REPORT:
Benchmarking of Air Quality Management Capacity for BreatheLife Network Members in Asia

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BREATHELIFE CLEAN AIR ASIA

Contents

1. Introduction

Air pollution is one of the most pervasive health problems in Asia. In 2018, 98% of its urban population are exposed to unsafe air, with fine particulate pollution ($PM_{2.5}$) levels exceeding the World Health Organization (WHO) Air Quality Guideline Value of 10μg/m^3. The situation is even more acute in developing cities in the region where 60% have annual mean levels of $PM_{2.5}$ that are higher than the least stringent target of the WHO of 35 μg/m^3 (Clean Air Asia, 2018a).

Exposure to air pollution has a number of health consequences, which range from asthma attacks and increased hospitalizations due to respiratory and cardiovascular diseases in the short-term, and chronic illnesses and death from respiratory and heart diseases as well as lung cancer in the long-term. In 2017, air pollution is the leading environmental risk factor, exceeding that of unsafe water and inadequate sanitation, and the fifth highest mortality risk factor, next only to behavioural and metabolic factors. It also reduces life expectancy by 20 months, an impact comparable to active tobacco smoking. Globally, approximately 4.9 million deaths and 147 million years of healthy life lost can be attributed to air pollution that year. Of these impacts, 70% of air pollution-related deaths are in Asia. Within Asia, developing countries are disproportionately affected because they represent six of the top 10 countries with the highest mortality burden (Health Effects Institute, 2019). The regional average of 78 premature deaths in 100,000 people due to air pollution also increases to 107 in predominantly developing economies of Central and South Asia (Clean Air Asia, 2018a).

Aside from posing significant threats to human health, air pollution is an environmental concern because activities that generate air pollution are also major sources of greenhouse gases (GHGs). For instance, air polluting activities, such as combustion of fossil fuels for transport and power, agriculture, and improper management and disposal of waste also release carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) (West et al., 2013). Moreover, a class of air pollutants, called short-lived climate pollutants (SLCPs), are potent greenhouse gases with higher global warming potential than CO_2. Although they have shorter residence times relative to CO_2, the main SLCPs, black carbon, CH_4, tropospheric ozone (O_3), and hydrofluorocarbons (HFCs), are responsible for 45% of the current warming and are projected to contribute to 0.6°C warming by 2050 (Institute of Governance and Sustainable Development, 2013).

Improving air quality, thus, yields multiple dividends. In addition to improving health outcomes, it limits the extent of climate change and contributes to the achievement of development targets, such as Sustainable Development Goals 3 (Good Health and Well-Being), 7 (Affordable and Clean Energy), and 11 (Sustainable Cities and Communities) (IGSD, 2013; West et al., 2013; WHO, 2018).

The BreatheLife Campaign, a joint initiative by the WHO, UN Environment, the World Bank, and Climate and Clean Air Coalition (CCAC), aims to raise awareness of the threat of air pollution and climate change by maximizing clean air, climate, and sustainable development co-benefits. Clean Air Asia, as the regional focal point of BreatheLife in Asia, conducted this “Benchmarking of Air Quality Management Capacity for BreatheLife Network Members in Asia” to assess the air quality management (AQM) capacities of 24 BreatheLife Members and inform future BreatheLife and CCAC support to sub-national governments towards clean air solutions implementation.

1.1. Objectives

Robust air quality monitoring is the backbone of AQM because it helps determine the extent and evolution of air pollution in an area. It subsequently informs the design and prioritization of interventions as well as track their effectiveness. However, data collection alone does not automatically translate to policies and public support. Communicating air quality information is also critical in raising public awareness and in elevating the issue to the policy agenda. Given these, this report aims to:

- Assess the AQM capacity of 24 BreatheLife Network Members, focusing on monitoring and communication activities
- Document good practices that simultaneously improve air quality and mitigate climate change
- Establish a benchmark for AQM from which future initiatives and progress can be assessed and compared

To meet these objectives, the questionnaire that the cities accomplished when they signed up for the BreatheLife network were analysed. The questionnaire covered the following: initiatives and targets on air pollution and climate mitigation, monitoring capacity, and communication. The initial information derived from the questionnaire was supplemented by a review of published reports and unpublished but verified sources, an online survey sent out to all BreatheLife Network Members based on Clean Air Asia’s Clean Air Scorecard Tool, and interviews with selected resource persons as needed. The Clean Air Scorecard is an assessment tool that scores a city’s air quality. It provides an objective assessment of a city’s air quality status, management practices, and policies. These key assessment areas are represented by the three indexes of the scorecard, namely Air Pollution and Health Index, Clean Air Management Capacity Index, and Clean Air Policies and Actions Index (Clean Air Asia, 2015). The survey draws on indicators on air quality monitoring and communication capacities under the Clean Air Management Capacity Index. The following table summarizes the data sources used for each of the BreatheLife Network Members.

Table 1. Summary of data sources for the benchmarking

BreatheLife Network Members	Data Source	
	Air quality monitoring and communication information (Sections 2 and 3)	Practices on addressing emission sources (Section 5)
Indonesia		
1. Balikpapan	Benchmarking survey form	BreatheLife Questionnaire
2. Bogor	Benchmarking survey form	BreatheLife Questionnaire
3. Jambi	Benchmarking survey form	BreatheLife Questionnaire
Philippines		
4. Baguio	Environmental Management Bureau – Cordillera Administrative Region [EMB-CAR] (2020)	BreatheLife Questionnaire
5. Bataan Province	Benchmarking survey form	BreatheLife Questionnaire
6. Calapan	Benchmarking survey form	BreatheLife Questionnaire
7. Davao	Environmental Management Bureau [EMB] (2019), Department of Environment and Natural Resources [DENR] (2020)	BreatheLife Questionnaire
8. EMB-NCR	EMB-NCR, personal communication, 20 July 2020	BreatheLife Questionnaire (Draft)
9. Iloilo	Benchmarking survey form	BreatheLife Questionnaire
10. La Trinidad	EMB-CAR (2020)	BreatheLife Questionnaire (Draft)
11. Limay	Benchmarking survey form	BreatheLife Questionnaire
12. Malabon	EMB-NCR, personal communication, 20 July 2020; DENR (2020)	BreatheLife Questionnaire
13. Manila	Survey form, Clean Air Asia (2020)	BreatheLife Questionnaire
14. Marikina	EMB-NCR, personal communication, 20 July 2020; Clean Air Asia (2020a); DENR (2020)	BreatheLife Questionnaire
15. Naga	EMB (2019), DENR (2020)	BreatheLife Questionnaire
16. Parañaque	Benchmarking survey form	BreatheLife Questionnaire

BreatheLife Network Members	Data Source	
	Air quality monitoring and communication information (Sections 2 and 3)	Practices on addressing emission sources (Section 5)
17. Pasig	Interview with EMB-NCR, DENR (2020)	BreatheLife Questionnaire
18. Quezon City	Benchmarking survey form, Clean Air Asia (2020)	BreatheLife Questionnaire
19. San Juan	EMB (2019), DENR (2020)	BreatheLife Questionnaire
20. Santa Rosa	Survey form	BreatheLife Questionnaire
21. Vigan	BreatheLife Questionnaire	BreatheLife Questionnaire
Nepal		
22. Kathmandu Metropolitan City	Survey form	BreatheLife Questionnaire
23. Lalitpur Metropolitan City	Survey form	BreatheLife Questionnaire
Vietnam		
24. Can Tho	Survey form	BreatheLife Questionnaire

1.2. Scope and Limitations

The report covers 24 governments that are part of the BreatheLife Network in four countries in Asia. They are as follows:

- Indonesia - Balikpapan, Bogor, Jambi
- Nepal – Kathmandu Metropolitan City, Lalitpur Metropolitan City
- Philippines - Baguio, Bataan Province, Calapan, Davao, Environmental Management Bureau - National Capital Region (EMB-NCR), Iloilo, La Trinidad, Limay, Malabon, Manila, Marikina, Naga, Paranaque, Pasig, Quezon City, San Juan, Santa Rosa, Vigan
- Vietnam - Can Tho

It should be noted that the Environmental Management Bureau – National Capital Region in the Philippines is not an administrative unit (e.g. national, provincial or city government), but rather an environmental management agency responsible for the National Capital Region which includes BreatheLife Cities Malabon, Marikina, Paranaque, Pasig, Quezon City and San Juan. Information on air quality monitoring activities reported under the National Capital Region are the sum total of stations EMB-NCR manages within the 17 local governments of the National Capital Region including the six BreatheLife Cities. Aside from these, monitoring activities are also reported at the individual city-level for BreatheLife Cities Malabon, Marikina, Paranaque, Pasig, Quezon City and San Juan.

Only government-operated stations are included in this report. The benchmarking was designed to focus on three air quality monitoring objectives: (a) monitoring compliance to national and WHO air quality guidelines; (b) monitoring to inform air quality action and (c) monitoring for public communication or advisories. Given these, government-operated air quality monitoring stations are assumed to comply with national air quality monitoring technology standards or guidelines and therefore acceptable to their respective monitoring agencies to be used for these three objectives.

The report provides an overview of the status of AQM and documents good practices. It also aims to facilitate knowledge-sharing, inform target setting and prioritization, and enable scaling-up of AQM initiatives in the region. It is meant for policymakers and technical staff involved in AQM, climate change mitigation, and urban development planning. Non-government organizations (NGOs), civil society organizations (CSOs), and international development agencies that are working on AQM advocacy, capacity-building, and policy development could also find this report useful.

2. Status of Air Quality and Monitoring Capacity in BreatheLife Members

The status of air quality across and within countries vary. Approaches to manage it are also cross-scalar and transdisciplinary because air pollution is not confined to political boundaries and can be attributed to a variety of activities. To assess the context in which the BreatheLife Network Members operate, this section examines legislations and institutional arrangements for AQM, particularly focusing on the sharing of responsibilities between the national and local governments. It then examines whether these countries have ambient air quality standards and how these compare against the WHO guidelines, and air quality indices, which are key regulatory and communication tools. The section finally elaborates the air quality status of these countries as an indicator of progress of their AQM initiatives.

2.1. National AQM Framework

2.1.1. Indonesia

Indonesia does not have a national law dedicated to AQM (Greenstone & Fan, 2019). However, it enacted a series of regulations, ministerial decrees, technical guidance, and other legal instruments related to AQM (Clean Air Asia, 2010, 2018b). Chief among these regulations is Act No. 23 of 1997 on Environmental Management (later strengthened as Act No. 32 of 2009) which mandates the Ministry of Environment and Forestry (MOEF) to regulate pollution and ensure environmental compliance. The MOEF issued a series of regulations to operationalize this act. For air quality, it issued Government Regulation No. 41 of 1999 on Air Pollution control which sets standards for ambient air quality, emissions of industries and motor vehicles, and pollution index. It also allows provincial governments, but not cities, to develop their own standards provided that they are consistent with, or more stringent than the national standards.

The move to decentralize and enhance local autonomy, through Law No. 22 of 1999 and later with Law No. 32 of 2004, shifted most regulatory and enforcement functions from the national to the local governments, including natural resource management (Widianarko, 2009). For AQM, this meant that local governments have autonomy in developing and implementing their own AQM plans as well as in areas related to air quality, such as transport, waste, and urban development. In this new arrangement, the MOEF, at the national level, formulates roadmaps, harmonizes and monitors subnational AQM initiatives, sets standards, and supports local governments in developing and implementing their own AQM plans (Clean Air Asia, 2018b). Aside from the MOEF, other agencies also have initiatives that are related to AQM and contribute to improving air quality, albeit with varying degrees of harmonization. As an example, the National Council for Climate Change developed its National Action Plan on Climate Change in close coordination with the MOEF and the National Development Planning Agency, while the air quality monitoring activities of different agencies, such as the Ministry of Transport, National Aeronautical Board, and Ministry of Health, are not integrated with the National Air Quality Monitoring Network (Clean Air Asia, 2010, 2018b)

2.1.2. Nepal

Like Indonesia, Nepal also does not have a law to specifically address and manage air pollution. Instead, it has overarching environmental laws and institutions, which cover air, among other environmental concerns. The foremost among these are the Environmental Protection Act of 1997 and Environmental Protection Rules of 1997 which aim to promote a healthy environment, manage natural resources, and pursue sustainable development. To meet these objectives, these laws authorize the Ministry of Forests and Environment (MOFE), then called Ministry of Population and the Environment (MOPE) prior to the recent government reorganization, to develop environmental standards and ensure compliance (SEI, 2009; Shrestha & Raut, 2002). For air quality, MOFE is responsible for developing and implementing a comprehensive AQM plan, crafting air quality legislations and regulations, and monitoring compliance to these regulations. A sub-unit of MOFE, the Department of Environment (DOE), is responsible for establishing and strengthening the country's air quality monitoring system, as well as conducting emissions inventories, dispersion modelling, and health and environmental impacts assessments of air pollution. As one of the nascent departments of MOFE, however, DOE's regional and local networks are limited (Air South Asia, 2017; Department of Environment, 2017). Aside from MOFE, other ministries also have roles in managing air quality at the national level, particularly the sectors that are major sources of air pollution. Among these are the Ministries of Industry and Commerce (MOIC) and Labor and Transport (MOLT), which oversee industrial and transport regulation and development, respectively (Clean Air Asia, 2016a). The National Planning Commission (NPC), the ministry tasked to formulate development plans and facilitate inter-agency coordination, also established the Environmental Protection Council (EPC), to harmonize environmental programs across agencies. However, given the breadth of NPC's work, environmental coordination has been given limited attention (World Bank, 2008).

In 1999, the passage of the Self Governance Act transferred a number of functions from the national to local governments. For environmental management and pollution control, the act enables local governments to establish their own environmental committees to formulate and implement plans to improve environmental quality and mitigate pollution (World Bank, 2008). Kathmandu Metropolitan City (KMC) , for example, established the Environment Department and Urban Environment Section to address air pollution. It coordinated with MOFE in establishing and siting its air quality monitoring stations and in developing policies for clean air (Shrestha & Raut, 2002). There were efforts to further clarify the coordination and roles among national agencies and between national and local governments in AQM through the development of a National Pollution Control Strategy and Action Plan which was led by MOFE in 2008. (World Bank, 2008).

2.1.3. Philippines

The Philippine Clean Air Act (CAA) of 1999 (Republic Act No. 8749) is the principal legislation for AQM in the country. It sets the country's ambient air quality guidelines for criteria pollutants and emission standards for industries and motor vehicles. It likewise designates the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR) as the focal office for its implementation. Among the DENR's functions are to set pollution standards and regulate pollution sources, monitor and communicate pollution levels, and develop action plans and frameworks for preventing and controlling pollutants. Within EMB, the AQM Section is tasked to monitor and analyze air quality (Clean Air Asia, 2016b). The law also mandates other offices to support DENR in implementing the CAA. Among these offices are the Department of Transport (DOTr) to implement emission standards and regulate volume of motor vehicles, Department of Science and Technology (DOST) to conduct research on air pollution prevention and control, Department of Energy (DOE) to set fuel standards and develop clean sources of energy, Department of Health (DOH) to conduct health impact studies of air pollution and monitor indoor air, and National Economic Development Authority (NEDA) to develop a national transport policy and integrate AQM in the Philippine Development Plan (Clean Air Asia, 2016b; Tsubogo, 2004).

Like most countries in Asia, the Philippines also devolved national functions to local governments, such as environment and natural resource management, through the Local Government Code of 1991 (Republic Act No. 7160). Unlike, Nepal and Indonesia, however, the Clean Air Act was implemented after decentralization and was, thus, able to better delineate the responsibilities of subnational entities for AQM. For instance, the act adopts an airshed model for managing local air quality (DENR, 2011). In this model, an airshed governing board, composed of heads of local government units such as cities and municipalities, regional heads of DOTr, DTI, DOE, DOST, non-government organizations, the academe, the private sector, and the provincial government, formulates and enacts policies to manage the airshed. The EMB also has regional offices that serve as the governing board's administrative and technical secretariat and operates regional air quality monitoring networks. Municipalities can also enact complementary ordinances and monitor compliance to emission standards. Despite these institutional arrangements that target greater horizontal and vertical integration, however, their operationalization remains a challenge (World Bank, 2002).

2.1.4. Vietnam

There are no legislations and institutions dedicated solely to AQM in Vietnam (Clean Air Asia, 2016c). Instead, air quality is a subset of environmental concerns covered by the Law of Environmental Protection (LEP) and functions of the Ministry of Natural Resources and Environment (MONRE). At the national level, Vietnam Environment Administration (VEA) under MONRE, is responsible for setting emission standards, regulating pollution sources, and developing policies and plans for environmental pollution, including air pollution. The Departments of Pollution Control, Appraisal and Environmental Impact Assessment, Policy and Legislations under the VEA perform these functions. VEA is likewise tasked to monitor environmental pollution, which are carried out in the Centers for Environmental Monitoring (CEM) and the Hydro-meteorological and Environmental Station Network Center. The former is the main focal point for environmental monitoring, data analyses, and reporting, whereas the latter supports these efforts by operating background monitoring stations (JICA, 2015).

The LEP, enacted almost a decade after decentralization in 2005, recognizes the role of subnational governments and authorizes provinces and districts to develop their own regulations and plans on environmental protection, granted that they are consistent with national policies and regulations. A number of decrees were also enacted to facilitate LEP's implementation. Among these are QD1899/2006/QD-BCA issued in 2006 and Decree No. 81/2007/ND-CP issued in 2007 which established the National Environment Police Agency to help enforce the LEP, and created Departments of Environment and Science and Technology within different ministries to assist them in developing environmental and pollution control programs and regulations within their sectors and jurisdictions, respectively (Clean Air Asia, 2016c). Despite these measures, the LEP was largely ineffective because the scope was too broad and the mandates were unclear. For instance, the scope was unclear for AQM and air pollution and control (JICA, 2015).

In 2014, LEP was amended and clarified the roles of different ministries and subnational governments in environmental protection. It mandates key ministries, such as the Ministry of Transport (MOT) to regulate pollution from motor vehicles and impacts of transport infrastructure, Ministry of Industry and Trade (MOIT) to facilitate and monitor compliance of industries to environmental standards, Ministry of Health (MOH) to conduct impact studies of pollution, and the Ministry of Science and Technology (MOST) to issue technical standards and procedures including the Vietnamese National Technical Regulation for Air Pollution Control. At the sub-national level, it mandates the creation of specialized bodies to assist the People's Committees in managing natural resources, implementing environmental plans, and monitoring compliance to national standards. Although these specialized bodies, called the Department of Natural Resources and Environment (DONRE) and Office of Natural Resources and Environment

(ONRE) at the provincial and district levels, respectively are mandated to the support People's Committees, they report administratively to the national government under MONRE (Clean Air Asia, 2016c). The amended LEP also has a dedicated section for air pollution and AQM, which covers emissions inventories, pollution control, monitoring, and issuing timely warnings (JICA, 2015).

2.2. National Air Quality Standards

Table 2 shows that countries in the study have ambient air quality standards for all criteria pollutants, except for Indonesia whose standards do not cover Lead (Pb). The table similarly shows that standards for short-term exposure are complete but are missing some values for long-term exposure. Specifically, annual standards are missing in Nepal and Indonesia for particulate matter (PM), Philippines for Nitrogen Dioxide (NO_2), and Nepal for Ozone (O_3).

Table 2. Summary of National Ambient Air Quality Standards of Selected Asian Cities vis-à-vis the WHO Guidelines (in $\mu g/m^3$)

Country	$PM_{2.5}$		PM_{10}		TSP		SO_2			NO_2			O_3		CO ('000)		Pb		
	24-Hr	Annual	24-Hr	Annual	24-Hr	Annual	1-Hr	24-Hr	Annual	1-Hr	24-Hr	Annual	1-Hr	8-Hr	1-Hr	8-Hr	8-hr	3 mos.	Annual
INDONESIA[1]	65	15	150	-	260	90	900	365	60	400	150	100	235	-	30	10	-	-	-
NEPAL[2]	40	-	120	-	230	-	-	70	50	-	80	40	-	157	-	10,000	-	-	0.5
PHILIPPINES[3]	50	25	150	60	230	90	-	180	80	-	150	-	140	60	35	10	-	1.5	1
VIETNAM[4]	50	25	150	50	200	100	350	125	50	200	100	40	300	120	30	10	1.5	-	0.5
WHO AQ Guidelines[5]	25	10	50	20	-	-	-	20	-	200	-	40	-	100	-	-	-	-	-
WHO IT-1[5]	75	35	150	70	-	-	-	125	-	-	-	-	-	160	-	-	-	-	-
WHO IT-2[5]	50	25	100	50	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-
WHO IT-3[5]	37.5	15	75	30	-	-	-	-	-	-	-		-	-	-	-	-	-	-

[1] Ministry of Environment and Forestry. (2017). *INDEX KUALITAS UDARA*. Indeks Standard Pencemar Udara (ISPU) - Daftar Istilah. http://iku.menlhk.go.id/aqms/istilah.

[2] Government of Nepal, Ministry of Forest and Environment. (2018, September). *Ambient Air Quality monitoring program: Report of the year 2017*. Department of Environment. http://doenv.gov.np/public/uploads/Pdffile/Aqms%20report%202017-1-52472.pdf.

[3] Clean Air Asia. (2017) *Clean Air Management Profile (CAMP) – Philippines*. Integrated Programme for Better Air Quality in Asia.

[4] Hanoi People's Committee. (2020, March*). Vietnam standards on ambient air quality*. Hanoi Air Quality Monitoring Network. https://moitruongthudo.vn/thu-vien/1/quy-dinh-quan-trac-chat-luong-khong-khi

[5] World Health Organization. (2005). *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide (Global update 2005): Summary of risk assessment*. World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf?sequence=1.

In terms of pollution thresholds, WHO developed guidelines for key pollutants based on the health effects of air pollution. Although non-binding, these serve as a reference for countries in setting pollution targets and in improving air quality (REF). Given that most national air quality standards are developed with other non-health considerations in mind, such as socio-economic conditions and technical feasibility (WHO, 2005), incrementally reconciling them with the WHO guidelines is instrumental in achieving the ultimate objective of AQM to reduce health risks due to air pollution.

Compared with the WHO guidelines, the air quality standards in these countries are generally less stringent. In particular, standards for daily and annual PM (both 2.5 and 10) and daily sulfur dioxide (SO_2) are only consistent with the more lenient WHO interim targets (IT) 2 and 1, respectively. For annual O_3, only the Philippines has a more stringent standard than the WHO, whereas the remaining countries are within the more lenient IT-1. For NO_2, hourly and annual standards in these countries are consistent with the WHO except for Indonesia whose benchmarks are more than double the WHO guideline values. Given that most of these standards were enacted almost a decade ago, an opportunity exists for these countries to review and upgrade them to be consistent with the WHO guidelines and recent scientific assessments on pollution levels that protect environmental and human health.

2.3. National Air Quality Indices

The four countries in this study have air quality indices (AQI) for converting pollutant concentrations into readily comprehensible health advisories. The table below shows that except for minor differences in color and an additional category, Nepal, Philippines and Vietnam have similar AQIs. Their AQIs are based on that of the United States Environmental Protection Agency's (US EPA) AQI which converts raw pollutant readings into a scale of 0 to 500. These pollutant concentrations are assigned values in the scale based on the national standard for that pollutant, with 50 and 100 being within the annual and short-term standards, respectively. The various breakpoints, which represent different AQI categories are based on health impact studies (US EPA, 2015; World Air Quality Project, 2020). The figure likewise shows that AQI for Indonesia, called, Indeks Standar Pencemar Udara (ISPU), has slightly different breakpoints because it does not disaggregate unhealthy levels for the sensitive and general population. The colors per category are also slightly different but still shows progression of danger as the colors become darker. In terms of pollutants covered, while all four countries cover criteria pollutants except Pb, only particulate matter is regularly monitored and reported (see DENR, 2020; Hanoi People's Committee, 2020; MOEF, n.d.; MOFE, 2020)

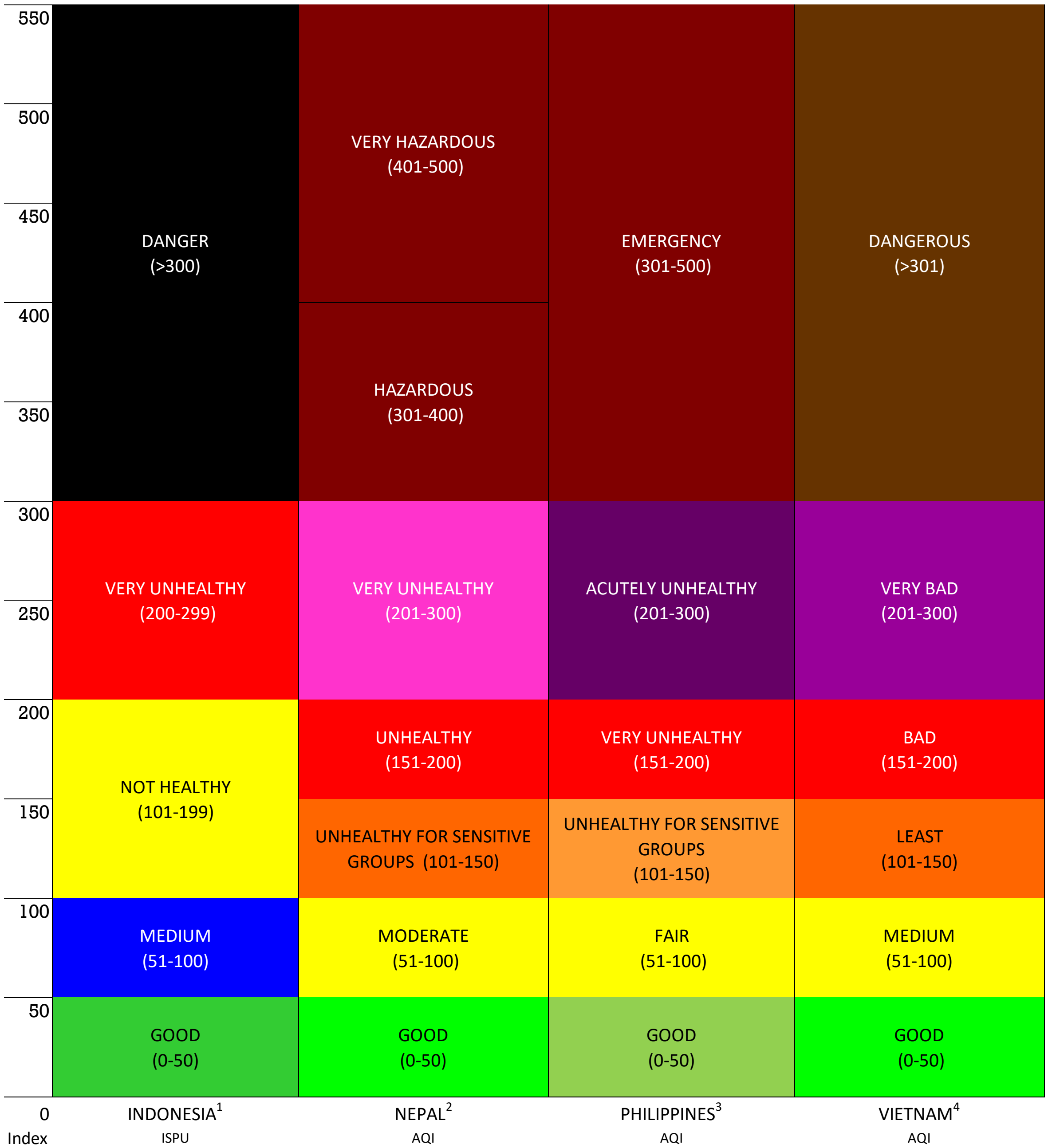

Figure 1. Air Quality Indices of Countries Covered in the Study

[1] Ministry of Environment and Forestry. (2017). *INDEX KUALITAS UDARA*. Indeks Standard Pencemar Udara (ISPU) - Daftar Istilah. (Retrieved: July, 2020). http://iku.menlhk.go.id/aqms/istilah.

[2] Government of Nepal, Ministry of Forest and Environment. (2020, July). *Air Quality Index (AQI) Basics*. Department of Environment. (Retrieved: July, 2020). http://pollution.gov.np/files/Air%20Quality%20Index%20(%20AQI%20)%20Basics.pdf.

[3] Department of Environment and Natural Resources – Environmental management Bureau (2020, July). *Air Quality Category: Index Values.* Philippine Air Quality App. (Retrieved: July, 2020). https://air.emb.gov.ph/ambient-air-quality-monitoring/

[4] Hanoi People's Committee. (2020, March*). AQI calculation method*. Hanoi Air Quality Monitoring Network. (Retrieved: July, 2020). https://moitruongthudo.vn/thu-vien/2/phuong-phap-tinh-toan-aqi

2.4. National Air Quality Status

Assessing the air quality status of developing countries is challenging because their air quality monitoring networks are sparse and they have difficulties sustaining monitoring activities. HEI developed a method to address this concern by estimating annual air pollution levels using a combined approach of ground measurements, satellite information, and global chemical transport models. These pollution estimates were then combined with population data to derive population-weighted average annual concentrations to better represent population exposure (Health Effects Institute, 2019). It should be noted that the data generated is at a national scale and used in this report to supplement limited monitoring data available at the local or city-level (see Table 3). The paper by Shaddick et al. (2017) provides more information on the analytical method used by HEI. Using HEI's dataset, Figure 2 illustrates the annual fine particulate levels of countries covered in the study from 1990 to 2017. Fine particulate pollution is a reasonable indicator of air quality status because it is the most harmful pollutant in developing countries (Kiesewetter et al., 2015).

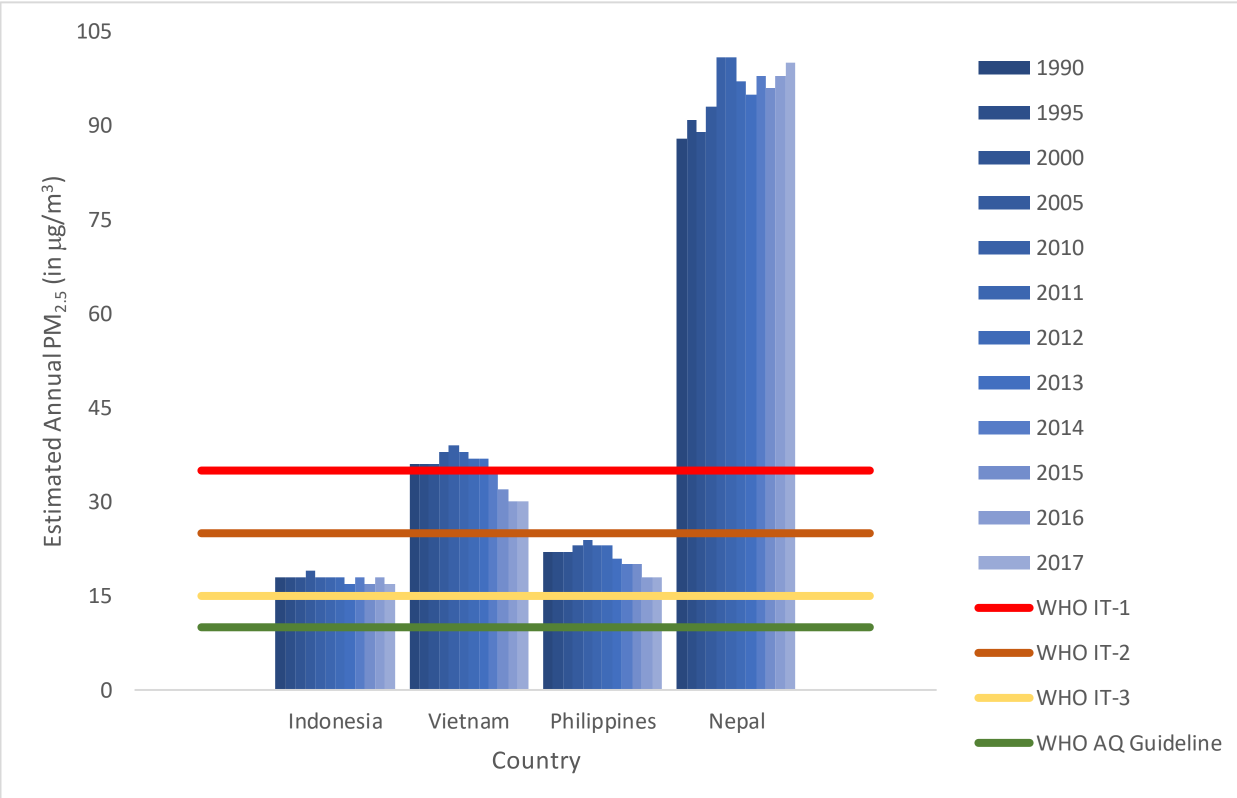

Figure 2. Population-weighted average annual concentrations of fine particulate matter in study countries vis-à-vis WHO standards (Data Compiled from: Health Effects Institute, 2019)

From the figure, it can be observed that these countries suffer from $PM_{2.5}$ pollution. Although the levels have decreased slightly in Philippines, Vietnam, and Indonesia over time, they still exceed the WHO Air Quality Guideline Value of 10 µg/m³. Particulate pollution levels in the Philippines and Indonesia are within the less-stringent WHO IT-2 value, and in Vietnam the WHO IT-3 value. The problem is even more severe in Nepal with fine particulate pollution levels that are increasing over time and are almost 10 times higher than the WHO guidelines. The limited monitoring data available in these countries, shown in Table 3 loosely confirm the level and trends of fine particulate pollution. Note, however, that city-level $PM_{2.5}$ data is unavailable for Indonesia and Nepal only has one data point.

Table 3. Available annual $PM_{2.5}$ data in the BreatheLife cities of the study from 2007 to 2017

Cities	Annual $PM_{2.5}$ concentration (µg/m³)										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Nepal[1]											

Cities	Annual $PM_{2.5}$ concentration ($\mu g/m^3$)										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Kathmandu Metropolitan City	57										
Philippines[1]											
Manila										29	29
Marikina										31	
Naga										15	
Pasig										34	24
Paranaque										20	
Quezon City										46	67
San Juan											22

[1] Clean Air Asia. (2018, November). *Regional Status Report: Final AQ Data for ASIA.* (Accessed: 28 July, 2020)

2.5. City-Level Indicators of Air Quality Monitoring Capacity

This section utilizes selected indicators from the Clean Air Management Capacity Index of the Clean Air Scorecard. The Clean Air Management Capacity Index assesses a city's capacity to perform air quality monitoring as one of the AQM areas that need to be undertaken to understand the city's air quality status. The indicators include the sufficiency of the number of monitoring stations based on the land area and population, whether all criteria pollutants are monitored, diversity of existing monitoring sites (e.g. ambient, roadside, etc.) and monitoring station types (manual or continuous) and whether meteorological parameters are measured alongside air quality levels. These indicators provide an initial picture of whether the existing monitoring network is sufficient to help cities in managing their air quality.

2.5.1. Number of Monitoring Stations

Table 4. Number of operational air quality monitoring stations for surveyed BreatheLife members vis-a-vis prescribed density[1] relative to population size[2]

Cities	Population	PM_{10} and $PM_{2.5}$		Pollutants except PM	
		Actual	Prescribed	Actual	Prescribed
Indonesia					
Balikpapan[3]	645,727 (2018)	12	3	3	2
Bogor[4]	1,081,009 (2017)	11	6	11	4
Jambi[5]	598, 103 (2018)	1	3	1	2
Philippines					
Baguio[6]	345,366 (2015)	3	3	0	2
Bataan Province[7]	760,650 (2015)	2	4	2	3
Calapan[8]	133,893 (2015)	1	2	0	1

Cities	Population	PM_{10} and $PM_{2.5}$		Pollutants except PM	
		Actual	Prescribed	Actual	Prescribed
Davao[6]	1,632,991 (2015)	1	7	1	5
EMB NCR[6]	12,877,253 (2015)	24	15	28	10
Iloilo[8]	500,000 (2015)	1	3	1	2
La Trinidad[7]	129,133 (2015)	2	2	0	1
Limay[7]	68,07 (2015)	2	2	2	1
Malabon[6]	365,525 (2015)	1	3	0	2
Manila[6]	1,780, 148 (2015)	1	7	4	5
Marikina[6]	450,741 (2015)	2	3	1	2
Naga[7]	196,003 (2015)	1	2	0	1
Parañaque[8]	696,837 (2015)	1	3	0	2
Pasig[8]	755,300 (2015)	1	4		3
Quezon City[6]	2,936,116 (2015)	2	10	3	7
San Juan[6]	122,180 (2015)	1	2		1
Santa Rosa[7]	353,767 (2015)	1	3	1	2
Vigan[7]	53,879 (2015)	1	2		1
Nepal					
Kathmandu Metropolitan City [8]	1,500,000	2	7		5
Lalitpur Metropolitan City [8]	284,000 (2011)	0	3	0	2
Vietnam					
Can Tho[8]	1, 400, 000	1	6	16	4

[2]Prescribed values are based on the EU Directive 2008/50/EC for high concentration areas

[3]Badan Pusat Statistik - Kota Balikpapan. (2019, May 16). *Population Statistics According to District and Sex in City of Balikpapan in 2018*. BPS Kota Balikpapan. https://balikpapankota.bps.go.id/statictable/2019/05/16/69/jumlah-penduduk-menurut-kecamatan-dan-jenis-kelamin-di-kota-balikpapan-tahun-2018.html.

[4]Badan Pusat Statistik - Kota Bogor. (2018, October 4*). Area, Population Number, and Population Density According to Subdistrict in Bogor City, 2017.* Badan Pusat Statistik Kota Bogor. https://bogorkota.bps.go.id/statictable/2018/10/04/190/luas-wilayah-jumlah-penduduk-dan-kepadatan-penduduk-menurut-kecamatan-di-kota-bogor-2017.html.

[5]Badan Pusat Statistik - Provinsi Jambi. (2020, January 29). *Population by Regency / City in Jambi Province, 2010 and 2018.* Badan Pusat Statistik. https://jambi.bps.go.id/dynamictable/2019/09/11/1227/penduduk-menurut-kabupaten-kota-di-provinsi-jambi-2010-dan-2018.html.

[6]Perez, J. B. (2019, March 21). *Urban Population in the Philippines (Results of the 2015 Census of Population*). Philippine Statistics Authority. https://psa.gov.ph/population-and-housing/node/138311.

[7]Philippine Statistics Authority. (2017, June 30). Philippine Population Surpassed the 100 Million Mark (Results from the 2015 Census of Population). Census of Population and Housing. https://psa.gov.ph/population-and-housing/node/120080.

[8]BreatheLife application questionnaire

As shown in the table above, six (shaded in green) out of 24 BreatheLife members comply with the prescribed number of monitoring stations for PM_{10} and $PM_{2.5}$ while three comply with the prescribed number for other pollutants. These indicate a general need for cities and governments to expand and sustain their air quality monitoring networks. It should be noted that as the survey only covers government-operated stations, some of the cities or governments may have additional existing monitors managed by academia, research institutions, and private sector. Collaboration and data sharing between government and other actors can potentially address the limitations in terms of number of stations and data.

2.5.2. Pollutants Monitored

Table 5. Type of pollutants monitored for surveyed BreatheLife members

Cities	Pollutants							
	TSP	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	CO	Pb
Indonesia								
Balikpapan		✓	✓			✓		
Bogor	✓	✓	✓	✓	✓	✓	✓	✓
Jambi		✓	✓	✓	✓	✓	✓	
Philippines								
Baguio		✓	✓					
Bataan Province		✓	✓	✓	✓	✓	✓	
Calapan		✓						
Davao		✓	✓	✓	✓	✓	✓	
EMB NCR	✓	✓	✓	✓	✓	✓	✓	
Iloilo	✓	✓						
La Trinidad		✓						
Limay		✓	✓	✓	✓	✓	✓	
Malabon		✓	✓					
Manila		✓	✓	✓				
Marikina	✓	✓		✓	✓	✓	✓	
Naga		✓	✓					
Parañaque		✓	✓					
Pasig		✓						
Quezon City	✓	✓	✓			✓	✓	
San Juan		✓						
Santa Rosa		✓	✓	✓	✓	✓	✓	
Vigan		✓						
Nepal								
Kathmandu Metropolitan City	✓	✓	✓					
Lalitpur Metropolitan City								

Cities	Pollutants							
	TSP	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	CO	Pb
Vietnam								
Can Tho								

Results of the benchmarking show that all 23 BreatheLife members which perform air quality monitoring measure PM_{10} levels. In addition to PM_{10}, 15 out of the 23 also monitor $PM_{2.5}$. These indicate a minimum capacity to set air quality targets for PM_{10} and monitor their progress towards these targets. Section 2.2. previously showed that out of the four countries, Nepal has the most stringent 24-hour air quality standards for PM_{10} (close to WHO IT-2). On the other hand, Vietnam annual air quality standards for PM_{10} is more stringent compared to the Philippines, corresponding to WHO IT-2. Indonesia and Nepal do not have annual air quality standards for PM_{10}. This alignment with more stringent air quality guidelines provides an opportunity for cities to integrate a health-based perspective into compliance monitoring. However this opportunity is open to all cities and local governments as they may also opt to set air quality objectives that are more stringent than national values if conditions demonstrate a need for stricter targets.

2.5.3. Types of Monitoring Sites

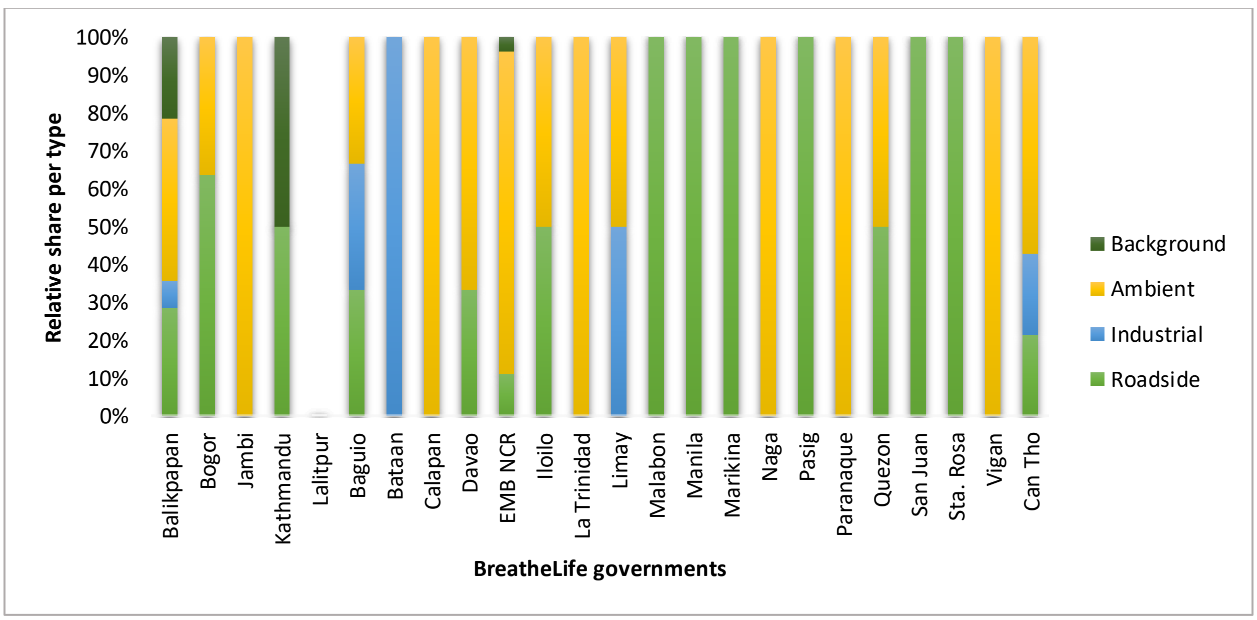

Figure 3. Composition of monitoring sites in BreatheLife governments

The figure above shows that ambient (16 in out of 23 BreatheLife members) and roadside (14 in out of 23 BreatheLife members) are the most common types of monitoring sites. These are expected as ambient sites provide information on air quality levels generally experienced by residents within the city, while roadside stations are useful in understanding the effect of mobile emissions to air quality levels, which an important consideration for all urban areas. It was also noted that some cities or administrative units with industrial sources such as Baguio, Bataan Province, Limay and Can Tho have corresponding monitoring stations within the vicinity of industrial facilities (referred to as industrial monitoring sites in this report) which are installed to measure air quality levels within breathing zones of the said industrial facilities.

2.5.4. Types of Monitoring Stations

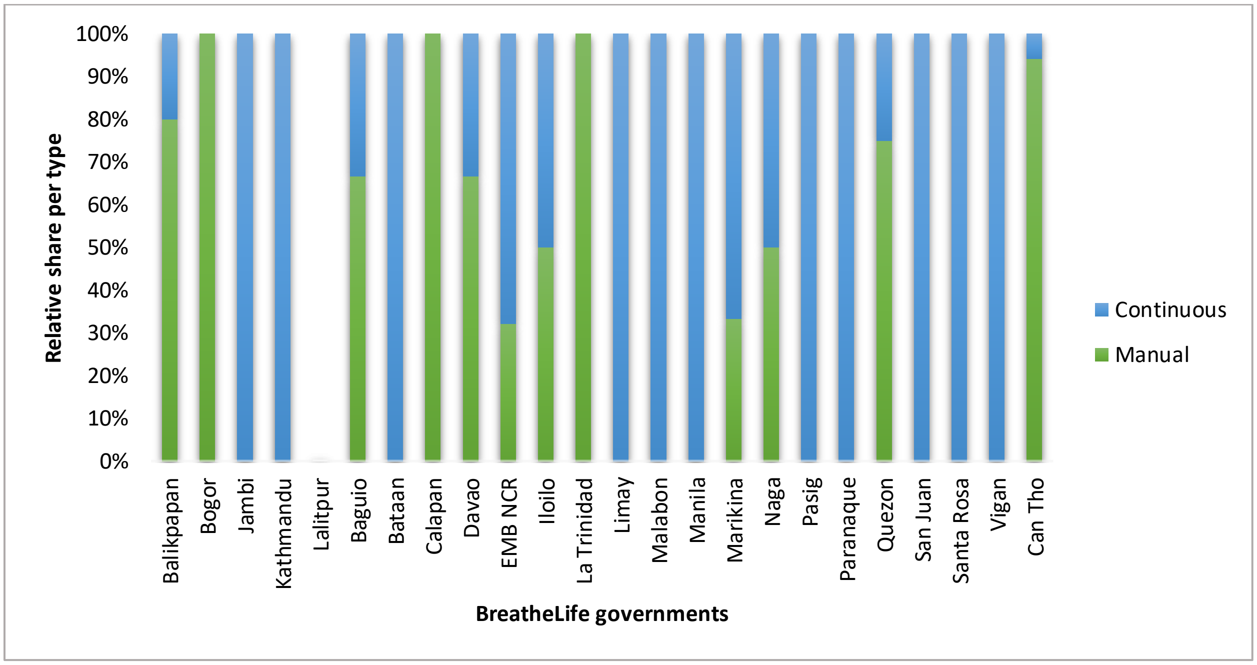

Figure 4. Composition of monitoring station types in surveyed BreatheLife members

Survey results show that 20 out of the 23 surveyed members have continuous monitoring stations allowing for collection of real-time data. However, 12 governments still maintain manual stations – with two of these (Calapan and La Trinidad in the Philippines) without complementary continuous stations. As manual stations continue to be important due to the accuracy and precision afforded by manual sampling and analysis methods, what is needed is for a city or government's air quality monitoring strategy to ensure that the sampling schedule or frequency of the manual stations addresses their monitoring objectives and data quality needs. As mentioned in an earlier section, three monitoring objectives were considered in this assessment: (a) monitoring compliance to national and WHO air quality guidelines; (b) monitoring to inform air quality action and (c) monitoring for public communication or advisories. It is important that a city's monitoring network – its size, sophistication of the monitoring equipment, location and number of sampling stations, duration and frequency of sampling, quality assurance and control (QA/QC) procedures – meet the monitoring objectives. More information on aligning the monitoring network with monitoring objectives and data quality needs can be found in Clean Air Asia's Integrated Programme for Better Air Quality in Asia City Solutions Toolkit (Clean Air Asia, 2020).

2.5.5. Meteorological Data Monitored

Table 6. Fraction of monitoring sites that measure meteorological data and types of data collected in surveyed BreatheLife members

Cites	% of sites	Meteorological parameters					
		Wind speed	Wind direction	Humidity	Temperature	Turbulence	Others
Indonesia							
Balikpapan	100						
Bogor	100						
Jambi	100						
Philippines							
Baguio	67						
Bataan Province	100						
Calapan	0						
Davao	50						
EMB NCR	71						
Iloilo	0						
La Trinidad	100						
Limay	100						
Malabon	0						
Manila	0						
Marikina	0						
Naga	100						
Parañaque	0						
Pasig	100						
Quezon City	79						
San Juan	0						
Santa Rosa	100						
Vigan	0						
Nepal							

Cites	% of sites	Meteorological parameters					
		Wind speed	Wind direction	Humidity	Temperature	Turbulence	Others
Kathmandu Metropolitan City	100						
Lalitpur Metropolitan City	0						
Vietnam							
Can Tho	65						

The survey shows that 15 out of 23 BreatheLife members measure meteorological data. Twelve out of the 15 measure wind speed and wind direction which are important parameters in understanding fluctuations and trends in air pollution levels. It will be important to further understand how the meteorological data are utilized in air quality data analysis during subsequent assessments following this benchmarking report.

3. Air Quality Communication

The indicators utilized for Section 3 are also taken from the Clean Air Management Capacity Index of the Clean Air Scorecard, focusing on air quality communication undertaken by cities or governments in terms of types of information shared and the channels used. These provide an initial picture of how monitoring data is analyzed and therefore applied in AQM, as well as the accessibility of the data in recognition of the fact that data sharing is a means of engaging the public and stakeholders.

3.1. Air Quality Information Shared and Channels Used

Table 7. Types of air quality information communicated by surveyed Breathelife members

Cities	Type of information					
	Concentration in number form	Concentration in graph form	Air quality index	Statistics	Spatial	Text
Indonesia						
Balikpapan						
Bogor						
Jambi						
Philippines						
Baguio						
Bataan Province						
Calapan						
Davao						
EMB NCR[1]						
Iloilo						
La Trinidad						
Limay						
Malabon						
Manila						
Marikina						
Naga						
Parañaque						
Pasig						
Quezon City						
San Juan						
Santa Rosa						
Vigan[1]						
Nepal						

Cities	Type of information					
	Concentration in number form	Concentration in graph form	Air quality index	Statistics	Spatial	Text
Kathmandu Metropolitan City						
Lalitpur Metropolitan City						
Vietnam						
Can Tho						

Notes:
[1] No information is available.

Results show that concentration in number form is the most common type of air quality information communicated, utilized by 17 out of 23 BreatheLife members. This is followed by the Air Quality Index or AQI (used by 10 respondents). For public communication, using the AQI is the recommended form due to the following factors: (a) it is assumed to consider all pollutants monitored and is based on the pollutant with the highest concentration, (b) it provides action-oriented advisories to the public based on long-term (24-hour) exposure concentrations; and (c) it can be easily understood by everyone.

Table 8. Platforms employed by BreatheLife members in disseminating air quality information

Cities	Dissemination platforms						
	Website/Social media/Mobile application	Published report	Upon request	Print Media	TV	Public Screen	Warnings
Indonesia							
Balikpapan							
Bogor							
Jambi							
Philippines							
Baguio							
Bataan Province							
Calapan							
Davao							
EMB NCR[1]							
Iloilo							
La Trinidad							
Limay							
Malabon							

Cities	Dissemination platforms						
	Website/Social media/Mobile application	Published report	Upon request	Print Media	TV	Public Screen	Warnings
Manila							
Marikina							
Naga							
Parañaque							
Pasig							
Quezon City							
San Juan							
Santa Rosa							
Vigan							
Nepal							
Kathmandu Metropolitan City							
Lalitpur Metropolitan City							
Vietnam							
Can Tho							

Note:
[1] EMB NCR, through the EMB Central Office, releases published reports on air quality information on behalf of BreatheLife cities Malabon, Marikina, Paranaque, Pasig, Quezon City, and San Juan.

The results show that most BreatheLife members make the data available upon request (20 out of 23 respondents). This assumes that requested data can be more detailed and comprehensive rather than what is easily available to the public. Moreover 18 BreatheLife members share information online through websites, social media or mobile applications to expand the reach of their communication efforts. It was noted that not all governments which use online platforms use AQI (out of the 17 using online communication, 13 provide the AQI while the remaining four provide concentration in number form). As AQI systems are in place for the four countries covered by this report, cities that do not yet report AQI but communicate online are provided two types of recommendations: (a) cities such as Balikpapan and Bogor with sufficient number of stations (from Section 2.5.1) are recommended to apply AQI in their online communication activities while (b) cities like Jambi and Iloilo which do not meet the number of prescribed stations can first focus on strengthening monitoring by expanding the network to make sure data used in communication is representative of actual conditions..

3.2. Selected Case Studies of Good Practices for Communicating Air Quality Information

3.2.1. Making timely air quality information accessible through multiplatform dissemination in Taiwan

Timely and accessible air quality information are instrumental in improving pollution-related health outcomes (Guillemin, 2017). During short-term pollution episodes, for instance, it allows individuals to take protective actions. It likewise enables authorities to institute temporary measures to reduce pollution levels. In Taiwan, various platforms are harnessed to make air quality information readily available.

Taiwan's air quality monitoring infrastructure has two parts. It has 76 monitoring sites that are linked to an electronic monitoring centre (EMC) that integrates readings from these sites along with that of local monitoring stations and civilian micro-sensors. The EMC processes these data by subjecting it to quality assurance and quality control, converting raw data into readily comprehensible formats, and feeding the data into a model (EPA, n.d.). The processed information, in the form of air pollution distribution maps, videos explaining the air quality that are akin to weather forecasts, and air quality indices with health warnings, are then disseminated in various platforms. Aside from publishing air quality information in a dedicated website (Figure 5), it is also made available through a mobile phone application called the Environmental Link-Green Life Map (Figure 6). In addition to real-time air quality information, it also publishes special reports that are issued thrice a day and air quality forecasts for the next three days. It also allows users to set a pollution threshold and notifies the users when it is exceeded. An SMS is also sent to the public during heavy pollution episodes to help the public plan and take measures to protect their health. On the regulatory end, air quality information corresponds to different warning levels that the Environmental Protection Bureau uses to prepare and enact emergency plans (Yuan You, 2014).

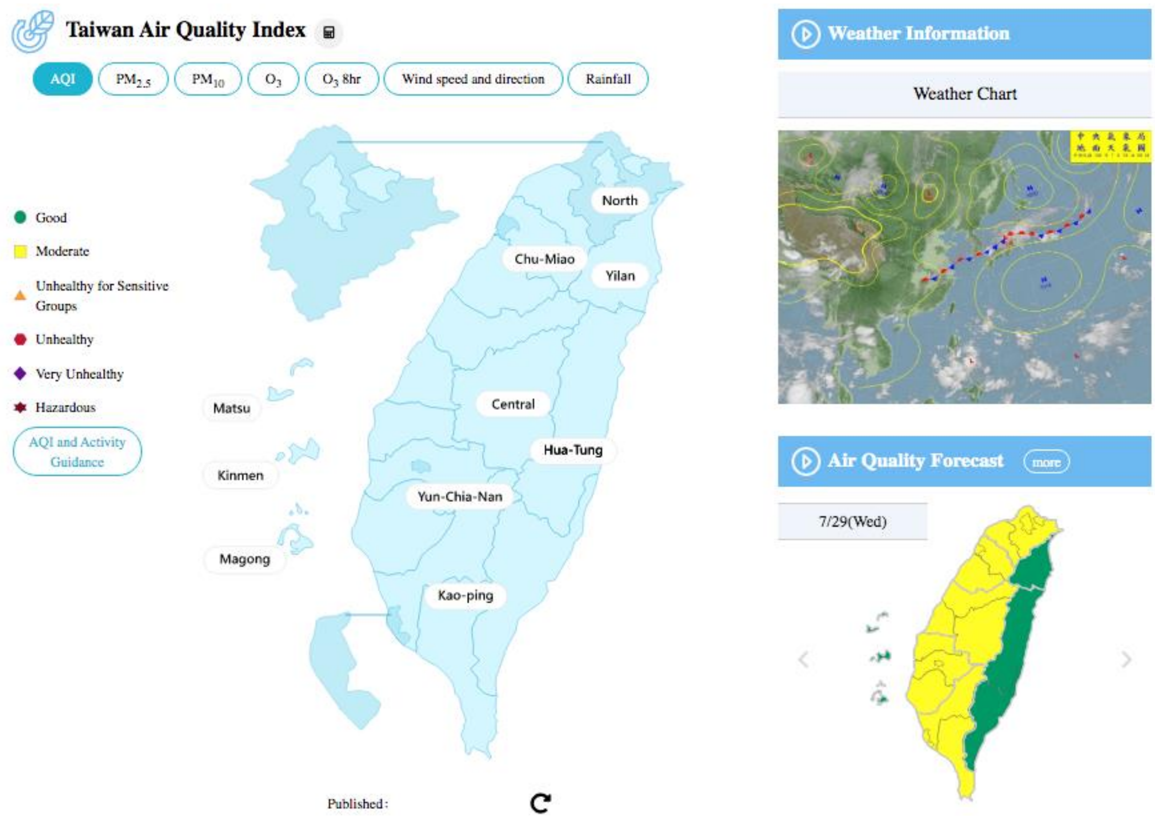

Figure 5. Website dedicated for publishing air quality information from Taiwan’s monitoring network

Figure 6. Interface of the Environmental Link-Green Life Map phone application

3.2.2. Harnessing citizen science and the private sector to increase public awareness and policy support for AQM in Pakistan

Raising public awareness and designing policies to effectively address air pollution require robust air quality information. In developing countries, however, such information may not be readily available because capacity and resources to establish and operate an air quality monitoring network may be limited. In Pakistan, air quality monitoring in major urban centres only commenced in 2016 and monitoring activities have been intermittent since then due to limited government resources and capacity (Air South Asia, 2019; Khan, 2019). To fill this gap, a group of stakeholders that are traditionally not associated with AQM have launched an initiative to monitor and raise awareness on air quality using low-cost sensors.

The Pakistan Air Quality Initiative (PAQI) was launched in 2016 as response to the limited official air quality information. It is a community-driven initiative to monitor and share real-time air quality data using low-cost sensors. It collaborated with IQAir, a Swiss company that develops low-cost sensors (Figure 7) and models air quality based on ground sensors, satellite data, and machine learning (IQAir, n.d.-a). In 2016, during a court hearing that examined the government response to smog in Lahore, PAQI's monitoring data was instrumental in establishing that air pollution was indeed a problem (Air South Asia, 2019; IQAir, n.d.-b). This then led the court to declare air pollution as a public health emergency and mandate the Pakistan Environment Protection Agency to monitor air pollution and formulate policies to manage air quality, including an action plan to address smog. PAQI's community-driven model in data collection together with its public engagement strategy open access to data (Figure 7) are also instrumental in raising public awareness on air pollution. Residents in large urban centres, for instance, often check PAQI's Twitter account or the phone application developed by IQAIr to check the air quality information in the absence of government monitoring data. Some residents with low-cost sensors also collect and contribute their data to PAQI (Khan, 2019).

In terms of technology choice, although these low-cost sensors are not substitutes for reference instruments for compliance monitoring and for informing policies or air quality actions, they can be useful for other applications. The case of PAQI, for instance, has demonstrated that it can be used to engage citizens and democratize air quality monitoring, raise public awareness on air pollution, and elevate air pollution in the policy agenda. (Li, Mattewal, Patel, & Biswas, 2020;).

Figure 7. Low-cost air quality sensor developed by IQAir (left) and PAQI's twitter account where it shares real-time air quality information and other awareness raising activities (right)

4. Integration of Air Quality and Climate Change Action for Urban Development

Due to the thrust of BreatheLife and the Climate and Clean Air Coalition in integrating air pollution, climate change and short-lived climate pollutants (SLCP), a short section of this report is devoted to a second survey for cities performed under another CCAC project to input to the recommendations located in the final section.

In 2019, the Institute for Global Environmental Strategies, Clean Air Asia and ICLEI East Asia Secretariat disseminated an online survey to understand the current practices in integrating air pollution, climate change and SLCP reduction in city plans, policies and projects. This was performed under the Integrating Short-Lived Climate Pollutants into Plans and Initiatives" project. A total of 52 cities participated in the survey from Indonesia, Nepal and the Philippines. A summary of the survey results is included in the table below.

Table 9. Percentage of responses for relevant survey questions

Question	% Responses		
	Yes	No	Unsure
Does your city have experience with integrated air quality and climate mitigation planning?	64	21	15.4
Are you familiar with the term "co-benefits"?	71	29	N/A
Are you familiar with "SLCPs"?	65	35	N/A

The survey also asked cities to choose the biggest barriers to integrating air quality and climate change planning in their cities. The options selected by the most number of cities are the following:

- Limited human resources (number of staff) to work on integrated planning (80%)
- Limited data to analyze impacts of integrated air quality and climate change planning (77%)
- Limited funding to implement policies reflecting integrated planning (77%)
- Limited access to technologies to implement the results of integrated planning (73%)
- Limited knowledge of decision- making support tools and assessment models that could contribute to integrated planning (73%)

The survey results showed that while there are efforts underway to integrate air pollution and climate change planning, opportunities to promote or strengthen these exist by providing financial and technical support to address the needs identified above.

5. BreatheLife Member Practices on Addressing Emission Sources

Section 5 provides a summary of the air quality and climate initiatives for each of the BreatheLife Network Members based on the information provided in the BreatheLife questionnaires they submitted. Policies and strategies selected in the questionnaire (with ticked checkboxes) were assumed to be existing or current unless specified as planned in any supporting information given by the respondents.

Table 10. Existing (green) and planned strategies (yellow) to reduce air pollutant emissions from transport

	Efficient mass transit	Land-use	Safe walking and cycling paths	Soot-free vehicles	Vehicle and fuel emission standards
Indonesia					
Balikpapan					
Bogor					
Jambi					
Philippines					
Baguio					
Bataan Province					
Calapan					
Davao					
EMB NCR					
Iloilo					
La Trinidad					
Limay					
Malabon					
Manila					
Marikina					
Naga					
Parañaque					
Pasig					
Quezon City					
San Juan					
Santa Rosa					
Vigan					
Nepal					
Kathmandu Metropolitan City					

	Efficient mass transit	Land-use	Safe walking and cycling paths	Soot-free vehicles	Vehicle and fuel emission standards
Lalitpur Metropolitan City					
Vietnam					
Can Tho					

Table 11. Existing and planned strategies in BreatheLife members to reduce household air pollution

	Building energy efficiencies/ passive solar design	Low-emission stoves and fuels	Replacing kerosene lamps with grid or solar electricity lighting
Indonesia			
Balikpapan			
Bogor			
Jambi			
Philippines			
Baguio			
Bataan Province			
Calapan			
Davao			
EMB NCR			
Iloilo			
La Trinidad			
Limay			
Malabon			
Manila			
Marikina			
Naga			
Parañaque			
Pasig			
Quezon City			
San Juan			
Santa Rosa			
Vigan			
Nepal			

	Building energy efficiencies/ passive solar design	Low-emission stoves and fuels	Replacing kerosene lamps with grid or solar electricity lighting
Kathmandu Metropolitan City			
Lalitpur Metropolitan City			
Vietnam			
Can Tho			

Table 12. Existing and planned strategies to reduce air pollutant emissions from waste

	Improved collection, separation, and disposal of solid waste	Improved wastewater treatment	Landfill gas recovery
Indonesia			
Balikpapan			
Bogor			
Jambi			
Philippines			
Baguio			
Bataan Province			
Calapan			
Davao			
EMB NCR			
Iloilo			
La Trinidad			
Limay			
Malabon			
Manila			
Marikina			
Naga			
Parañaque			
Pasig			
Quezon City			
San Juan			
Santa Rosa			
Vigan			
Nepal			

	Improved collection, separation, and disposal of solid waste	Improved wastewater treatment	Landfill gas recovery
Kathmandu Metropolitan City			
Lalitpur Metropolitan City			
Vietnam			
Can Tho			

Table 13. Existing and planned strategies to reduce air pollutant emissions from energy supply, energy use, and industrial activities

	Renewable power supply	Energy efficiencies	Fugitive emission control from other industries	Improved brick kilns	Improved coke ovens
Indonesia					
Balikpapan					
Bogor					
Jambi					
Philippines					
Baguio					
Bataan Province					
Calapan					
Davao					
EMB NCR					
Iloilo					
La Trinidad					
Limay					
Malabon					
Manila					
Marikina					
Naga					
Parañaque					
Pasig					
Quezon City					
San Juan					
Santa Rosa					

	Renewable power supply	Energy efficiencies	Fugitive emission control from other industries	Improved brick kilns	Improved coke ovens
Vigan					
Nepal					
Kathmandu Metropolitan City					
Lalitpur Metropolitan City					
Vietnam					
Can Tho					

Table 14. Existing and planned strategies to reduce air pollutant emissions from food and agriculture

	Alternate “wet-dry” rice paddy irrigation	Healthier, more sustainable food production	Improved livestock manure management	Reduced food waste	Reduced open burning of agricultural waste
Indonesia					
Balikpapan					
Bogor					
Jambi					
Philippines					
Baguio					
Bataan Province					
Calapan					
Davao					
EMB NCR					
Iloilo					
La Trinidad					
Limay					
Malabon					
Manila					
Marikina					
Naga					
Parañaque					
Pasig					

	Alternate "wet-dry" rice paddy irrigation	Healthier, more sustainable food production	Improved livestock manure management	Reduced food waste	Reduced open burning of agricultural waste
Quezon City					
San Juan					
Santa Rosa					
Vigan					
Nepal					
Kathmandu Metropolitan City					
Lalitpur Metropolitan City					
Vietnam					
Can Tho					

Table 15. Summary of number of BreatheLife members with planned or existing initiatives for each sector

Sector	Number of BreatheLife members with planned or existing initiatives
Transport	22
Waste	22
Energy	19
Food and agriculture	19
Household air pollution	16
Industry	13

Compiled responses of the BreatheLife Members showed most of the government respondents are looking at all sectors, with Transport, Waste and Energy solutions being the most planned or implemented. Further profiling of the cities or governments in terms of dominant emission sources in their areas vis-à-vis the policies and strategies in place would further provide more understanding of the prioritization of solutions for each government entity.

6. Recommendations to Improve and Scale-up Air quality Actions and Impacts

Based on the benchmarking results, this report recommends that the following needs be prioritized in supporting BreatheLife Network Members towards increased air quality and climate action.

On air quality monitoring

- Technical support for establishing an air quality monitoring plan with appropriate monitoring objectives, siting guidelines, data collection and quality assurance/quality control procedures, etc.
- Technical support for maximizing application of monitoring data to understand the city or area's air quality with respect to pollution sources, receptors or vulnerable populations, compliance to national standards or WHO guidelines and meteorological conditions, thereby informing the city's AQM
- Financial support or technical support for preparing proposals to expand the air quality monitoring network once an air quality monitoring plan is in place

On air quality communication

- Technical support for preparing an air quality communication plan which identifies target audience, communication platforms, frequency of communication, messaging and others
- Technical support for executing and/or improving current communication activities based on the communication plan

On air pollution and climate change integration, with air quality monitoring as entry point

- Technical support on data analysis and use of tools for linking air quality monitoring data with climate or greenhouse emissions data, such as the application of cost-benefit or co-benefit tools

For more information on strategies to improve capacity on air quality monitoring and air quality communication, please refer to the Roadmaps in the Guidance Framework for Better Air Quality in Asia. For more information on strategies to improve air pollution and climate change integration, please refer to the training curriculum developed under the "Integrating Short-Lived Climate Pollutants into Plans and Initiatives" project.

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