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Evidence-Based Air Pollution Policymaking in the ASEAN Region:

Good Practices, Experiences and Innovations

Working Paper

Disclaimer:
This paper shares the findings of a mapping of good practice case studies from the ASEAN region. All information has been submitted or reviewed by experts. If you notice an error, or would like to submit an update or new case study, please contact Diane Archer at SEI (diane.archer@sei.org) or Ekbordin Winijkul at AIT (*ekbordinw@ait.ac.th*).

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Table of Content

ACRONYMS

BC	Black Carbon
BMR	Bangkok Metropolitan Region
CAAP	Clean Air Action Planning
CCAC	Climate and Clean Air Coalition
CENRO	City Environment and Natural Resources Office
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EANET	Acid Deposition Monitoring Network in East Asia
EI	Emissions Inventory
EMB-AQMS	Air Quality Management Section of the EMB Central Office
EMB-NCR	Environmental Management Bureau – National Capital Region
FAO	Food and Agriculture Organization
GAINS	Greenhouse Gas – Air Pollution Interactions and Synergies
GBD	Global Burden of Disease
GHG	Greenhouse Gas
ICLEI	International Council for Local Environmental Initiatives
IHME	Institute for Health Metrics and Evaluation
IAP	Integrated Air Pollution
IPCC	Intergovernmental Panel on Climate Change
LEAP IBC	The Long-range Energy Alternatives Planning – Integrated Benefits Calculator
LMICs	Low- and Middle-Income Countries
LPG	Liquefied Petroleum Gas
MoE	Ministry of Environment
MONRE	Ministry of Natural Resources and Environment
NAAQS	National Ambient Air Quality Standard
NDCs	Nationally Determined Contributions
NO_2	Nitrogen Dioxide
NRERI	National Resource and Environment Institute
O_3	Tropospheric Ozone
PCD	The Pollution Control Department
PM	Particulate Matter
SDGi	Sustainable Development Goal Integration
SDGs	Sustainable Development Goals
SIP	Social Innovation Platform
SLCPs	Short-lived Climate Pollutants
SO_2	Sulphur Dioxide
TSP	Total Suspended Particulates
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP ROAP	United Nations Environment Programme Regional Office for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compounds
WHO	World Health Organization

1. Introduction

The 2022 United Nations (UN) General Assembly Resolution (A/RES/76/300) stipulates the human right to a clean, healthy and sustainable environment. Poor environmental conditions are linked to ill health: air pollution, water and solid waste contamination, and excessively noisy environments can all contribute to non-communicable disease risks and affect quality of life. Globally, air pollution is estimated to have caused 6.4 million premature deaths and 93 billion days lived with illness in 2019. Half a million of these deaths occurred in the 10 member states of the Association of Southeast Asian Nations (ASEAN) (Institute for Health Metrics and Evaluation [IHME], 2020). However, not everyone is equally exposed to and at risk from environmental harms: the unequal burden of pollution constitutes a form of "slow violence" on marginalized groups such as those on lower incomes, children and the elderly (Marks & Miller, 2022).

Data and tools can play an important role in assessing co-benefits and costs of inaction on environmental health issues. With regards to air pollution, data such as real-time $PM_{2.5}$ levels, emissions inventories, source apportionment studies, and health impact assessments can provide a clearer picture of the sources and impacts of air pollution. Therefore, indicating measures that should be taken to address the problem. Without such data, policy decisions are more challenging and can lead to action that fails to address the cause and impact of the air pollution. For policymakers and decision makers, data that can demonstrate the impact of inaction, such as analysis of predicted health costs from historic and future emissions, can spur changes in policy and mitigating action. Data can also highlight the unequal distribution of exposure and vulnerability to air pollution across different groups of individuals – and help to ensure more effective and equitable policymaking on air pollution. For the general population, openly accessible data on real-time pollution levels is important to inform people's behaviour, enabling them to take measures to mitigate their exposure.

In order for data to effectively inform policymaking, it must be presented to decision makers in a usable form. The science-policy interface can play a crucial role in analysing data to assist in making informed decisions. There are examples of good practices in ensuring this. These include emissions scenario tools to inform decision-making on environment and health; intelligent use of monitoring data to calculate health impacts and to increase knowledge of the likely sources of emissions; and institutional practices that involve linking institutions responsible for air quality and climate change, with planners and implementing departments (e.g. transport) within the government.

In this report, we compile examples of good practices in the use of tools and data to inform environmental policymaking in ASEAN countries. This compilation is an output of the 2021-2023 UNEP project *'Strengthening ASEAN Member State Policies with Environmental Health Data on Costs of Inaction and Co-benefits'* which aimed to support science-based policy planning and more integrated and inclusive policy interventions in Cambodia, Indonesia, Lao PDR and Thailand, and across the ASEAN region, in line with the aims of the *Manila Declaration* and as an activity under Action Line 3.2.1 of the *Plan of Action to Implement the Joint Declaration on Comprehensive Partnership between ASEAN and the United Nations* (2021-2025). The project was based on a concept endorsed by the ASEAN senior officials on Environment and ASEAN Health Cluster 2 and funded through the 13th Tranche of the United Nations Development Account. It was implemented by the United Nations Environment Programme Regional Office for Asia and the Pacific (UNEP ROAP) as part of its Subprogramme on Chemicals, Waste and Air Quality, in response to Resolution 3/4 of the UN Environment Assembly.

2. Approach

2.1. Definitions and criteria

In defining a good practice, experience or innovation, this study used an adapted version of the Food and Agriculture Organization (FAO)'s definition of a good practice being "a successful experience that has been tested [and replicated] in different contexts and can therefore be recommended as a model. It deserves to be shared so that a great number of people can adapt and adopt it"(FAO, 2013), broadening it out to also include experiences and innovations which may not yet have been replicated but have the potential for successful replication.

In the selection of case studies, the SUPER acronym was also adopted to assess each case, again with some adaptations to recognize the context of each case study:

- **S**USTAINABLE environmentally, socially and economically
- **U**SEFUL to confront real-life challenges
- **P**ARTICIPATORY of all people, everywhere (while recognizing that some government processes are by nature exclusionary)
- **E**FFECTIVE with measured impacts
- **R**EPLICABLE to share and scale-up

2.2. Categories of good practices

In order to better categorise the types of good practices, a typology was developed to categorise the variety of ways in which good practices can be applied in the context of environmental policymaking. In total, eight categories were detailed, as outlined below.

1. **Developing an emission mitigation planning process for air pollution:** The approaches which were taken to develop the air pollution mitigation planning processes, the stakeholder consultations, the institutional arrangements, and lessons learned from the planning process are considered here. Hence, cases where air pollution mitigation and climate change mitigation are included.
2. **Tools to inform decision-making on environment and health related to air pollution emission scenarios (baseline and mitigation) and their linkages:** Cases are included highlighting the experience of developing mitigation planning using tools that help to estimate current and past emissions, and with develop scenarios highlighting the emission reductions that can be achieved by implementing different policies, actions, and measures in the ASEAN region, and whether they are run by government agencies, universities or consultants – domestically or internationally and understanding if the tools integrate emissions causing climate change and air pollutants.
3. **Increasing knowledge of the likely sources of particulate matter and ozone concentrations (atmospheric modelling) and intelligent use of monitoring data to investigate trends and calculate impacts (using appropriate tools and methods):** Case studies of how data on monitoring air quality is used to inform policy are included.
4. **Assessment of health and other impacts associated with air pollution:** Case studies where health impacts have been estimated or used to support decision-making in ASEAN countries are included.
5. **Developing and implementing policies for air pollution mitigation:** Case studies of implementing mitigation policies and measures in ASEAN countries that have reduced air pollutant emissions are included.
6. **Integrated assessment of the net benefits of policy interventions on all economically important outcomes:** Case studies of where planning has estimated impacts other than those related to air pollution and health when developing decision-making on emissions and the measures that will be prioritized are included.

7. **Institutional practices that involve linking institutions responsible for air quality and climate change, as well as planners and implementing departments (e.g. transport) in government:** Case studies that outline attempts to link these planning processes in government and case studies that showcase the linkages between different ministries when identifying measures and targets are included.
8. **Assessing costs of air pollution and using this in decision-making:** Case studies where estimations of costs of mitigation and the magnitude of the economic cost of the impacts are included.

2.3. Case study collection

The collection of country case studies was done through a literature review based on an online search and literature provided by the key project contacts. To supplement this and gather primary data, an online questionnaire to gather preliminary details of a potential good practice was developed. This questionnaire was disseminated via Google Forms to key contacts. The online questionnaire included the following questions:

1. What country does the case study relate to?
2. What is the key department, agency or stakeholder?
3. Who are the key partners (if applicable)?
4. Which of the 8 categories does your case study relate to (can select more than 1 answer – multiple choice with brief description of each)
5. What are the objectives of the project or the programme?
6. What is the timescale? (start year, end year)
7. Who or what is the key trigger for the action?
8. What are the outcomes?
9. Are there any challenges towards the implementation? If so please explain.
10. Are there any opportunities created as a result of the project or the programme?
11. Is there any other relevant information?
12. Would you be willing to write up further details with our guidance?
13. If not, who can we contact for a follow-up interview?
14. Please include links to any relevant reports or documents.

We received eight responses through the survey form. Using the responses to the survey, the key information was compiled into short country case studies which are presented in this report. Where any details were missing, the authors contacted the submitter of information to try and gather the missing information, either by email or through a telephone conversation, to ensure a complete case study could be compiled. For countries where we were unable to gather responses via the online questionnaire, the team approached contacts through governments and other stakeholders such as UN partners and ASEAN Secretariat, to identify and write up appropriate case studies.

The resulting 12 case studies are compiled based on information available at the time. If any information is incorrect or needs updating, the interested parties can contact *diane.archer@sei.org* or *ekbordinw@ait.ac.th.* Likewise, relevant details in the report can be rectified or updated. In addition, the sharing the details of new case studies is warmly welcomed.

Table 1: Summary of 12 selected case studies

Country	Case study	Case study category
Cambodia 1	LEAP modelling for air quality projections.	2, 3 and 5
Cambodia 2	Revision of the 2000 Sub-decree on Air Pollution, Noise, and Vibration Management.	5
Cambodia 3	Using IPCC guidelines to develop greenhouse gas (GHG) national inventory to inform nationally determined contributions (NDCs).	2 and 5
Philippines 1	Moving from TSP to PM_{10} and $PM_{2.5}$ monitoring in Metro Manila.	3
Philippines 2	Clean Air for Sustainable Future: A Transdisciplinary Approach to Mitigate Emissions of Black Carbon in Metro Manila, Philippines (TAME-BC).	1
Philippines 3	Developing Clean Air Action Plan for Santa Rosa.	2 and 5
Thailand 1	Revising Thailand National Ambient Air Quality Standard.	5
Thailand 2	Study on estimating health and economic benefits from emission reduction scenarios.	4
Thailand 3	Investigating mortality and morbidity associated with $PM_{2.5}$ in Thailand based on available air quality monitoring data.	4
Laos 1	Integrated Policy Modelling and Systems-based Engagement for Transboundary Air Pollution Mitigation.	2
Laos 2	Developing an emissions inventory for Lao PDR.	3

3. Cambodia

3.1 Using the Long-range Energy Alternatives Planning – Integrated Benefits Calculator (LEAP IBC) Modelling for Developing a Clean Air Plan

Objectives: The objectives of this project were to use the LEAP IBC tool to estimate pollution levels and calculate emission projections, to analyze the costs and benefits of different scenarios, and to inform concrete plans for action. The LEAP modelling tool can produce data projections of air pollution impacts, and these predictions helped to inform the Clean Air Plan of Cambodia and scenarios for government planning.

Background: The key triggers for action were to fill a gap in information and to inform the development of Cambodia's first national Clean Air Plan. Cambodia sees air quality maintenance as a key priority for protecting public health. Until 2020, Cambodia's main framework for tackling air pollution was its Sub-decree on Air Pollution, Noise and Vibration Management, which was dated from 2000. In 2020, the government issued a Circular on Air Pollution Prevention and Measurement which laid out seven key mitigation measures, such as open burning controls and installing monitoring stations.

Key stakeholders: Ministry of Environment, the Ministry of Public Works and Transport, Ministry of Industry, Science, Technology and Innovation, Ministry of Urban Planning and Construction, Ministry of Mining and Energy, and Ministry of Agriculture

Timescale: The period of 2020-2021 was allocated for the development of the Clean Air Plan. The LEAP modelling provided projections from 2015 to 2030.

Outcomes: Based on the LEAP IBC estimations of emissions concentrations and projections, Cambodia developed its first Clean Air Plan. LEAP modelling and emissions assessment found the transport sector to be a major source of emissions and the Clean Air Plan includes a strategy to reduce transport emissions. The Plan is a roadmap for cross-cutting mitigation measures, with each ministry asked to develop the policies to help implement them. For example, the Transport Ministry should promote public transport, while the Ministry of Rural Development has to promote biogas for cooking. Currently (as of August, 2023), the 2000 Sub-decree is also being updated to include higher EURO standards, with a roadmap to EURO 6, as well as ambient air quality standards. A cost-benefit assessment of the health impacts and prevented deaths has also been carried out. The Clean Air Plan has also helped Cambodia to successfully secure funding support from the Climate and Clean Air Coalition (CCAC) to carry out an updated assessment of industrial emissions.

Recommendations:

1. For the Department of Air Quality Management and for line ministries, the lack of specific skills with regards to using tools like LEAP IBC remains a challenge, for example the country still lacks capacity on LEAP IBC. Based on the Cambodian experience, it would be beneficial for other ASEAN countries to organize regional training on specific scenarios like cost-benefit analysis or energy scenarios.
2. To begin the gathering of comprehensive data, it is recommended to first form a working group compromising representatives from each ministry. This group will assist in data collection and identifying the data required for running models and estimating pollution. For example: data on the number of vehicles from the Ministry of Public Works and Transport, General Directorate of Tax and Excise; data on the numbers of construction sites projections from the Ministry of Construction; and data from the Ministry of Finance on projections of economic growth.
3. It is also recommended to involve the cross-ministerial working group in LEAP IBC training as they can use it to develop their own policies and increase the capacity of line ministries.
4. To support capacity, funding from agencies like United Nations Environment Programme (UNEP) and CCAC is important for Low- and Middle-Income Countries (LMICs) to build their technical skills. In the Cambodian case, the government co-funded the staff time and the office space.

Links:

- *Clean Air Plan of Cambodia: https://www.ccacoalition.org/en/resources/clean-air-plan-cambodia*
- *Leap IBC factsheet: https://www.sei.org/publications/leap-ibc/*

3.2. Revision of the 2000 Sub-decree on Air Pollution, Noise, and Vibration Management

Objectives: To update the existing 2000 Sub-decree on Air Pollution, Noise, and Vibration Management by including more emission standards for mobile and stationary air pollution sources. Drawing from the new Clean Air Plan for Cambodia, the updated Sub-decree includes a wider range of sources of emissions, such as point source and non-point source, heavy industry, open burning and forest fires, and setting parameters for ambient air quality standards.

Background: As Cambodia now has a Clean Air Plan and a better understanding of sources of emissions through LEAP IBC modelling, the 2000 Sub-decree was in need of updating to better reflect the current sources of pollution. Additionally, the World Health Organization (WHO) has updated its air quality guidelines. Hence, the updated Sub-decree will now include new national ambient air quality standards for Cambodia.

Key stakeholders: Department of Air Quality, Noise and Vibration Management of the Ministry of Environment, Ministry of Interior, Ministry of Public Works and Transports, Ministry of Industry, Science, Technology and Innovation, Ministry of Planning, Ministry of Economy and Finance, and Ministry of Mine and Energy

Timescale: Ongoing, with the updated Sub-decree to be issued from 2024 onwards. The draft update has already passed through an internal consultation and review.

Outcomes: The new Sub-decree will offer more comprehensive coverage of the current sources of air pollution in Cambodia, including the transport sector (vehicles) which was shown through the LEAP modelling to be a key source of emissions. The original Sub-decree only covered EURO 1 emissions standards for vehicles, while the update will include a

roadmap towards achieving EURO 6 standards. The Sub-decree also better reflects Cambodia's economic situation as it will include heavy industry as well as light industry, and emissions from non-point sources like open burning of waste and forest fires. As the new Sub-decree will include ambient air quality standards (for example $PM_{2.5}$ standards) for Cambodia, it sets a target for ensuring better health outcomes and can be more easily assessed through real-time monitoring. Enforcing the new Sub-decree should lead to reductions in emissions in Cambodia, which can be reflected in future updates to Cambodia's Clean Air Plan.

3.3. Using IPCC Guidelines to Develop a Tier 2 GHG National Inventory for the Agriculture Sector to Inform Cambodia's NDCs

Objectives: The objective of this project is to develop a GHG national inventory by using the IPCC guidelines to inform Cambodia's NDCs. The previous inventory in Cambodia's NDCs used IPCC Tier 1 to estimate GHG, and with CCAC support, it was possible to carry out a GHG inventory for the agricultural sector using Tier 2. Now, there is a potential to extend the scope of the GHG inventory to other sectors.

Background: Cambodia is being impacted by climate change and is labeled as a vulnerable country by the United Nations Framework Convention on Climate Change (UNFCCC). Having more detailed data in the GHG inventory will encourage more targeted actions.

Key stakeholders: The key stakeholder is the Ministry of Environment (MoE) which is responsible for using IPCC guidelines to estimate pollutant concentrations from all sectors. This project involved different departments within MoE such as Department of Climate Change, and other line ministries such as Ministry of Agriculture, Forestry and Fisheries.

Timescale: From 2023 to 2024 (ongoing)

Outcomes: This project will results in an updated GHG inventory report, capacity building and endorsement of emissions assessment. These will inform updated NDCs with chapters on estimated pollutant concentrations, with the agricultural sector estimates being detailed based on IPCC Tier 2 data (for example, this assesses GHG emissions from cow-rearing based on the type of feed the cows eat). These estimates are important as they will help Cambodia to prioritize strategies and measure that tackle the most significant sources of emissions. This can also support Cambodia to further develop and update its long-term carbon neutralization strategy. Cambodia is the second country in Southeast Asia to produce this plan and commit to carbon neutrality by 2050.

Implementation challenges: The key challenge of realizing these outcomes has been the availability of local data. Compared to Tier 1, the Tier 2 requires a greater depth of data, which requires more resources to collect. For example, additional data on the type of food livestock and manure management is required.

Opportunities: The experience of developing the updated emissions inventory for the agricultural sector means Cambodia will be better placed to update other sectors' inventories, such as the waste sector. In addition, the increased capacity for GHG emissions inventory development can be fed into future UNFCCC reporting.

Links:

- *"Long-Term Strategy for Carbon Neutrality (LTS4CN)"*
- Cambodia's updated *2020 Nationally Determined Contributions (NDCs)*

4. Lao PDR

4.1. Integrated Policy Modelling and Systems-based Engagement for Transboundary Air Pollution Mitigation

Objective: United Nations Development Programme (UNDP) applied the Social Innovation Platform (SIP) approach in Lao PDR with a focus on air pollution, to strengthen local development planning processes to be inclusive, participatory, and resilient. The SIP methodology looks at the process of systemic transformation and social dynamics of the society, proposing a portfolio approach to local development and sustainable development goals (SDGs) localization. In Lao PDR, it was applied to develop stakeholder mapping, deep listening, sensemaking, co-creation, co-design and prototyping. At the same time, the UNDP team also developed an Integrated Air Pollution (IAP) Model and User Interface for Vientiane, to represent the key sources of air pollution, their drivers, and their implications for health and socio-economic development. This allows the development of an endogenous theory of change focusing on ambient air pollution, where the key elements of the system are dynamically interconnected through feedback mechanisms. The analysis of simulation results coupled with a deeper understanding of the underlying structure through the SIP, provided critical insights into the root causes and origins of the challenge and on effective leverage points for interventions.

Background: In Lao PDR, average exposure to $PM_{2.5}$ air pollution currently is ~21 μg/m^3 - more than four times higher than the WHO guidelines. Long-term exposure to this pollution is estimated to result in almost eight thousand deaths per year (IMHE, 2019). This is the second largest risk factor for human health in Lao PDR, contributing a larger health burden than tobacco use, dietary health risks, and malnutrition. Reducing air pollution exposure is therefore a key mechanism to improve public health in Lao PDR. However, much more information is required on the key sources, as well as the opportunities and challenges to implementation, before targeted and cost-effective mitigation measures can be developed.

Key stakeholders: UNDP Country Office in Lao PDR; Sustainable Development Goal Integration (SDGi) team in the UNDP Bangkok Regional Hub; Agirre Lehendhakaria Center for Social and Political Studies; and the Millennium Institute

Timescale: From 2021 to 2023

Outcomes: The SIP mainly relied on qualitative data from interviews and focus group discussions, and led to the following outcomes:

1. Better understanding of the issue through listening and personal stories with directly impacted people to capture opinions and perceptions of residents of Vientiane on the current air pollution situation, existing initiatives, opportunities and future risks and gain a deeper understanding of the dynamics of the challenge and people's needs.
2. Co-creating a people centered portfolio to create relevant outputs related to waste management (open burning, agricultural waste, industrial waste), infrastructure and transportation (public transport, electric vehicles, urban planning), and transboundary actions (public awareness, transboundary haze, intersectoral collaboration).
3. The development and prototyping of potential solutions through a co-creation workshop.

Participants at the workshop selected and voted for the projects and ideas that came from the portfolio. The co-creation workshop was followed by more consultations to further develop the top-three prototypes:

- Prototype 1: Public transport improvement and digitalization (level of intervention: services and infrastructure)
- Prototype 2: Regulation to increase green areas in urban planning and practices with open and inclusive platform to monitor and report to better enforce the urban law (level of intervention: regulation)
- Prototype 3: Temple composting (level of intervention: community)

Alongside the SIP, the IAP Model resulted in a better visualization of causal-impact-investment linkages. The model suggested realistic policy interventions, drawn from the outcomes of the stakeholder inception workshops which identified different interventions and objectives. The model also provided information on the cost of investment for different interventions and the impact of the investments in the air pollution concentration and exposure. It relied on several data sources including socio-economic indicators, pollution and health indicators, and economic activity indicators (transportation, fuel, waste, agriculture, cooking, etc.).

Challenges: The main challenge with the SIP was to be as inclusive as possible. It was challenging to have full representation, especially from the private sectors generating more pollution and the most vulnerable population within the community. For the IAP model, the main challenge was the availability of up-to-date data related to the air quality in Vientiane Capital and surrounding provinces. The accuracy of the model could be improved with better data.

Links:

- *UNDP SIP approach*
- *An individual's perspective on air-pollution | United Nations Development Programme (undp.org)*
- *The IAP Model*
- *A Tutorial on the IAP*

4.2. Developing an Emission Inventory for Lao PDR

Objective: The objective of this project is to develop an integrated emission inventory for Lao PDR.

Background: Air pollution is estimated to contribute approximately 10,000 premature deaths per year in Lao PDR. Despite this, there is currently a lack of comprehensive and consistent data on national air pollution emissions. This deficiency is highlighted in several existing plans including the National Pollution Control Strategy and the 9th National Socioeconomic Development Plan. Limited data is available on the magnitude and source of air pollutant emissions in the Lao PDR and this weak evidence limits the capacity of national institutions to develop informed and targeted policies on air pollutants and GHGs.

Key stakeholders: National Resource and Environment Institute (NRERI) of the Ministry of Natural Resources and Environment (MONRE), SEI and the University of Health Sciences

Timescale: From June to August, 2023

Outcomes: The national inventory is the first comprehensive air pollutant inventory in Lao PDR. It provides quantitative data on air pollutant emissions and has provided policymakers with evidence to identify key source sectors which need to be targeted for mitigation actions. Going forwards, the inventory can further be used to track progress and evaluate the effectiveness of policies once they are implemented. The emission inventory has since formed the basis of the cost of inaction assessment in which different interventions can be evaluated, and it can also form the basis of mitigation assessments in which various interventions are evaluated in terms of their emissions reduction potential.

Challenges: There were some gaps in availability and accessibility of data which were used to develop the inventory. For example, vegetation fires were identified as a key source of $PM_{2.5}$ emissions, however this relied on international data from the FAO as there is no national system to monitor vegetation fires.

Lessons learned: Emission inventories can provide an important foundation on which to build effective air pollution management strategies, but input and buy-in from relevant stakeholders is essential to effectively utilize the data in policy processes.

4.3. Undertaking a National Assessment of the Costs of Inaction on Air Pollution in Lao PDR

Objective: Objective of this project is to develop a national assessment on the costs of inaction on air pollution in Lao PDR.

Background: The existing emission inventory for Lao PDR was limited to past years and could not be used in scenario analysis to quantify the emission reductions of different mitigation options. The mitigation assessment can be used to quantify the benefits of taking action on air pollutants and the costs if the action is not taken. In addition, the capacity and awareness of methods used to develop air pollution management strategies are currently limited in Lao PDR.

Key stakeholders: NRERI (MONRE), other workshop participants including representatives from: Department of Climate Change, Department of Energy Policy and Planning, Department of Agricultural Land Management, Ministry of Industry and Commerce, Department of Environment, University of Health Sciences (Supported by SEI and funded by UNEP)

Timescale: From June to August, 2023

Outcomes: The assessment provides quantitative data on the impacts of air pollution in terms of human health. It estimates that the introduction of 14 targeted mitigation measures

could lead to a near 40% reduction in $PM_{2.5}$ emissions and halve the number of life years lost to air pollution by 2030, compared to the baseline. This evidence can be used to bolster support for air pollution action as well as being used to increase understanding of the issue. The data provided by the assessment will be used to inform the first Clean Air Plan in Lao PDR, a national plan which will aim at mitigating air pollution in Lao PDR. In addition, through a multi-day training workshop and on-going engagement, the capacity within MONRE to conduct air pollutant mitigation assessments is improving. The workshop helped to demonstrate how existing national and international data can be utilized to inform air pollution policies.

Challenges: The key challenge relates to how to implement the mitigation measures outlined by the assessment and to continue the progress made beyond the end of the project. In order to reap the full benefits of the assessment, the policy measures identified need to be effectively implemented and work needs to continue to monitor and evaluate progress as new policies are introduced.

Lessons learned: Data analysis can lead to greater policy impacts through being responsive and opportunistic. The potential impact of the mitigation assessment will be elevated through providing results to be included in the ASEAN Transboundary Haze meetings taking place in Lao PDR in August, 2023.

5. Philippines

5.1. Moving from Total Suspended Particulates (TSP) to Multi-Pollutant Monitoring in Metro Manila

Objectives: The objectives of this project were to upgrade air quality monitoring from roadside monitoring to include ambient air quality monitoring, and to strengthen emphasis on the protection of public health and the environment.

Background: Prior to 2014, most of the monitoring stations in Metro Manila focused on monitoring TSP in nine stations, all of which were located along major roads to monitor hotspots of emissions. Studies have brought attention to PM_{10} and $PM_{2.5}$ due to their adverse impacts on human health. In addition, monitoring other pollutants such as CO_2, SO_2, NO_2, O_3, and hazardous pollutants has gained traction because of their combined impacts to health and the environment (i.e., climate change). With support from various stakeholders, the Department of Environment and Natural Resources Environmental Management Bureau – National Capital Region (EMB-NCR) and the Air Quality Management Section of the EMB Central Office (EMB-AQMS) upgraded its monitoring system to include ambient air quality monitoring. Monitoring was expanded from TSP to multiple pollutants, including PM_{10}, $PM_{2.5}$, CO, SO_2, NO_2, O_3, benzene, toluene, and p-xylene.

Key stakeholders: EMB-NCR and EMB-AQMS

Timescale: From 2014 to 2018

Impacts on policy: The awareness of diverse stakeholders on the interlinked issues of air pollution and climate change has increased, and the demand for better understanding of ambient air pollution and different sources (not only of traffic hotspots) in the Metropolitan Regions has grown as well. This interest of stakeholders has been a contributing factor to strengthen efforts of the government on air quality monitoring.

Outcomes: According to Acid Deposition Monitoring Network in East Asia (EANET) (2021), the concentration levels of PMs (both $PM_{2.5}$ and PM_{10}) and SO_2 are gradually decreasing at Metro Manila site, which could be attributed to the efforts of the government for improving air quality and the above initiative.

Challenges: While data is being collected, there remain challenges in carrying out an assessment of air quality and its health impacts at the regional level. This also makes harmonizing policies at the airshed level challenging. Meanwhile, inter-agency participation on air quality and health remains weak. The monitoring equipment is nearing obsolescence, whilst the distribution of the existing air quality monitoring stations is not representative (Department of Environment and Natural Resources, 2020).

Recommendations: Based on the 2014-2018 upgrading of the monitoring network, the following recommendations are made:

1. The monitoring scope should be broadened to encompass sites where vulnerable populations are most affected (e.g., communities, schools, hospitals), and to utilize the gathered data for undertaking appropriate mitigating actions.
2. Further identification of trends connecting air pollution and urban development (e.g., land use, transport planning) would be helpful to recognize and project the impacts of policies and mitigation measures defined by the Clean Air Action Planning (CAAP).
3. Air quality data overlaid with reported health outcomes and population growth would illustrate impacts and identify pollution hotspots to inform the development of policies and measures.

5.2. Clean Air for Sustainable Future: A Transdisciplinary Approach to Mitigate Emissions of Black Carbon (TAME-BC) in Metro Manila, Philippines

Objectives: The goal of the project was to reduce black carbon (BC) emission levels in Metro Manila and to raise awareness on the roles of different stakeholders on air pollution. The TAME-BC project aimed to do this by (1) assessing BC pollution levels and adaptation strategies in the transport sector; (2) assessing the institutional environment of air pollution regulation and governance; (3) determining the human exposure to BC and its potential health effects; and (4) analyzing the institutional workings of the air pollution-related innovation system.

Background: In 2019, Clean Air Asia and partners from Germany and the Philippines launched the Clean Air for Sustainable Future: A TAME-BC in Metro Manila, Philippines project with the aim of catalyzing evidence-based action from different sectors to address BC in the metropolitan region. The project was built on the 2015 Manila Aerosol Characterization Experiment, which demonstrated the elevated concentrations of BC especially in Metro Manila roadsides (Kecorius et al., 2017; Allas, 2018; Madueño et al., 2019). The TAME-BC project implemented a transdisciplinary approach to develop and empirically test strategies towards the development and enforcement of evidence-based BC standards and emission control frameworks in Metro Manila.

Key stakeholders: The project was supported by German Federal Ministry of Education and Research, and implemented by German institutions (Leibniz Institute for Tropospheric Research, German Development Institute, and the Leibniz Research Institute for Environmental Medicine) together with Philippine partners: Ateneo de Manila University, Manila Observatory MO, De La Salle University Manila, University of the Philippines Diliman, Lung Center of the Philippines, Quezon City Government, Philippine Port Authority, Manila North Harbor Port, Inc., Pasig Mandaluyong Quiapo Operators And Drivers Alliance Transport Service Cooperative, Partner Jeepney Drivers Associations and Clean Air Asia.

Timescale: From July, 2019 to March, 2021

Outcomes: Some of the key outcomes of the project are as follows:

- Because of the data collected from the project, the national air quality guideline value for BC is currently being reviewed and developed by the national government. The local air quality management plan of Quezon City, where most of the measurements were performed, is also being developed.
- The transport sector, particularly the jeepney drivers and associations, were found to be willing to understand and learn what they can do to reduce emissions and were aware of the gaps in knowledge and resources.
- Technological solutions previously offered or available in the market were found to be not sustainable or effective by the jeepney drivers, so alternate technologies to reduce BC emissions should be tested.
- The policy review has revealed that there is a low recognition of air pollution risk by different stakeholders. Gaps in the implementation of policies related to air quality were identified.

Opportunities and recommendations: The project has identified the scope for further work including: (1) assessment of technological innovations; (2) understanding of air pollution governance; (3) deeper understanding of health benefits of air pollution reduction; and (4) the continuous adoption of a transdisciplinary approach towards institutional innovations and transformation pathways.

5.3. Developing a Clean Air Action Plan for the City of Santa Rosa

Objectives: The objective was to develop a Clean Air Action Plan (CAAP) for the city of Santa Rosa in the Philippines. The local government, under the leadership of the City Environment and Natural Resources Office (CENRO) allocated city resources for the development of an emissions inventory to develop the evidence base for identifying key emission sources in the city and thereby informing the development of targeted measures for emission reduction in the CAAP.

Background: Santa Rosa has experienced rapid economic development which has led to increased emissions in the city. Santa Rosa's efforts to reduce emissions focused on improving sustainable transport systems, enforcing national and local waste management regulations, encouraging waste reduction, diversion and segregation, and promoting the use of renewable energy. These efforts fed into Santa Rosa's involvement in several international initiatives for air quality and climate change action over the last decade, working on air quality-related projects with organizations including International Council for Local Environmental Initiatives (ICLEI), Clean Air Asia, United States Agency for International Development and German Agency for International Cooperation (Breathelife, 2018). The local government has signified their commitment to address air pollution and climate change in an integrated approach through the BreatheLife campaign.

Key stakeholders: Clean Air Asia, Institute for Global Environmental Strategies, ICLEI-Southeast Asia, CCAC, Santa Rosa City Environment and Natural Resources Office, University of the Philippines – National Center for Transportation Studies, Polytechnic University of the Philippines-Santa Rosa, and Mitsubishi Motors Philippines, Inc.

Timescale: From 2018 to 2020

Outcomes: With combined support from the CCAC, Integrated Programme for Better Air Quality in Asia, and Mitsubishi Motors Philippines, Inc., the city's CAAP was developed through a participatory approach under the leadership of the CENRO. The city-level emissions inventory (EI) covering transport, area, and stationary emissions sources, fostered partnerships between key local government agencies, academia (i.e., the Polytechnic University of the Philippines-Santa Rosa), and private sector and maximized the mobilization of human and financial resources for the database development. Capacity for data gathering, analysis, management, and communication of CENRO and other Santa Rosa city agencies was strengthened for EI development. In collaboration with the Institute for Global Environmental Strategies and ICLEI-Southeast Asia, the capacity of the local government to undertake integrated air pollution and climate change action was also strengthened through training. The CAAP served as the basis for further development of the city's programmes targeted at reducing emissions from the transport sector, and mainstreamed air pollutant and Short-lived Climate Pollutants (SLCP) mitigation actions through integrated action planning and capacity building activities.

Impact on policy: The results of the inventory were used to prioritize mitigation measures in the CAAP. For example, as mobile sources were found to be the most significant source of emissions, the CAAP included a strong focus on improving public transportation, vehicle inspection and maintenance, and promoting sustainable and active transport options.

Challenges: The main challenge for developing the EI was the lack of available data. As a result, emissions from some sectors, such as industry sources, may have been underestimated. At the

policymaking level, it was also challenging to translate and align emission reduction targets, based on the EI findings, into the development of concrete measures that were integrated into the city's development plans.

Opportunities and recommendations: Based on the experience of this project, it recommends to:

1. Collect data for future EIs as part of existing surveys or bureaucratic procedures. For example, this could include adding a survey module to a regular household survey, or adding questions to the application procedure for commercial permits (Clean Air Asia, ICLEI & IGES, 2021)
2. Establish a focal steering committee or technical working group to streamline action planning for air pollutant and SLCP mitigation into city development planning processes. The group's work should include supporting the mainstreaming of data collection, stakeholder engagement and policymaking.

6. Thailand

6.1. Revising Thailand's National Ambient Air Quality Standard

Objectives: The objective of this project was to revise Thailand's National Ambient Air Quality Standard (NAAQS).

Background: Thailand's previous National Ambient Air Quality Standard for $PM_{2.5}$ (50 µg/m^3 for 24-hr average and 25 µg/m^3 for annual average) had been in effect for more than ten years. During the past 2-3 years, the annual average $PM_{2.5}$ concentration was lower than the existing NAAQS in Thailand. As a result, the Thai government decided to tighten the NAAQS to allow stricter regulations and mitigating actions to be implemented under the new NAAQS. In the supporting document during the public hearing process of the new NAAQS, health impacts of air pollution was provided as co-benefits. To be more specific, the data from the study of Chulabhorn Research Institute with the support from the UN Environment showed that the health benefits of tightening standards to WHO's interim target 3 (37.5 µg/m^3) could save 1.85 billion THB in Chiang Mai, 1.96 billion THB in Saraburi, and 1.06 billion THB in Songkhla provinces respectively, while 4.87 billion THB in total in just these three provinces[1].

Key stakeholders: The Pollution Control Department (PCD), with the Ministry of Public Health, Ministry of Energy, Ministry of Industry, Office of the Prime Minister, non-profit organizations, and research and academic institutions

Timescale: from 2021 to 2023

Outcomes: Following a review of new evidence and data on air pollution and its health and economic impacts, as well as consultations across government departments, the new NAAQS was announced in 2022, with the annual standard introduced in June, 2022 and the new 24-hr standard in June, 2023. Following the introduction, Thailand's Air Quality Index was revised to align with the new standards.

Challenges: The implementation of the new standards will be challenging. Although more regulations will be applied to bring down $PM_{2.5}$ concentration to be lower than the new standard, this will not happen within a short period of time. Thus, more standard exceedances will happen which require more attention, actions and information sharing with the public on the new exceedances relative to the standards.

[1] Details of the public hearing can be found here: *https://www.pcd.go.th/wp-content/uploads/2021/10/pcd-new-2021-10-28_04-12-33_133858.pdf.*

6.2. Study on Estimating Health and Economic Benefits from Emission Reduction Scenarios

Objectives: Estimating the health and associated economic benefits gained from 10 selected emission reduction scenarios related to road traffic in Bangkok as compared to a Business-As-Usual scenario.

Background: Fine Particulate Matter ($PM_{2.5}$) is an important environmental factor contributing to human disease burden. In the Bangkok Metropolitan Region (BMR), concentrations of $PM_{2.5}$ continuously exceed the WHO standards. To mitigate this, Thailand's PCD introduced a number of operating guidelines which could be implemented to reduce emissions. In this study, these guidelines were assessed for their effectiveness by estimating the health and associated economic benefits gained as compared to a Business-As-Usual scenario. Total emissions of primary $PM_{2.5}$ and secondary $PM_{2.5}$ precursors were estimated using the approach suggested by the PCD and the European Environmental Agency. The related health burden for each scenario was then calculated following an approach based on impact characterization factors, which have been adapted for Thai-spatially differentiated conditions (Chavanaves et al., 2021).

Key stakeholders: The key drivers of the analysis were the Department of Civil and Environmental Engineering of Mahidol University, and the PCD.

Timescale: From 2019 to 2021

Outcomes: The conclusions of this study were as follows:

- Cars driven in Bangkok city cause more health damage than driven in the other five BMR cities.
- Retrofitting vehicles with DPF and 10 ppm sulfur fuel can lead to 14 billion THB in benefits.
- Upgrading vehicle emission standards can lead to larger benefits in 2029 than in 2024.
- Electric vehicles will lead to little health benefits even ten years after the implementation.
- Health impacts are 6.4 times higher when emissions of the whole supply-chain are added.

These results can help Thai policy-makers to evaluate the most effective strategies to reduce $PM_{2.5}$ from road transport, and to compare the benefits of implementing policies related to air pollution with other sector policies that bring benefits to public health. The results could also help policymakers in other developing countries, which share similar problems of transport-related air pollution, by offering insights into the effectiveness of various $PM_{2.5}$ emission-reducing actions (Chavanaves et al., 2021)

6.3. Developing a local database for health impact assessment of air pollution in Thailand

Objectives: To investigate mortality and morbidity associated with $PM_{2.5}$ in Thailand based on available air quality monitoring data.

Background: A 2020 study identified sources of health data for air quality impact assessment. This was then used to develop a BenMAP pre-loaded dataset and guidelines for Thailand. As a result, this dataset can be used in the future to estimate health impacts due to air pollution for different scenarios and policies in Thailand.

Key stakeholders: Center for Clean Air Solutions (Dr. Thao Pham) and PCD

Timescale: From 2020 to 2022

Outcomes: The study showed that by decreasing the annual $PM_{2.5}$ concentration in

Bangkok to the Thai NAAQS and WHO air quality standards, a consequential reduction in premature mortality attributable to unsafe $PM_{2.5}$ levels can be achieved (Fold et al., 2020). As a small-scale study using locally available data, the results of this study can be used with a higher degree of confidence than studies that use cost data from international datasets. These results can help to quantify the health impacts of different air pollution mitigation policies that reduce emissions by different amounts, thus helping to guide policy decisions. The study led to the creation of BenMAP inputs for Thailand, and has informed a 2023 assessment of the costs of inaction on air pollution in Thailand, which can also guide policy decisions, and was developed with the involvement of PCD (Kiesewetter et al, 2023).

Challenges: Several challenges were faced in developing the 2020 study. These included:

- Mortality data for Bangkok had limitations regarding the specificity of the district in which the mortality occurred. Because of this, the calculated incidence rates were generalized according to the entire Bangkok area, as opposed to specific districts within the province.
- Of the available data, there were long periods in which $PM_{2.5}$ values were not recorded. This was especially obvious between 2012 and 2014 when most monitoring stations only collected PM_{10} data. Missing $PM_{2.5}$ concentration values were estimated using a daily $PM_{2.5}/PM_{10}$ ratio, which allowed for a continuous data set of $PM_{2.5}$ (Fold et al., 2020).
- There is limited data on health problems related to air pollution in Thailand, for example the hospital visits due to increase in air pollution level.

Opportunities: Further studies should focus on investigating how $PM_{2.5}$ may affect population health at the local level in Thailand.

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