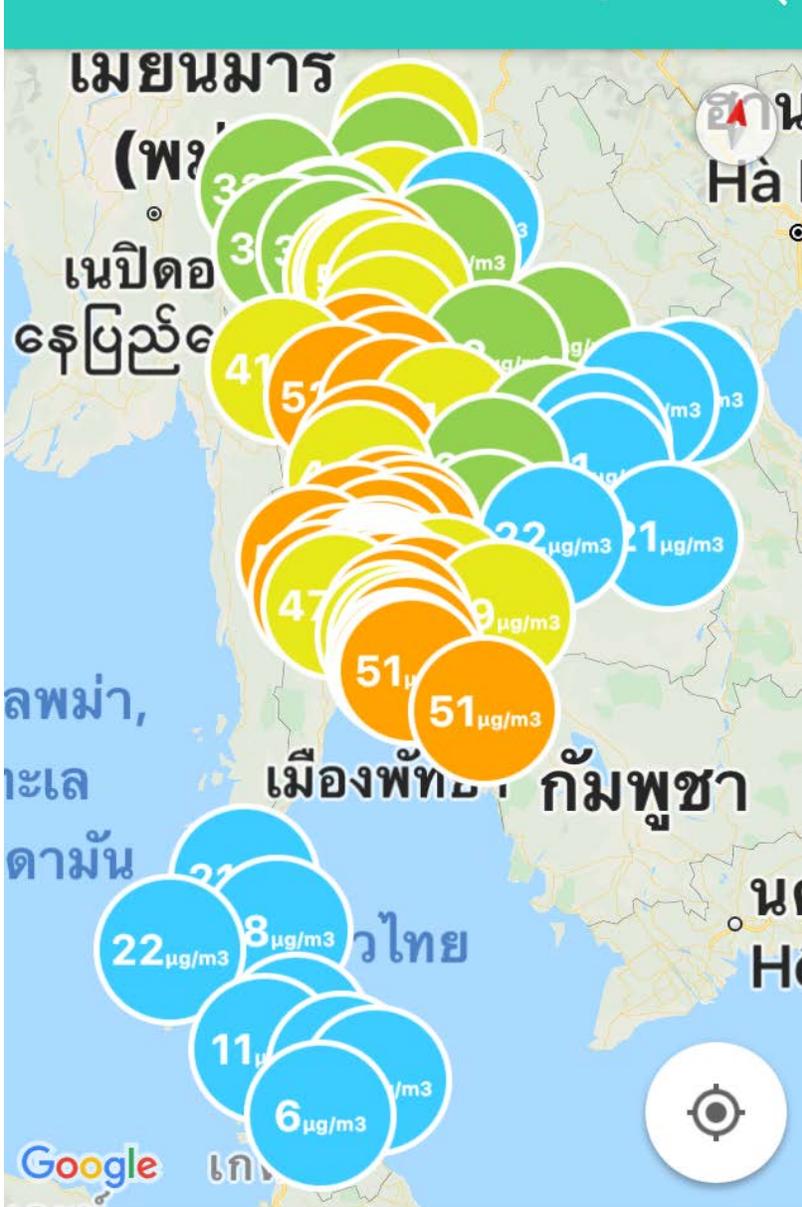
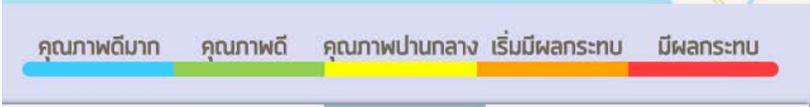
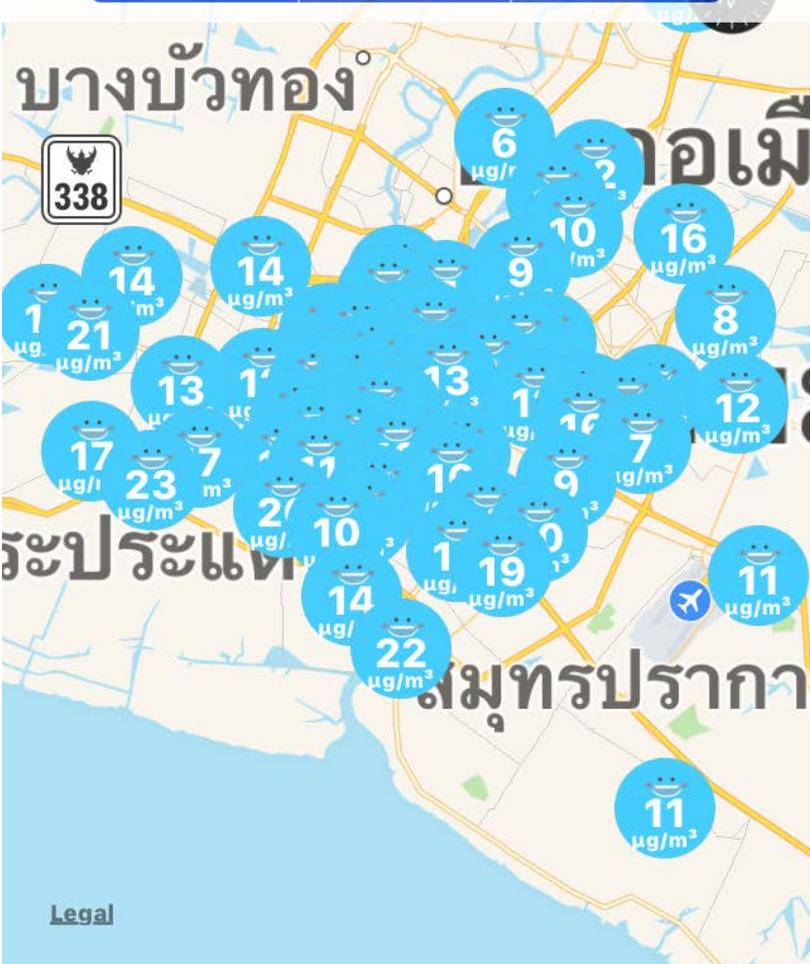


Daily PM_{2.5} Concentrations in Bangkok 2011 - 2021



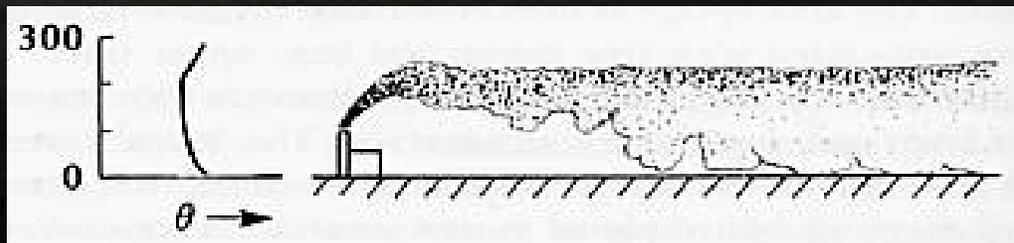
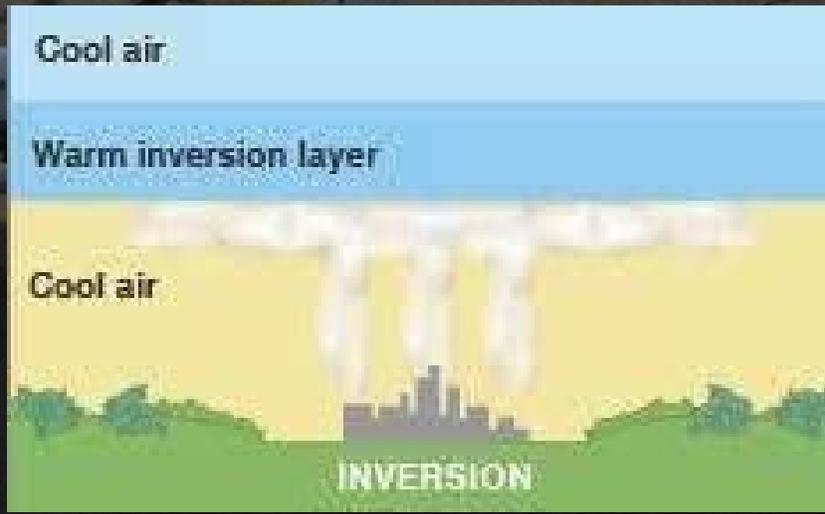
State of Problems and Sources of Air Pollution

Standard Satellite Hybrid

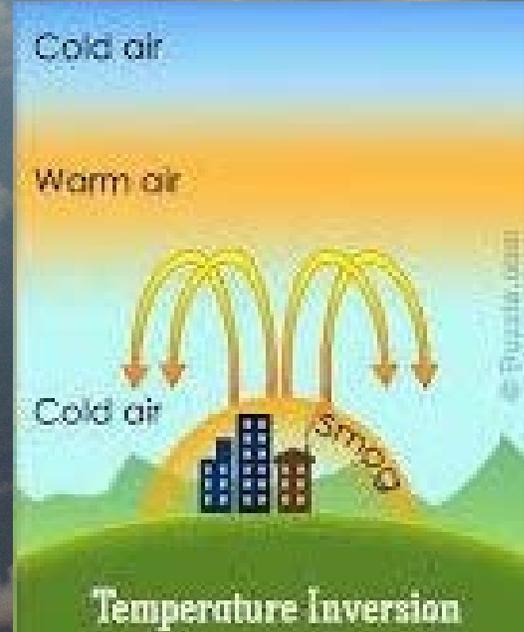


Don Muang Airport

Air pollutants are trapped because of temperature inversion and low wind speed

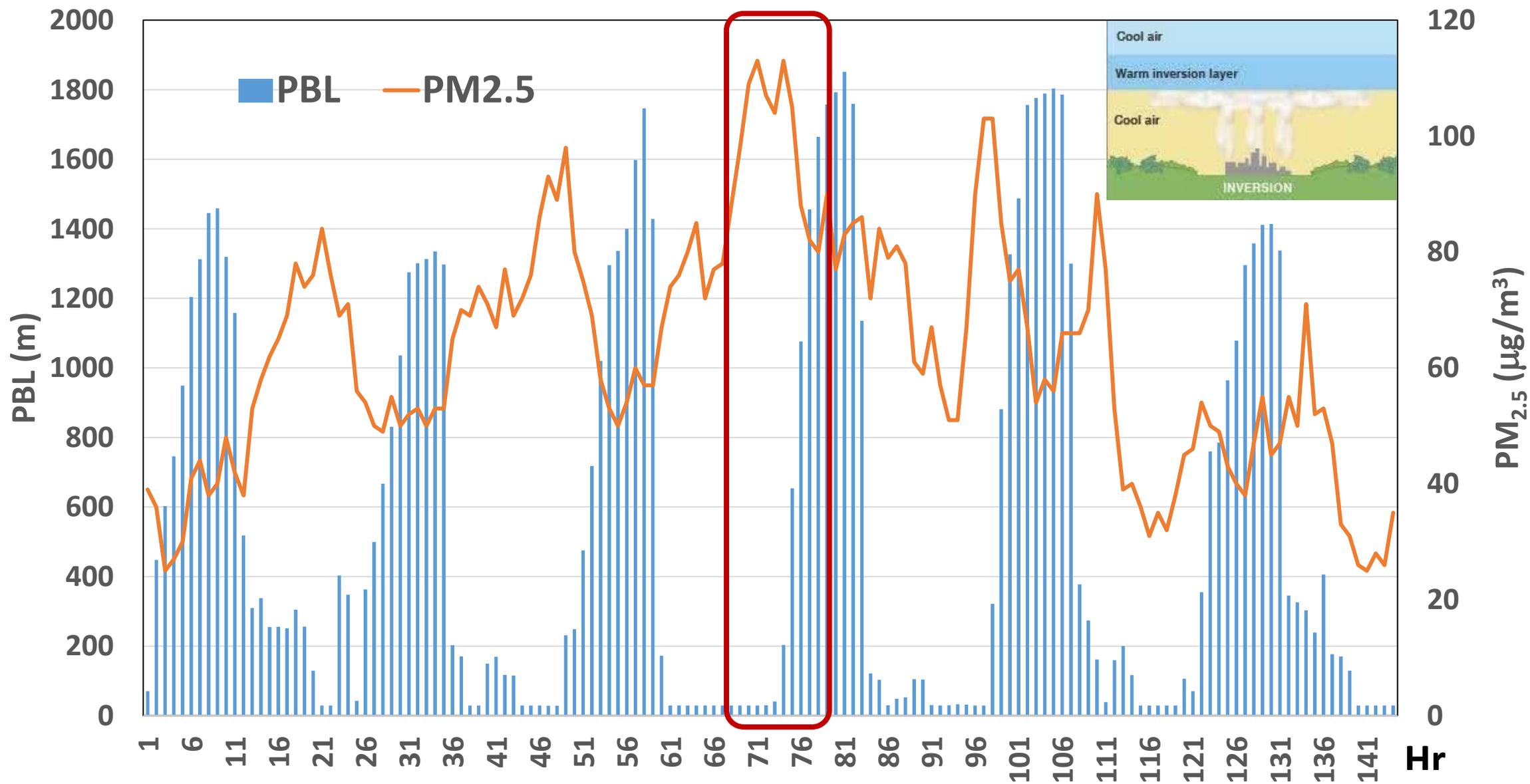


Sky over Bangkok early this year from a plane landing at Don Muang Airport

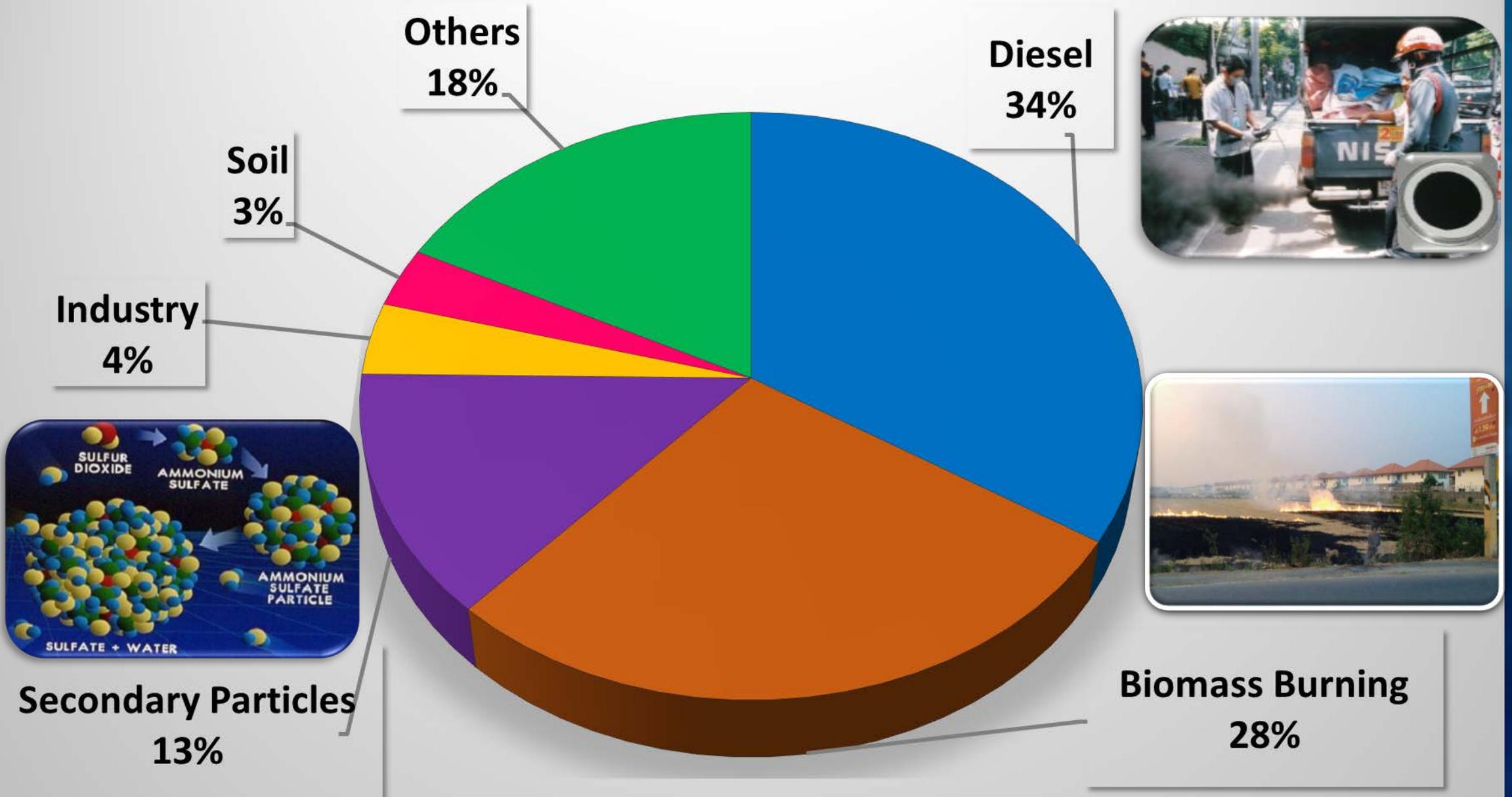


PBL vs PM_{2.5} 27/01/2019 - 2/02/2019

PBL = Planetary Boundary Layer



Source Contribution of PM_{2.5} in Bangkok



Biomass Open-burning in Thailand



Burning of Solid Waste

- Burning of open-dumped garbage
- Burning of trash and plant residues



Burning of Agricultural Residues (during and after harvesting)

- Rice
- Sugar Cane
- Corn/Maize



Forest Fire

- Slash and burn agriculture
- Wild animal hunting
- Wild mushroom and plant harvesting

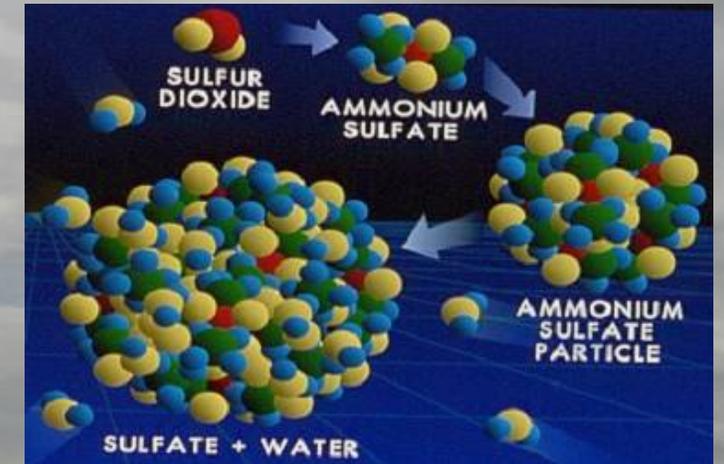


Land Clearing Fire



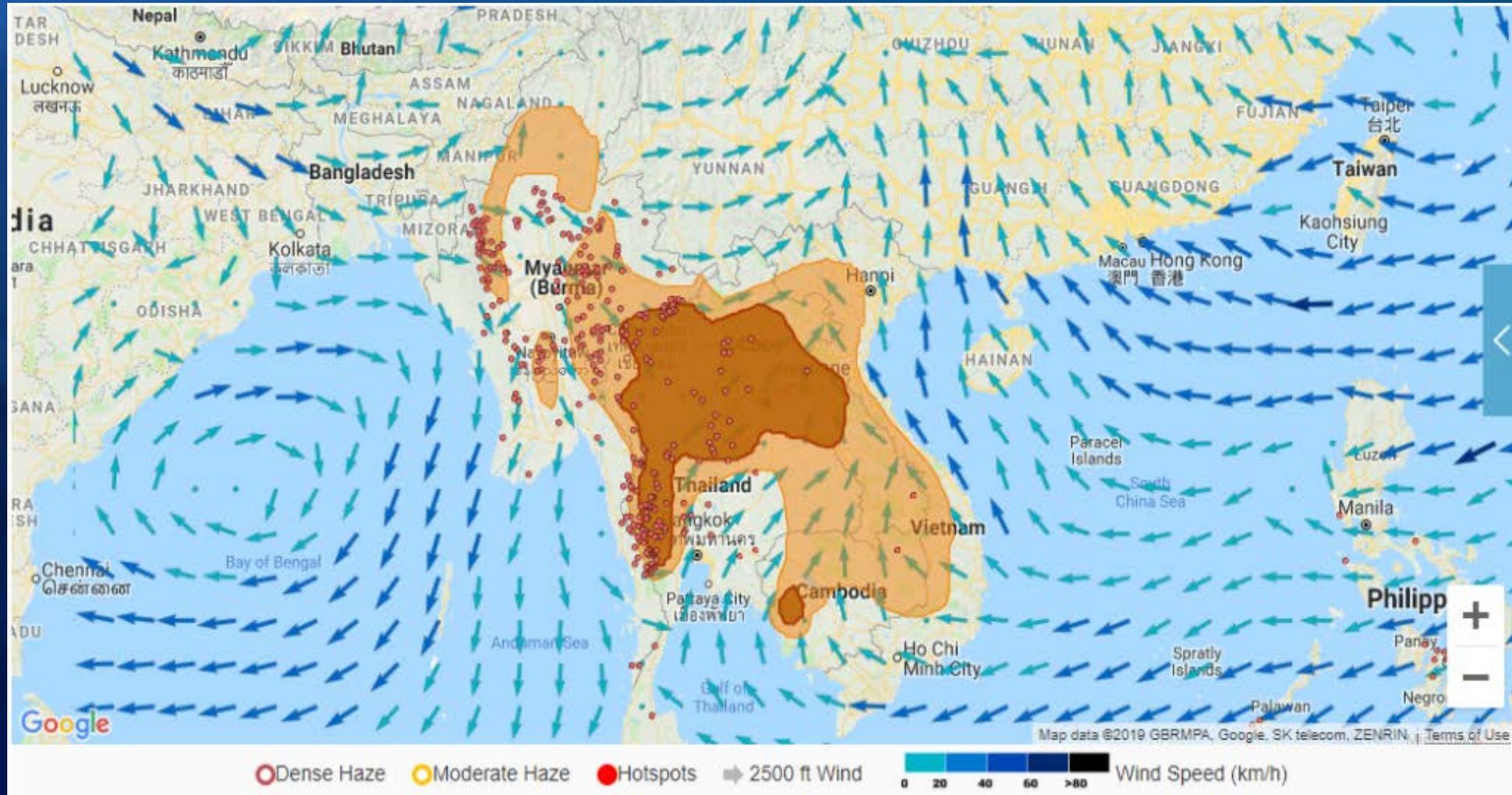
Secondary Particles

Gas-to-Particle Conversion

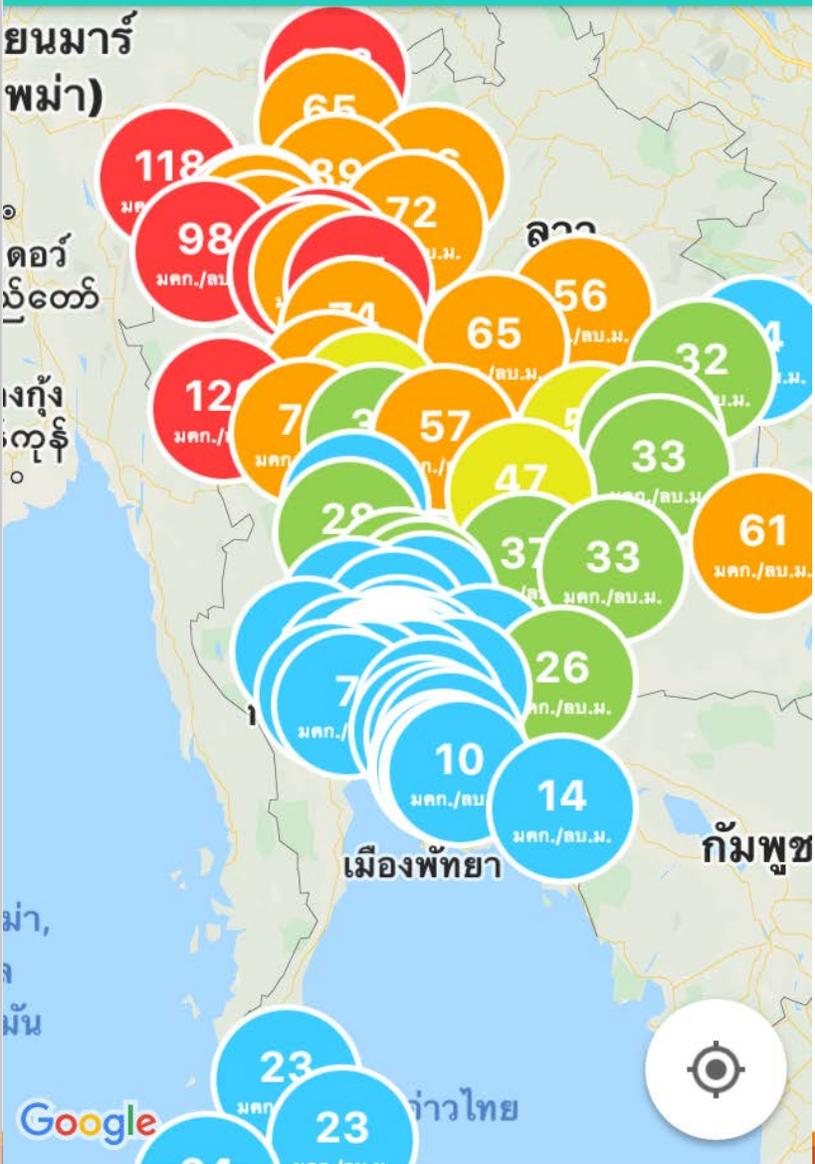


After February, PM_{2.5} problem moves from Bangkok to the northern and western parts of Thailand due to movement of weather pattern and open-burning of biomass residues

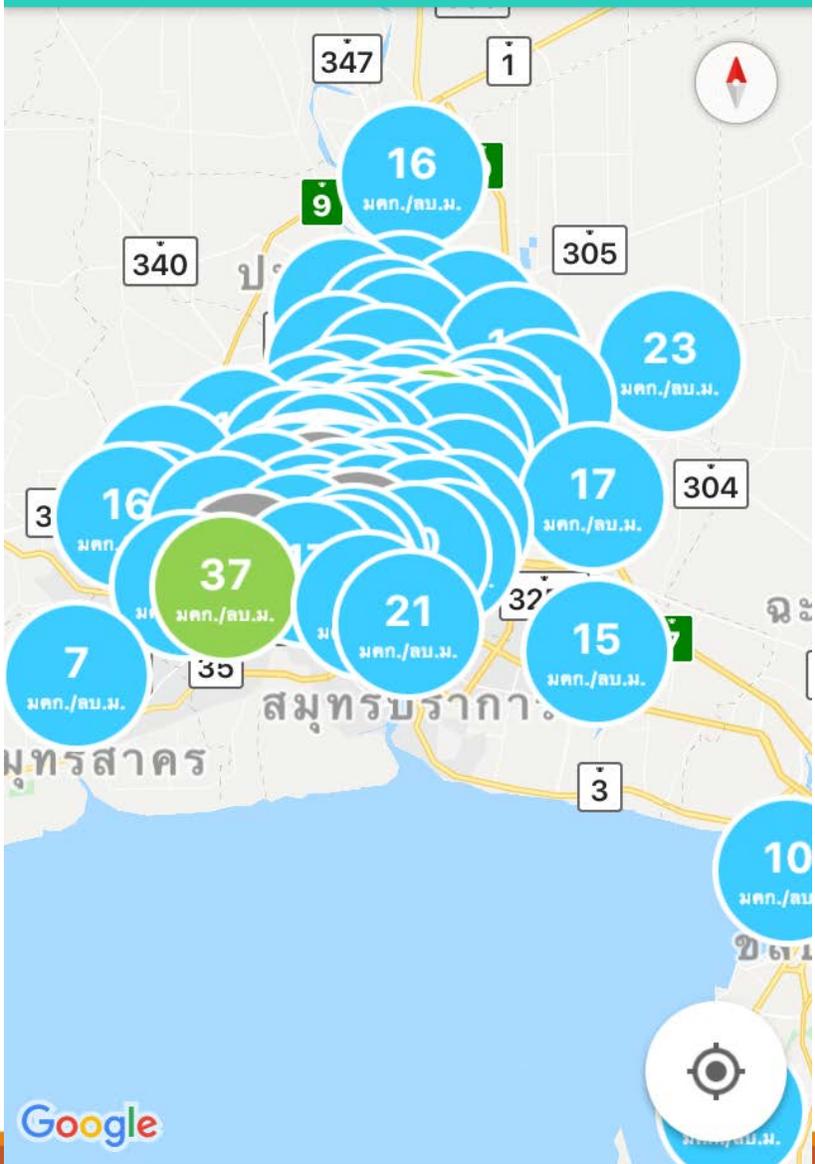
ASEAN
(Mekong
Sub-Region)
Haze and
Hotspot
Map on 13
March 2019
(ASMC)



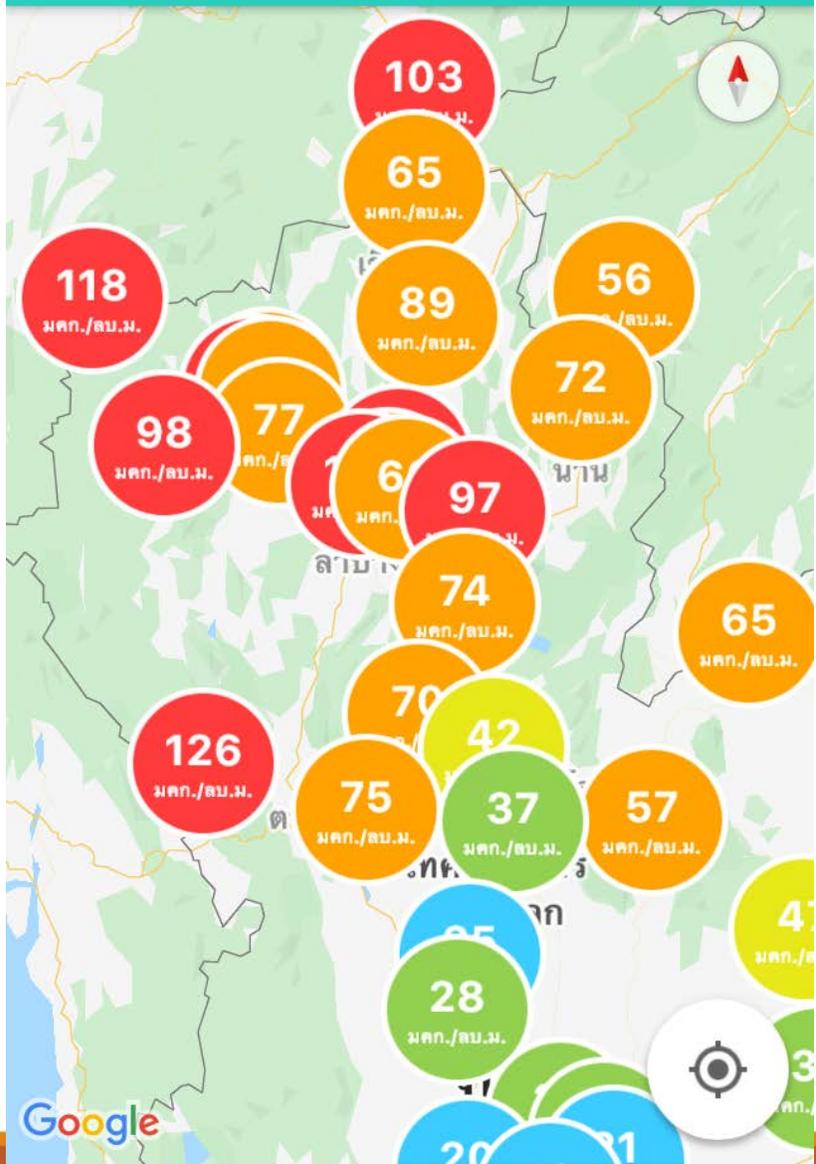
แผนที่สถานการณ์ PM2.5



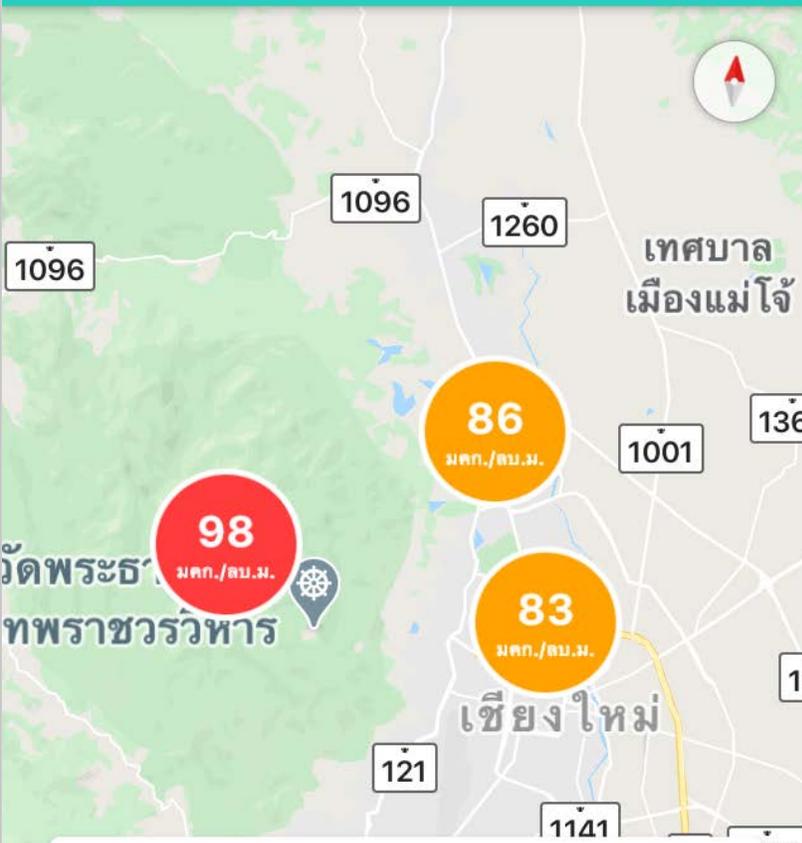
แผนที่สถานการณ์ PM2.5



แผนที่สถานการณ์ PM2.5



แผนที่สถานการณ์ PM2.5





98
มคก./ลบ.ม.

ต.สุเทพ อ.เมือง, เชียงใหม่

3 มีนาคม 2564 09:00 น.

มีผลกระทบต่อสุขภาพ

← ต.สุเทพ อ.เมือง, เชียงใหม่

PM_{2.5}



มีผลกระทบต่อสุขภาพ

3 มีนาคม 2564 09:00 น.

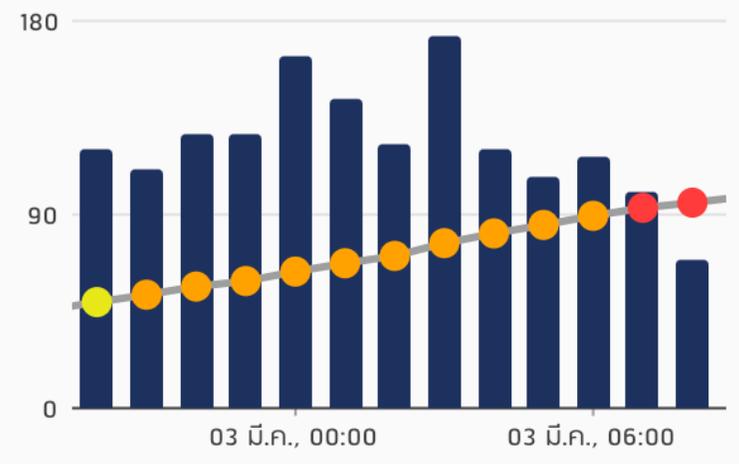
คำแนะนำสุขภาพ



คุณภาพอากาศมีผลกระทบต่อสุขภาพ ประชาชนทั่วไป

กราฟแสดงผล

มคก./ลบ.ม.



- * กราฟแท่ง หมายถึง ค่ารายชั่วโมงนั้นๆ
- * กราฟเส้น หมายถึง ค่าเฉลี่ย 24 ชั่วโมงย้อนหลัง

ข้อมูลสถานี และ แหล่งที่มา



พระตำหนักภูพิงคราชนิเวศน์
กรมควบคุมมลพิษ

Amount of Sugar Cane Burned and PM_{2.5} in North Eastern Region

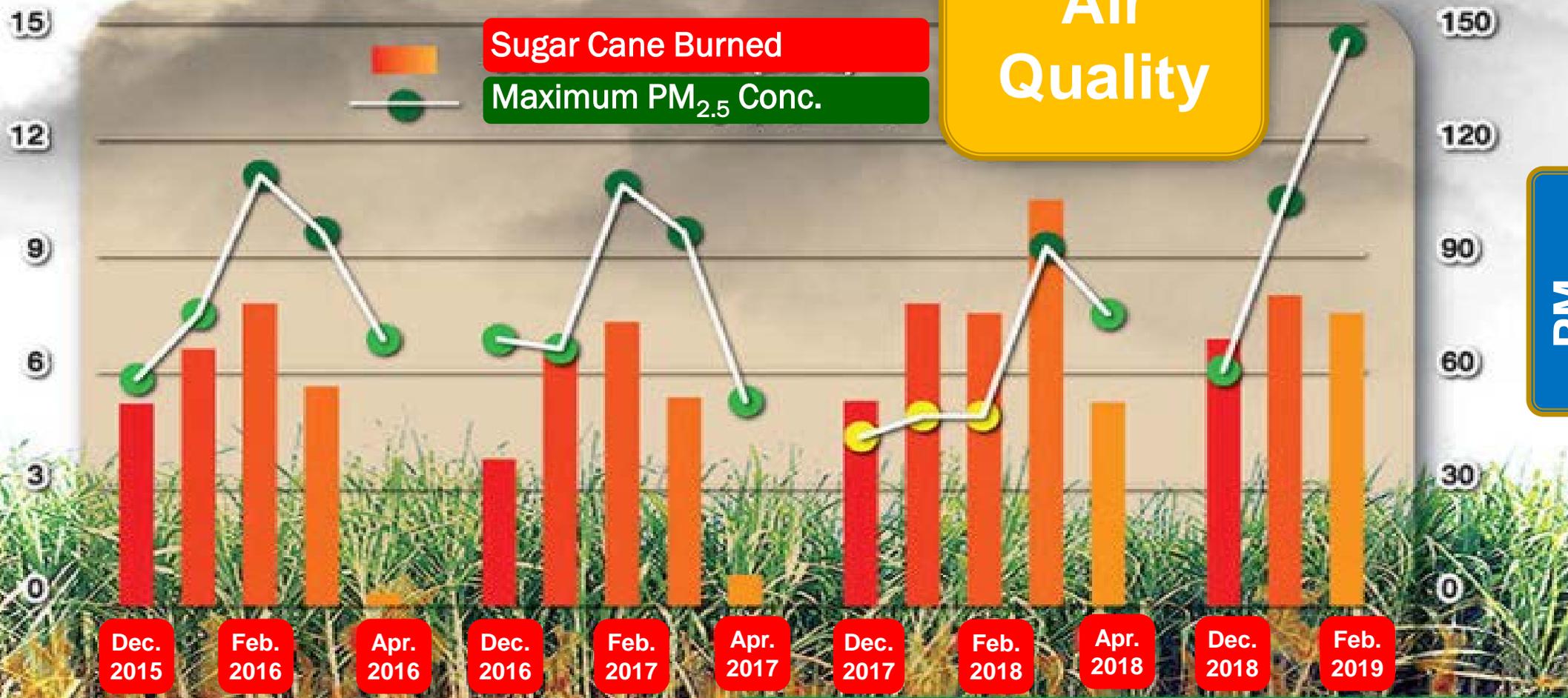
Million ton

µg/m³

Sugar Cane Burned

PM_{2.5}

Air Quality

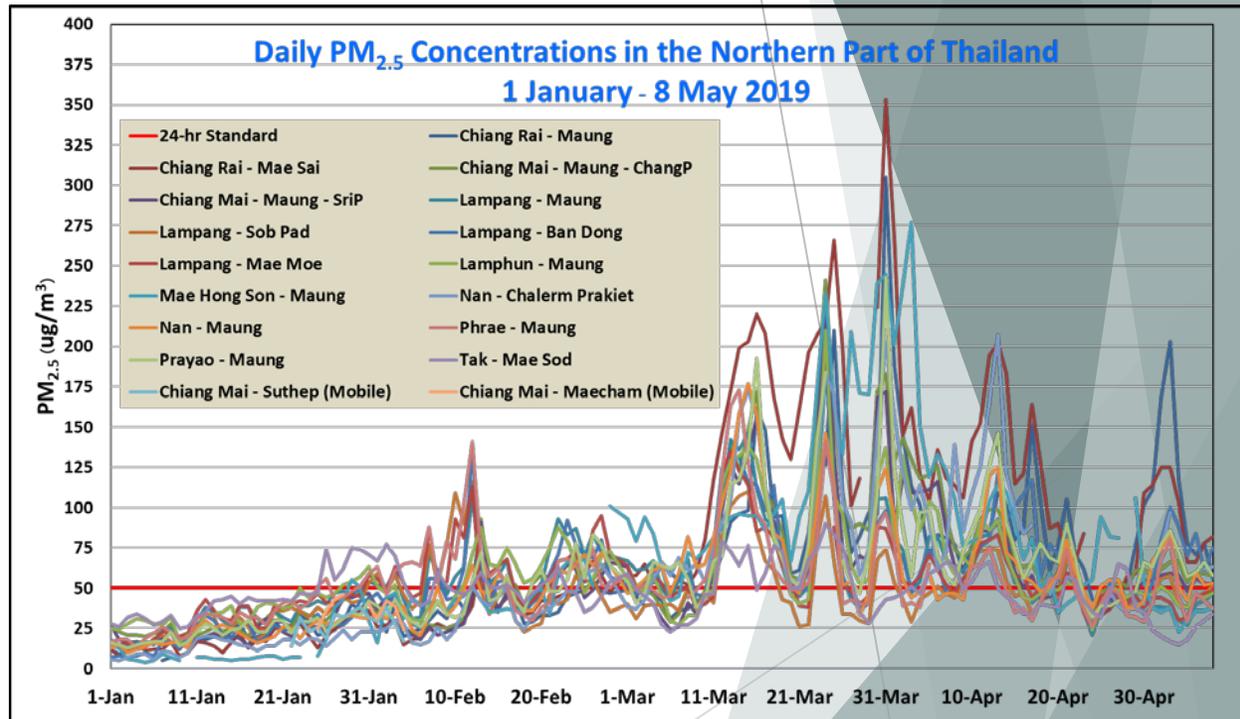
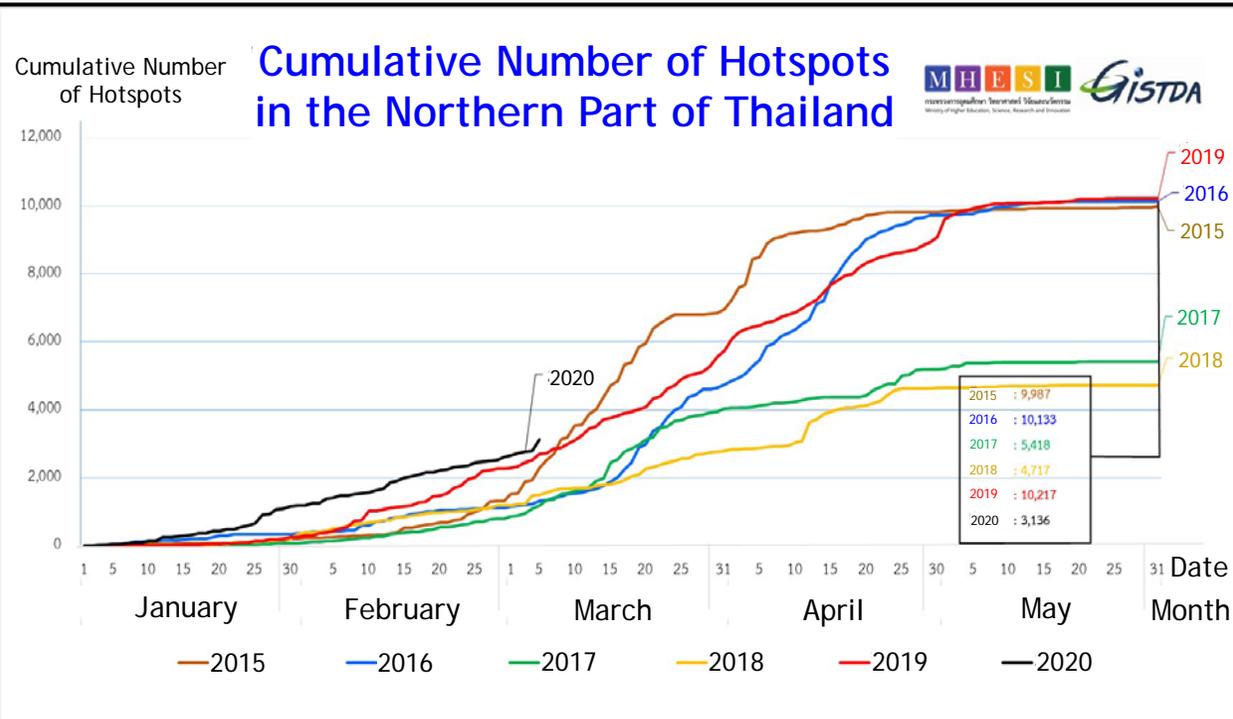


หมายเหตุ : ข้อมูล PM 2.5 เป็นข้อมูลประมาณการจากสถานีตรวจวัดคุณภาพอากาศในพื้นที่จังหวัดขอนแก่น 4 สถานี

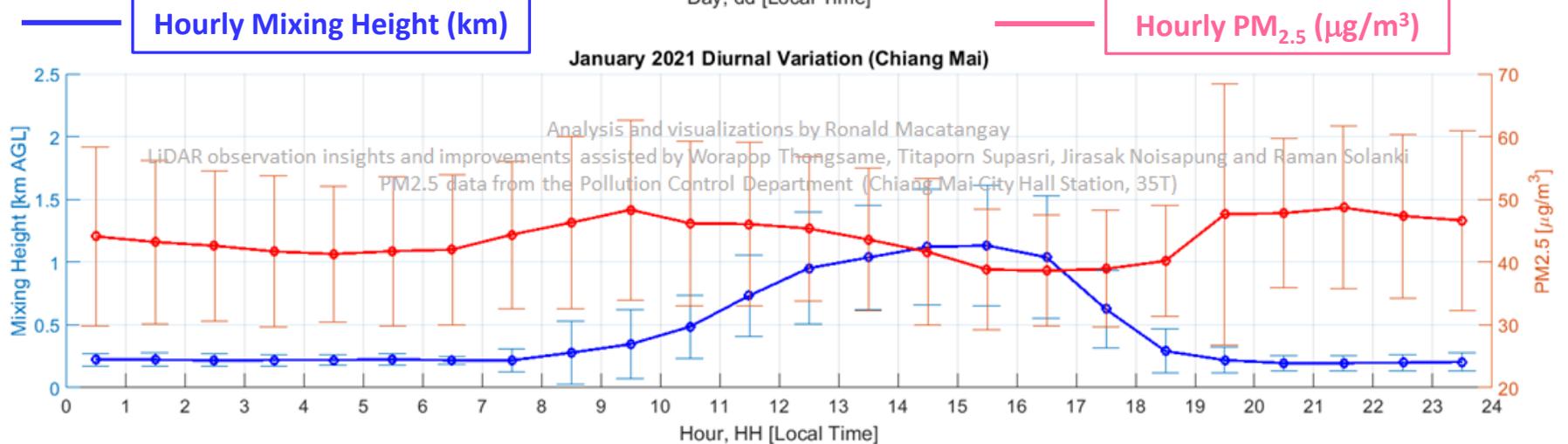
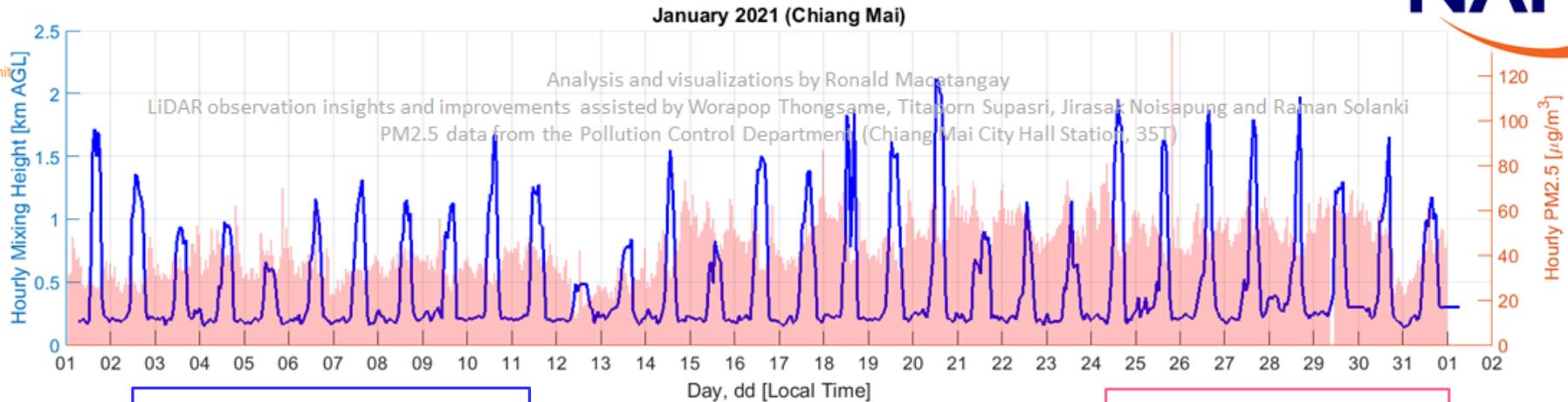
ที่มา : สำนักงานส่งเสริมการค้าในต่างประเทศ ณ นครเชียงใหม่

ประชาชาติกราฟิก

Cumulative Hotspots Number and PM_{2.5} in Northern Part of Thailand



Mixing Height vs PM_{2.5} in Northern Part of Thailand



Biomass Open-burning in Thailand



Burning of Solid Waste

- Burning of open-dumped garbage
- Burning of trash and plant residues



Burning of Agricultural Residues (during and after harvesting)

- Rice
- Sugar Cane
- Corn/Maize



Forest Fire

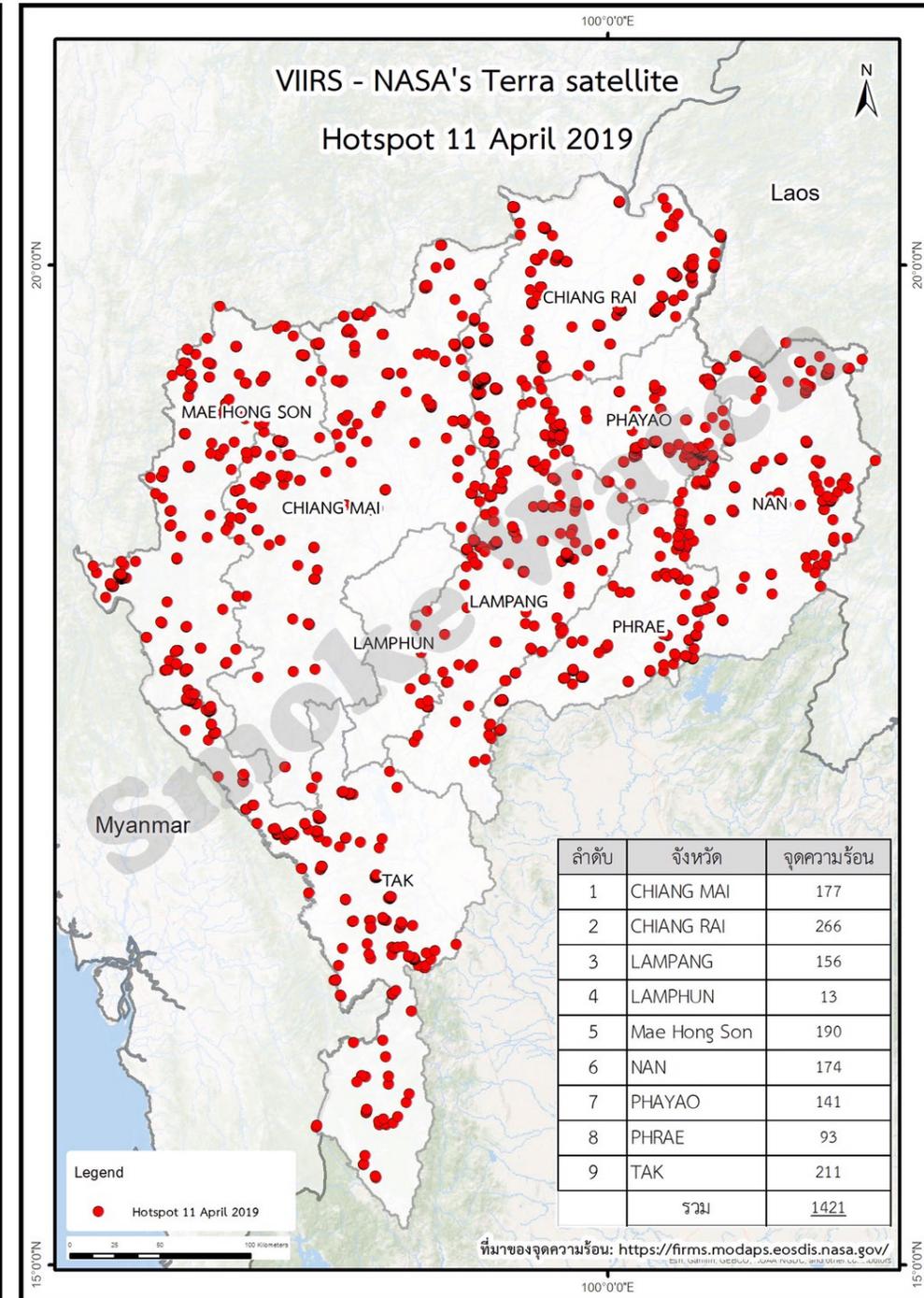
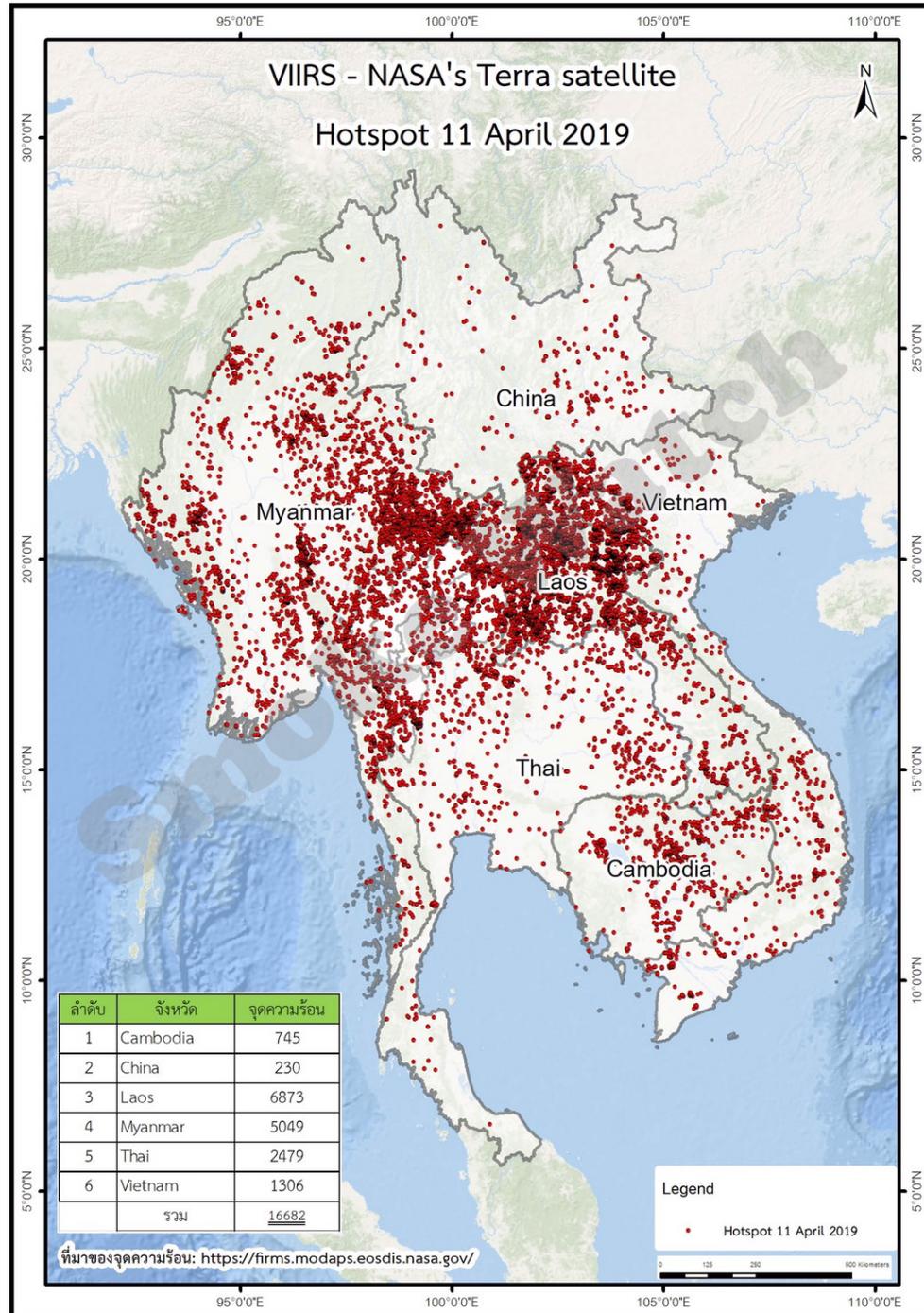
- Slash and burn agriculture
- Wild animal hunting
- Wild mushroom and plant harvesting



Land Clearing Fire



Hotspots
in ASEAN
Mekong Sub-
Region and
in the
northern part
of Thailand
detected by
VIIRS-
NASA's Terra
Satellite on
11 April 2019



Process in Developing Clean Air Action Plan

Cabinet Declare Mitigation of Particulate Matter Problem as the National Agenda on 12 February 2019



Clean Air Actions in Thailand to Mitigate PM_{2.5} Problem

Cabinet Resolution

1 October 2019

Indicators and Targets

- 1) Number of days having PM_{2.5} in compliance with the standard increase 5%/year
- 2) Number of hotspots decrease
- 3) Number of people having air pollution related respiratory disease decrease

Clean Air Action Plan for the Mitigation of PM Problem (2019-2024)



แผนปฏิบัติการขับเคลื่อนวาระแห่งชาติ
“การแก้ไขปัญหาหามลพิษ
ด้านฝุ่นละออง”

ISBN: 978-616-316-535-0
PW. 03-129

กรมควบคุมมลพิษ
กระทรวงทรัพยากรธรรมชาติและสิ่งแวดล้อม



Clean Air Action Plan for the Mitigation of PM Problem (2019-2024)



แผนปฏิบัติการขับเคลื่อนวาระแห่งชาติ
“การแก้ไขปัญหามลพิษ
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กรมควบคุมมลพิษ
กระทรวงทรัพยากรธรรมชาติและสิ่งแวดล้อม



3 Major Strategies

- 1 Increasing Effectiveness of Control Measures on Area Based during Critical Period
- 2 Control and Minimization of Air Pollutant Emissions at Sources
- 3 Improving Air Quality Management Efficiency

Strategy 1

Increasing effectiveness of control measures on area based (critical period)

Actions

- Before critical period – meeting, information, preparation
- **Critical period**
- After critical period – After action review

Activities: Response plan

Level 1 $PM_{2.5} < 50 \mu\text{g}/\text{m}^3$

Normal Operation

Level 2 $PM_{2.5} 51- 75 \mu\text{g}/\text{m}^3$

Increase level of operation

Level 3 $PM_{2.5} 76 -100 \mu\text{g}/\text{m}^3$

Governor give direct order to control sources and activity in specific area

Level 4 $PM_{2.5} > 100 \mu\text{g}/\text{m}^3$

Propose measures to relevant committees and to Prime Minister for approval

Major Organizations

Ministry of Interior, Bangkok Metropolitan Administration, Ministry of Education, Ministry of Agricultural Work, Ministry of Transport, Ministry of Digital, Ministry of Health, Ministry of Industry, Royal Thai Police, Ministry of Natural Resources and Environment

Strategy 2

Actions

Transport

Open burning /Agriculture

Industry

Construction and City Planning

Household

Control and Minimization of Air Pollutant Emissions at Sources

Short term 2019-2021

- Enforce Euro 5 for new vehicle in 2021
- Improve public transportation network
- Reduce years requirement of in-use vehicle for annual inspection
- Improve vehicle inspection and database system
- Introduce incentive measures for promotion of electricity car

- Promote use of agricultural waste instead of open burning
- Promote change plantation type from single crop into standing timber
- Absolute abandon of agricultural waste open burning and municipal waste burning
- Effective protection and management of forest fires

- Establish air pollution emission standard as per emission loading for area-based capacity
- Enforce CEMs for Industry type 3

- Control particulate matter emission from construction activity and practice law enforcement
- Increase green area
- Promote environmental-friendly construction concept

- Use clean energy in household
- Promote use of non-smoke stove/pollution free char

Long term 2022-2024

- Enforce Euro 6 for new vehicle in 2022
- Enforce fuel quality: sulfur content <10 ppm from January 1, 2024
- Improve public transportation network
- Apply incentive measures for promotion of electricity car
- Change all public bus into electric bus/NGV/Hybrid
- Improve annual tax collection system for in-use vehicle

- **Abandon 100% sugarcane agricultural area open burning in 2022**

- Improve air pollution emission standard to correspondent with international standard

Major Organizations

Ministry of Energy, Ministry of Industry, Ministry of Natural Resources and Environment, Ministry of Interior, Ministry of Agricultural Work, Ministry of Transport, Ministry of Commerce, Royal Thai Police, Ministry of Health

Strategy 3

Improving Air Quality Management Efficiency

Actions

❖ Improve ambient air quality monitoring network

❖ Review/improve law, regulation, standard/code of practice

❖ Promote research/improve knowledge/public relation

❖ Transboundary issues

❖ Establish air pollution emission inventory

❖ Improve database and forecast system

Short term 2019-2021

- Develop ambient air quality monitoring manual
- Increase monitoring technology (Light Scattering)
- Expand monitoring network/risk area and encourage local government to operate local monitoring network
- Improve PM_{2.5} annual standard equivalent to WHO IT-3
- Improve Enhancement and Conservation of National Environmental Quality Act /Study feasibility of Clean Air Act
- Consider schedule open burning in agricultural area
- Study possibility of installation of DPF in used vehicle
- Promote public relation/transfer knowledge
- ASEAN Haze Free Roadmap
- Develop air pollution emission inventory in critical area
- Integrate air quality data and health surveillance system
- Improve air pollution forecast model

Long term 2022-2024

- Expand monitoring network to cover 77 provinces and encourage local government to operate local monitoring network
- Improve PM_{2.5} annual standard equivalent to WHO IT-3
- Consider possibility to install Clean Air Tower and sensor monitoring network
- Promote public relation/transfer knowledge
- ASEAN Haze Agreement
- Integrate air quality data and health surveillance system

Major Organizations

Ministry of Interior, Ministry of Health, Ministry of Education, Ministry of Industry, Ministry of International Affairs, Ministry of Military, Ministry of Transport, Ministry of Natural Resources and Environment

Additional Cabinet Resolution on 23 November 2020

Additional Ad Hoc Plan for the Mitigation of PM Pollution

- 1. Communicating and building awareness among all target groups**
- 2. Establishing Sub-Committee on the prevention and mitigation of forest fire, haze and particulate matter under the National Committee on Disaster Prevention and Mitigation**
- 3. Managing fuel in the forest by collection and utilization.**
- 4. Building forest fire control volunteer networks**
- 5. Mobilizing reforestation and forest fire prevention**
- 6. Increasing efficiency of decentralization of forest fire control to local authority**
- 7. Forecasting PM concentrations for the next three to provide warning to the people**
- 8. Applying satellite technology to report area-based PM levels**
- 9. Developing forecast system and decision support system for fire control and management**
- 10. Developing fuel burning registration system for fuel management**
- 11. People participation in forest management and forest fire reduction through allocation of right to use the land for making living**
- 12. Building cooperation with neighboring countries at ASEAN, bilateral and borderland levels**

Additional Actions for the Mitigation of PM Pollution in 2022

National Environment Board on 23 August 2021

Communication

1. Increasing perception efficiency for all relevant stakeholders and issuing advance warning on PM_{2.5} situation

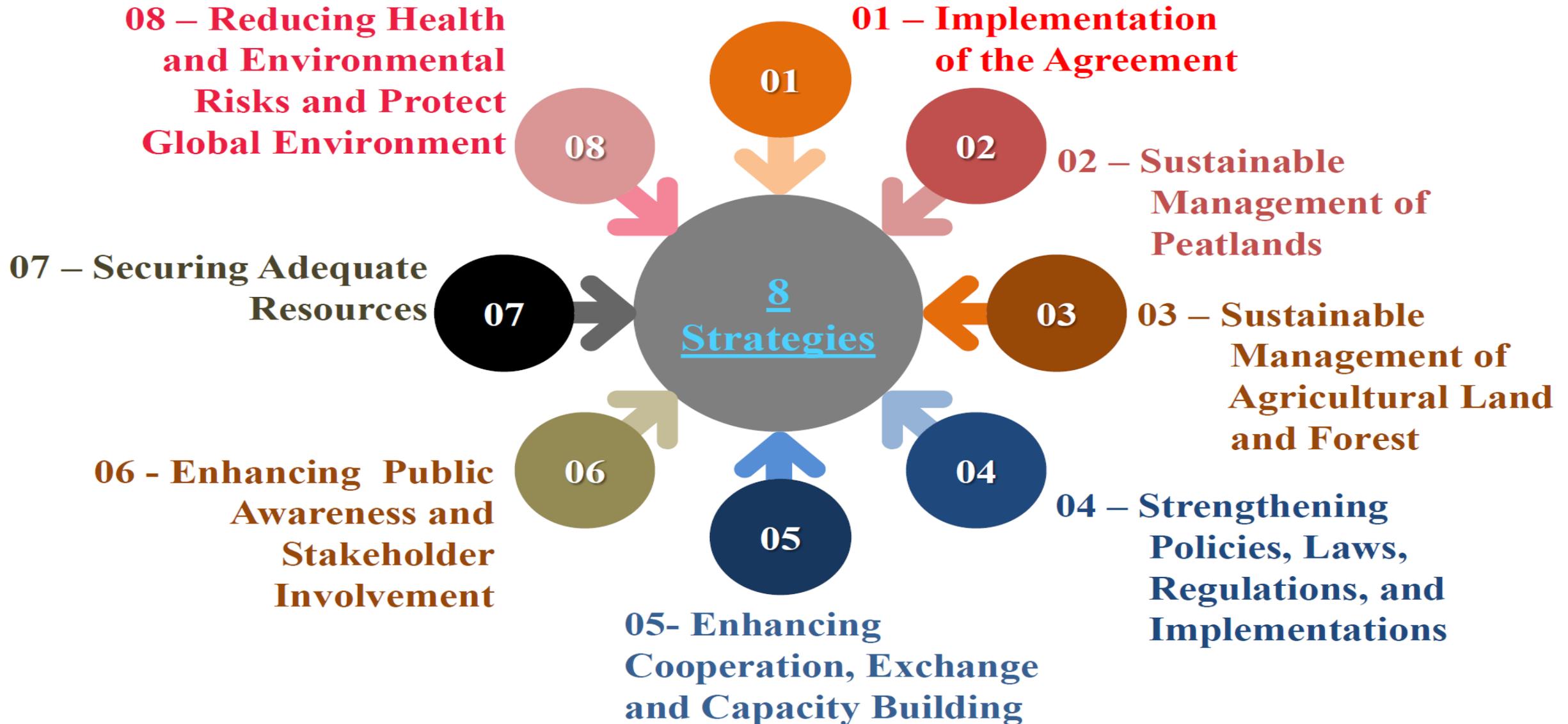
Prevention

2. Every province to develop action plan to address forest fire, haze and PM_{2.5} in the provincial disaster prevention and mitigation plan
3. Management of fuels in the forest by collection and utilization and by fuel management registration application
4. Mobilization of reforestation and forest fire prevention through Royal Volunteers project
5. Building networks and volunteers to support the prevention and mitigation of forest fire, haze and PM_{2.5}
6. Supporting clean energy and alternative energy to reduce PM_{2.5}

Incident Actions

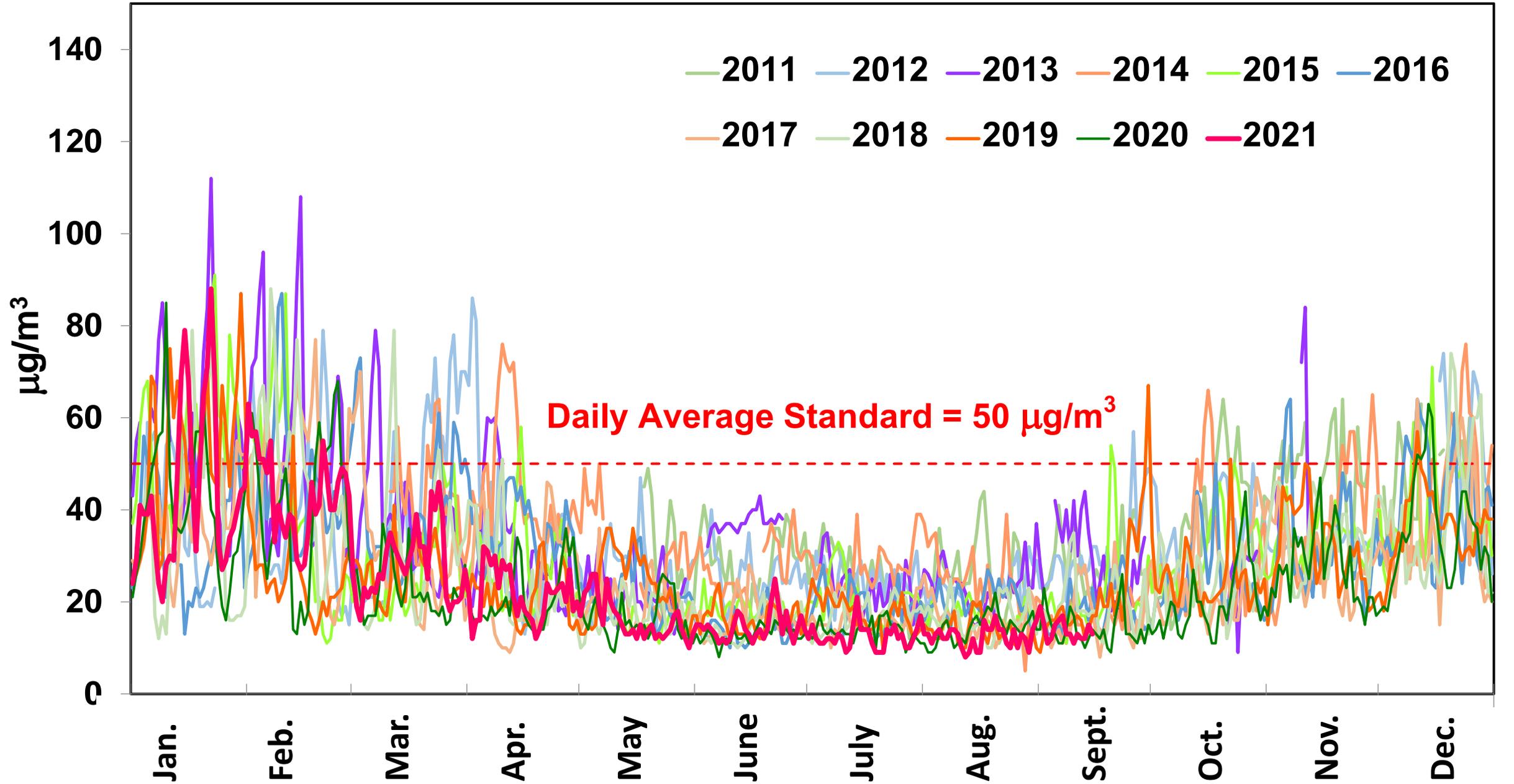
7. Increasing restrictiveness in controlling emissions from sources including vehicles and industries in the urban and industrial areas
8. Increasing efficiency in forest fire control in natural forest
9. Establishing common indicators and targets to drive the operation of ASEAN Agreement on Transboundary Haze Pollution and expanding parallel border villages under Joint Border Committee framework

Key Strategies of ASEAN Haze Free Roadmap

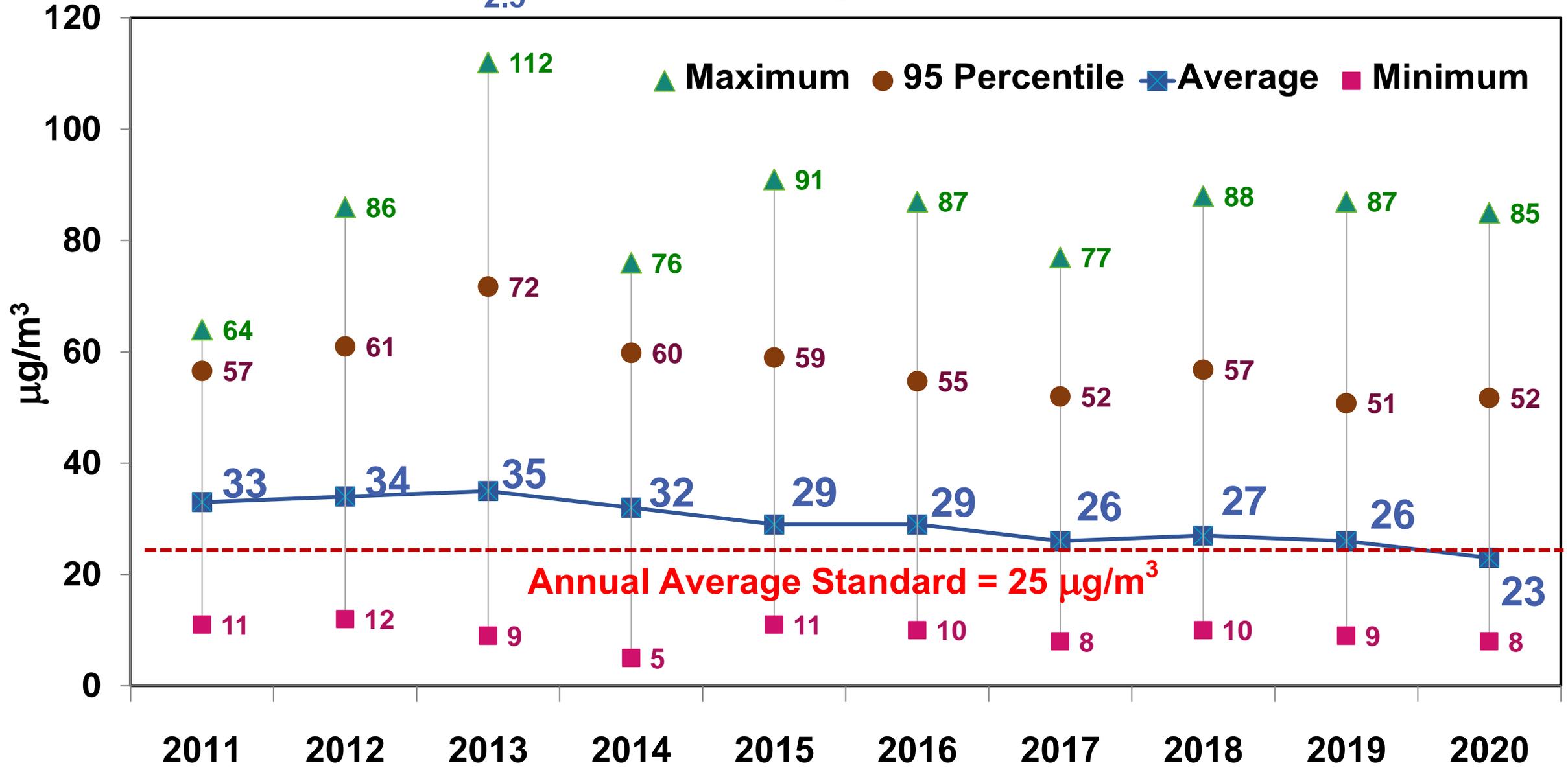


Evaluation of Success

Daily PM_{2.5} Concentrations in Bangkok 2011 - 2021



PM_{2.5} Levels in Bangkok 2011 - 2020





**Faculty of Public Health
Thammasat University**

**Establishment
of
Technical Center for Clean Air and
Climate Change Collaboration
(CCACCC)**

Thank you for your attention