CLEAN AIR FUND

A Clean Air Platform for Southeast Asia

From Fragmented Effort to Coherent Action



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Acknowledgements

Clean Air Fund is a global philanthropic organisation working with governments, funders, businesses, and campaigners to ensure everyone, everywhere breathes clean air.

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CONTENTS

Executive Summary vii
1. Introduction and Objectives 1
2. Drivers, Sources and Impacts 3
3. Air Quality Management in SEA 9
3.1 Malaysia 12
3.2 Thailand 12
3.3 Vietnam 14
3.4 Indonesia 15
3.5 Philippines 17
3.6 Cambodia 18
3.7 Laos 18
3.8 Myanmar 19
4. Air Quality Management Needs and Priorities 20
4.1 Air Quality Fundamentals 21
4.2 The Enabling Environment 23
4.3 Sectoral Solutions 27
4.3.1 Transport 27
4.3.2 Industry/Energy 29
4.3.3 Agriculture/Waste 30
4.4 National Level Assessment 31
5. Regional and CSO Initiatives in SEA 32
5.1 Regional Frameworks and Initiatives 32
5.2 CSO Initiatives 35
5.3 Regional Level Assessment 37
6. A Regional Platform for Clean Air in SEA 39
References 42
Appendix 48

LIST OF FIGURES

Figure 1: Drivers of Air Pollution in SEA 3
Figure 2: $PM_{2.5}$ Emissions by Country and Sector, 1980–2022 3
Figure 3: NO_x Emissions by Country and Sector, 1980–2022 4
Figure 4: Annual Average $PM_{2.5}$ Concentrations in 50 Cities 4
Figure 5: Ozone Concentrations in Key Cities, 2022–2023 4
Figure 6: BC Emissions by Country and Sector, 1980–2024 5
Figure 7: CO_2 Emissions by Country and Sector, 1980–2024 5
Figure 8: Deaths Associated with Ambient $PM_{2.5}$, 2000–2023 6
Figure 9: Subregional and Seasonal Differences between Northern and Southern SEA 8
Figure 10: Three Tiers of Air Quality Management Frameworks in SEA 9
Figure 11: Thailand's CLEAR Sky Strategy 13
Figure 12: Key Targets in Vietnam's Recent Clean Air Plans 14
Figure 13: Recent Milestones in Indonesia's Clean Air Policies and Plans 16
Figure 14: Air Quality Priorities and Needs in SEA 21
Figure 15: $PM_{2.5}$ Annual Air Quality Standards in Key SEA Countries 22
Figure 16: Funding for Climate Change, Environment, Pollution Control and Air Pollution in Key SEA Countries 26
Figure 17: Emissions Standards for Light-Duty Vehicles in SEA 27
Figure 18: Penetration of Electric Two/Three Wheelers and Passenger Vehicles in Key SEA Countries 28
Figure 19: Circular Economy Model for Managing Rice Crop Residue 30
Figure 20: Nine Strategies of the Second Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation (2023–2030) 34
Figure 21: Fragmentation in Air Quality Management in SEA 37
Figure 22: A Regional Platform for Clean Air in SEA 39

LIST OF TABLES

Table 1: Key Findings on Air Pollution and Health Impacts in SEA 7
Table 2: Summary of the Air Quality Management Landscape in SEA 10–11
Table 3: Air Quality Monitoring Systems, Emission Inventories, Source Apportionment 24–25
Table 4: Thermal Power Plant Standards 29
Table 5: Regional Air Pollution Frameworks and Initiatives 33
Table 6: CSOs Working on Air Pollution and Related Issues in SEA 36
Table 7: Near and Medium-Term Goals for the Regional Platform for Clean Air in SEA 40–41

LIST OF BOXES

Box 1: Research Methods 1
Box 2: Clean Energy Transitions Deliver Significant Co-Benefits 30

LIST OF ACRONYMS

Acronym	Full Name
AATHP	ASEAN Agreement on Transboundary Haze Pollution
ADB	Asian Development Bank
AI	Artificial Intelligence
APCAP	Asia Pacific Clean Air Partnership
APIMS	Air Pollutant Index Management System
AQI	Air Quality Index
AQM	Air Quality Management
ASEAN	Association of Southeast Asian Nations
AWGESC	ASEAN Working Group on Environmentally Sustainable Cities
BAT	Best Available Techniques
BC	Black Carbon
CAF	Clean Air Fund
CAMS	Copernicus Atmosphere Monitoring Service
CCAC	Climate and Clean Air Coalition
CEMS	Continuous Emissions Monitoring System
CO_2	Carbon Dioxide
CSO	Civil Society Organization
EANET	Acid Deposition Monitoring Network in East Asia
ECMWF	European Centre for Medium-Range Weather Forecasts
EVIDA	Electric Vehicle Industry Development Act
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IAQIF	Integrated Air Quality Improvement Framework
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
JRC	Joint Research Centre
LCS	Low-Cost Sensor(s)
LEAP-IBC	Low Emissions Analysis Platform-Integrated Benefits Calculator
LEZ	Low-Emission Zone
LGUs	Local Government Units
MDA8	Maximum Daily 8-Hour Average
NAAQGV	National Ambient Air Quality Guideline Values
NAQCAP	National Air Quality Control Action Plan
NDC	Nationally Determined Contribution
NESSSAP	National Emission Standards for Source Specific Air Pollutants
NMAAQS	New Malaysia Ambient Air Quality Standards
NO_x	Nitrogen Oxides
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development

$PM_{2.5}$	Fine Particulate Matter (particles ≤2.5 μm in diameter)
PM_{10}	Particulate Matter (particles ≤10 μm in diameter)
PPP	Public–Private Partnership
PRANA	Platform for Regional Air Quality Networks
QA/QC	Quality Assurance/Quality Control
RAPAP	Regional Action Programme on Air Pollution
SEA	Southeast Asia
SEACAI	Southeast Asia Climate and Clean Air Initiative
SEI	Stockholm Environment Institute
SLCP	Short-Lived Climate Pollutant
SME	Small and Medium-Sized Enterprise
SO_2	Sulfur Dioxide
TSP	Total Suspended Particulates
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organization
WRI	World Resources Institute

Executive Summary

Investing in clean air can deliver significant health, economic, and development benefits across Southeast Asia (SEA)

Bringing clean air to SEA could dramatically improve the livelihoods and development prospects of more than 660 million people. Ambient air pollution is responsible for at least 300,000 deaths annually in SEA (HEI 2025). Economic losses from delayed action on air pollution can reach 1–2% of gross domestic product (GDP) in key SEA countries (Kiesewetter et al. 2023a, 2023b, 2023c). Cleaner air could deliver particularly important benefits to disadvantaged communities, which often face greater exposure and vulnerability. Stronger regional cooperation on clean air could also help build trust among countries.

The urgency of addressing air pollution is increasing across SEA

Now is the time to address the growing pressures driving air pollution and its impacts in SEA. Rapid urbanization, rising energy use, industrialization, and motorization—particularly the growth of two- and three-wheelers—have doubled emissions of fine particulate matter ($PM_{2.5}$) over the past four decades in SEA (European Commission 2026; World Bank 2026; ASEAN Statistics Division 2026; World Bank 2024; GGGI 2021). Agricultural and waste burning, as well as forest and peatland fires, have made transboundary pollution a problem in both northern and southern SEA (ASEAN 2023). $PM_{2.5}$ concentrations have reached up to 20-times World Health Organization (WHO) annual guideline levels in some cities, while ground-level ozone has emerged as a growing regional concern (Gu et al. 2024). Short-lived climate pollutants (SLCPs), including black carbon and ground-level ozone, contribute to near-term warming in one of the world's most climate-vulnerable regions (UNEP 2025b).

National and regional clean air action is growing, but implementation gaps slow progress

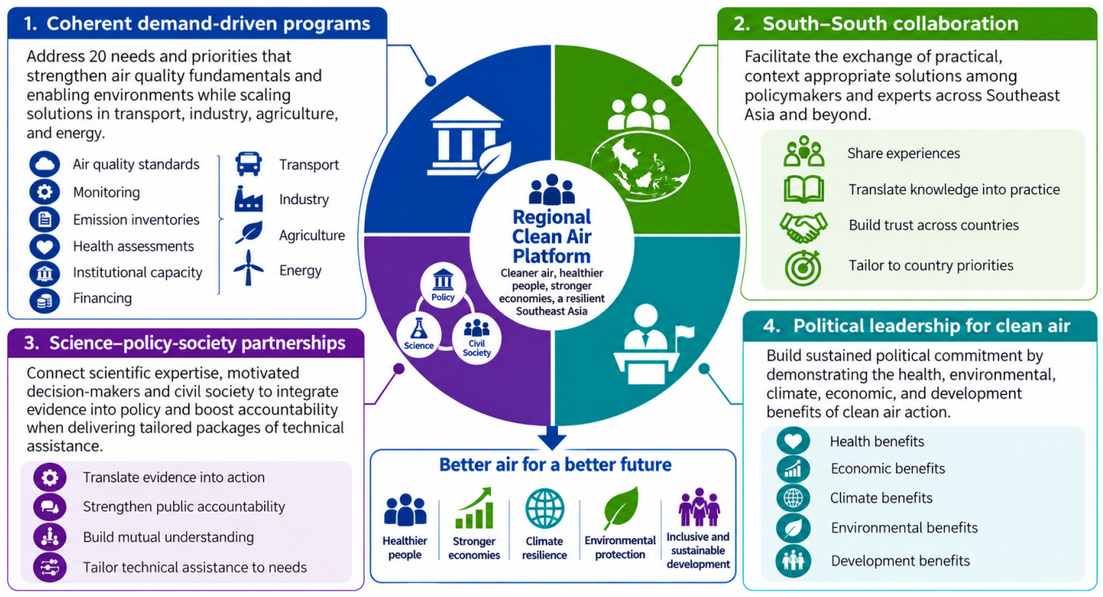
National and regional responses demonstrate growing interest in changing these trends. Countries across SEA have adopted environmental laws and clean air plans, expanded monitoring networks, and introduced sectoral and subnational solutions. Efforts to strengthen regional frameworks, such as the Association of Southeast Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution, also demonstrate a growing commitment to regional cooperation on clean air. Despite this progress, implementation and coordination within and across levels of government remain significant challenges.

A sizable opportunity exists to turn fragmented efforts into coherent action in SEA

Several countries require additional support to develop more coherent approaches to clean air. Greater coherence could encourage a shift away from isolated projects that have reinforced rather than removed divisions (Project interviews). Well-deisgned assistance could also bring sectors, stakeholders, and countries closer together, building momentum behind more effective responses.

A regional clean air platform for SEA could strengthen cooperation through four interrelated workstreams (see proposed structure below)

1. **Coherent demand-driven programs:** Address 20 needs and priorities that strengthen air quality fundamentals and enabling environments while scaling solutions in transport, industry, agriculture, and energy.
2. **South–South collaboration:** Facilitate the exchange of practical, context-appropriate solutions among policymakers and experts across SEA and beyond.
3. **Science–policy-society partnerships:** Connect scientific expertise, forward-thinking decision-makers and civil society to integrate evidence into policy and boost accountability when delivering tailored packages of technical assistance.
4. **Political leadership for clean air:** Build sustained political commitment by demonstrating the health, environmental, climate, economic, and development benefits of clean air action.



Proposed Structure for Regional Clean Air Platform for SEA

1. Introduction and Objectives

In 2026, the Clean Air Fund (CAF) initiated a project to review air pollution data, policies, regional initiatives, and civil society organization (CSO) activities in Southeast Asia (SEA). Drawing on original analysis of data and expert insights, this report is intended to help donors and the air pollution community better understand strengths and weaknesses in SEA's air pollution regulatory landscape. Toward that end, the report has four related objectives.

1. **Offer a data-driven assessment of the drivers, sources and impacts of air pollution in SEA.**
2. **Review progress, gaps and needs in national and local air quality management in SEA.**
3. **Assess how CSO and air pollution initiatives and activities are addressing those gaps and needs.**
4. **Describe how a regional platform for clean air in SEA could build on existing success while addressing gaps and needs in the region.**

To achieve these objectives, the report uses three empirically grounded methods (see Box 1) that are employed across six sections. The next section presents data on air pollution drivers, sources and impacts. Section three provides an analysis of key institutions and policies in eight SEA countries as well as funding opportunities. Section four describes 20 priorities and needs for countries in SEA, grouped into three broader categories: 1) air quality fundamentals; 2) the enabling environment; and 3) sectoral solutions. Section five profiles initiatives and activities from key regional frameowrks and CSOs in SEA. Section six details how a regional platform could bring coherence to existing efforts and deliver clean air and other benefits to SEA.

Box 1: Research Methods

The report's main content and conclusions are based on three main methods:

1. Data-driven analysis. Many parts of the report draw upon primary data from key international, regional and national sources and databases. The data were downloaded and synthesized to present an overview of trends in key drivers, sources and impacts of emissions. Where needed, this is supplemented by secondary data-driven analyses of issues such as the health and economic impacts of air pollution in the region.

2. Desk study. A comprehensive desk study was conducted of primary and secondary sources to detail changes in policies and institutions as well as other parts of the enabling environment.

3. Key informant interviews. A series of interviews were conducted with more than 30 policymakers, practitioners, and civil society representatives.

2. Drivers, Sources and Impacts

The drivers of air pollution have grown sharply in SEA. Population has more than doubled over the past 50 years, with much of that growth occurring in cities. In parallel with population growth, gross domestic product (GDP) has increased more than six-fold since 2000 (World Bank 2026). Population growth and economic development have contributed to increased energy consumption—to some degree moderated by improved energy intensity (World Bank 2026) (Figure 1).

The above trends have fueled and been fueled by shifts in key sectors. For example, value added from industry and manufacturing as a percentage of GDP sits above 60% in many SEA countries (World Bank 2026). Industrial emissions originate not only from large energy-intensive industries, such as cement, steel, manufacturing, and coal-fired power generation, but also from small- and medium-sized enterprises (SMEs) (de Sousa Jabbour et al. 2020; Gu et al. 2024). Rapid development has both contributed to and been accompanied by a doubling of motor vehicles in less than a decade. Importantly, much of that growth comes from two- and three-wheelers that can account for 80% to 90% of the vehicle fleet in countries across SEA (ASEAN Statistics Division 2026; GGGI 2021; World Bank 2024).

While SEA's economy has grown, development across the region has been uneven. Pockets of poverty persist, and about one in seven people live below the poverty line (ASEAN 2025). Further, though much of the region's growth comes from cities and industry, rural residents face growing pressure to increase agricultural production (Akahoshi et al. 2024).

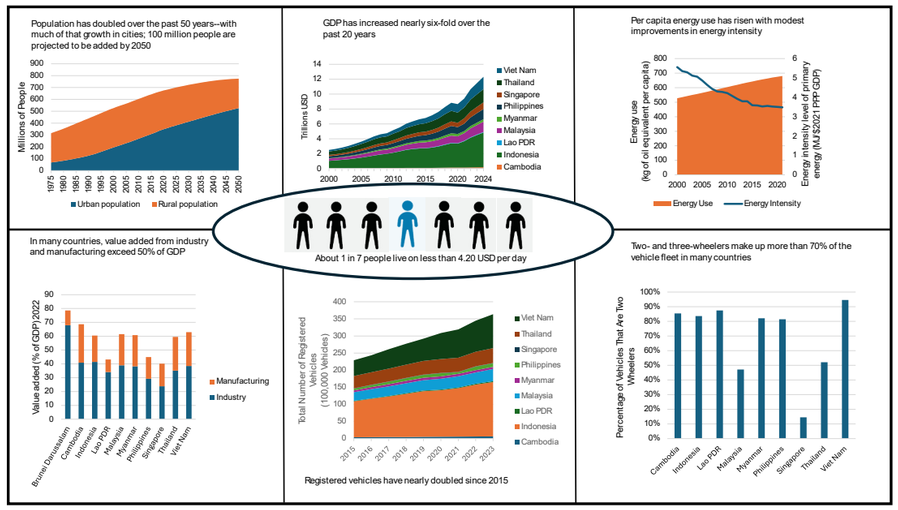


Figure 1: Drivers of Air Pollution in SEA

Sources: (ASEAN Stats Division 2026; GGGI 2021; World Bank 2024; World Bank 2026)

These drivers have led to high levels of emissions and ambient air pollution. $PM_{2.5}$ emissions have nearly doubled across key SEA countries since 1980 (European Commission 2026). Those emissions are largest in Indonesia, Vietnam, Thailand, Philippines and Myanmar with agriculture (open burning), residential energy/cookstoves, and industry as the main sectoral contributors (European Commission 2026) (Figure 2). Importantly, while larger industrial facilities remain major sources of $PM_{2.5}$, limited access to cleaner technologies and compliance capacity also lead to significant emissions from SMEs (de Sousa Jabbour et al. 2020; Gu and Zhang 2024).

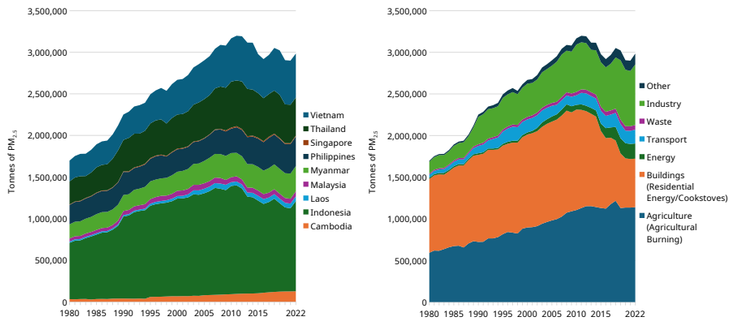


Figure 2: $PM_{2.5}$ Emissions by Country and Sector, 1980–2022

Source: (European Commission 2026)

$PM_{2.5}$ is not the only pollutant contributing to unhealthy air; NO_x emissions, a precursor of ground-level ozone and secondary $PM_{2.5}$, have also grown sharply in the region. NO_x emissions have more than tripled over the past 40 years (Figure 3). While the countries with the highest NO_x emissions are broadly similar to those with the highest $PM_{2.5}$ emissions, the sectoral breakdown differs: industry, transport and energy are the largest sectoral contributors (Figure 3).

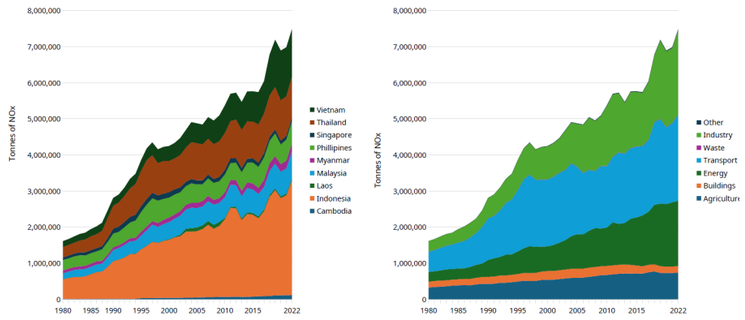


Figure 3: NO_x Emissions by Country and Sector, 1980–2022

Source: (European Commission 2026)

Increases in $PM_{2.5}$ emissions have translated into high concentrations of ambient $PM_{2.5}$, especially in cities. Among the 50 most populated cities in SEA, satellite data show that annual average concentrations can reach up to 20 times above WHO guideline annual guideline values (see Figure 4).

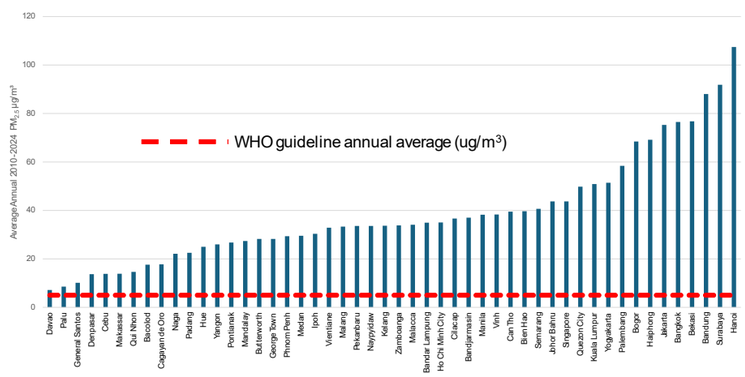


Figure 4: Annual Average $PM_{2.5}$ Concentrations in 50 Cities

Source: (Copernicus Atmosphere Monitoring Service 2024)

Although the limited number, accuracy and coverage of ozone monitoring stations make precise estimates difficult (project interviews), indicative ozone concentration estimates suggest some exceedances of WHO's guidelines in key cities during peak seasons in SEA (Figure 5). Ground-level ozone—a secondary pollutant formed when NO_x and volatile organic compounds (VOCs) react in the presence of sunlight—can harm human health, damage vegetation, and reduce crop yields. This is a significant concern in SEA since rapid urbanization, growing transport and industrial emissions, high temperatures, and abundant sunlight can contribute to ozone formation (Gu et al. 2024).

Ozone is also a short-lived climate pollutant (SLCP). SLCPs have relatively short atmospheric lifetimes, while degrading air quality and disrupting climate systems (UNEP 2025b). In so doing, SLCPs can generate significant near-term warming, change precipitation patterns and intensify storms. These near-term local and regional changes are particularly important since SEA is home to many countries that are already vulnerable to the effects of climate change (Shaw et al. 2022). By amplifying the near-term impacts of climate change, increased emissions of SLCPs can also undermine efforts to achieve many Sustainable Development Goals (SDGs).

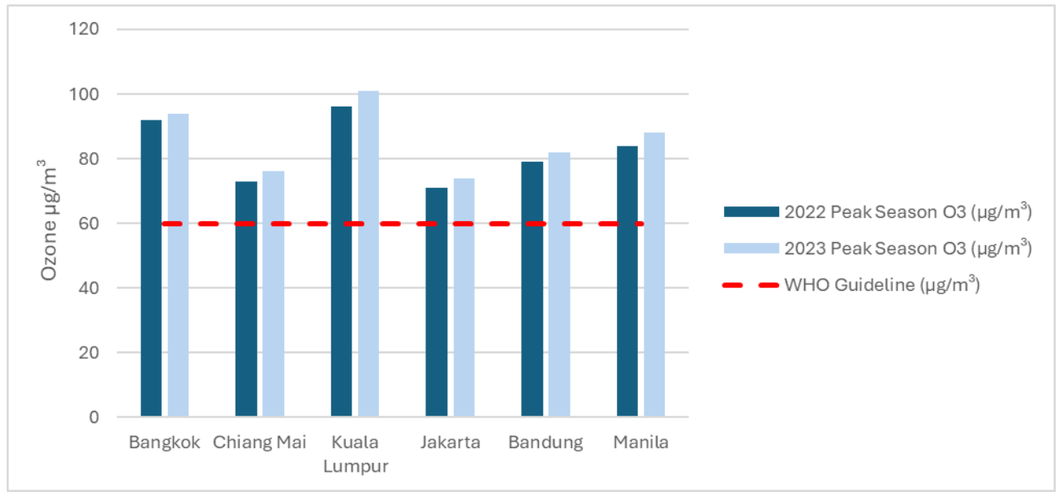


Figure 5: Ozone Concentrations in Key Cities, 2022–2023

Note: *Figure 5 presents indicative peak-season ozone concentrations for selected cities in SEA in 2022 and 2023. The values were compiled from publicly accessible air-quality monitoring information provided through national monitoring networks and aggregated platforms such as the World Air Quality Index Project (AQICN). National monitoring systems consulted included the Pollution Control Department Air4Thai network, the Department of Environment Malaysia Air Pollutant Index Management System (APIMS), and the National Environment Agency air-quality reporting system. "Peak season" refers to the six-month period of the year with the highest average ozone concentrations for each city, reflecting periods of stronger photochemical pollution formation associated with sunlight, heat, biomass burning, and urban emissions. The values are intended as screening-level estimates rather than formally calculated WHO guideline values because consistent hourly ozone datasets were not publicly available for all cities.*

Sources: (Based on data from World Air Quality Index Project n.d.; Department of Environment Malaysia, n.d.; Air4Thai n.d.)

Emissions of another SLCP, black carbon (BC), have also nearly doubled over a 40-year period—though there has been a modest reduction over the past decade from programs aimed at lowering cookstove emissions in Indonesia (European Commission 2026; Thoday et al. 2018) (Figure 6). The largest emitters of BC are Indonesia, Vietnam, Thailand, the Philippines and Malaysia, and the greatest sectoral sources are industry, agriculture, residential energy/cookstoves and transport (diesel vehicles) (European Commission 2026) (Figure 6).

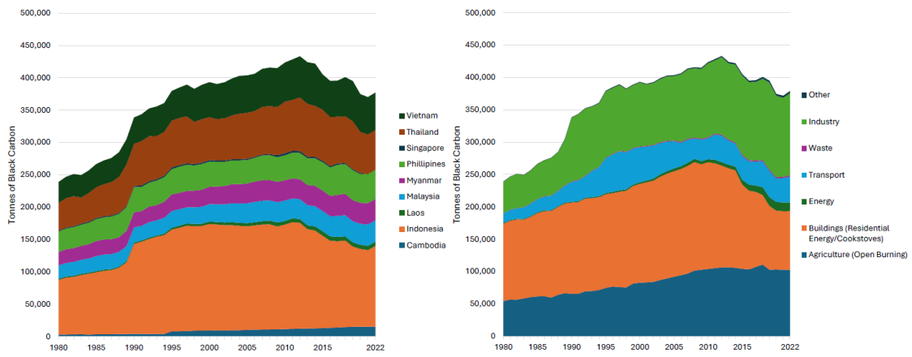


Figure 6: BC Emissions by Country and Sector, 1980–2024

Source: (European Commission 2026)

The SEA region is a significant and fast-growing source of carbon dioxide (CO_2). Energy-related CO_2 emissions in SEA have risen quickly, especially since 2000 (Figure 7). The largest emitters are Indonesia, Vietnam, Malaysia and Thailand. Energy, industry and transport are the largest sectoral sources of CO_2.

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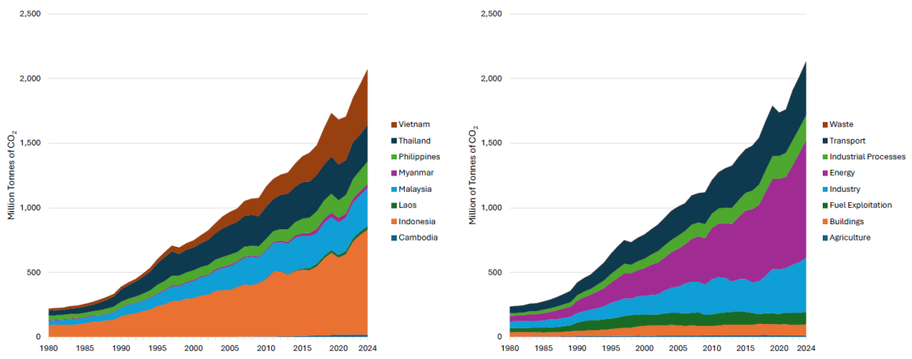
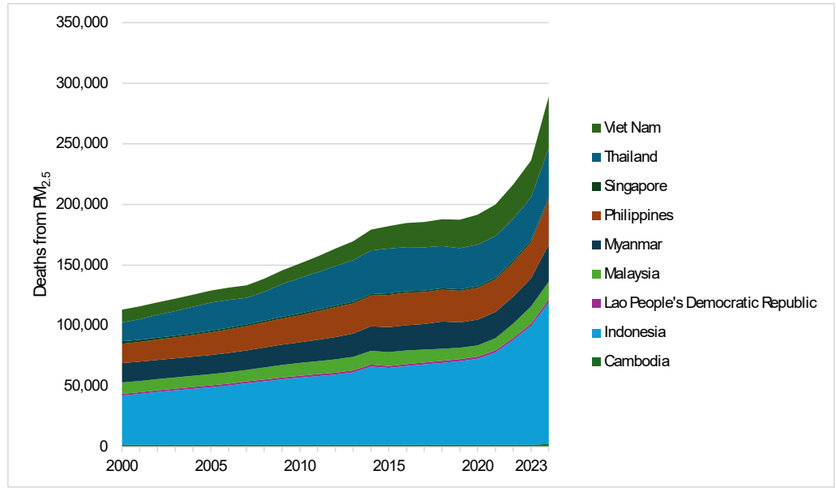


Figure 7: CO_2 Emissions by Country and Sector, 1980–2024

Note: Energy refers to CO_2 from burning fuels to produce energy (electricity, heat, or fuel use across sectors). Industry refers to CO_2 from burning fuel in factories and industrial facilities (e.g., coal, oil, or gas burned to make steel, cement, chemicals, etc.). Processes refers to CO_2 released from chemical reactions in making materials, not from fuel (e.g., CO_2 released when limestone is turned into cement).

Source: (European Commission 2026)

The impacts of these emissions have been significant. Deaths from ambient $PM_{2.5}$ annually are approximately 300,000 in SEA—a nearly threefold increase over the past two decades (Health Effects Institute 2025) (Figure 8). Some estimates that use different modeling approaches and include indoor air pollution suggest that these figures could be more than three times higher (Fang et al. 2025). Studies also show the health impacts of air pollution are not limited to $PM_{2.5}$; curbing ozone pollution and its precursors such as NO_x and VOCs can also deliver sizable health benefits (Gu et al. 2024).



Source: (Data from HEI 2025)

Significant economic benefits can also be lost if countries lag in curbing emissions. For example, delaying action on 12 clean air and climate solutions could impose costs equivalent to an average of 1.5–2% of GDP in Thailand, Cambodia, and Indonesia by 2030 (Kiesewetter et al. 2023a, 2023b, 2023c). The benefits of early action extend beyond the economy to the climate. A similar set of 15 solutions could also generate significant benefits by reducing both near-term warming and long-term climate change in SEA (UNEP 2025b).

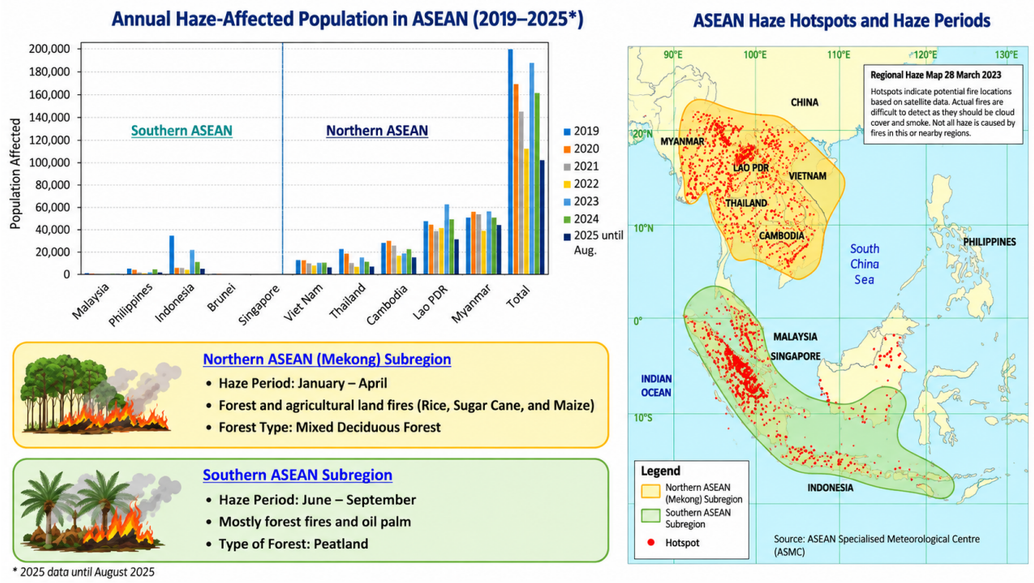
Table 1: Key Findings on Air Pollution and Health Impacts in SEA

Issue	Key Finding	Source
Ozone and NO_x	Ozone-related mortality is strongly influenced by NO_x-sensitive ozone formation and cross-border pollution.	(Hu et al. 2026)
$PM_{2.5}$ and climate change	$PM_{2.5}$ causes over one million premature deaths annually in SEA in this study; climate change could increase future health and economic losses.	(Fang et al. 2025)
Local and transboundary sources	Most $PM_{2.5}$- and ozone-related deaths are driven by local industrial, residential, transport and biogenic emissions, with important transboundary contributions.	(Gu et al. 2024)
Biomass burning	Peak fire seasons cause severe $PM_{2.5}$ exposure and thousands of premature deaths.	(Marvin et al. 2024)
Mainland SEA burning	Open biomass burning causes tens of thousands of deaths and billions of dollars in losses, particularly affecting Myanmar and Laos.	(Nguyen et al. 2022)
Indonesian peatland fires	The 2019 peatland fires generated extreme $PM_{2.5}$ pollution and tens of thousands of excess deaths.	(Grosvenor et al. 2024)
Thailand haze	Seasonal biomass burning, including pollution from neighboring countries, contributes substantially to $PM_{2.5}$ exposure, especially in northern Thailand.	(Thongsame et al. 2025)

Note: Mortality estimates differ across studies because of differences in exposure-response functions, $PM_{2.5}$ exposure estimates, and methodological frameworks. The CMAQ-GEMM approach employed in some studies can generate higher estimates than the Global Burden of Disease framework used in the State of Global Air database (Fang et al. 2025).

Health and other impacts related to open burning, forest fires, and seasonal haze are also growing. Transboundary haze from the burning of forests, peatland, shrubs and crop residues is a persistent problem in SEA. Though previously concentrated in forests and peatland fires in Southern ASEAN, recent years

have seen the problem intensifying in Northern ASEAN (Figure 9 (left panel)). At the same time, the effects of transboundary haze are often concentrated seasonally and geographically as evidenced in Figure 9.



Research also suggests those impacts cross borders. For instance, biomass burning (mostly from Laos and Myanmar) is a major contributor to $PM_{2.5}$ in mainland Thailand (Thongsame et al. 2025). More concretely, those emissions are estimated to account for 23%–38% of $PM_{2.5}$ concentrations in mainland Thailand during the haze season (February–April 2019).

3. Air Quality Management in SEA

This section maps the quickly evolving air quality management landscape for eight SEA countries, summarizing progress as well as opportunities for donor support. Table 2 (see next page) highlights some of the more important policies, institutions, and subnational implementation efforts. Although differences in development levels and governance structures complicate cross-country comparisons, the analysis suggests that countries in SEA can be roughly grouped into three tiers as illustrated in Figure 10.

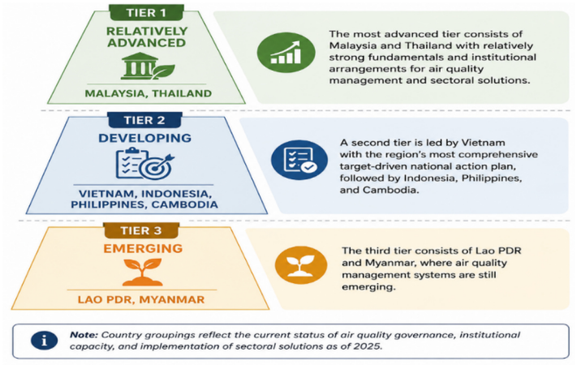


Figure 10: Three Tiers of Air Quality Management Frameworks in SEA

Source: (Authors)

Beyond the three-tier classification, Table 2 illustrates concrete examples of the key laws and policies, main implementing agencies, and subnational efforts for eight featured SEA countries. The table suggests that eight SEA countries have developed national air pollution laws, clean air plans, ambient air quality standards, and sectoral solutions. They have also created environmental agencies at the national and subnational levels to enable implementation.

Table 2 also demonstrates that national governments have adopted a broadly similar approach to regulating air pollution. National environmental agencies take the lead, working with transport, energy, industry, agriculture, health and other ministries on sector-specific measures. In addition, Table 2 illustrates many countries in SEA are strengthening emissions standards, expanding monitoring networks, and improving emissions inventories to arrive at more evidence-based national policies. For example, Vietnam's 2026 to 2030 National Action Plan establishes targets for reducing $PM_{2.5}$ and requires expanded national monitoring, while Indonesia is developing and enhancing emissions standards and air quality management.

Table 2 also highlights the importance of subnational action in SEA. In Thailand, for instance, this has included creating LEZs in urban areas, while more rural northern provinces have placed greater emphasis on open burning and transboundary haze.

While Table 2 illustrates that countries have developed a sound regulatory foundation, it offers fewer insights into the challenges of implementing policies and regulations at different levels. The following country profiles provide a more detailed overview of key policies, institutions, and funding opportunities, drawing on desk research and project interviews (see Box 1).

Table 2: Summary of the Air Quality Management Landscape in SEA

Malaysia	
Key laws/policies	Environmental Quality Act (1974) Environmental Quality (Clean Air) Regulations (2014) Strengthening of ambient standards through Interim Targets (IT-1, IT-2), informing the New Malaysia Ambient Air Quality Standards (NMAAQS) (2020)
Key institutions	Ministry of Natural Resources and Environmental Sustainability. Department of Environment Ministry of Transport, Energy Transition and Water Transformation Malaysian Meteorological Department
Subnational implementation	Department of Environment regional and state offices implement national regulations Subnational initiatives include continuous and mobile monitoring, public reporting, and state-level haze responses
Sources	(GIZ 2023; Ab Rahman and Sirat 2024; SUHAKAM 2024; Yap 2025)
Thailand	
Key laws/policies	Enhancement and Conservation of National Environmental Quality Act National Ambient Air Quality Standards National $PM_{2.5}$ Action Plan for 2025–2032 CLEAR Sky Strategy (2024–2030) Disaster Prevention Law and Public Health Law, activated during severe air pollution episodes Clean Air Bill (under consideration)
Key institutions	Ministry of Natural Resources and Environment and its Pollution Control Department National Environmental Board Ministries of Interior, Public Health, Agriculture, Transport and Industry
Subnational implementation	Bangkok serves as a focal point for action on transport emissions during high-pollution episodes Northern Thailand focuses on seasonal agricultural burning and forest-fire management and control High-$PM_{2.5}$ episodes trigger coordinated public communication and advisories
Sources	(UNEP 2022c; GIZ 2023; ADB 2026; PCD, n.d.)
Vietnam	
Key laws/policies	Law on Environmental Protection (2020) National Action Plan on Pollution Remediation and Air Quality Management for 2026–2030 (with a vision to 2045) Decision 43/2025/QD-TTg
Key institutions	Ministry of Agriculture & Environment Ministry of Construction, Health, Trade and Industry
Subnational implementation	Provincial People's Committees responsible for local air quality management plans Hanoi and Ho Chi Minh City implement clean-air plans to achieve reduction targets Mandatory $PM_{2.5}$ reductions within five years Administrative restructuring (2025–26) from 63 to 30 provinces
Sources	(UNEP 2022d; GIZ 2023; ADB 2026; Decision No 2025)
Indonesia	
Key laws/policies	Law No. 32/2009 on Environmental Protection and Management Government Regulation No. 22/2021 (PP 22/2021) Ministerial Regulation No. 5/2026 National Action Plan for Air Quality Management (2026)
Key institutions	Ministry of Environment and its Directorate of Air Pollution Control Ministry of Forestry (post-2024 restructuring) Ministries of Transport, Energy & Mineral Resources, Industry and Agriculture
Subnational implementation	Jakarta and Greater Jakarta serve as subregional locus for action South Sumatra, Jambi and other fire-prone provinces tasked with managing seasonal haze Provincial and municipal governments responsible for monitoring/enforcement
Sources	(UNEP 2022a; GIZ 2023; ADB 2026)

Table 2: Summary of the Air Quality Management Landscape in SEA (cont.)

Philippines	
Key laws/policies	Clean Air Act (1999) Department of Environment and Natural Resource Administrative Orders 2000-81 and 2000-82 (Implementing Rules and Regulations) Department of Environment and Natural Resource Administrative Orders 2013-13 and 2020-14 (Air Quality Standards) Department of Environment and Natural Resource-Environmental Management Bureau Memo Circular No. 2020-003 (CEMS-OHS) Integrated Air Quality Improvement Framework–National Air Quality Control Action Plan for 2025–2035
Key institutions	Department of Environment and Natural Resources (through the Environmental Management Bureau, Air Quality Management Section) DENR-EMB Regional Offices Local government units (LGUs) within designated airsheds Ministries of Transport, Industry and Energy
Subnational implementation	Metro Manila serves as a subregional focal point for action Iloilo, Cagayan de Oro, Marikina, Quezon and La Trinidad have developed clean air plans
Sources	(GIZ 2023; DENR Administrative Order No 2000)
Cambodia	
Key laws/policies	Law on Environmental Protection and Natural Resource Management (1996) Environment and Natural Resources Code (2023) Circular Strategy on Environment 2023–2028 Clean Air Plan (2021-2030) Sub-Decree No. 42 on Air Pollution Control and Noise Disturbance (2000) Circular No. 01 on Measures to Prevent and Reduce Ambient Air Pollution (2020)
Key institutions	Ministry of Environment National Council for Sustainable Development Ministry of Public Works and Transport Ministry of Industry, Science, Technology & Innovation
Subnational implementation	Provincial Departments of Environment in 25 provinces are responsible for implementation, monitoring, inspections and enforcement Monitoring expanding to provincial capitals
Sources	(Ministry of Environment 2021; GIZ 2023)
Laos	
Key laws/policies	Law on Environmental Protection (1999; Revised 2024) National Environmental Standards/ National Air Quality Standards (2017) Prime Minister's Order No. 11 (2023) National Pollution Control Strategy and Action Plan (2018–2025; Vision to 2030) National Green Growth Strategy to 2030
Key institutions	National Agriculture and Forestry Research Institute Biotechnology and Ecology Institute Ministries of Industry and Commerce and Health provincial and municipal authorities
Subnational implementation	Provincial/municipal authorities are responsible for monitoring, wildfire control/open-burning prevention Hotspot monitoring and enforcement during peak burning seasons (January–May) Expanding $PM_{2.5}$ monitoring and low-cost sensors
Sources	(UNEP 2022d; GIZ 2023; ADB 2026; Decision No 2025)
Myanmar	
Key laws/policies	National Environmental Policy (1994; Updated 2019) Environmental Conservation Law (2012) Environmental Conservation Rules (2014) National Environmental Quality (Emission) Guidelines (2015)
Key institutions	Ministry of Natural Resources and Environmental Conservation, through the Environmental Conservation Department Environmental Conservation Committee Environmental Management Committees (subnational implementation) Meteorology and Hydrology and other sectoral ministries
Subnational implementation	Growing emphasis on delegating enforcement and monitoring support to municipal/regional authorities Select fixed, mobile and portable monitoring with limited nationwide coverage Growing focus on air quality management in Yangon and Mandalay
Sources	(GIZ 2023)

3.1 Malaysia

Overview

Malaysia has a well-established air quality management (AQM) system supported by an equally robust environmental governance framework. The Environmental Quality Act (1974) and associated regulations such as the Environmental Quality (Clean Air) Regulations (2014) underpin that framework. Since 2000, the New Malaysia Ambient Air Quality Standards (NMAAQS) have become an important component of the country's regulatory framework. A National Clean Air Action Plan (2025–2040) is expected to strengthen monitoring, regulatory standards, and management of urban, industrial, and indoor pollution.

The Department of Environment (DOE) under the Ministry of Natural Resources and Environmental Sustainability leads AQM. This includes tasks ranging from compliance and enforcement to reporting and monitoring. It is supported by regional and state offices and a nationwide monitoring network in these efforts.

Malaysia has continued to strengthen sectoral solutions in energy and transport. For instance, the Energy Efficiency and Conservation Act (2024) establishes requirements for energy management, audits, reporting, and minimum performance standards across key sectors. In transport, Malaysia applies Euro 5 vehicle emission standards for both gas and diesel vehicles and offers incentives and expanded charging infrastructure for electric vehicles. Malaysia has also established regulatory and technical measures for industrial and power-sector emissions such as Best Available Techniques (BAT) guidance. The country is planning to strengthen its air quality monitoring system, using low-cost sensors to complement existing fixed and mobile monitoring networks.

Funding Opportunities

Malaysia faces some air quality management challenges, although these are relatively modest. For instance, it continues to face challenges from transboundary haze, urban transport, and industrial pollution, including emissions from fossil fuel use. Further modernizing monitoring systems, strengthening industrial emissions management, and improving implementation of clean transport and energy-efficiency measures top the list of identified needs. Regional cooperation on transboundary haze also remains important. The forthcoming National Clean Air Action Plan could provide an important mechanism for consolidating efforts to address these needs.

3.2 Thailand

Overview

Thailand has a mature AQM framework based on the Enhancement and Conservation of National Environmental Quality Act (1992), national ambient air quality standards and several supporting sectoral policies. The Pollution Control Department (PCD), under the Ministry of Natural Resources and Environment (MONRE), leads air quality management; the National Environment Board provides overarching environmental policy guidance and direction. A Clean Air Management Bill that could strengthen the case for action is under consideration in Thailand's parliament. Thailand is also implementing the second phase of its National $PM_{2.5}$ Action Plan for 2025–2032. This plan aims to bring 24-hour $PM_{2.5}$ concentrations to levels that are not harmful to health and reduce burned areas by at least 50% relative to the previous five-year average while regulating other sources of emissions. Thailand's national ambient air quality standards were revised in early 2026, bringing them closer to Interim Target 3 under the WHO guidelines ($PM_{2.5}$, 24-hour average and annual average standards are 37.5 μg/m³ and 15 μg/m³, respectively). Finally, Thailand is developing an official Thailand National Emission Inventory Platform to be hosted by PCD. The platform will be designed to facilitate the development and periodic updating of provincial emission inventories.

Thailand has also strengthened emissions controls in transport and other key sectors. Fuel quality standards for gasoline and diesel are equivalent to Euro 5 standards. Vehicle emission standards are progressively being tightened, including Euro 6 requirements for vehicles manufactured in or after 2026. Bangkok has also created low-emission-zone restrictions for heavy and light-duty diesel vehicles during pollution episodes. These restrictions apply to pickup trucks and vehicles with six or more wheels that are not registered in the Green List Plus system because they failed to meet maintenance requirements. Additionally, most buses in Bangkok are now battery-electric vehicle (BEV) buses. Continuous emission monitoring systems (CEMS) are required for industries in Bangkok.

Thailand has also pursued regional strategies, reflecting context-specific variation in the sources and characteristics of pollution. For instance, Bangkok has been designated a Pollution Control Area and developed an Action Plan to Mitigate Air Pollution that was submitted to the National Environment Board (NEB). At the same time, northern provinces such as Chiang Mai, Chiang Rai, Lamphun and Mae Hong Son were also designated Pollution Control Areas and required to develop provincial action plans targeting seasonal pollution. Thailand has actively sought to strengthen subregional cooperation with Laos and Myanmar. In early 2023, it launched the so-called "Clear Sky Strategy" aiming to effectively address transboundary haze pollution as illustrated in Figure 11. The Joint Plan of Action (2024-2030) under the CLEAR Sky strategy was adopted a year later.

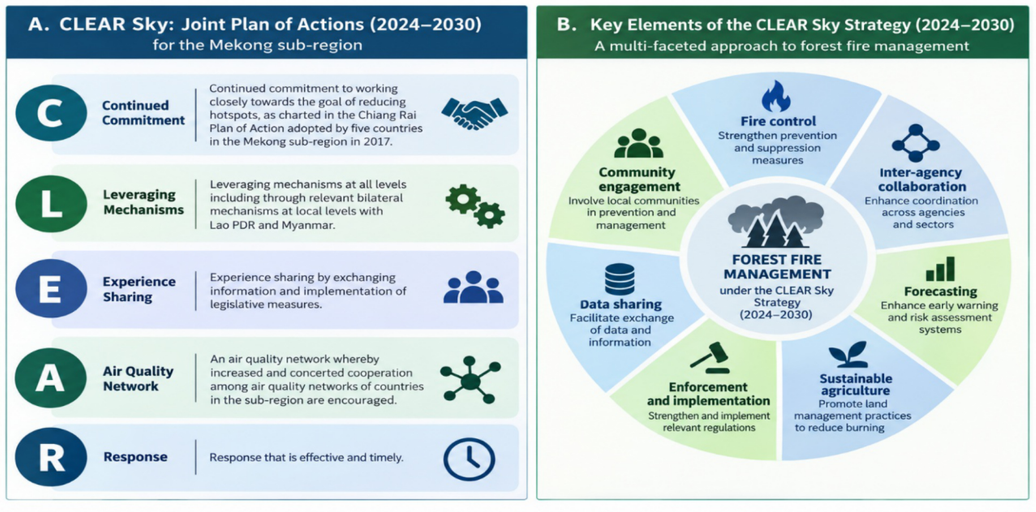


Figure 11: Thailand's CLEAR Sky Strategy

Source: (Ministry of Foreign Affairs of Thailand 2024)

Funding Opportunities

Key gaps include the development of comprehensive and regularly updated emissions inventories and stronger source-apportionment capacity. Improved mechanisms to support farmers and communities in moving toward alternatives to open burning are another area requiring support. Transboundary pollution remains a challenge, increasing the need for regional monitoring, data sharing and technical cooperation. Strengthening integrated forest fire management and sustainable agricultural residue

management are hence related opportunities. Additional priorities include strengthening institutional capacity, improving interministerial coordination, and making air quality management expenditures transparent and trackable. Additional support could also strengthen LEZs by including a wider range of vehicles and greater integration with sustainable transport policies.

3.3 Vietnam

Overview

Air quality management is anchored in the Law on Environmental Protection (2020) and several recently adopted high-profile plans in Vietnam. These plans include the National Plan on Air Quality Management (2021–2025) and the National Action Plan on Pollution Remediation and Air Quality Management for 2026–2030 (with a vision to 2045) approved under Decision No. 2530/QĐ-TTg in November 2025. As illustrated in Figure 12, the plan includes a range of quantitative targets for key regions and sectors. For instance, by 2030, the plan calls for an annual average $PM_{2.5}$ concentration in Hanoi below 40 μg/m³ (representing a 20% reduction from 2024 levels) and achieving "good" or "moderate" Vietnamese National AQI system/standards for at least 80% of days. Surrounding provinces are expected to reduce annual average $PM_{2.5}$ by at least 10%. The plan also requires all key industrial emission sources (cement, thermal power, steel and boilers) to strengthen environmental management and implement reduction roadmaps.

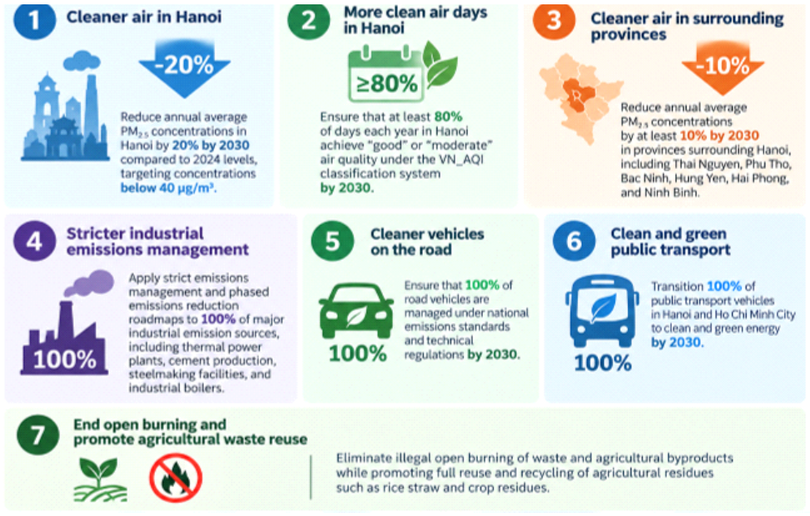


Figure 12: Key Targets in Vietnam's Recent Clean Air Plans

Source: (Authors)

The plan bolsters Vietnam's air pollution regulations. Following a 2025 administrative restructuring, the Ministry of Agriculture and Environment has assumed responsibility for air quality, while provincial and municipal authorities remain in charge of other implementation functions. The plan calls for the development of a national multisector emission database; it also mandates provincial inventories that are to be integrated into a national emissions inventory system. It further provides for 22 new automatic national air-quality monitoring stations. This will include six regional background stations, three mobile monitoring units, and technical guidance on integrating low-cost sensors into monitoring networks during 2026–2027.

In Hanoi and Ho Chi Minh City, the plan calls for making source apportionment more robust through $PM_{2.5}$ chemical characterization and application of receptor and dispersion modeling.

Vietnam has prioritized regulating transport emissions. This is reflected in Decision No. 43/2025/QĐ-TTg, which established a five-level emissions classification for in-use automobiles and accelerated requirements for Hanoi and Ho Chi Minh City in 2026. The new national action plan also requires road vehicles to be managed under national emissions standards while calling for the entire public transport fleets of Hanoi and Ho Chi Minh City to use clean or green energy by 2030. In so doing, it links air pollution controls with efforts to promote a national green-transport transition under Decision No. 876/QĐ-TTg. Hanoi is also implementing low-emission zones with a pilot covering specified areas within Ring Road 1—though less ambitious than the blanket ban initially planned for the entire ring road.

Funding Opportunities

The scope of the new national program creates several opportunities for external support. These opportunities include strengthening emissions inventories and source-apportionment capacity, expanding and integrating monitoring and data systems, and developing national forecasting and early-warning infrastructure. Promoting clean transport and industrial emissions reductions and building provincial and municipal technical capacity are also notable priorities. Related priorities include strengthening cross-sectoral and multilevel coordination and integrating data systems. Ensuring sufficient institutional capacity to manage the estimated US$5.37 billion (140 trillion VND) to implement priority projects is yet another concern.

3.4 Indonesia

Overview

Indonesia's air quality management framework is embedded in several foundational environmental laws and regulations. These include Law No. 32/2009 on Environmental Protection and Management and Government Regulation No. 22/2021 that provides for ambient air quality standards, emissions controls, monitoring, and compliance. The Ministry of Environment leads national air pollution control efforts through its Directorate of Air Pollution Control, cooperating with sectoral and planning agencies. However, interagency coordination remains a challenge, particularly following the 2024 restructuring that divided the former Ministry of Environment and Forestry into two separate ministries.

Subnational governments have significant implementation responsibilities. Jakarta (and the Greater Jakarta metropolitan area) is the focal point for urban air quality management efforts, while provinces such as South Sumatra, Jambi, and Kalimantan are charged with managing seasonal pollution risks associated with peatland and forest fires.

Indonesia is currently adopting several reforms aimed at strengthening its national air pollution regulations. For instance, in December 2026 Indonesia's National Action Plan for Air Quality Management will harmonize stationary-source emission standards; this will be followed by revised technical guidelines for controlling stationary source pollution in December 2027. Meanwhile, a Greater Jakarta pilot (2025–2028) is supporting the development of emissions inventories and source-apportionment and $PM_{2.5}$ reduction scenarios that will culminating in a region-specific Air Quality Management Plan in 2028 that can be replicated in other metropolitan areas.



Figure 13: Recent Milestones in Indonesia's Clean Air Policies and Plans

Source: (Silaban 2026)

Monitoring infrastructure is also being strengthened, although coverage remains uneven relative to Indonesia's geographic scale; pilot low-cost sensor deployments have generated near-real-time data in locations including South Sumatra, Jambi, and Bandung, but these systems remain project-based rather than fully integrated into the national monitoring framework.

Transport, industrial activity, power generation, waste, and biomass burning remain key air pollution sources. Indonesia is implementing Euro 4 vehicle emission standards and considering further strengthening, while heavy-duty vehicle emissions control, inspection and maintenance, and retrofit programs remain areas for improvement. Jakarta is also pursuing substantial public transport electrification, with an objective of achieving 50% zero-emission TransJakarta buses by 2027 and 100% by 2030. At the same time, industrial emissions controls remain uneven, particularly among SMEs, where financing and enforcement constraints can limit adoption of pollution-control technologies.

Funding Opportunities

Key needs identified through the assessment include institutionalizing a comprehensive national emissions inventory; expanding and integrating monitoring networks, including appropriate use of low-cost sensors; strengthening source-apportionment, forecasting and early-warning capacity; improving heavy-duty vehicle and industrial emissions controls; and strengthening cross-sectoral coordination, financing, and technical capacity beyond Jakarta. The absence of a consolidated public data set on government expenditure specifically for AQM also limits transparency and strategic investment planning.

3.5 Philippines

Overview

The Philippines' air quality management framework is anchored in the Philippine Clean Air Act of 1999. This law establishes legally binding ambient air quality standards, emissions controls, monitoring requirements, and an airshed-based approach to AQM. The Department of Environment and Natural Resources, chiefly through the Environmental Management Bureau (DENR–EMB), leads national air quality management. In this role, it handles not only monitoring and emissions inventories but also permitting, compliance and policy implementation. Legally designated airsheds are used to govern AQM while local government units (LGUs) are responsible for local enforcement and compliance.

The national monitoring network is being strengthened, including efforts to integrate reference-grade monitoring with low-cost sensors, while approximately 60 power plants currently have CEMS, although integration of CEMS data into centralized monitoring and reporting systems is a challenge.

The Philippines is currently working through a multi-stakeholder consultation process to update its Integrated Air Quality Improvement Framework–National Air Quality Control Action Plan (IAQIF–NAQCAP). The revision seeks to streamline the existing framework while strengthening technical specifications and implementation provisions as well as aligning air quality, clean energy and climate strategies. Other ongoing reforms include revisions to the National Emission Standards for Source Specific Air Pollutants (NESSSAPs), development of Mass Emission Rate Standards for key pollutants, review of National Ambient Air Quality Guideline Values, and possible emissions charges.

In key sectors, authorities are also considering reforms. Notable examples include upgrading transport emissions standards from Euro 4 to Euro 5 while strengthening vehicle inspection and maintenance. Urban air quality initiatives increasingly include active transport and other measures to reduce pollution exposure. The Electric Vehicle Industry Development Act also provides a framework for accelerating electric mobility.

Funding Opportunities

Donor opportunities include expanding and harmonizing air quality monitoring and emissions monitoring; strengthening emissions inventories and digital reporting systems; improving vehicle and industrial emissions controls; and strengthening cross-sectoral coordination and enforcement capacity. More coherent and transparent tracking of AQM expenditures and stronger resource mobilization to support long-term monitoring and implementation are related needs. The integration of reference monitors and low-cost sensors, expansion of CEMS and digital monitoring, and development of real-time systems for identifying exceedances and issuing public alerts could strengthen both regulatory oversight and public access to information. Sustained technical and financial support will be particularly important for translating national reforms into implementable actions by key agencies and local governments.

3.6 Cambodia

Overview

Cambodia's air quality management framework is anchored in the Clean Air Plan (2021) and the Sub-Decree on Air Pollution Control and Noise Disturbance (2000). These two policies establish the statutory basis for air quality standards, emissions controls, monitoring, permitting, and enforcement. The Clean Air Plan is an evidence-based framework covering emissions inventories, air quality modeling, regulatory measures, monitoring, enforcement, public participation and other issues. The Environmental and Natural Resources Code (2023) and Circular Strategy on Environment 2023–2028 further strengthen environmental governance by linking air quality, public health, climate resilience, and sustainable development.

The Ministry of Environment leads national air quality management, with the General Directorate of Environmental Protection and Department of Air Quality, Noise and Vibration Management responsible for key technical and regulatory functions. Provincial and municipal environmental offices support implementation across the country's 25 provinces. However, coordination, technical capacity, monitoring, and enforcement at both national and subnational levels tend to be weak in some cases.

Cambodia developed a national emissions inventory using the Low Emissions Analysis Platform (LEAP) to cover major sectors and pollutants during preparation of the Clean Air Plan. However, a fully institutionalized and regularly updated national air pollutant inventory system is nonetheless lacking. Monitoring infrastructure has expanded with international and regional support, though additional stations, maintenance capacity, and stronger early-warning systems are still needed. The Plan's open-burning component is being updated, while transport standards have progressed from Euro 3 to Euro 4, with UNEP helping to strengthen them further. Cambodia's NDC 3.0 (2025) also highlights air quality as an adaptation priority, while renewable energy expansion, coal phase-down, electric mobility, improving waste management, reducing open burning, and promoting clean cooking could deliver clean air co-benefits.

Funding Opportunities

Several priorities exist for funding and support. These include strengthening emissions inventories and analytical capacity; expanding and maintaining monitoring networks; developing more advanced forecasting and early-warning systems; and improving enforcement and institutional coordination. Addressing open burning of biomass and waste remains a priority, while there are also opportunities to support efforts to curb growing transport emissions, fossil-fuel use, and inadequate waste management. Greater integration of air quality considerations into energy transition, transport, waste management, and climate planning could help capture cross-sectoral benefits. Financing also remains a challenge: government expenditure on air quality is not publicly disaggregated, while implementation is expected to continue relying on international climate finance, blended finance, and the private sector. Strengthening cost–benefit analysis, economic evidence on pollution impacts, and technical capacity could improve the justification and mobilization of AQM resources.

3.7 Laos

Overview

In Laos, air quality management is addressed within the Law on Environmental Protection (revised 2024) and National Air Quality Standards (2017). Other relevant frameworks include the National Green Growth Strategy to 2030, Forestry Law (2019), Forestry Strategy to 2035, and the National Pollution Control Strategy and Action Plan (2018–2025; Vision to 2030). Following the 2025 merger of the Ministry of Agriculture and Forestry and Ministry of Environment, the newly created Ministry of Agriculture and Environment (MoAE) serves as the lead authority for air quality management, supported by technical and research institutions as well as provincial authorities. Prime Minister's Order No. 11 (2023) strengthens efforts to control open burning in forest and agricultural areas, while Laos also participates in the Mekong Subregion CLEAR Sky Strategy.

Laos is strengthening its monitoring and policy framework, including through low-cost sensor deployment in schools, collaboration on early-warning systems for haze events, and the Air Quality Index and Air Quality Analysis Method Agreement. The country has improved vehicle emissions standards to approximately Euro 4-equivalent levels, although challenges remain around fuel quality, vehicle inspection and maintenance, and older imported vehicles. A National Investment Framework and National Clean Air Plan are currently under development, with the former intended to prioritize emission sources for targeted reduction measures. The government is also working toward a dedicated clean air law or act and greater integration of air pollution and SLCPs into future NDC updates, while planned measures increasingly link air quality with climate and development objectives.

Funding Opportunities

Identified funding needs include strengthening emissions inventories and source apportionment; expanding and maintaining monitoring and early-warning systems; improving air quality modeling and integration of meteorological and satellite data; and improving interagency coordination. Practical alternatives to biomass and solid waste burning are additional priorities. Assistance is also needed to strengthen vehicle standards and inspection and maintenance, industrial emissions standards and inspection, and translate science into policy. Limited public financing information, uneven institutional and enforcement capacity, limited local civil society engagement, and gaps in public access to air quality data are related constraints.

3.8 Myanmar

Overview

Myanmar does not have a dedicated clean air law but manages air quality under environmental protection laws. The Environmental Conservation Law, Environmental Conservation Rules, National Environmental Policy, Environmental Impact Assessment Procedure, and National Environmental Quality (Emission) Guidelines (2015) provide the regulatory basis for managing transport, industry, and other sectoral emissions. This applies to, for instance, recent efforts to strengthen vehicle emissions standards to approximately Euro 4-equivalent levels.

The Ministry of Natural Resources and Environmental Conservation (MONREC), principally through its Environmental Conservation Department (ECD), is responsible for implementing national environmental and air-quality policies and regulations. Environmental committees at the national, state, and regional levels play a complementary coordination and oversight role, helping to guide policy, coordinate among government bodies, and support implementation at their respective levels. To support regulatory efforts, Myanmar has participated in bilateral and regional cooperation on transboundary haze, including the Mekong Subregion CLEAR Sky Strategy.

Ambient air quality monitoring is conducted by the Environmental Conservation Department in select states and regions, with results published periodically. However, the monitoring network remains limited and does not yet provide comprehensive national coverage. Monitoring currently relies on portable devices, mobile units, and fixed stations.

Funding Opportunities

Opportunities for funding include strengthening ambient air quality standards and technical guidelines, expanding monitoring and early-warning systems, improving city- and subnational-level air quality planning and implementation, and strengthening compliance with regional haze-management commitments. Publicly available information on government expenditure specifically dedicated to air quality management is also limited, constraining assessment of the resources available for implementation.

4. Air Quality Management Needs and Priorities

While all SEA countries have established policies and institutions to address air pollution, the maturity and scope of their air quality management systems vary considerably. There is therefore no one-size-fits-all approach to strengthening air quality management across the region. Nevertheless, common priorities and needs can be identified and grouped into three areas: 1) air quality management fundamentals; 2) the enabling environment; and 3) sectoral solutions. Figure 14 assesses the relative priority of these needs across the target countries, drawing on the country assessment and project interviews.

Heatmap Key

Significant priority **Moderate priority** **Not identified as a priority**

	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Philippines	Thailand	Vietnam
Air Quality Fundamentals								
1. Strengthening/harmonizing air quality standards (in line with WHO standards)								
2. Institutionalizing emission inventories/source apportionment/health impact assessment								
3. Expanding monitoring and harmonizing reference/low-cost sensors								
4. Leveraging satellite/AI data								
5. Creating early warning systems								
Enabling Environment								
6. Improving resource mobilization and developing funding proposals								
7. Creating coherent, transparent, trackable budgetary data								
8. Supporting development of national/subnational clean air action plans								
9. Integrating social justice/inclusivity into clean air and energy planning								
10. Strengthening interministerial coordination and enforcement capacities								
11. Improving disaster response management (extreme haze event) and mainstreaming air pollution into adaptation measures								
12. Expanding multi-stakeholder partnerships by including health professionals and impacted groups into decision-making processes								
Sectoral Solutions								
13. Accelerating transitions to tighter emissions standards (Euro 4/5/6)								
14. Creating sustainable ecosystem for electric vehicles, especially 2-3 wheelers								
15. Improving controls on heavy duty freight (diesel)								
16. Bolstering vehicle inspection and maintenance (controls on older vehicles)								
17. Spreading industrial emission controls, especially to SMEs								
18. Extending continuous emissions monitoring to more industrial facilities and power plants								
19. Identifying and spreading innovative solutions to open burning of waste								
29. Identifying and spreading innovative solutions to open burning of crop residue								

Figure 14: Air Quality Priorities and Needs in SEA

Source: (Authors)

4.1 Air Quality Fundamentals

Strengthening and harmonizing ambient air quality standards with WHO guidelines is critical to improving air quality and health across ASEAN (see Figure 15 for annual $PM_{2.5}$ ambient air quality standards). The WHO's 2021 Global Air Quality Guidelines tightened recommended limits for $PM_{2.5}$ and other pollutants, underlining robust evidence linking even low levels of exposure to risks of cardiovascular and respiratory disease (WHO 2021). Aligning national standards with these guidelines can motivate decision-makers to invest in stronger policies and enforcement to counter both national and transboundary air pollution.[1] Several SEA countries are already moving in this direction.

[1] The WHO Air Quality Guidelines establish health-based recommendations for concentrations of $PM_{2.5}$ in ambient air. The WHO annual guidelines recommend an annual mean $PM_{2.5}$ concentration of no more than 5 µg/m³ and a 24-hour mean of no more than 15 µg/m³. Recognizing that many countries may require a gradual pathway toward achieving these levels, the WHO guidelines also defined a series of interim targets (IT-1 through IT-4). For example, the annual mean interim targets are set at 35 µg/m³ (IT-1), 25 µg/m³ (IT-2), 15 µg/m³ (IT-3), and 10 µg/m³ (IT-4). These interim thresholds provide stepwise benchmarks for reducing $PM_{2.5}$ pollution, with each incremental reduction associated with measurable public health benefits and lower risks of air pollution-related disease and death.

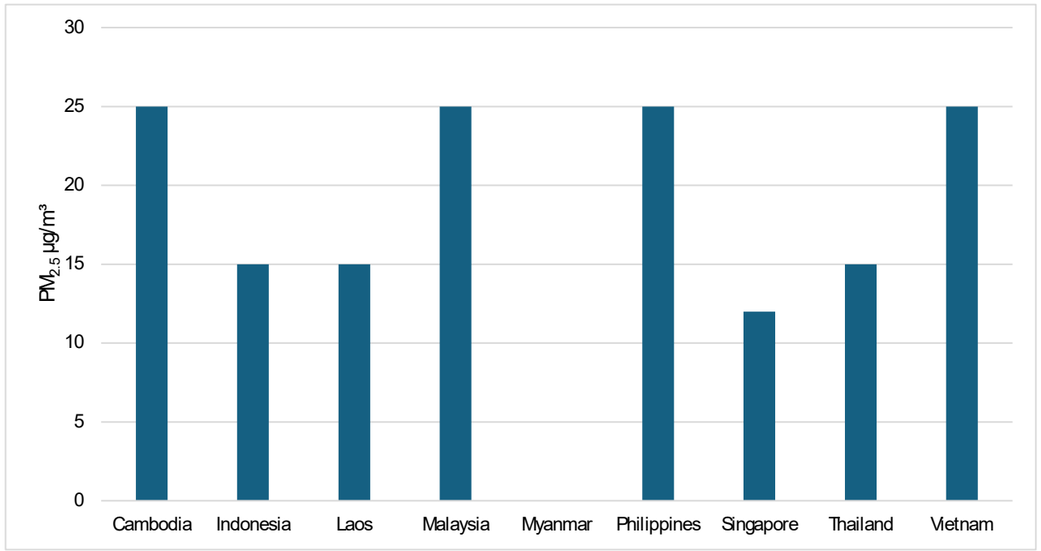


Figure 15: $PM_{2.5}$ Annual Air Quality Standards in Key SEA Countries

Note: Myanmar currently has a 10 ug/m³ guideline but does not yet have a legally binding national ambient air quality standard.

Sources: (ADB 2026; ASEAN 2024; Clean Air Asia 2021; ICEM 2022; Singapore, Ministry of Sustainability and the Environment, n.d.; Stockholm Environment Institute 2022)

Robust emissions inventories, supported by source apportionment and health impact assessment data, are central to evidence-based air quality management. Regularly updated emissions inventories enable governments to identify pollution sources and design targeted air quality strategies, while source apportionment studies help determine how much different sources contribute to observed air pollution levels. Several countries are already strengthening these systems. However, many countries in SEA face technical, institutional, and data-related challenges, including fragmented monitoring systems, limited analytical capacity, and a lack of standardized methodologies (Verma 2023).

Expanding air quality monitoring networks in SEA requires extending the coverage and quality of reference-grade systems as well as integrating low-cost sensors (LCS) into decision-making processes. While reference monitors remain essential for regulatory compliance and accuracy, their high cost and limited coverage constrain their potential. LCS provide a complementary solution by enabling more affordable, spatially dense, real-time monitoring while also helping to close data gaps in underserved locations (UNEP 2021).

Countries in SEA nonetheless face several challenges as they work to strengthen monitoring networks (ADB 2026). These include issues with monitoring accuracy and sensitivity as well as establishing calibration and verification methods. These issues are particularly notable when it comes to LCS. Understanding how to co-locate LCS with reference instruments and ensuring monitoring equipment conforms to emerging international guidance and standards are related challenges (USEPA 2026). Ensuring sufficient technical capacity and human resources for managing and reporting monitoring data is another hurdle. This is often a difficulty since staff charged with operating the systems and quality assurance/quality control (QA/QC) may lack sufficient skills and time. A related issue—as implied above—

is the geographic coverage of monitoring systems. In SEA countries (and Asia more generally), monitoring is less dense than Europe, the United States and China (Smith et al. 2025).

Another set of challenges involves limited coverage and reporting on different pollutants. Nearly all monitoring stations in SEA cover $PM_{2.5}$, reflecting a heightened awareness of its health impacts and relationship with haze pollution. However, even in countries with relatively robust monitoring networks such as Thailand, coverage of ozone can be limited and inconsistent. Monitoring equipment is also unevenly distributed and often concentrated in major urban centers, leaving rural areas, industrial corridors, and agricultural zones, and haze pollution under-monitored. In addition, monitoring networks may be operated by different agencies using different systems and reporting practices, resulting in inconsistent or fragmented air quality data.

Making use of satellite observations and AI presents a significant opportunity to enhance air quality monitoring in SEA. Satellite data offers consistent coverage, enabling the tracking of transboundary pollution and regional emission patterns. When combined with AI and machine learning, datasets can be further refined to generate high-resolution, surface-level pollution estimates, improving forecasting and decision-making, including through early-warning systems (Chadalavada et al. 2025). However, translating this data into policy requires investment in both technical capacity and standardized methodologies to ensure comparability. In addition, at present satellite data may not have sufficient spatial resolution to capture some pollution events. Several SEA countries have nonetheless identified AI and satellite integration as priorities.

Developing air quality forecasting and early-warning systems for air pollution is a need for many countries in SEA, enabling governments to anticipate and respond to episodic pollution events. Early-warning systems integrate data from monitoring networks, satellite observations, and meteorological and air quality forecasting to provide alerts on episodic pollution. When supported by advanced analytics and predictive modeling, these systems can expedite responses, public health advisories and other mitigation measures (Environmental Modelling and Software 2026).

4.2 The Enabling Environment

Increasing funding requires a coordinated approach that boosts domestic and international resources (Clean Air Fund 2023). This can be facilitated by integrating AQM into national development, climate and sectoral plans, while also building capacity for bankable project proposals (Tamayo-Araneta 2023). Greater integration with climate finance remains important since the amount of funding earmarked for climate change can be greater than resources allocated for environment, pollution control or air quality (see Figure 16). Access to climate and environmental finance, including grants, concessional loans, and blended finance, can also be improved by linking AQM actions to climate, health, and sustainable development priorities. Promoting public–private partnerships (PPP) can also help mobilize additional resources, particularly for monitoring and clean technologies, while stronger coordination across ministries can ensure more effective use of available funds (ADB 2018; UNEP 2025b). Exploring innovative financing approaches, such as results-based financing and mechanisms that incorporate the economic costs of pollution into investment decisions, can also help mobilize resources (Tamayo-Araneta 2023).

Table 3: Air Quality Monitoring Systems, Emission Inventories, Source Apportionment

Heatmap Key

Relatively Strong | Room for Improvement | Significant Gap

Country / Population / Size Network (Stations-LCS)	QA/QC Technology	Management	Geographic Pollutant Coverage	Public Data Access	Emission Inventory	Source Apportionment	Modeling and Mitigation Pathways
Indonesia– 286m **~133 stations | ~225 LCS** ***Relatively large network***	Reference-grade and LCS; QA/QC and maintenance uneven	Mainly government owned monitoring but some private entities own and operate monitoring stations	Monitoring concentrated in major cities and on Java; limited and inconsistent monitoring coverage in other regions	Public data available but access can be inconsistent	No regular national inventory yet (but one is scheduled for December 2027); provincial guidance on inventories exists. Jakarta has an inventory and Greater Jakarta is updating inventories.	Jakarta-based studies identify vehicles, coal, open burning, construction and road dust as key sources. Limited work elsewhere; Source apportionment is not institutionalized nationally.	Greater Jakarta pilot to develop $PM_{2.5}$ reduction scenarios for a legally grounded AQM Plan by 2028; national cost-of-inaction scenarios. No national mitigation pathway developed.
Philippines– 117m **~155 stations | ~36 LCS** ***Expanding, urban-focused network***	LCS expanding; calibration and maintenance challenges	Government-led monitoring system	Mainly urban; national coverage uneven limited and inconsistent coverage of ozone	Real-time data available but access can be inconsistent	National inventory is required every three years; latest available inventory is for 2021, covering mobile, stationary and area sources.	Metro Manila studies identify vehicles as the largest source, (followed by biomass burning, industry and secondary sulfate). Source apportionment is not institutionalized nationally	SLCP National Plan (2025) used Low Emissions Analysis Platform-Integrated Benefits Calculator (LEAP-IBC) to estimate emissions and 13 priority measures to 2050 IAQIF–NAQCAP update underway. Limited $PM_{2.5}$ concentration and health scenario modeling.
Thailand– 71.6 m ~150+ stations | ~2,000 LCS *Relatively large, mature network*	Established QA/QC; reference-grade network + other sensors	Government-led monitoring system	Broad but still uneven coverage between urban and rural areas; some reference stations cover ozone but geographic coverage limited	Real-time data readily accessible	National inventory platform under development; several provincial inventories exist. The most comprehensive national inventory is currently developed by researchers.	Several studies identify important local and transboundary sources, including biomass burning during haze episodes. Source apportionment yet to be institutionalized nationally.	Cost-of-inaction scenarios for 12 clean air and climate measures; $PM_{2.5}$ Action Plan targets are not yet linked to a published national mitigation pathway. Modeling is used to assess the effectiveness of the plan.
Vietnam– 102m ~106 stations | ~306 LCS *Expanding network*	Mixed technologies; QA/QC capacity varies	Government-led monitoring	Concentration on major urban areas	Real-time data readily accessible	National and provincial inventories mandated in 2025; national inventory not institutionalized.	Hanoi studies identify industry, rice-straw burning, road dust and transport, with substantial regional contributions. Source apportionment is not institutionalized nationally	GAINS scenarios developed for the Hanoi region. National plan sets quantitative 2030 $PM_{2.5}$ targets but no published national mitigation pathway.
Laos– 7.9m ~10 stations | ~170 LCS *Small, developing network*	Limited QA/QC and technical capacity	Government-led monitoring	Largely urban no reference stations for ozone (mobile measurement only)	Some real-time data available but access can be inconsistent	First national and provincial inventory developed but not national inventory not institutionalized.	No national or city-level source apportionment study identified.	Government staff trained on LEAP. National Clean Air Plan and National Investment Framework under development to prioritize sources. No mitigation pathway developed.
Cambodia– 17.8m ~11 stations | LCS: insufficient data *Small, developing network*	Limited QA/QC and technical capacity	Government-led monitoring system	Limited; concentrated in urban areas No monitoring of ozone identified	Some real-time data but access can be inconsistent	National inventory developed for the Clean Air Plan, covering key sectors; not regularly updated.	No national or city-level source apportionment study identified.	Clean Air Plan based on a LEAP scenario of 14 measures cost-of-inaction scenarios
Malaysia– 36m ~68 stations | LCS: no official count *Mature network*	Established monitoring system	Government-led monitoring system	Relatively broad national coverage ozone covered	Real-time public data accessible	No national inventory identified; available inventories are developed for researchers or local sources	Significant amount of research identifies secondary aerosols, biomass burning, traffic and industry, and other sources; not integrated into routine AQM.	National Clean Air Action Plan (2025–2040) being finalized; no published national mitigation pathway identified.
Myanmar-54.9m ~30 stations | LCS: no official count *Limited, fragmented network*	Limited QA/QC and technical capacity	Information limited	Concentrated in selected urban areas ozone no monitoring identified	No consistent real-time data	No national inventory; some inventories produced by researchers for Greater Yangon.	Limited number of studies identify dust and biomass burning as important sources in Yangon.	No national modeling or mitigation pathway identified

Note: Data on air quality monitoring networks are often difficult to obtain and compare across countries. In particular, information on the number of reference-grade monitoring stations and low-cost sensors (LCS) is frequently incomplete or inconsistent. Monitoring networks also vary considerably in their operation, geographic coverage, and daily availability. Although the number of LCS is growing across the region, their data are generally not accepted for official regulatory monitoring purposes. Despite these limitations, efforts were made to collect and verify the information presented in this table. Station counts are approximate and may include different types of monitors depending on national reporting practices.Ozone monitoring remains a significant regional gap. Coverage is limited or inconsistent in Indonesia, the Philippines, Thailand, and Vietnam. No fixed or routine ozone monitoring was identified in Laos, Cambodia, or Myanmar, while Malaysia reports ozone monitoring coverage.

Sources: (Ab Rahman and Sirat 2024; Abdullah 2024; Air4Thai n.d.; Biotechnology and Ecology Institute 2026; Clean Air Asia 2022; Dejchanchaiwong et al. 2023; Department of Environment and Natural Resources Environmental Management Bureau n.d.; Electricity Generating Authority of Thailand, 2021.; Graham et al. 2024; IQair 2025; Soe and Than 2022; Cariaso 2025; Thailand Pollution Control Department, n.d.; Verma et al. 2023; Vietnamnet, 2024; World Bank 2023; World Resources Institute (WRI) 2023; Amil 2016; Azhari 2021; Clean Air Asia 2025; Department of Environment and Natural Resources Environmental Management Bureau, n.d.; DLH DKI Jakarta and Vital Strategies 2021; Junpen et al. 2018; Huy 2020; Le et al. 2026; Pabroa 2022; Stockholm Environment Institute 2024; Simpas et al. 2014; Sokharavuth et al. 2023; Sricharoenvech 2020; The Jakarta Post 2026; Vital Strategies 2020; World Bank 2021)

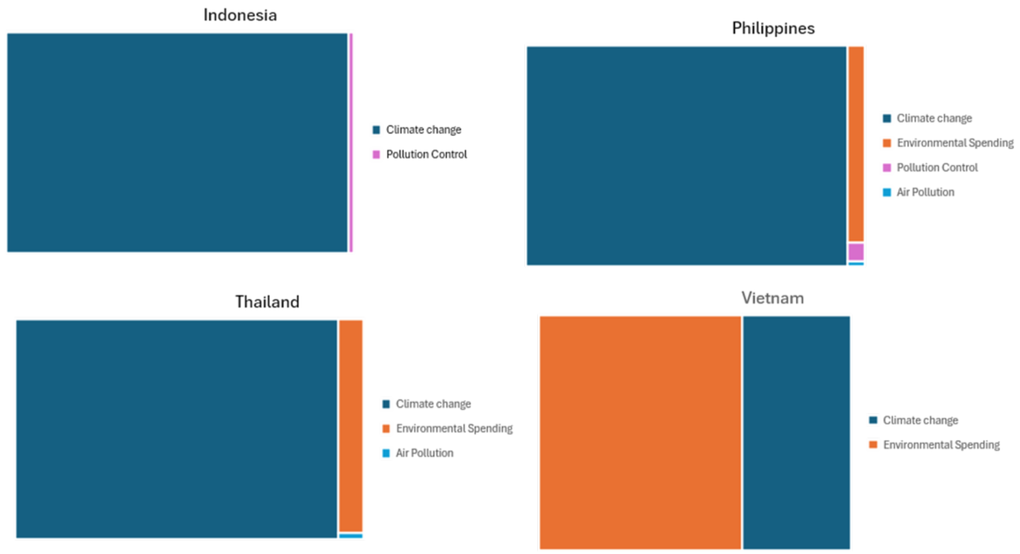


Figure 16: Funding for Climate Change, Environment, Pollution Control and Air Pollution in Key SEA Countries

Note: As noted in the discussion of the air quality landscape, it is difficult to acquire data on funding for air quality management. The above figure offers an illustrative example of how much is allocated for climate change, environmental issues, pollution control, and air pollution.

Sources: (Jejakin 2025; Philippine Statistics Authority. n.d.: Rathore 2025; Turner 2025; UNDP 2022; UNDP 2025)

Improving how governments report and track AQM funding data is as important as the amount of resources (Clean Air Fund 2023). Budget tagging and/or tracking systems can help identify and monitor AQM-related expenditures across budgets, while aligning them with climate, health, and other priorities. Regular public reporting can enhance government accountability and support more transparent and informed decision-making. This kind of reporting can help create pressures to make fragmented budgeting more coherent and limit waste. Better monitoring and reporting can also support performance-based approaches and enhance the overall effectiveness of AQM investments (World Bank 2014).

Strengthening national and subnational clean air plans and policies is a growing priority for SEA countries, providing a structured yet relatively flexible framework to translate commitments into specific measures. Such plans can highlight major pollution sources, set clear targets, and outline specific interventions aligned with national development priorities. Boosting national and local technical and institutional capacity is essential to ensure that plans are actionable, evidence-based, and locally appropriate.

Strengthening coordination across ministries as part of a whole-of-government approach can enable clean air policies. This is particularly true since managing air pollution and building enforcement capacities often requires clear roles and responsibilities and coordination mechanisms to optimize resources (UNEP 2025b; Zusman et al. 2021). Greater participation by health professionals and affected communities can be particularly important in this regard, helping to connect scientific evidence with community concerns and lived experience. Establishing platforms for ongoing consultation and feedback with these groups can also make decision-making more responsive, inclusive, and effective over time (Ward et al. 2022).

A related issue involves environmental justice. Ensuring that clean air and energy policies deliver fair and inclusive outcomes is increasingly important in SEA. Air pollution and its adverse health impacts often disproportionately affect low-income and vulnerable groups, underscoring the need to embed equity into policies (Vona 2021). Further, some clean air solutions such as promoting renewable energy or vehicle inspection and maintenance programs can lead to job and income losses. Prioritizing targeted interventions in high-risk communities, supporting reskilling programs and ensuring that affected populations are meaningfully engaged in planning processes are a growing need in SEA.

Improving disaster response to extreme haze events, while integrating air pollution into broader climate adaptation efforts, is also emerging as a priority in SEA. Developing preparedness and response systems, including early-warning systems, health advisories, and emergency coordination, can help reduce the impacts of haze episodes. In addition, integrating air pollution into national adaptation strategies can improve health and foster socioeconomic resilience.

4.3 Sectoral Solutions

4.3.1 Transport

Since the transport sector is a significant contributor to pollution, accelerating the adoption of tighter vehicle emissions standards can significantly reduce the region's air pollution. Aligning standards with Euro 4, 5, and 6 can help limit harmful pollutants from the transport sector, particularly in urban areas (see Figure 17 for a timetable on emissions standards for light-duty petrol and diesel vehicles in SEA). Clear regulatory timelines, supported by effective enforcement and improvements in fuel quality, are essential to a successful transition. Complementary transport measures, such as the promotion of inspection systems, incentives for electric vehicles, and establishment of LEZs can further support sustained air quality and health benefits (Ali et al. 2025).

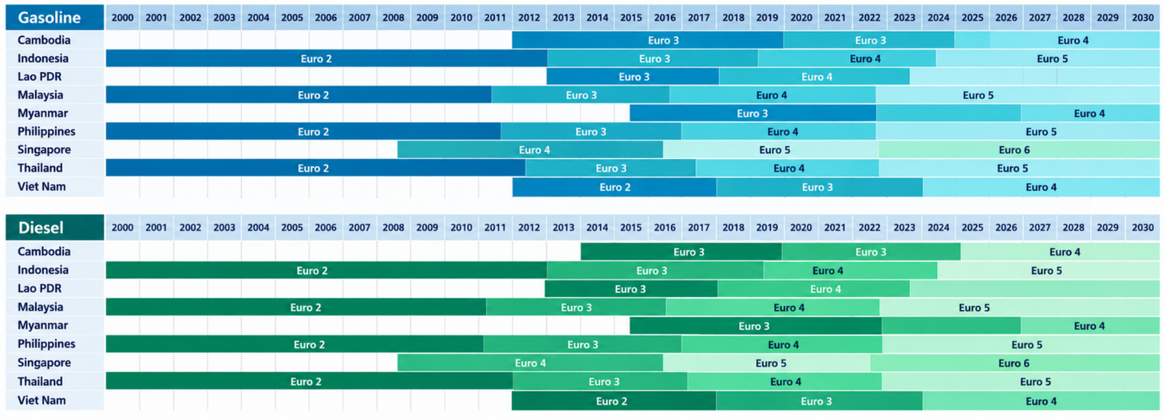


Figure 17: Emissions Standards for Light-Duty Vehicles in SEA

Source: (Tamayo-Araneta 2023; ADB 2026)

Similarly, expanding markets for electric vehicles, particularly two- and three-wheelers, can help reduce air pollution in SEA (see Figure 18 for an overview of penetration of electric vehicles in select SEA countries). Expanding the use of electric vehicles also often requires supportive enabling reforms such as expanding charging infrastructure, strengthening supply chains, and providing incentives to increase affordability. Clear standards and integration with public transport systems can also increase the receptiveness to electric vehicles (IEA 2023).

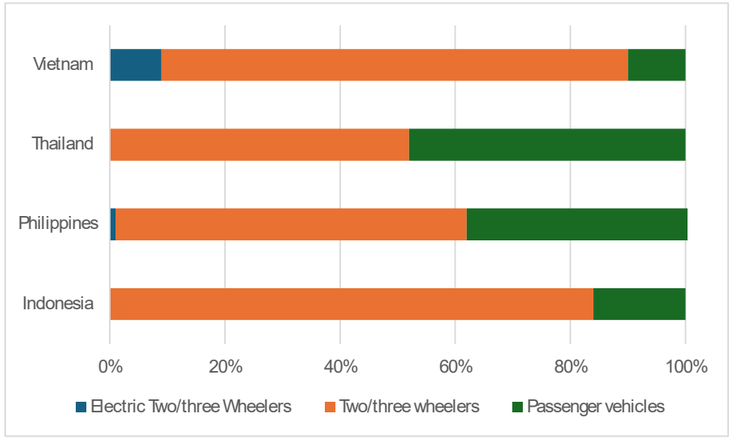


Figure 18: Penetration of Electric Two/Three Wheelers and Passenger Vehicles in Key SEA Countries

Sources: (AR 2025; Le et al. 2025; Wu 2025)

Strengthening regulation of heavy-duty diesel freight is also critical to reducing PM, BC and NO_x in SEA, underscoring the need for tighter emissions standards and improved fuel quality. Freight vehicles also tend to have longer operational lifetimes than passenger vehicles. As such, enhancing inspection and maintenance systems, promoting cleaner fuels and technologies, and supporting the gradual transition to lower emission green freight options will often need to complement these efforts (UNEP 2025a).

IIt will similarly be important to target older vehicles. Enhancing vehicle inspection and maintenance systems is key to reducing emissions from aging, super-emitting vehicles. Aging vehicle fleets, particularly those using diesel, can contribute disproportionately to urban air pollution when not properly maintained. Strengthening periodic inspection programs, improving compliance monitoring, and phasing out the most polluting vehicles can further help to address these risks (UNEP 2025a).

4.3.2 Industry/Energy

Extending the adoption of industrial emission controls to SMEs is critical in manufacturing hubs and peri-urban areas. While large facilities are often regulated, smaller firms can be significant sources of emissions due to limited access to cleaner technologies, lower compliance capacity and higher monitoring costs. Supporting SMEs through targeted incentives, technical assistance, and financing can facilitate the adoption of pollution controls, while targeted regulatory frameworks, compliance systems, and awareness raising can also enhance implementation (Ma et al. 2024).

Expanding the use of CEMS across industrial facilities and power plants can improve the accuracy of emissions data. More comprehensive monitoring can also encourage regulatory compliance among large industries and power plants. Ensuring data transparency is equally important for enhancing the credibility of emissions data and enabling comparisons across facilities (Dinh et al. 2026). Increased transparency and improved monitoring could also contribute to tightening standards on large emissions sources and thermal power plants. Though variation exists across pollutants and countries, emission standards for thermal power plants are often several orders of magnitude weaker than benchmark standards in the European Union and China (see Table 4).

Table 4: Thermal Power Plant Standards

Heatmap Key

Relatively Strong | **Room for Improvement** | **Significant Gap**

Country	PM (mg/Nm^3)	NO_x (mg/Nm^3)	SO_2 (mg/Nm^3)	Hg (mg/Nm^3)	Year
Indonesia	50	100	100	0.02	2019
Vietnam	10–30	100–500	60–200	—	2025
Thailand	50	180	260	0.03	2023
Philippines	150	1,000	700	—	1999
Malaysia	50	500*	500*	0.03	2024
Laos	100	350–500	400–700	—	2017
Cambodia	400	1,000	500	—	2000
Myanmar	50	510	400–2,000	0.03	2015
European Union	2–5	65–85	10–75	<0.001–0.002	2015
China	10	50	35	—	2017

*Note: Values are selected emission limits for thermal power plants and may vary by fuel, plant type, capacity, technology, or whether facilities are new or existing. "—" indicates that a limit was not specified in the source reviewed. *Malaysia values vary for existing and proposed/new facilities. Sources: Indonesia—MoEF Decree No. 15/2019; Vietnam—QCVN 22:2009/BTNMT and subsequent regulations; Thailand—Ministry of Natural Resources and Environment notification; Philippines—Clean Air Act implementing regulations; Malaysia—Environmental Quality (Clean Air) Regulations and related guidance; Laos—Environmental Protection Law/national environmental standards; Cambodia—Sub-Decree on Air Pollution and Noise Disturbance; Myanmar—National Environmental Quality (Emission) Guidelines. NDRC/Ministry of Environmental Protection/National Energy Administration (2015) ultra-low-emission policy for China and European Commission Implementing Decision (EU) 2017/1442 for the EU*

Over the past decade, countries in SEA have also demonstrated growing interest in clean energy transitions (Anser et al. 2022). This is evident at the regional level in ASEAN's target to increase the share of renewable energy in the energy mix to 23% by 2030, and at the national level in initiatives such as Thailand's regularly updated Energy Efficiency Plan. More targeted efforts are also emerging. For example, the Cambodian government has helped de-risk investment in a national solar park project (Aleluia et al. 2022; Dhakal and Shrestha 2021). As suggested in Box 2, there are significant air quality and health benefits from accelerating clean energy transitions, but they require strong policies and enabling environments.

Box 2: Clean Energy Transitions Deliver Significant Co-Benefits

Southeast Asia's rapidly growing electricity demand presents a significant challenge for reducing both air pollution and greenhouse gas (GHG) emissions. Regional electricity generation more than tripled between 2000 and 2020, while coal- and natural gas-fired power plants still supplied about 72% of electricity in 2020. Electricity generation consequently accounted for substantial shares of regional SO_2, NO_x, and CO_2 emissions (Kim Oanh and Huy 2024).

Addressing these emissions will require closing substantial investment gaps, estimated at around $14 billion by 2025 (Dhakal and Shrestha 2021), while strengthening longer-term clean energy commitments. Key enabling measures include expanding renewable energy, strengthening emission controls for existing thermal power plants, developing carbon markets, and improving regional energy connectivity. These measures will become increasingly important as electricity demand continues to grow and could otherwise offset gains from a cleaner energy mix (Kim Oanh and Huy 2024). Finally, the transition will need to account for socioeconomic impacts, including potential job losses, to ensure that changes in the energy system are both environmentally effective and socially just (Aleluia et al. 2022).

4.3.3 Agriculture/Waste

Driven by limited alternatives and cost constraints for farmers, addressing the open burning of crop residue is a high-profile seasonal challenge in many SEA countries (see also Figure 9 for an overview of seasonal and regional variation). Countries in the region are increasingly looking for alternatives to restrictions on burning, which can be difficult to enforce. One promising approach is to collect agricultural residues and convert them into useful products. Developing viable business models and partnerships with the private sector can help create markets for products such as bioenergy, biochar, and agricultural inputs. Targeted incentives, access to equipment, and technical support can further help farmers and businesses adopt and scale up these solutions (see Figure 19).

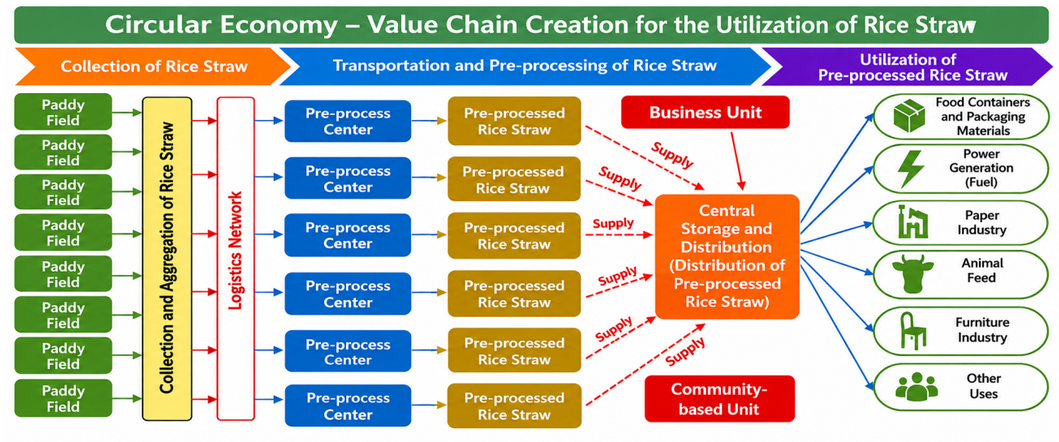


Figure 19: Circular Economy Model for Managing Rice Crop Residue

Source: (Supat 2022)

Managing the open burning of solid waste is an emerging air quality priority in SEA, particularly where waste collection and disposal systems remain limited. Open waste burning can release not only conventional air pollutants but also highly toxic substances, including benzene, dioxins, cadmium, and furans. Some countries in the region are beginning to give this issue greater attention. Laos, for example, has identified solid waste burning as a priority in recent planning and is considering community-based surveys to better understand why households and communities burn waste. Across the region, tighter and better-enforced emission standards are also needed for municipal solid waste incinerators.

4.4 National Level Assessment

While some SEA countries have strengthened air quality management, key informant interviews and desk study suggested that fragmentation continues to limit progress. That fragmentation can also be compounded by a lack of high-level political leadership and a weak science-policy interface. Further, this can create a mutually reinforcing dynamic. More concretely, a lack of coordination among institutions, disconnected data systems, and insufficient financing can undermine political leadership and evidence-based decision-making. It can also create gaps between clean air plans and the sectoral actions needed to reduce emissions, achieve broader development goals and build trust across the region.

The situation can unfortunately result in countries adopting increasingly ambitious clean air plans but not achieving equally impressive results. An important question that was discussed in the interviews was whether regional initiatives and CSOs can change this dynamic? The next section surveys several regional frameworks and CSO initiatives, before reflecting on this larger question.



5. Regional and CSO Initiatives in SEA

International organizations, regional frameworks, and CSOs can play important roles in addressing the air quality management needs identified in Section 4. This section reviews key agreements, frameworks, and initiatives established to improve air quality in SEA. Although the region has no shortage of initiatives, their diversity and limited coordination can unintentionally reinforce fragmentation at the national and regional levels.

5.1 Regional Frameworks and Initiatives

Many of the key regional frameworks and initiatives are led by international organizations working directly with national governments. Table 5 provides an overview of these frameworks and initiatives, including their year of establishment, geographic coverage, and main objectives. The following text offers more detailed descriptions of their key activities and operational approaches.

Table 5: Regional Air Pollution Frameworks and Initiatives

Initiative	Year Established	Coverage / Members	Focus and Objectives
Acid Deposition Monitoring Network in East Asia (EANET)	2001	13 countries (8 in SEA)	Standardized regional network for monitoring acid deposition.
ASEAN Agreement on Transboundary Haze Pollution (AATHP)	2002 (Entered into force 2003)	11 ASEAN Member States	Legally binding agreement to prevent, monitor, and mitigate transboundary haze pollution.
ASEAN Air Quality Management Framework	2025	ASEAN Member States	Provides a flexible platform to support progressively achieving cleaner air by 2035.
Asia Pacific Clean Air Partnership (APCAP)	2015	Asia and the Pacific	Strengthens cooperation by connecting science, policy, and implementation.
Mekong CLEAR Sky Strategy	2023	Thailand, Laos, Myanmar	Strengthen cooperation on seasonal transboundary haze.
Regional Action Programme on Air Pollution (RAPAP)	2022	53 UN ESCAP member states	Fosters open data sharing, capacity-building, and collaborative policy to align with international standards.
Southeast Asia Climate and Clean Air Initiative (SECAI)	2025 (Runs to 2028)	ASEAN (Focus on Lower Mekong)	Aims to reduce emissions of short-lived climate pollutants (SLCPs).
Development Organizations (ADB, JICA, Clean Air Asia)	-	SEA/ Asia	Support sector-specific clean air investments, financing, and technical assistance.

Acid Deposition Monitoring Network in East Asia (EANET): Spanning 13 participating countries (eight of the participating countries are in SEA), EANET provides a standardized regional network for monitoring acid deposition and has expanded its scope to address broader air pollution issues, including $PM_{2.5}$ and ozone. Beyond monitoring, EANET supports data analysis and quality assurance, technical training and capacity building, research and emission inventories, public awareness, and regional knowledge sharing.

ASEAN Agreement on Transboundary Haze Pollution (AATHP): A legally binding regional agreement that provides the overarching framework for ASEAN cooperation to prevent, monitor, and mitigate transboundary haze pollution. Signed in 2002 and in force since 2003, the Agreement now covers all 11 ASEAN Member States following Timor-Leste's accession in November 2025. It promotes coordinated national and regional action to prevent and control open burning from agriculture, land and/or forest fires, including peatland fires, as well as monitoring and early warning, preparedness and emergency response, information exchange, and capacity building. Implementation is currently guided by the Second Roadmap for ASEAN Cooperation on Transboundary Haze Pollution Control with Means of Implementation (2023–2030), which sets the vision of a "Transboundary Haze-Free ASEAN by 2030" and identifies nine mutually reinforcing strategies covering implementation of the AATHP.



Figure 20: Nine Strategies of the Second Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation (2023 – 2030)

Source: (ASEAN 2023)

ASEAN Air Quality Management (AQM) Framework: Initiated in 2025 with World Bank support and collaboration from the ASEAN Secretariat and the ASEAN Working Group on Environmentally Sustainable Cities (AWGESC), the framework provides a flexible platform to support ASEAN Member States in progressively achieving cleaner air by 2035. It complements existing regional efforts on transboundary haze while taking a broader approach to air quality management.

Asia Pacific Clean Air Partnership (APCAP): A voluntary regional partnership launched by UNEP and partners in 2015 that strengthens cooperation on air pollution by connecting science, policy, and implementation across Asia and the Pacific. APCAP provides a platform for governments, researchers, international organizations, civil society, and the private sector to exchange knowledge and good practices; supports capacity building, technical assistance, and air-quality assessments; and uses its Science Panel to translate scientific evidence into policy-relevant guidance. Its flagship Joint Forum provides a regional venue for dialogue on emerging air-quality priorities and solutions. More recently, APCAP has placed greater emphasis on mobilizing finance and private-sector engagement for clean-air action, including investment in measures that can simultaneously reduce air pollution and GHG emissions.

Mekong CLEAR Sky Strategy and its Joint Plan of Actions: Established in 2023 by Thailand, Laos, and Myanmar, the CLEAR Sky Strategy aims to strengthen cooperation on seasonal transboundary haze through six elements: 1) continued commitment to reducing hotspots; 2) stronger coordination mechanisms; 3) experience sharing; 4) enhanced air quality monitoring networks; 5) effective and timely responses; and 6) implementation of the 2024–2030 Joint Plan of Actions, including measures on fire control, forecasting, sustainable agriculture, and enforcement (see also section two's review of Thailand).

Regional Action Programme on Air Pollution (RAPAP): Created in 2022, RAPAP provides a broad but flexible multilateral framework across the Asia-Pacific to foster open data sharing, capacity-building, and collaborative policy interventions as part of a broader effort to align domestic air quality action with international standards. In so doing, RAPAP focuses on five objectives: 1) promoting science-based cooperation; 2) sharing information and good practices; 3) strengthening national and regional action; 4) mobilizing technical and financial resources; and 5) advancing cooperation on air quality management, including transboundary pollution. RAPAP was approved by all 53 United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) member states and is developing a new three-year plan to make the initiative more dynamic and interactive.

Southeast Asia Climate and Clean Air Initiative (SEACAI): SEACAI is a regional initiative running from 2025 to 2028 that aims to reduce emissions of short-lived climate pollutants (SLCPs) across ASEAN, with a particular focus on the Lower Mekong Subregion. Supported by Germany and Switzerland and implemented by GIZ in partnership with the ASEAN Secretariat and national agencies, SEACAI combines regional cooperation, capacity building, knowledge exchange, and locally-tested solutions. In the Lower Mekong, it works with Cambodia, Laos, Thailand, and Vietnam to strengthen cooperation on SLCP mitigation, including through regional roundtables, joint capacity development, knowledge transfer, and a regional knowledge platform. Country-level activities include demonstrations addressing agricultural burning, forest management, and waste in Cambodia, Laos, and Thailand, while support in Vietnam focuses on strengthening technical expertise for policy development. Lessons from these activities are intended to inform wider ASEAN cooperation and implementation of the ASEAN Haze-Free Roadmap.

Other Sectoral and Regional Initiatives: In addition to regional frameworks and partnerships, several development organizations support sector-specific clean air investments and technical assistance across SEA. The Asian Development Bank (ADB) combines air quality assessments and policy support with financing for cleaner transport, energy and urban infrastructure, including public transport, electric mobility and other low-emission investments; it also increasingly emphasizes mobilizing finance for clean air action. The Japan International Cooperation Agency (JICA) provides long-term technical cooperation to strengthen air quality management, including monitoring, emissions inventories, source identification, institutional capacity and pollution-control measures, with substantial work on $PM_{2.5}$ and other pollution sources in countries such as Thailand. Clean Air Asia, headquartered in Manila with programs across SEA, works with national and city governments to strengthen air quality management and clean-air action plans while advancing sectoral solutions in transport, energy and urban development, including vehicle emission standards, electric mobility, sustainable urban transport and climate-sensitive planning. Together, these initiatives complement ASEAN-wide cooperation by helping countries and cities translate regional clean air priorities into policies, investments and practical interventions in major emitting sectors.

5.2 CSO Initiatives

As illustrated in Table 6, CSOs in SEA address diverse sets of priorities. In Indonesia and the Philippines, the focus is on the "just energy transition," linking coal-fired power plant emissions and fossil fuel finance to public health harms. Seasonal transboundary haze from agricultural and peatland burning is the main concern in Indonesia, Thailand, Malaysia, Singapore, Laos and Cambodia. Additionally, waste management and anti-incineration advocacy have emerged as critical battlegrounds in the Philippines and Indonesia.

Table 6: CSOs Working on Air Pollution and Related Issues in SEA

Focus	Select Organizations	Main Clean Air Entry Point
Philippines		
Energy and Coal	Institute for Climate and Sustainable Cities, Center for Energy, Ecology, and Development, Philippine Movement for Climate Justice, Sanlakas, Greenpeace PH	Coal phase-out; stationary-source emissions
Health	Health Care Without Harm Southeast Asia, Healthcare Advocates for Climate and Clean Air Philippines, HealthJustice PH	Health impacts; morbidity/mortality evidence
Transport	350 Pilipinas, MNL Moves, Clean Mobility Collective	Vehicle emissions; sustainable mobility
Air quality and Research	Clean Air Asia, Centre for Research on Energy and Clean Air, UP CARE	Monitoring, standards, data analysis
Zero waste / legal	EcoWaste, Global Alliance for Incinerator Alternatives – Asia Pacific, No Burn Pilipinas, Legal Rights and Natural Resources Center	Incineration restrictions; rights and policy reform
Thailand		
Industry	EARTH, Arnika	Industrial emissions, toxic hotspots
Haze and Agriculture	RECOFTC, Greenpeace Thailand, Breathe Councils	Crop/forest burning; transboundary haze
Health and Legal Issues	ThaiHealth, Center for Clean Air Solutions, EnLaw, EarthRights, Thailand Clean Air Network	$PM_{2.5}$ health impacts; clean-air rights and law
Research and Transport	SEI Thailand, Center for Clean Air Solutions, Greenpeace Thailand	Monitoring, sensors, diesel and urban transport
Community and Youth Issues	RECOFTC, NDF, Climate Strike Thailand, Mayday	Fire management, land rights, youth action
Vietnam		
Energy and Climate	GreenID, CHANGE Vietnam	Coal impacts; clean energy and transition policy
Community and Waste	Live & Learn, GreenHub	Cookstoves, waste, education, community action
Public policy	LPSD	Coal pollution; community rights; environmental law advocacy
Air Quality	VCAP, Vietnam Clean Air Network, PAM Air, Live & Learn	$PM_{2.5}$ monitoring, advocacy, citizen science
Laos		
Agriculture and Forestry	Sustainable Agriculture and Environment Development Association, RECOFTC Laos	Burning prevention; agroecology; community fire management
Conservation and Livelihoods	WWF Laos, SNV Laos	Fire-risk reduction; alternatives to burning
Mekong-related Research and Public Advocacy	Towards Ecological Recovery and Regional Alliance, Sustainable Mekong Research Network	Land-use/fire drivers; research-to-policy

Note: Select organizations and activities are illustrative rather than exhaustive. Information on CSOs is considerably more limited for Cambodia and Myanmar; detailed mapping therefore focuses on the Philippines, Thailand, Vietnam and Laos.

5.3 Regional Level Assessment

Despite a wide range of initiatives, the results of the key informant interviews and desk study suggest that fragmented institutions, data and finance hamper regional cooperation on clean air in SEA (see Box 1 for a review of methods). Different regional frameworks and initiatives have varying memberships, rely on diverse data sources, and focus on unique sets of problems (haze, urban air pollution, SLCPs). The incoherence can often result in piecemeal attempts at capacity building, limiting the depth and breadth of impacts.

Interviews and desk study underlined two additional factors contributing to the fragmentation. The first is that national and local CSOs possessing the flexibility to bridge divides have few opportunities to participate in regional fora. Those limits not only reduce opportunities for CSOs to strengthen regional cooperation but hold policymakers accountable for delivering results. This can, in turn, weaken high-level political support and curb incentives for investing in clean air. The second related challenge is a weak science-policy interface at the regional level. The lack of regularly updated modeling on solutions and their implementation prospects can weaken political support and leadership nationally and regionally.

Finally, as illustrated in Figure 21, the interviews revealed that many of the challenges with fragmentation were similar at national and regional levels. Further, these mirror images can create a vicious cycle wherein progress is made but more could be achieved. The next section reflects on how coherent approaches to strengthening air quality fundamentals, enabling environments, and sectoral solutions can break that cycle and bring greater coherence to air quality management in SEA.

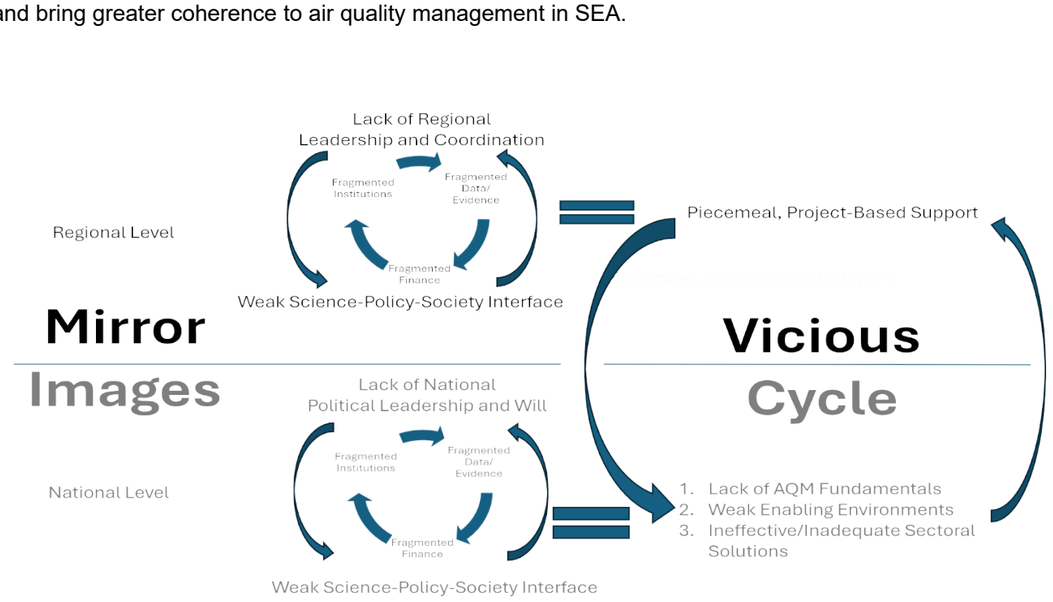


Figure 21: Fragmentation in Air Quality Management in SEA

Source: (Authors)

6. A Regional Platform for Clean Air in SEA

A significant opportunity exists to establish a “Regional Platform for Clean Air in SEA.” The proposed platform would not need to reinvent the wheel. Rather, it can help strengthen existing platforms by facilitating collaboration across the activities of different partners in the region. For instance, it could work with organizations ranging from ASEAN to the WHO to the World Bank to Clean Air Asia to align external support with needs, while disseminating resources and knowledge that those organizations hold on AQM. It could also be designed to support integrated actions across four pillars.

- **Coherent demand-driven programs:** Address 20 needs and priorities (see Table 7 on the next page) that strengthen air quality fundamentals and enabling environments while scaling solutions in transport, industry, agriculture, and energy.
- **South–South collaboration:** Facilitate the exchange of practical, context-appropriate solutions among policymakers and experts across SEA and beyond.
- **Science–policy-society partnerships:** Connect scientific expertise, motivated decision-makers and civil society to integrate evidence into policy and boost accountability when delivering tailored packages of technical assistance.
- **Political leadership for clean air**: Build sustained political commitment by demonstrating the health, environmental, climate, economic, and development benefits of clean air action.

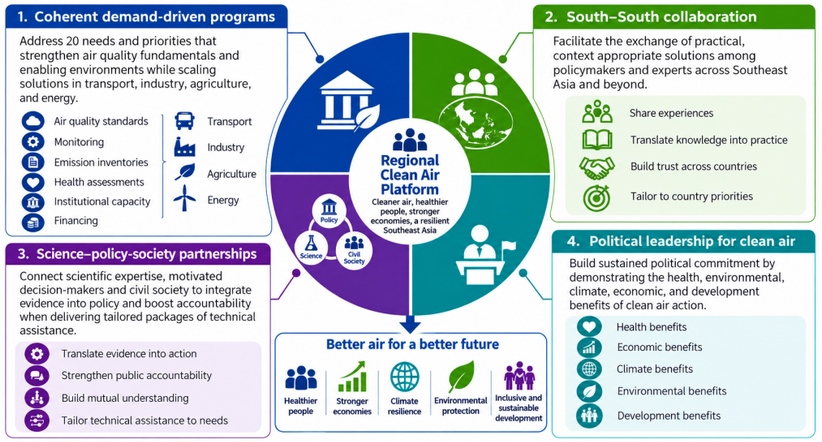


Figure 22: A Regional Platform for Clean Air in SEA

Source: (Authors)

Importantly, the platform can build on and strengthen existing regional programs while providing sufficient flexibility for experience sharing, better use of data and evidence, and additional financing for more coherent programs of support. This approach can also reduce the time needed to establish the platform, helping to maintain near-term momentum and strengthen its effectiveness over the medium to long term.

In this context, the platform should set clear two- and five-year goals. These goals can guide timelines and milestones, identify potential collaborators, and help ensure that programs of support respond to the needs of SEA countries. Table 7 outlines what the platform could reasonably aim to achieve within these two- and five-year timeframes.

A final consideration is when work on this platform should begin. The answer is clear: efforts should start as soon as possible to put the recommendations in this report into practice. Few investments of time and resources could be more valuable than a concerted effort to deliver cleaner air—and the health, economic, and environmental benefits it brings—to the more than 660 million residents across SEA

Table 7: Near- and Medium-Term Goals for the Regional Platform for Clean Air in SEA

Needs/Priorities	What could be achieved in 2 years	What could be achieved in 5 years
1. Strengthening/ harmonizing air quality standards (in line with WHO guideline annual values)	Myanmar launches a national air quality standards framework; Cambodia, Indonesia, Laos, Philippines, and Vietnam complete policy reviews and initiate revisions toward WHO guideline interim target levels.	Myanmar adopts WHO interim targets with basic enforcement mechanisms in place; Cambodia, the Philippines, and Vietnam progress toward IT-3; Indonesia and Laos progress toward IT-4. These standards are supported by operational monitoring and accountability systems.
2. Institutionalizing emission inventories/source apportionment/health impact assessment	Indonesia, Laos, and Myanmar develop or substantially upgrade national emission inventories and complete first source apportionment studies; Cambodia, Philippines, Thailand, and Vietnam strengthen existing systems and conduct pilot health impact assessments.	Indonesia, Laos, and Myanmar maintain institutionalized, regularly updated emission inventory systems; Cambodia, Philippines, Thailand and Vietnam integrate health impact assessment into routine national policymaking.
3. Expanding monitoring and harmonizing reference/ low-cost sensors	Indonesia, Laos, Myanmar, and Vietnam significantly expand monitoring networks and deploy calibrated low-cost sensors in urban and hotspot areas; Cambodia and Philippines strengthen and harmonize their existing monitoring infrastructure. All SEA countries develop plans to integrate ozone into monitoring networks. Laos, Indonesia, and the Philippines improve the reliability of real-time air quality data. Cambodia reviews real-time air quality data plans. Myanmar plans for release of real-time air quality data as part of an expanding air quality monitoring network.	Indonesia, Laos, Myanmar, and Vietnam achieve near-comprehensive monitoring coverage, standardized monitoring coverage with integrated low-cost sensors; Cambodia and Philippines fully harmonize sensor networks with national reporting systems. All SEA countries integrate ozone monitoring into significant portion of their monitoring network. All countries in SEA provide publicly accessible, reliable, real-time air quality data platforms.
4. Leveraging satellite/AI data	Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, and Vietnam each pilot satellite-based hotspot detection and AI-supported air quality forecasting with government staff trained in data interpretation.	All countries in SEA fully integrate satellite and AI tools into national planning, enforcement, forecasting, and early-warning decision-making processes.
5. Creating early-warning systems	Laos, Myanmar, and Philippines establish foundational national early-warning systems for haze and air pollution events; Cambodia, Indonesia, and Vietnam upgrade existing systems with improved health thresholds and public communication protocols.	Laos, Myanmar, and Philippines operate fully functional early-warning systems with regional coordination; Cambodia, Indonesia, and Vietnam advance systems with automated health advisories and response triggers in place.
6. Improving resource mobilization and developing funding proposals	Vietnam develops comprehensive national clean air funding proposals and secures access to major international funds; Cambodia, Indonesia, Laos, Myanmar, Philippines, and Thailand strengthen resource mobilization and submit targeted funding proposals.	Vietnam establishes a sustainable domestic financing mechanism for clean air; Cambodia, Indonesia, Laos, Myanmar, Philippines, and Thailand diversify financing through environmental funds, pollution charges, and green investment frameworks.
7. Creating coherent, transparent, trackable budgetary data	Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, and Vietnam introduce functional systems to track clean air expenditures across relevant ministries; Thailand expands and improves its existing budget tracking to include subnational levels.	Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, and Vietnam operate fully transparent, publicly accessible clean air budget tracking systems; Thailand achieves comprehensive tracking with annual public audits.
8. Supporting development of national/subnational clean air action plans	Indonesia, Laos, and Myanmar develop or substantially revise national clean air action plans with sector-specific measurable targets; Cambodia, Philippines, Thailand, and Vietnam update existing plans and begin implementing priority measures.	Indonesia, Laos, and Myanmar fully operationalize national clean air action plans with independently verified emission reductions; Cambodia, Philippines, Thailand, and Vietnam demonstrate measurable emission reductions and conduct regular public evaluations.
9. Integrating social justice/ inclusivity into clean air and energy planning	Indonesia, Laos, and Vietnam make visible efforts to integrate vulnerable groups into clean air planning and deliver targeted interventions in high-exposure communities; Cambodia, Myanmar, Philippines, and Thailand complete equity assessments and pilot inclusive planning processes.	Indonesia, Laos, and Vietnam embed equity into clean air policies with measurable reductions in exposure disparities; Cambodia, Myanmar, Philippines, and Thailand achieve meaningful improvements in equity outcomes across their clean air programs.
10. Strengthening interministerial coordination and enforcement capacities	Cambodia, Indonesia, Laos, Myanmar, and Vietnam establish formal interministerial coordination bodies and enforcement frameworks for clean air; Philippines and Thailand strengthen existing coordination mechanisms with improved sectoral enforcement.	Cambodia, Indonesia, Laos, Myanmar, and Vietnam operate effective cross-sector governance with accountable enforcement systems; Philippines and Thailand achieve integrated governance with enforcement and performance reporting.

Table 7: Near- and Medium-Term Goals for the Regional Platform for Clean Air in SEA (cont.)

Needs/Priorities	What could be achieved in 2 years	What could be achieved in 5 years
11. Improving disaster response management (extreme haze event) and mainstreaming air pollution into adaptation measures	Cambodia and Laos develop foundational haze emergency response protocols and health preparedness systems; Indonesia, Myanmar, Philippines, Thailand, and Vietnam strengthen existing response frameworks and improve cross-border coordination.	Cambodia and Laos operate fully integrated disaster risk management systems for haze events; Indonesia, Myanmar, Philippines, Thailand, and Vietnam measurably reduce health and economic impacts from haze, with air quality mainstreamed into national climate adaptation plans.
12. Expanding multi-stakeholder partnerships by including health professionals and impacted groups into decision-making processes	Vietnam establishes structured multi-stakeholder engagement platforms including health professionals and impacted communities; Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, and Thailand broaden civil society and academic participation in clean air planning.	Vietnam operates institutionalized multi-stakeholder platforms driving clean air policy accountability; Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, and Thailand embed diverse stakeholder partnerships meaningfully into policy design and implementation.
13. Accelerating transitions to tighter emissions standards (Euro 4/5/6)	Indonesia strengthens enforcement of existing Euro 4 standards and announces a clear timeline for Euro 5 adoption; Myanmar develops its initial vehicle emission standards framework; Cambodia progresses toward its committed Euro 5 target; Laos initiates regulatory development toward Euro 4 adoption; Vietnam strengthens enforcement of existing Euro 5 standards for new vehicles and advances implementation for motorcycles and in-use vehicle controls. Countries explore the feasibility of leapfrogging to Euro 6 (given possible challenges with fuel quality and imported vehicles), especially for diesel-powered vehicles.	Indonesia achieves nationwide implementation of Euro 5 standards with improved enforcement; Myanmar adopts and begins full implementation of Euro 4 standards; Cambodia completes Euro 5 implementation in line with its commitment; Laos achieves substantial implementation of Euro 4 standards with a transition roadmap toward Euro 5; Vietnam achieves full enforcement of Euro 5 standards across vehicle categories, including motorcycles and in-use vehicles, alongside strengthened inspection and maintenance systems. Where possible, leapfrog to Euro 6, with a focus on diesel-powered vehicles.
14. Creating sustainable ecosystems for electric vehicles, especially two- and three-wheelers	Cambodia, Thailand and the Philippines develop and/or strengthen EV policy frameworks, launch incentive schemes, and establish pilot charging infrastructure for two- and three-wheelers; Indonesia scales up existing policies and infrastructure; Laos expands pilot programs; Vietnam further expands its already growing two- and three-wheeler EV market and charging network.	Cambodia, Thailand and the Philippines establish functional EV ecosystems with increasing two and three-wheeler adoption and supporting infrastructure; Indonesia achieves significant market penetration supported by strong domestic production; Laos makes moderate progress through continued policy and infrastructure development; Vietnam achieves high market penetration with a mature EV ecosystem and extensive charging network.
15. Improving controls on heavy duty freight (diesel)	Indonesia introduces comprehensive diesel freight emission regulations and establishes pilot low-emission freight zones in major cities; Cambodia, Philippines, and Vietnam strengthen regulatory frameworks and implement corridor-level controls.	Indonesia achieves significant fleet modernization with progressively enforced nationwide; Cambodia, Philippines, and Vietnam implement emission controls with measurable NO_x and PM reductions on major freight corridors.
16. Bolstering vehicle inspection and maintenance (controls on older vehicles)	Cambodia, Indonesia, Laos, Philippines, Thailand, and Vietnam substantially overhaul vehicle inspection and maintenance systems targeting older high-emitting fleets; Myanmar establishes foundational inspection capacity.	Cambodia, Indonesia, Laos, Philippines, Thailand, and Vietnam operate robust nationwide inspection systems with high compliance rates and measurable on-road emission reductions; Myanmar has a basic functional inspection framework in place.
17. Spreading industrial emission controls, especially to SMEs	Cambodia and Indonesia develop comprehensive industrial emission control frameworks and deliver direct technical support to SMEs for cleaner technology adoption; Laos, Myanmar, Philippines, Thailand, and Vietnam strengthen existing controls and expand SME outreach programs.	Cambodia and Indonesia achieve widespread industrial emission control adoption with scaled SME support programs; Laos, Myanmar, Philippines, Thailand, and Vietnam attain high compliance rates with cleaner technologies integrated into industrial licensing systems.
18. Extending CEMS to more industrial facilities and power plants	Laos, Thailand, and Vietnam mandate and roll out CEMS in major industrial facilities and power plants; Cambodia, Indonesia, and Philippines expand CEMS coverage and improve data reporting quality.	Laos, Thailand, and Vietnam operate mandatory CEMS with real-time public reporting across most major industries and power plants; Cambodia, Indonesia, and Philippines achieve comprehensive CEMS coverage with enforcement directly linked to emissions data.
19. Identifying and spreading innovative solutions to open burning of waste	Laos, Myanmar, and Vietnam pilot and begin scaling alternative waste management systems with strengthened enforcement of burning restrictions; Cambodia, Philippines, and Thailand expand existing programs and improve compliance.	Laos, Myanmar, and Vietnam achieve significant reductions in open waste burning through community-based waste management systems scaled nationally; Cambodia, Philippines, and Thailand sustain and deepen reductions with robust enforcement.
20. Identifying and spreading innovative solutions to open burning of crop residue	Cambodia, Indonesia, Laos, Philippines, and Vietnam scale pilot programs for crop residue alternatives (biochar, composting, animal feed) with farmer incentive schemes active in major burning hotspots; Myanmar and Thailand strengthen enforcement and expand existing alternative programs.	Cambodia, Indonesia, Laos, Philippines, and Vietnam achieve large-scale adoption of crop residue alternatives with measurable reductions in agricultural burning; Myanmar and Thailand sustain and expand reductions through robust incentive programs and enforcement.

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Appendix

Questions for Semi-Structured Interviews

1. Current Achievements

What have been the main achievements from your organization's efforts to improve air quality management in Southeast Asia over the past 3 years? (Examples: Development of air pollution monitoring networks, support for creating emission inventories, assistance in strengthening policies/laws, etc.)

2. Implementation Challenges

What have been the main challenges and how have they been overcome during the implementation of the above efforts in Southeast Asia? (Examples: Lack of local data, political commitment, funding shortages, etc.)

3. Future Gaps and Needs

What do you foresee as the main air quality management gaps and needs in what parts of SEA over the next 3–5 years?

4. Future Projects and Plans

What air quality management projects might your organization support in which parts of Southeast Asia over the next 3–5 years? (Examples: Decarbonization of the transport sector, prevention of agricultural residue burning, transition to clean energy, etc.)

5. Regional Initiatives and Partnerships

What have been the main opportunities and challenges from working with regional air pollution initiatives and other partners outside your organization on air pollution (including coordination challenges and overlapping remits)? What kinds of partnerships have generated the best results? (Examples: UNESCAP's Regional Action Programme on Air Pollution (RAPAP), ASEAN Haze Agreement, projects funded by MDBs and/or implemented by NGOs).

List of Interviews

Interview No.	Country	Organization	Date
Interview 1	Myanmar	Environmental Conservation Department, Ministry of Natural Resources and Environmental Conservation	19-Feb-26
Interview 2	Indonesia	Kopernik	20-Feb-26
Interview 3	Thailand	Breathe Bangkok Council	24-Feb-26
Interview 4	Vietnam	Vietnam Clean Air Partnership (VCAP)	24-Feb-26
Interview 5	International Org	UNEP	24-Feb-26
Interview 6	Indonesia	Center for Research on Energy and Clean Air (CREA)	24-Feb-26
Interview 7	Philippines	Institute for Climate and Sustainable Cities (ICSC)	24-Feb-26
Interview 8	Philippines	AktivAsia	24-Feb-26
Interview 9	Cambodia	Department of Air Quality, Noise and Vibration Management, Ministry of Environment	25-Feb-26
Interview 10	Indonesia	Air Quality Management & Atmospheric Chemistry at Bandung Institute of Technology (ITB)	25-Feb-26
Interview 11	International Org	UNESCAP-RAPAP	25-Feb-26
Interview 12	Indonesia	Earthjustice (also as former Indonesian Center for Environmental Law (ICEL))	25-Feb-26
Interview 13	Indonesia	Bicara Udara	02-Mar-26
Interview 14	Vietnam	Epidemiology Department, The Institute of Public Health in HCM City, MOH	03-Mar-26
Interview 15	Indonesia	Nexus3 Foundation	03-Mar-26
Interview 16	Indonesia	Forest and Land Fire Management, MoEF	04-Mar-26
Interview 17	Vietnam	Institute of IMHEMS in HCMC	05-Mar-26
Interview 18	Thailand	RECOFTC Thailand	06-Mar-26
Interview 19	Philippines	Department of Environment and Natural Resources	11-Mar-26
Interview 20	International Org	World Bank	11-Mar-26
Interview 21	International Org	GIZ	12-Mar-26
Interview 22	International Org	Climate and Clean Air Coalition	12-Mar-26
Interview 23 (Shared Interview)	Laos	Ministry of Agriculture and Environment	12-Mar-26
Interview 23 (Shared Interview)	Laos	National Agriculture and Forestry Research Institute	12-Mar-26
Interview 24	Philippines	Clean Air Asia	12-Mar-26
Interview 25	Malaysia	Ministry of Natural Resources and Environmental Sustainability	13-Mar-26
Interview 26	Philippines	350.org	16-Mar-26
Interview 27	Thailand	Ecological Alert and Recovery-Thailand (EARTH)	18-Mar-26
Interview 28	Philippines	Health Care Without Harm	20-Mar-26
Interview 29	Philippines	Philippines Movement for Climate Justice	20-Mar-26
Interview 30	Thailand	Pollution Control Department	22-Mar-26
Interview 31	Thailand	Urban Studies Lab	25-Mar-26
Interview 32	International Org	World Bank	12-May-26
Interview 33	Philippines	Clean Air Asia	22-May-26

Ambient Air Quality Standards

Pollutant	KHM	IDN	LAO	MYS	MMR	PHL	THA	VNM
$PM_{2.5}$ (24-hr)	50	55	50	35		35	37.5	50
$PM_{2.5}$ (Annual)	25	15	15	15		25	15	25
PM_{10} (24-hr)	125	75	120	100		150	100	100
PM_{10} (Annual)	50	40	50	40		60	50	50
TSP (1-hr)	–	--	–	–		–	200	300
TSP (24-hr)	–	230 (SPM)	330	–		230	80	200
TSP (Annual)	100	90 (SPM)	50	–		90		140
SO_2 (1-hr)	500	900	130	250		–	100 ppb	350
SO_2 (24-hr)	300	365	50	80		180	50 ppb	125
SO_2 (Annual)	100	60	100	–		80		50