PMEH

POLLUTION MANAGEMENT & ENVIRONMENTAL HEALTH

WORLD BANK GROUP

POLLUTION MANAGEMENT AND ENVIRONMENTAL HEALTH

2020 ANNUAL REPORT

The Pollution Management and Environmental Health (PMEH) Multi-Donor Partnership, established in 2014 and administered by the World Bank, supports countries in managing air quality and toxic sites and generates cutting-edge knowledge and guidance to reduce pollution for public health, poverty reduction, economic growth, and environmental and climate co-benefits.

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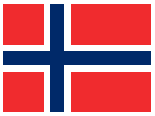

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Pollution Management and Environmental Health (PMEH),
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All dollar amounts are in US dollars ($) unless otherwise indicated.

CONTENTS

LIST OF FIGURES AND TABLES

FIGURES

TABLES

ACRONYMS

AAP	ambient air pollution
AAQM	ambient air quality monitoring
AF	additional financing
AOD	aerosol optical depth
AQ	air quality
AQM	air-quality management
AQMP	air-quality management plan
ARI	acute respiratory infection
ASGM	artisanal / small-scale gold mining
BBB	Breathe Better Bond (green bonds program)
BC	black carbon
BE	Bank-executed ("Bank" in "BE" in this report refers to the World Bank)
BEIS	United Kingdom's Department for Business, Energy & Industrial Strategy
BETF	Bank-executed trust funds
BMU	Germany's Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
BSPCB	Bihar State Pollution Control Board
CCAC	Climate and Clean Air Coalition
CEA	country environmental analysis
COED	cost of environmental degradation
CPCB	Central Pollution Control Board
CRAES	Chinese Research Academy of Environmental Sciences
CSIR	Council for Scientific and Industrial Research of South Africa
DEFF	Department of Environment, Forestry and Fisheries of South Africa
DFID	United Kingdom's Department for International Development
EEAA	Egyptian Environmental Affairs Agency
EPA Ghana	Ghana Environmental Protection Agency

FYP	Five-Year Plan
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies
GAMA	Greater Accra Metropolitan Area
GBD	Global Burden of Disease
GCA	Greater Cairo Area, which includes Cairo, Giza, and the Qalyubia Governates
GDP	gross domestic product
GFR	grant-funding request
GHG	greenhouse gas
GJA	Greater Johannesburg Area
GLM	ground-level monitoring
GoC	government of China
HAP	household air pollution
IC-AQMP	Integrated Climate and Air Quality Management Plan
IFC	International Finance Corporation
IGP	Indo-Gangetic Plain
IIASA	International Institute for Applied Systems Analysis
IPA	Innovations for Poverty Action
JJJ	Jing-Jin-Ji region, consisting of the municipalities of Beijing and Tianjin surrounded by the Province of Hebei
LMIC	low- and middle-income country
LRT	long-range transported particulates
MEE	Ministry of Ecology and Environment of China
MoEF&CC	Ministry of Environment, Forest and Climate Change of India
MoNRE	Ministry of Natural Resources and Environment
NCAP	National Clean Air Programme of India
NCR	National Capital Region of India
NDC	nationally determined contributions
NEP	National Environmental Policy of Ghana
NKN	National Knowledge Network

PforR	Program for Results of the World Bank
PMEH	Pollution Management and Environmental Health (Multi-Donor Partnership)
QA	quality assurance
QC	quality control
RE	recipient executed
RETF	recipient-executed trust fund
SA	source apportionment
SAAQIS	South African Air Quality Information System
SCAP	National Air Pollution Control and Prevention Action Plan of China
SEI	Stockholm Environment Institute
SLCP	short-lived climate pollutants
SOPs	standard operating procedures
TA	technical assistance
TERI	The Energy and Resources Institute
TSC	Technical Service Consultancy
TYAP	Three-Year Action Plan
UCSD	University of California, San Diego
ULAB	used lead-acid batteries
VTAPA	Vaal Triangle Airshed Priority Area
WB	World Bank
WBPCB	West Bengal Pollution Control Board
WHO	World Health Organization
YLDs	years lived with disability

PREFACE

Air pollution is one of the leading causes of disease and death globally, as has been documented in research studies conducted by organizations such as the World Bank. Some of those landmark studies are cited and their findings discussed in the present report.

Although some individuals have not experienced air pollution to any significant degree, literally billions of others suffer its effects daily. For change to come about in the lives of the billions who suffer from unsafe levels of air pollution, decision-makers must picture themselves in the places of those who are breathing highly polluted air.

Decision-makers must visualize having to keep their children out of school on days or weeks when pollution is highest. Decision-makers must also picture themselves breathing toxic fumes of burning tires to earn income to support a family, feeling isolated and shut in due to not being able to breathe outdoors, or watching a family member suffer or perish from one of the diseases associated with polluted air: ischemic heart disease, stroke, chronic obstructive pulmonary disease, asthma, and cancer. Such cases are not unique. An estimated seven million lives are lost annually as a result of ambient and household air pollution.

Women and children are among the most vulnerable to air pollution, often facing adverse impacts from poor outdoor and poor household air quality from substances burned for cooking and heating. Air pollution can cause stunting and loss of mental capacity in addition to disease. Lead exposure in children can result in lifelong intellectual disabilities, which can, in turn, affect individuals' competitiveness in the job market and make it difficult to avoid or rise out of poverty. The effects of pollution are expansive, including strong impacts on poverty reduction and shared prosperity.

The universal desire to keep loved ones healthy knows no income demarcation or national boundaries, and the kinds of reductions in quality of life mentioned here should not be happening. Being able to breathe unpolluted air should not be a luxury, but in many places, it is.

The kinds of problems caused by severe air pollution result in harm to households and whole societies, including threats posed to both current and future generations. Until recently, air pollution was seen as simply an environmental problem. However, air pollution is increasingly recognized as the worldwide public health crisis that it is and a top

development priority in fostering the creation of competitive, prosperous cities whose residents and visitors can breathe safe air.

Toxic contaminated sites are another major challenge; they pollute the land and often the water and air as well. The resulting health impacts can be devastating for families and communities—and markedly harmful to national economies' competitiveness and development.

Economic development and increasing urbanization are resulting in increased pollution that disproportionately affects low-income people, children, the elderly, and other vulnerable groups. Helping client countries to address pollution-related challenges is indispensable to the World Bank's mission of ending extreme poverty and promoting shared prosperity in a sustainable manner—so that urbanization is characterized by competitive, prosperous cities.

The work supported by PMEH, and the results of that work to date, reaffirm that stepping up to the pollution challenge requires p`olitical will and decisive action on the part of countries, regions, and subregions, including coordination of relevant actors and entities, sustained investment, effective monitoring and reporting systems, policies that govern polluting sectors, and attention to the specific needs of the most vulnerable.

Country demand is high for outside support and the best-available knowledge to effectively combat air pollution and other forms of pollution. The Pollution Management and Environmental Health (PMEH) Multi-Donor Trust Fund has been providing such support in several countries. It has used its convening power to coordinate donors in various countries and to help in the design and implementation of air-quality monitoring systems, incentive structures for meeting air-quality (AQ) milestones, and remediation of contaminated toxic sites.

STRENGTHENING AIR-QUALITY MANAGEMENT

AIR-POLLUTION IMPACTS

Ambient air pollution (AAP) is a leading cause of disease and death in low- and middle-income countries (LMICs). The health consequences and economic costs of air pollution harm individuals, families, communities, and the prosperity of companies, cities, and nations — and those consequences and costs cumulatively have negative effects on the global economy. Although AAP's role as a leading cause of mortality and morbidity in LMICs is well established, many cities in LMICs lack adequate air-quality management (AQM).

A PMEH-supported study[1] found a negative correlation between air pollution and the business environment. Even at lower levels of pollution than would be expected to produce such harmful impacts, this study found negative pollution-related effects on firm performance. This research also found that the effects of capacity agglomeration on labor productivity growth are stronger in the African regions studied as compared to other regions. Pollution has also been found to negatively affect the health and development of a city's human capital, resulting in negative economic impacts. Further, pollution can exacerbate inequalities because higher-skilled workers have greater opportunity to work in less-polluted areas, thereby improving the productivity and competitiveness of those less-polluted areas.[2]

Country-specific research yields similar findings. PMEH-supported research in Uganda collected survey data on small manufacturing firms and air-pollution data from more than 30 monitors throughout the country. Analysis showed clear patterns of temporal and geographic variation in pollution levels. Combined with firm data, the analysis indicated a clear positive relationship between firm density and pollution levels.

Initial findings from an experiment in Dhaka, Bangladesh, indicated a link between air pollution and worker productivity. In Zanzibar, Tanzania, researchers found links between perceptions of the extent of street cleanliness and tourists' willingness to return, recommend a visit to friends, or both return and recommend that others visit.

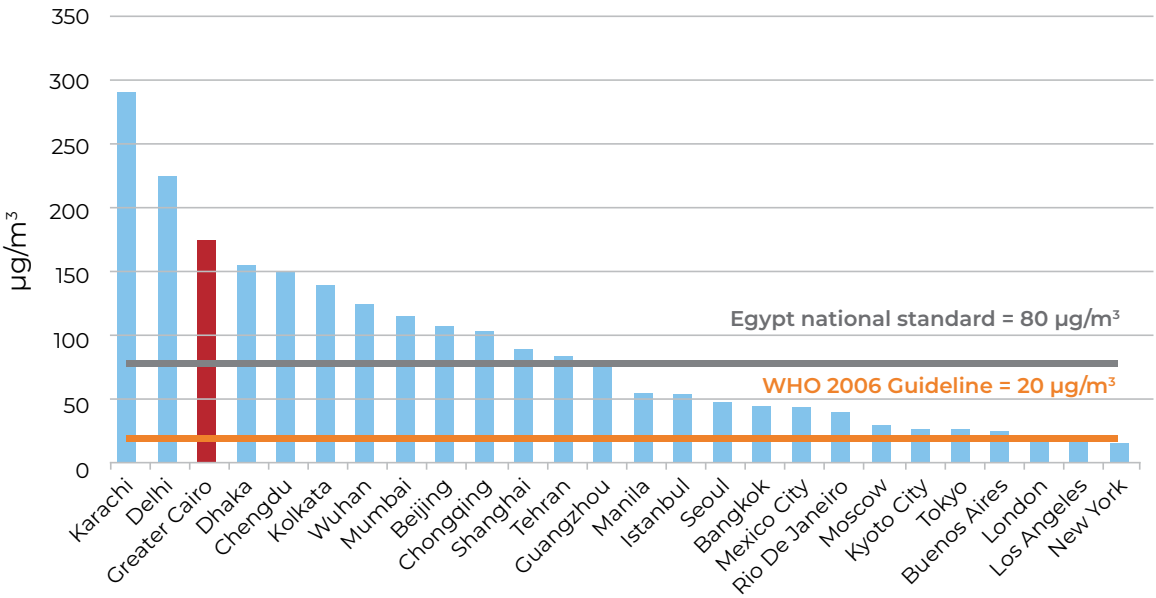
COUNTRY UPDATES

ARAB REPUBLIC OF EGYPT

Egypt is relatively advanced in its existing air-quality management (AQM) practices, including its robust monitoring network. The data from this monitoring network have enabled epidemiological analysis showing approximately 12,600 annual deaths related to air quality and the equivalent of more than 60,000 years lived with disability (YLDs) annually that are related to air quality in the Greater Cairo Area alone. The Greater Cairo Area includes Cairo, Giza, and the Qalyubia Governates.

PM_{10} pollution in Cairo is four times the 2006 World Health Organization (WHO) guideline value and two times the national standard (see figure 1). The cost of AAP in Greater Cairo is approximately 1.4 percent of its gross national product (GDP). The two key sources of fine particulate matter ($PM_{2.5}$), the air pollutant that causes the most significant health effects, have been motor vehicles and open burning. A principal objective of the PMEH work in Egypt is to improve local capacity to carry out source-apportionment studies to obtain information about pollution sources and the amount they contribute to air-pollution levels, so that in the future they can be carried out with regularity by Egyptian institutions.

FIGURE 1. GREATER CAIRO AREA'S ANNUAL AVERAGE PM_{10} CONCENTRATIONS IN COMPARISON TO OTHER MAJOR CITIES



Source: World Bank. 2020.

PMEH support to Egypt during 2020 centered on the following areas:

- Procurement of air quality monitoring equipment
- Source apportionment analysis and training
- Technical review of inventory of point-source and area-source emissions
- Roadmap for inventorying mobile-source and biogenic emissions
- Foundational work for the Integrated Climate and Air Quality Management Plan under the Greater Cairo Air Pollution Management and Climate Change Project

The PMEH's 2020 program also supported development of a roadmap for establishing a mobile-source inventory to complement the existing point-source and area-source inventory. The roadmap will identify necessary data and future mobile source reporting requirements to enable comprehensive and ongoing support and refinement. PMEH support has also laid the foundation for an inventory that integrates criteria air pollutant inventories with greenhouse gases (GHGs) and short-lived climate pollutants (SLCPs), an essential step to design interventions that simultaneously reduce local air pollution and mitigate climate change.

PMEH-supported work in Egypt during 2020 demonstrated the major public health and economic impacts of air pollution on Greater Cairo Area residents and on Egyptian government policies, finances, and related operations. Based on that foundational work, in September 2020, the World Bank Group Board of Directors approved a US$200 million loan for the Greater Cairo Air Pollution Management and Climate Change Project. The project's emphases include the following activities:

- Planning for integrated management of climate-change and air quality issues
- Improving the monitoring of GHGs and SLCPs
- Further developing and integrating city and national inventories across pollutants and sectors
- Developing institutional responses, and early warning systems, for days with high levels of air pollution
- Operationalizing air quality forecasting
- Piloting e-mobility options for public transport
- Improved solid waste management to reduce/eliminate open burning

The PMEH's activities completed in Egypt during 2020 include the following:

- Market analysis of monitoring equipment finalized
- Protocols reviewed and improved for quality assurance (QA) – quality control (QC) of AQ and SLCP monitoring

- Health-impact assessment
- Design of technical, operational, and administrative components for the networks to monitor AQ and SLCPs and for the associated laboratory facilities

An additional financing component was added to a current World Bank-funded project for the purpose of one-time procurement of capital goods, supplies, and services. These included source apportionment sampling equipment, consumables, and laboratory supplies for sample collection and analysis; laboratory equipment for chemical-speciation analysis; and a service contract for one-year operation of an source apportionment network.

PMEH resources remain critical, enabling comprehensive AQM planning for the Greater Cairo Area and seeding interest in the Greater Cairo Air Pollution Management and Climate Change project building on the foundations established by PMEH.

Reports and publications include or cover the following:

- Protocol for air quality and SLCP monitoring/quality assurance-quality control
- Review of air pollution ground-level monitoring system
- Health-impact assessment
- Economic analysis on cost of environmental degradation analysis
- Air pollution impact analysis of transport and fuel price interventions
- Technical review of area source emissions inventory
- Road map for mobile source emissions inventory
- Biogenic emissions inventory and geogenic emissions inventory
- Source apportionment network design
- Inputs to bidding documents for the procurement of monitoring and laboratory equipment

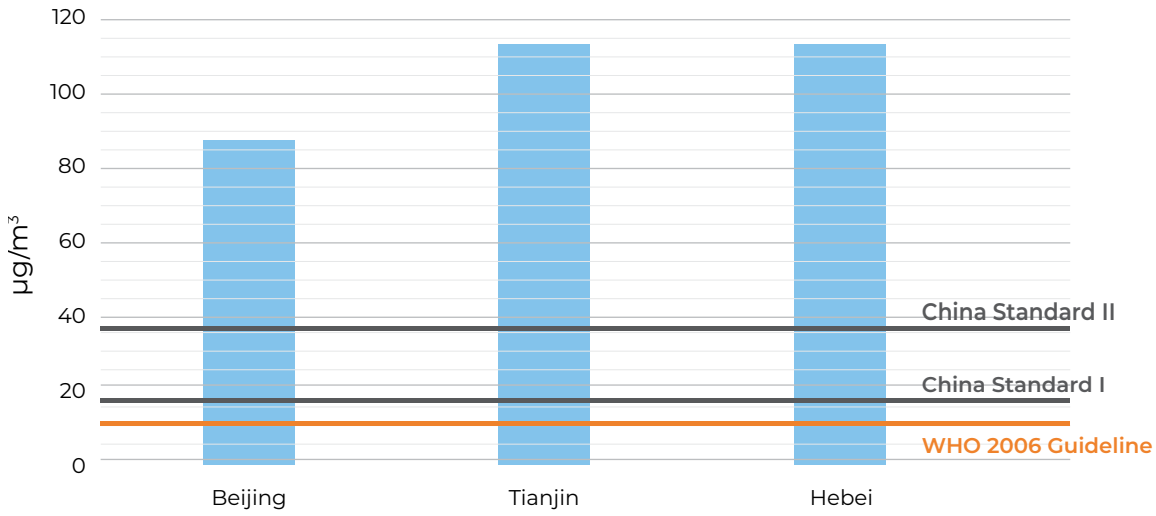
The following information sessions and workshops were held:

- Capacity-building workshops on source apportionment analysis (sampling, statistical and modelling analysis; and laboratory and monitoring equipment operation)
- A detailed stakeholder and institutional analysis as part of the preparation and negotiation phase of the Greater Cairo Air Pollution Management and Climate Change project to build on the PMEH Air Quality Management Plan. This analysis involved key stakeholders and governates associated with the primary sources of AAP in the Greater Cairo Area. Participants included representatives of the Cairo Transport Authority, Ministry of Local Development, and Waste Management Regulatory Authority of the Ministry of Environment, as well as representatives of the three Greater Cairo Area governates.

CHINA

China's highest levels of air pollution in 2012 were in its Jing-Jin-Ji (JJJ) region, consisting of the municipalities of Beijing and Tianjin surrounded by the Province of Hebei. Within the JJJ region in 2012, Hebei had the highest annual average ambient $PM_{2.5}$ concentration with 112.9 µg/m³, followed by Tianjin with 112.7 µg/m³, and Beijing with 88.3 µg/m³. Thus, the annual average ambient $PM_{2.5}$ concentration for the JJJ region was three times as high as the new Standard II of 35 µg/m³ set by the government of China. These circumstances led the government of China to set the country's most ambitious pollution-reduction target. (See figure 2.)

FIGURE 2. ANNUAL AMBIENT $PM_{2.5}$ CONCENTRATION BY PROVINCE IN 2012



Source: World Bank. 2020.

The goal of PMEH-supported programming in China is to support Beijing, Hebei, Tianjin, and the JJJ region to develop short-term, mid-term, and long-term Air Quality Management Plans. The first two phases of China's air-quality action plans set objectives for immediate results and actions by 2020. Further steps in PMEH-supported cost effectiveness analysis in China are calculations to assess how air pollution disperses downwind from key sources, which will be reviewed by experts from the International Institute for Applied Systems Analysis (IIASA), and a series of trainings and analysis to assess the contributions of different policies to reduced air pollution and the costs of implementing them.

In 2013, China's State Council announced the National Air Pollution Control and Prevention Action Plan (SCAP 2013–17) with specific targets set for 2017 (in 2018, the second phase a action plan was issued for the period 2018–20). For the first time in its five-year planning

cycle, the government of China included reduction of ambient $PM_{2.5}$ concentration as a binding target in the 13th Five-Year Plan (FYP) for the period 2016–20. Since 2013, significant public budget resources have been committed to support SCAP's implementation. In 2018, additional resources were allocated to SCAP's successor, the Blue Skies Battle Action Plan (2018–20).

Although air-quality management plans were developed systematically, implementation was initially been delayed because of limited technical capacity or experience. Considering that plans were prepared quickly to respond to the national crisis, the government of China acknowledged that the cost and effectiveness of planned mitigation measures were not well understood. In this context, the government of China requested World Bank assistance to provide support by bringing international knowledge and by sharing lessons learned to strengthen the government of China's policy making and enforcement capacity through analytical work and regional coordination for AQM in the JJJ area.

Specific measures to tackle air pollution were supported by the WB-financed Program for Results (PforR) in the JJJ region.

Results from AQM measures supported by PforR have achieved a 48 percent reduction in the JJJ region between 2013 and 2018. In the first half of 2019, the JJJ region reduced $PM_{2.5}$ concentration from 93 μg/m^3 to 61 μg/m^3. However, the current level is still over 1.7 times the national Standard II of 35 μg/m^3.

The PMEH's work in China is providing support to enhance the granularity of emission inventories of the provinces in JJJ. The PMEH is also building capacity and supporting analyses to introduce cost-effectiveness in the next air-quality management plans. Specific activities enabled by the PMEH included the use of the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model, sharing of international best practices on emission inventories, development of air-quality policy scenarios, and conducting air-quality modelling.

The cost effectiveness analysis was completed and found that, under the baseline policy scenario, in which the Three-Year Action Plans are fully implemented, the total primary emissions of $PM_{2.5}$, SO_2, and NOx will decrease by 23 percent, 25 percent, and 28 percent, respectively, compared to 2017.

China's Ministry of Ecology and Environment (MEE) has issued technical guidelines for inventories of air-pollutant emissions on the following topics:

- Primary emissions sources of PM_{10}
- Primary emissions sources of atmospheric fine particulates
- Emissions sources of atmospheric volatile organic compounds
- Emissions sources of atmospheric ammonia
- Air pollutant emissions from civilian use of coal
- Air pollutant emissions by road vehicles

- Air pollutant emissions by non-road mobile sources
- Air pollutant emissions from biomass combustion
- Pollutant emissions from suspended dust particles

PMEH-supported activities in China completed during 2020 include the following:

- Protocol for air quality and SLCP monitoring/quality assurance-quality control
- Emission inventories for air quality and SLCPs for the cities in the JJJ region
- Source apportionment for air quality and SLCPs
- Stakeholder and institutional analysis

Reports and publications include or cover the following:

- Emissions inventory of air pollutants ($PM_{2.5}$, NOx, and SO_2) in the "2+26" JJJ cities
- Report on cost-effectiveness assessment of various regional approaches to the control of air pollution
- Report on scenario-simulation analysis and optimization of the control of regional air pollution in the key region
- A draft cost-effectiveness assessment on various approaches to the control of regional air pollution relevant to the "2+26" cities. This assessment was prepared by the Chinese Research Academy of Environmental Sciences and IIASA in collaboration with Beihang University. That report used the GAINS model to address the cost-effectiveness of the emission measures from the Three-Year Action Plan for the "2+26" cities. The analysis conducted for that project employed the GAINS AQM model, developed by IIASA to identify potential options for improving air quality in the "2+26" cities under the implementation of the Three-Year Action Plan.

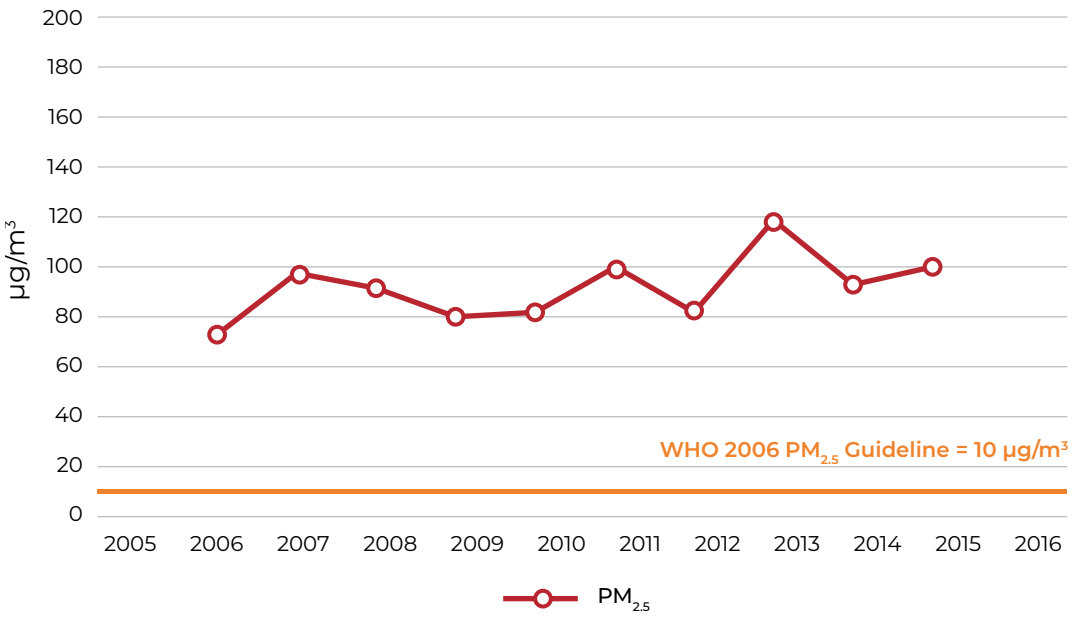
Information sessions and workshops:

- A training and exchange workshop was held for 20 AQM modelers and analysts in Beijing.
- Further coordination and training on cost effectiveness and policy-scenario analysis focusing on the key "2+26" cities under PMEH's China support program (Beijing, Tianjin, Shijiazhuang, Tangshan, Langfang, Baoding, Cangzhou, Hengshui, Xingtai Handan, Taiyuan, Yangquan, Changzhi, Jincheng, Jinan, Zibo, Jining, Dezhou, Liaocheng, Binzhou, Heze, Zhengzhou, Kaifeng, Anyang, Hebi, Xinxiang, Jiaozuo, and Puyang)

GHANA

The focus of the PMEH's 2020 activities in Ghana was on the Greater Accra Metropolitan Area because of its high annual average $PM_{2.5}$ levels (see figure 3a), which are about 10 times the levels recommended by the 2006 World Health Organizations guidelines. The associated human toll of air pollution is nearly 24,000 premature deaths annually[3], with roughly half from ambient air pollution (AAP) and half from household air pollution (HAP). The economic cost of air pollution is estimated at US$2.5 billion (approximately 4.2 percent of GDP).[4]

FIGURE 3A. ANNUAL AVERAGE $PM_{2.5}$ CONCENTRATIONS IN ACCRA, GHANA (INFERRED FROM PM_{10} MEASUREMENTS)*



*$PM_{2.5}$ has been estimated as .61xPM_{10}
Sources: World Bank. 2020.

The PMEH's development objective in Ghana is to improve capacity to address ambient air pollution and support development of a full-scale air-quality management plan for the Greater Accra Metropolitan Area. Ghana is unique in that it launched a preliminary air-quality management plan in 2018 based on available data. Thus, the focus of PMEH support since that time—and in 2020—has been to build capacity and improve data acquisition, analysis, and management in line with the National Environmental Policy (NEP) and Ghana's General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels. All of this work was done, and continues to be done, in close collaboration with the Ghana Environmental Protection Agency (EPA Ghana), which is implementing the AQMP. EPA Ghana is using the outputs of its collaboration with

the PMEH to improve the database that underlies these AQMP efforts and to consider strengthened air-quality standards and other implementation measures.

PMEH's 2020 work built on key prior milestones achieved by the PMEH in Ghana: Prior achievements include the completion of the data-acquisition plan in October 2019 and completion of the training plan in December 2019. The PMEH-supported data-acquisition plan and training plan were implemented in large part with a phased set of five virtual training programs. These activities enabled deployment of continuous-monitoring instrumentation (including for black carbon [BC], $PM_{2.5}$, and meteorological parameters) with a quality assurance plan and standard operating procedures (SOPs) for all equipment. All equipment was in place in 2020 at three sites in the Greater Accra Metropolitan Area, and data (including $PM_{2.5}$ and BC) are being streamed into an interim data management system (Campbell Connect) until the new AirNOW International platform is launched by the UN Environment Programme (see figure 3b).

The PMEH's 2020 work in Ghana was able to build upon the following resources, among others:

- Prior monitoring implemented under the US Environmental Protection Agency (EPA) African Megacities Partnership focused on calibrating low-cost sensors with two high-grade $PM_{2.5}$ monitors and two BC monitors
- A comprehensive national emission inventory by the Stockholm Environment Institute as part of the Climate and Clean Air Coalition (CCAC), funded by the Urban Health Initiative
- Source apportionment of air pollutants and SLCPs—a consistent focus of PMEH support to result in a source apportionment analysis for the Greater Accra Metropolitan Area
- World Bank support, as a CCAC partner, of the Urban Health Initiative and World Bank support of WHO's work with health workers to improve understanding of the role of air quality in health risks

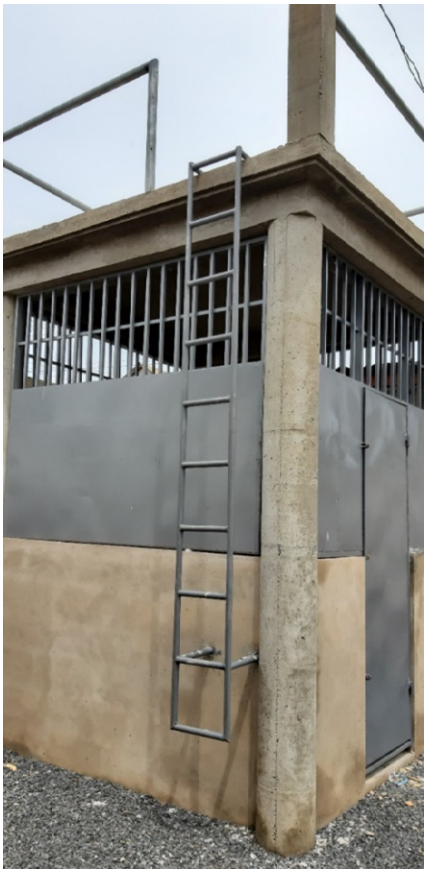
The above-mentioned prior work and the PMEH's 2020 activities in Ghana highlight the uniqueness of the PMEH's Greater Accra Metropolitan Area project among PMEH pilots, notably its ongoing collaborations with other development partners that continue to support EPA Ghana's work in AQM planning, lending to the sustainability of this program.

Under the PMEH work in Ghana, a draft HAP exposure policy guideline was completed for consideration by EPA Ghana. The draft guideline leverages research on the impacts of cookstoves and their fuels on indoor air quality. The draft describes the associated research and relevant local data, and it provides evidence-based recommendations to manage this crucial aspect of air pollution in Ghana's urban centers.

During 2020, deployment and operation of source apportionment network facilities continued to be an integral part of the protocols for monitoring air quality and SLCPs. Deployment of three new sets of speciation samplers and sample collection for the different sites began in 2020, and chemical analysis of the collected samples will begin in 2021.

PMEH-supported activities in 2020 contributed to the World Bank Country Environmental Analysis (2020)[5] for Ghana, which confirmed and updated prior health-impact assessments to demonstrate the extent of air pollution's health effects, with data broken down by ambient and household levels, and urban and rural levels, and stratified by age.

FIGURE 3B. DEPLOYMENT OF INSTRUMENTATION AT DIFFERENT GHANA PMEH SITES



Source: World Bank. 2020.

During 2020, the PMEH's Ghana program

- Launched a country environmental analysis (CEA) with health-impact assessment and cost of environmental degradation
- Implemented the protocols for air quality and SLCP monitoring developed in 2019 including aspects of quality assurance-quality control and data management

- Developed and implemented a COVID-19 contingency plan for AQM and capacity-building training
- Conducted a stakeholder and institutional analysis as part of the development of the air-quality management plan mid-term review due in 2021, which will include an updated implementation matrix with contributions of various stakeholders to future AQM strategies to be implemented by EPA Ghana

The PMEH-Ghana air quality analysis, public-health engagement, and capacity building will provide a strong justification for investment in the development of solid-waste planning for municipalities, for continued investment in eco-transport, and potentially for strengthening clean-cooking air quality projects across Ghana.

Reports and publications include or cover the following:

- Protocol for air quality and SLCP monitoring/quality assurance- quality control
- Emissions inventory of air pollutants and SLCPs
- Source apportionment of air quality and SLCPs
- Health-impact assessment
- Household air pollution draft guideline

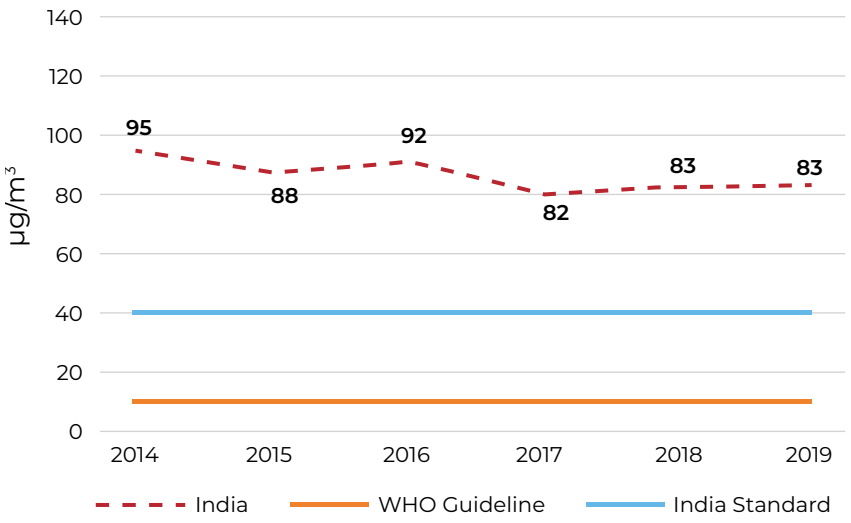
Information sessions and workshops:

- Five virtual training programs that have enabled deployment of continuous-monitoring instrumentation.
- Facilitation and coordination by the PMEH team of more than a dozen international donors and partners supporting air quality efforts in Accra with quarterly conference calls and sharing of resources.
- Engagement by the PMEH team with key local institutions like EPA Ghana, Ghana Health Services, and local government to support the overall goals of PMEH work products toward AQM planning for Accra and all of Ghana.
- Senior-level country engagement conducted in Ghana with the First International Day of Clean Air for blue skies.
- Continued engagement by the PMEH with senior government officials in Ghana—activities that have served to focus attention on the importance of air quality.

INDIA

India's rapid economic growth and burgeoning population intensify concerns about deteriorating air quality. In 2019, the population-weighted annual average $PM_{2.5}$ concentration in India was 83 µg/m³ (see figures 4a and 4b). In other words, 100 percent of India's population was exposed to ambient concentrations of particulate matter, $PM_{2.5}$, above WHO 2006 guidelines. In the same year, India experienced 980,000 deaths attributable to $PM_{2.5}$, and 607,000 deaths were attributable to HAP alone.[6] One hundred and sixteen thousand newborn deaths were attributable to air pollution in 2019. India experienced welfare losses of approximately US$505 billion in 2013 due to air pollution.[7]

FIGURE 4A. ANNUAL TRENDS IN $PM_{2.5}$ CONCENTRATIONS IN INDIA (2014–2019)



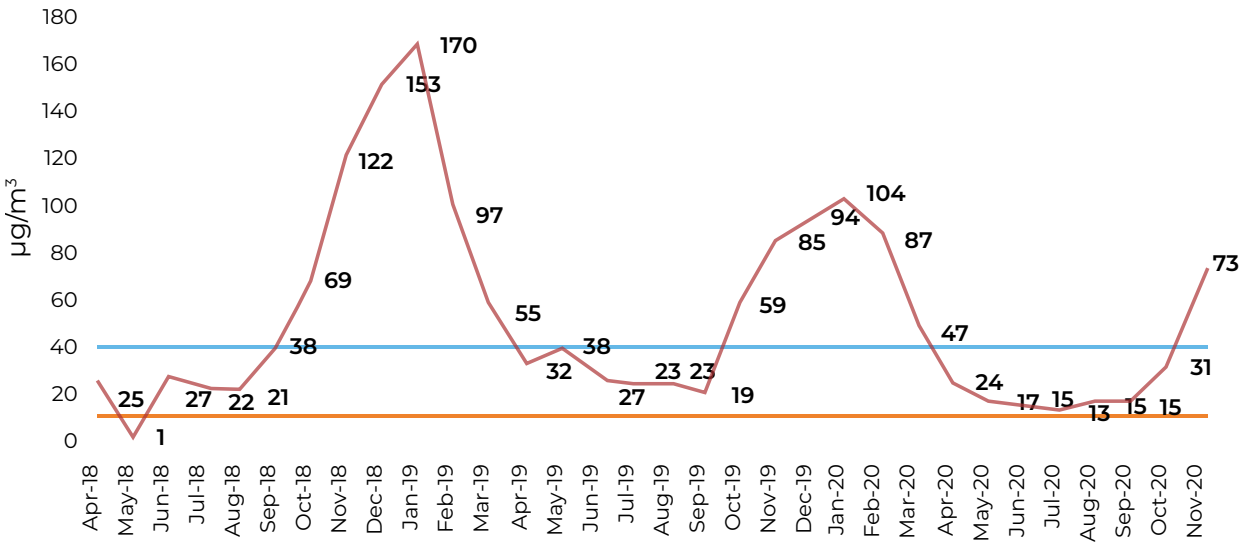
Source: World Bank. 2020.
Note: WHO Guideline refers to the WHO 2006 guideline.

The World Bank provides technical assistance (TA) to the government of India across the following three focus areas: (a) improved AQM planning in selected geographic areas and prioritized funding to achieve National Clean Air Programme (NCAP) goals and targets; (b) policy and institutional reforms for improving air quality outcomes triggered through continuous dialogue and effective knowledge exchange, and (c) support for cross-jurisdictional and cross-sector institutional coordination to develop airshed-based air-quality management plans across different sectors.

Delhi was a close partner in the first PMEH-supported discussions on AQM in India. This engagement resulted in analytical reports with recommendations for strengthening the design of the ambient air quality monitoring and source apportionment network, as well as air quality modeling and forecasting for Delhi and the wider National Capital Region. The Ministry of Environment, Forest and Climate Change has advised that World Bank

resources (both TA and follow-on investment) will have more impact in the severely air-polluted and low-income-level states on the side of the Indo-Gangetic Plain.

FIGURE 4B. $PM_{2.5}$ CONCENTRATION TRENDS IN VICTORIA, KOLKATA (APRIL 2018–NOVEMBER 2020)



Source: World Bank. 2020.
Note: WHO Guideline refers to WHO 2006 Guideline.

A baseline assessment report of monitoring systems in seven Indo-Gangetic Plain cities (Delhi, Kolkata, Patna, Muzzafarpur, Gaya, Chandigarh, and Lucknow) has been completed. International expert review for AAQM station guideline updates has also been completed and was shared with the Central Pollution Control Board (CPCB) in January 2020. A National Knowledge Network (NKN) webinar was held in September 2020 to share, with international experts, design principles for AQ monitoring, practices for developing a source apportionment network, and information about advancements in Bihar's ambient air quality monitoring and source apportionment network. The World Bank is working with The Energy and Resources Institute (TERI) to help the government develop a digital application system for documenting patients' information related to acute respiratory infection (ARI) and correlating related patient data with air quality data.

Kolkata has been a focus for air quality improvement. It is home to approximately 14.1 million people in the metropolitan area. West Bengal, the state where Kolkata is located, experienced 94,534 deaths attributable to air pollution in 2017.[8] The program objective for Kolkata and West Bengal is to support improvement of AQM and reduce $PM_{2.5}$ and PM_{10} concentrations by 20 to 30 percent. A state-level air action plan will be developed to ensure consistent city-state actions towards reducing air pollution. Infrastructure for monitoring BC is being developed to identify relevant sources through Kolkata and the state. Discussions regarding such infrastructure were initiated with the West Bengal Pollution Control Board in September 2020.

The state of Bihar and the Patna urban area have also been a focus for air quality improvement. Bihar is in the top five India states that have a high burden of deaths related to air pollution. In 2017, Bihar experienced 96,967 deaths attributable to air pollution. The $PM_{2.5}$ concentration in Patna for 2018 was 150 µg/m^3. The largest contributing sector to $PM_{2.5}$ is residential biomass burning followed by power plants, industry, transportation, and agricultural sources.[9] An ambient air quality monitoring tender document for establishing real-time monitoring stations covering rural, urban, and border areas across 38 districts of Bihar with technologies such as BC monitors in selected stations was created. There is also ongoing dialogue with the sectors and institutions in Bihar to understand and advise on the contributions from sectors and additional action items under the air-quality management plan. PMEH is supporting the strengthening of Bihar State Pollution Control Board's capacity to implement AQM, upgrading the air-quality management plan, and establishing critical building blocks for a multi-sector state-level action plan.

Reports and publications include or cover the following:

- Report on recommendations for strengthening the design of ambient air quality monitoring and source apportionment networks following initial discussions on AQM
- Report on air quality modeling and forecasting for Delhi and the National Capital Region
- Baseline assessment report of monitoring systems in seven Indo-Gangetic Plain cities
- International expert review of update to ambient air quality monitoring station guidelines
- AQM learning needs assessment report with IIT-Kanpur as a baseline for National Knowledge Network educational materials

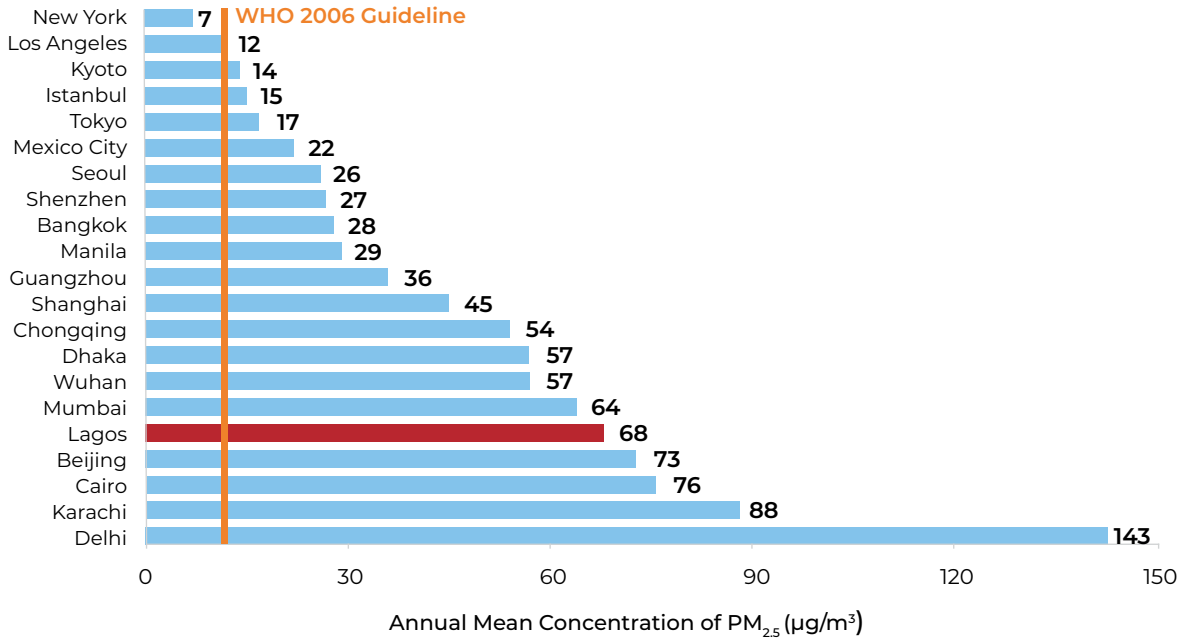
Information sessions and workshops:

- A convention of international and national policy experts in Washington, DC, in October and November 2019 for a workshop conducted on policy and institutions.
- The first National Knowledge Network Pan-India meeting was convened in Lucknow, Uttar Pradesh, in December 2019, where moderators and speakers shared the World Bank's global AQM experience.
- A knowledge-sharing webinar series for the National Knowledge Network, launched in the period July through December 2020.

NIGERIA

Nigeria's commercial capital is Lagos, a coastal megacity of about 23.7 million people that contributes 25 percent of national GDP and 70 percent of national industrial activities. Lagos is the world's fastest-growing megacity; by 2035, it will experience an annual population growth rate of 4.8 percent.[10] Currently, there is no reliable estimate of AAP's impacts on Lagos and no comprehensive plan to control air pollution (see figures 5a and 5b).

FIGURE 5A. RANKING OF LAGOS CITY ANNUAL AVERAGE $PM_{2.5}$ CONCENTRATIONS IN COMPARISON TO OTHER MAJOR CITIES

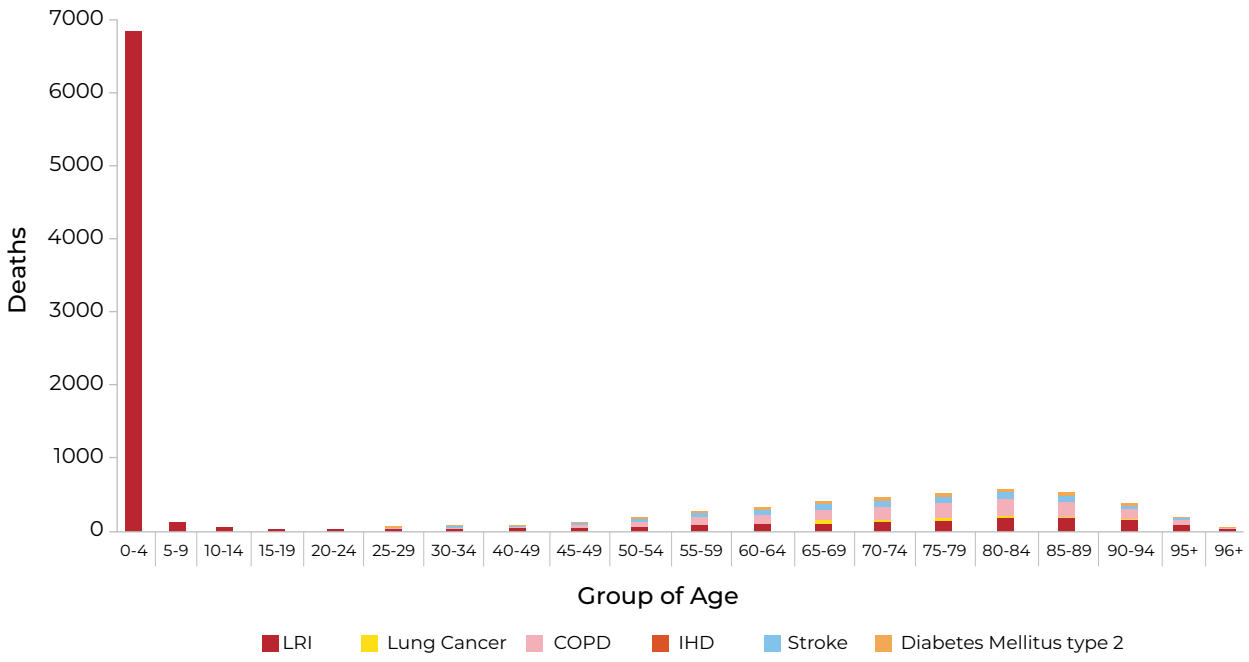


Source: World Bank. 2020.

The PMEH's objective in Nigeria has been to support the government of Lagos State in developing an air-quality management plan for Lagos City by strengthening data collection and undertaking critical analytical work. In 2020, the PMEH supported work on the Protocol for Air Quality and SLCP Monitoring/quality assurance– quality control. A range of PMEH activities provided policy recommendations to the Lagos State government to create incentives to purchase cleaner passenger vehicles, improve vehicle inspection, retrofit the most-polluting vehicles, shift further to public transport, and adopt cleaner fuel.

In 2020, PMEH activities in Nigeria focused on the inception of air-quality monitoring and source apportionment. An additional key output is a stand-alone report documenting protocols and standard operating procedures for use in monitoring; sample handling, storage, and analysis; data reporting; quality assurance; and quality control. That report contains training materials on these procedures for local staff.

FIGURE 5B. MORTALITY LEVELS DUE TO $PM_{2.5}$ EXPOSURE BY AGE GROUP



Sources: Based on data from GBD 2017, Risk factors collaborators (2018) and IHME (2018).
Note: LRI = lower respiratory infection; COPD = chronic obstructive pulmonary disease; IHD = ischemic heart disease.

The PMEH's contribution to the design and implementation of the Lagos City Air-Quality Management Plan centers on ensuring the quality of baseline ambient air quality and PM monitoring data input to the plan—that is, criteria pollutants ($PM_{2.5}$, PM_{10}, SO_2, NO_2, O_3, Pb, and CO), as well as GHG (CO_2) and the SLCPs BC, BrC, and NH_3.

The World Bank team is working with the International Finance Corporation (IFC) to pilot the innovative Breathe Better Bond (BBB) program to help Lagos State identify potential clients for participation in this program. The BBB targets subnational clients and aims to provide TA and funding support to clients in their efforts to reduce air pollution and GHG emissions. The approach consists of three components: (a) TA support to fill gaps, identify pollution-reducing projects, build capacity, and so forth; (b) funding through a bond (or loan) with the IFC acting as an anchor investor; and (c) concessional support, possibly in the form of results-based payment.

Reports and publications include or cover the following:

- Report on current data and proposed plans consisting of
    - Evaluation of existing data
    - Methodologies, protocols, and equipment specifications to be used going forward
    - Detailed plan and schedule of steps needed to generate reliable monitoring data

    - Schedule to supply, install, and commission equipment and infrastructure needed to generate monitoring and sample-analysis data
    - Plans for incorporating staff to build local capacity for monitoring and analytics
- Report documenting proposed protocols and standard operating procedures for
    - Monitoring sample handling, storage, and analysis
    - Data reporting
    - Quality assurance
    - Quality control
    - Training materials on these procedures for local staff
- Monthly reports summarizing air quality, meteorological, and PM analysis data

Information sessions and workshops:

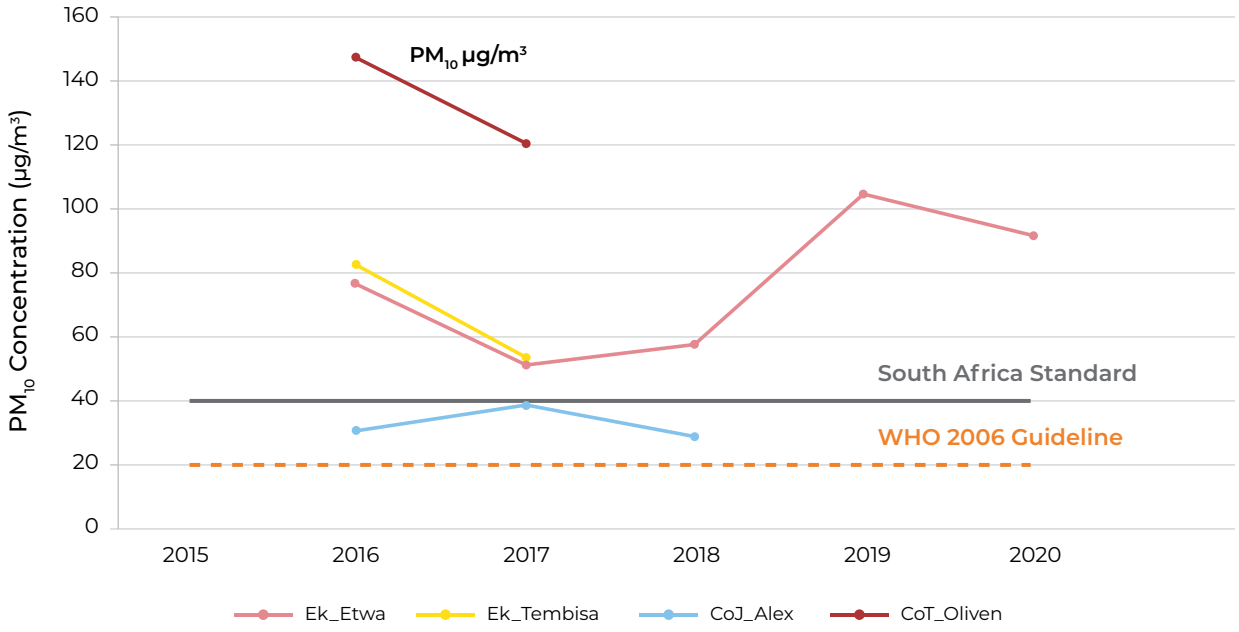
- Participation by Nigeria in the first UN International Day of Clean Air for blue skies in September 2020.
- World Bank Nigeria activity in education via social media, reaching 58,478 "impressions" on its posts.

SOUTH AFRICA

Heavy dependence on fossil fuels has resulted in South Africa having the highest air pollution in Sub-Saharan Africa. Air pollution's human toll in South Africa was approximately 30,000 premature deaths in 2019, with roughly 25,000 from AAP and 5,000 from HAP.[11] (See figures 6a and 6b.) Older findings indicate that 7.4 percent of all deaths in South Africa in 2012 were due to chronic exposure to fine particulate matter, costing the country approximately 6 percent of its GDP.

The development objective of PMEH-supported work in South Africa is to improve the country's capacity to address air-pollution levels and support development of full-scale AQMPs in the Greater Johannesburg Area, which comprises three metropolitan municipalities: Johannesburg, Ekurhuleni, and Tshwane. The implementing agency for PMEH activities in South Africa is that country's Department of Environment, Forestry and Fisheries (DEFF).

FIGURE 6A. EXISTING CONDITIONS AND TREND OF PM_{10} CONCENTRATION IN THE GREATER JOHANNESBURG AREA



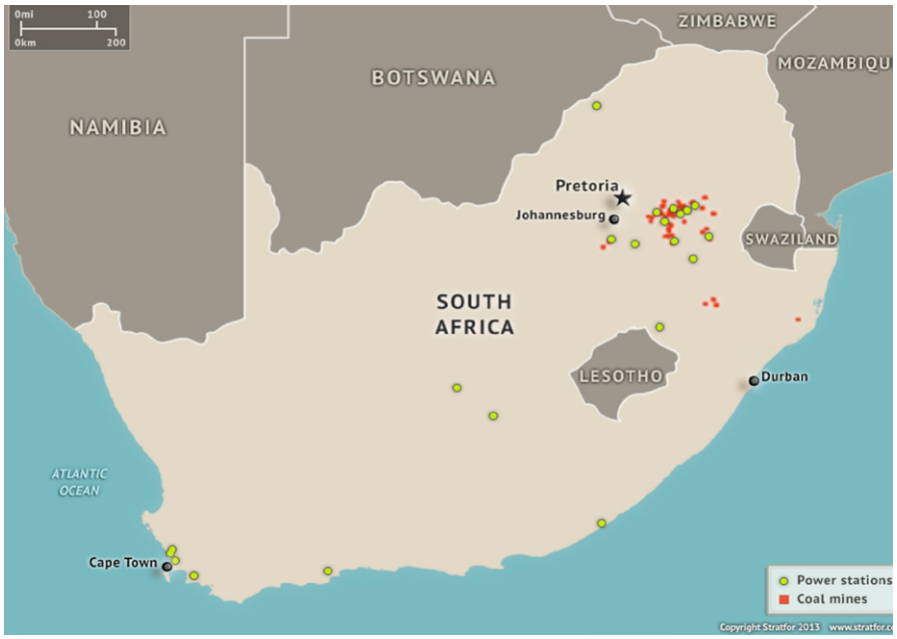
Source: World Bank. 2020.

As part of the PMEH program, reporting of air-pollution data through the existing South African Air Quality Information System (SAAQIS) is being enhanced through upgrades and improvements to the network for monitoring ambient air quality that are critical to maintaining a high degree of reliability of the data. The program is also supporting the alignment and strengthening of the Johannesburg and Tshwane emission inventories, development of the Ekurhuleni emission inventory, and integration of these inventories into a format useful for joint air-quality management plan development purposes.

South Africa Progress

With PMEH support, DEFF initiated the air-quality management plan development process with major Gauteng Province municipalities (City of Johannesburg, City of Tshwane, and Ekurhuleni municipalities) to ensure a shared and common understanding and acceptance of the input data, tools, and models used for these analyses. The output of these efforts will be a joint analysis that can serve each of these municipalities as well as other municipalities within surrounding Gauteng Province. Creating a common understanding of sources and a common vision for addressing them will enable each municipality to contribute to the whole-of-province solutions that are needed to address Greater Johannesburg Area air-pollution challenges.

FIGURE 6B. LOCATION OF COAL MINES AND COAL-FIRED POWER PLANTS RELATIVE TO THE GREATER JOHANNESBURG AREA



Source: World Bank. 2020.
Note: Red circles indicate coal mines; green circles indicate coal-fired power plants.

A Bank-executed trust fund (BETF) supports the air-quality management plan development process led by South Africa's Council for Scientific and Industrial Research (CSIR), which was appointed to develop a reliable emissions inventory, run dispersion models, and synthesize all products into a Greater Johannesburg Area air-quality management plan for use by all municipalities within Gauteng. Also included is the Source Apportionment Analysis being undertaken by the North-West University. DEFF is assessing whether the regional air-quality management plan will consist of individual municipal plans updated on a statutory cycle or a regional Greater Johannesburg Area or Gauteng air-quality management plan that would be adopted at the national level.

With support from a recipient-executed trust fund (RETF), the DEFF has initiated the process of procuring capital goods such as laboratory equipment, consumables, and supplies for source apportionment and chemical-speciation analyses. This equipment will complement sampling already underway and will enable special studies in other locations in the future. Procurement, delivery, and installation of all PMEH-funded capital goods is expected to be completed by early 2022.

There is a high level of government commitment to addressing air pollution in South Africa. This commitment is reflected in, among other actions, the Air Quality Act of 2004, which established national norms and standards for regulating air quality and the issuance of national ambient air quality standards for $PM_{2.5}$ in 2012. Furthermore, the minister responsible for Environmental Affairs has declared specific airsheds in

the country as air-quality priority areas. These areas include parts of Johannesburg and Ekurhuleni, which are also focus areas for PMEH. Being declared as priority areas ensures that these areas get priority national attention and multilateral interventions as needed.

DEFF has also expressed interest in working with the World Bank to scale up the current PMEH program in collaboration with partners such as local universities and research institutions. The World Bank met with senior South African authorities to present opportunities and stimulate interest in air quality and associated public health economic productivity issues.

Reports and publications include or cover the following:

- Preliminary GAINS analysis (using global model and default data) for the Gauteng Province
- Air-quality management plan for Tshwane (2019) (following the 2018 air-quality management plan for Johannesburg)
- City emissions inventories for Johannesburg and Tshwane
- Source apportionment protocols completed by the PMEH secretariat

Information sessions and workshops:

- Stakeholder-engagement meetings (comprising DEFF and local municipality officials) held in December 2019 and September 2020
- Planned PMEH closeout presentation to senior South African authorities to stimulate interest in the adoption of an air-quality management plan template for specific areas of national interest
- Planning and preparation for
    - September 2020 stakeholder engagement meetings
    - December 2020 kickoff stakeholder meeting with cities to provide inputs for the GAINS-Greater Johannesburg Area model

VIETNAM

Vietnam's progress in economic growth and poverty reduction has continued as it transforms from a rural to an urban economy. Available data for Hanoi since 2010 indicate annual average $PM_{2.5}$ in the range of 35 to 60 µg/m^3 depending on the specific location. Estimates of $PM_{2.5}$ concentrations by integrating ground-level monitoring[12] and MODIS satellite imagery for the period December 2010 to September 2014 also indicate high annual average $PM_{2.5}$ concentrations in Hanoi (approximately 50 µg/m^3)[13]. The available data show distinct seasonal variations in $PM_{2.5}$ concentrations, in December through March and reaching the lowest levels in July through August.[14]

According to Vietnam's national technical regulation, ambient $PM_{2.5}$ limit values are 50 µg/m^3 for the 24-hour average and 25 µg/m^3 for the yearly average. The annual cost of the health effects of ambient $PM_{2.5}$ for the greater Hanoi region is estimated at 7.5 percent of regional GDP in 2019[15].

Vietnam has made strong progress in developing its air-quality management plan. PMEH is supporting the Ministry of Environment and Natural Resources in the larger Hanoi metropolitan area, including the city of Hanoi and the provinces of Bac Ninh and Hung Yen, to develop an understanding of emissions sources and create a cost-effective, full-scale air-quality management plan that can be implemented at the city level. In November 2019, four sampling devices were operational in Hanoi, and the full 12-month source apportionment analysis was complete. The source apportionment study demonstrates that the key sources of $PM_{2.5}$ in Hanoi are (a) biomass burning, approximately 17 percent to 20 percent; (b) secondary inorganic aerosols (ammonium nitrate and ammonium sulfate), approximately 39 percent to 44 percent; (c) traffic, approximately 7 percent to 9 percent; (d) long-range transported particulates (LRT), approximately 12 percent to 18 percent; (e) industrial particle, approximately 7 percent to 12 percent; and (f) dust, approximately 15 percent.

Policy scenarios for air-quality management and air-quality measures are being drafted initially with PMEH support. The plans are based on the complete picture presented by the inventory of air-pollution sources, monitoring of ambient air quality, field sampling, subsequent laboratory analysis of chemical composition of samples, health-impact assessments, and then the determination and agreement between national and regional Vietnamese stakeholders regarding the most cost-effective policy and investment options to achieve abatement.

The initial GAINS AQM model has been prepared for the greater Hanoi area. The analysis of emission-inventory data for the GAINS AQM model on the basis of formal government statistics (where available) and external data was completed for Hanoi, Bac Ninh, and Hung Yen but is still being updated due to differences that were observed between the modelled emissions in the GAINS model and the monitored emissions. The GAINS AQM model is also being updated to provide the basis for policy air quality scenario analysis.

FIGURE 7. AIR QUALITY MONITORING EQUIPMENT DEPLOYED IN VIETNAM AS PART OF PMEH-SUPPORTED RESEARCH

Source: World Bank, 2020.

Reports and publications include or cover the following:

- GAINS AQM model prepared for the greater Hanoi area
- Analysis of emission-inventory data for the GAINS AQM and update of emission-inventory data on the basis of the monitored emissions compared to the modelled emissions
- Analytical report on a craft-village survey
- Policy scenario and draft report (in progress) on air-quality measures

Information sessions and workshops:

- Initial discussions on resource mobilization to address AQM issues were held with the Ministry of Natural Resources and Environment and Hanoi, including exploration of potential support through joint Air Quality Management/Climate Change financing from the World Bank. Also discussed was implementation of the government of Vietnam's Nationally Determined Contribution (NDC) with regard to its agenda for mitigation, including air quality, along with the preparation of the government of Vietnam's NDC program to support implementation.

RESEARCH AND ANALYTICS

AIR QUALITY

A fundamental challenge to achieving improved air quality is the lack of reliable data in LMICs. World Bank objectives regarding this challenge center on developing knowledge and strengthening understanding for improving air quality monitoring and estimation of the health effects of ambient air pollution in LMICs. Another challenge in efforts to improve air quality relates to understanding the air pollution – climate change nexus and maximizing climate co-benefits. Research and strengthened analytics bearing on the links between AQ measures and climate change mitigation measures are of importance since some approaches can simultaneously and synergistically address both air pollution and climate change.

PMEH-supported research on air quality was presented in a report titled "Getting Down to Earth: Are Satellites Reliable for Measuring Air Pollutants that Cause Mortality in Low- and Middle-Income Countries?"

Based on this research, the following journal article was published: Matthew J. Alvarado, Amy E. McVey, Jennifer D. Hegarty, Eben S. Cross, Christa A. Hasenkopf, Richard Lynch, Edward J. Kennelly, Timothy B. Onasch, Yewande Awe, Ernesto Sánchez-Triana, and Gary Kleiman. 2019. "Evaluating the Use of Satellite Observations to Supplement Ground-Level Air Quality Data in Selected Cities in Low- and Middle-Income Countries." *Atmospheric Environment* 218. 117016.

This article reports on a study of the potential for applying satellite measurements for air quality monitoring in LMICs. This study aims to improve knowledge on the extent to which satellite measurements can best be used to enhance air quality monitoring in LMICs, thus improving estimation of human exposure to air pollution; and on how satellite measurements can be brought into closer agreement with ground-level data, considering the shortcomings and advantages of satellite measurements.

Three key tasks were involved in the study:

(a) A literature review of the approaches used to combine satellite observations with ground-level monitoring measurements of $PM_{2.5}$

(b) Testing the ability of satellite aerosol optical depth (AOD) to predict ambient $PM_{2.5}$ by developing and evaluating novel methods for converting the parameters that satellites measure, notably AOD, into surface $PM_{2.5}$ estimates based on an initial selection of three pilot cities: Delhi, India; Lima, Peru; and Ulaanbaatar, Mongolia, which later expanded to include Accra, Ghana; Addis Ababa, Ethiopia; Dakar, Senegal; Hanoi, Vietnam; Kampala, Uganda; and Kathmandu, Nepal. The initial set of cities tested was selected based on availability of ground-level monitoring (GLM) datasets such as $PM_{2.5}$ monitoring data from US diplomatic facilities, OpenAQ, and field campaigns

(c) Results and lessons learned from testing the AOD algorithms in the initial cities were subsequently applied in the additional LMIC cities that were analyzed

Many different conditions common in LMICs—including mountainous terrains, snow, coasts, clouds, and dust—prevent accurate representations of air-pollution conditions by satellites in the cities tested. Overall, this work suggests that satellites cannot be a replacement for a high-quality GLM network in any of the cities evaluated. Rather, establishment of GLM networks that include adequate quality assurance and quality control and follow standard operating procedures to ensure the data are of sufficient quality would likely enable better understanding of human exposure to air pollution specific to an individual city. In countries with no GLM data available, satellite estimates of surface $PM_{2.5}$ concentration may have errors in the range of 22 percent to 85 percent.

PMEH-supported research on air quality was presented in another report, "Filling the Gaps: Improving Measurement of Air Quality in Low- and Middle-Income Countries," and a report on harmonization of protocols and procedures for AQ monitoring in LMICs.

Findings from these reports contributed to the following journal article: Robert W. Pinder, Jacqueline M. Klopp, Gary Kleiman, Gayle S. W. Hagler, Yewande Awe, and Sara Terry. 2019. "Opportunities and Challenges for Filling the Air Quality Data Gap in Low- and Middle-Income Countries." *Atmospheric Environment* 215. 116794.

This research investigates the strengthening of air quality monitoring in developing countries, specifically the standardization and harmonization of air quality monitoring protocols and procedures in those countries. To provide background information, the report examines air quality monitoring experience in developed countries and draws lessons from it in outlining a comprehensive approach to air quality monitoring in developing countries. The study proposes typologies of developing countries according to their institutional capacity for, and engagement in, air quality monitoring, with a view to use these typologies to develop context-appropriate guidance and protocols for air quality monitoring in developing countries.

PMEH-supported research on AQ in 2020 also resulted in the following three additional reports:

Report titled "When the Dust Settles: A Review of the Health Implications of the Dust Component of Air Pollution."

This study examines the implications of exposure to dust on the burden of diseases from air pollution. The study acknowledges the far-reaching impacts of dust storms on the immediate vicinity of the storm's origin and also the dispersion of associated particles over thousands of miles. In addition to their high concentrations of particulate matter, dust storms may pick up $PM_{2.5}$ from various sources in their trajectories, as well as biological materials (bacteria, pollen, fungi, and viruses); and pollutants such as pesticides, heavy metals, and dioxins, which affect dust toxicity. Furthermore, dust particles may provide a core for the attachment of gases that ultimately become fine particles.

The report highlights challenges associated with estimating the health impacts of immediate and downwind exposures to dust, and specifically of determining the independent effect of dust, including the lack of, or limited, ground-level monitoring to measure concentrations and exposures; variations in the methods used for measuring dust-related contribution to particulate matter; and the differences in statistical methods, exposed populations, and co-pollutants in such studies. Based on the epidemiologic evidence, the paper posits that there is a reasonable evidence base for including the effects of dust on mortality and morbidity in quantitative estimates of the global burden of air pollution. The paper further posits that evidence to date also supports risk estimates for dust that are generally similar to those regarding $PM_{2.5}$.

Report titled "Are All Air Pollution Particles Equal? – How Constituents and Sources of Fine Air Pollution Particles ($PM_{2.5}$) Affect Health."

This report examined the health effects from exposures to constituents and sources of fine particulate-matter air pollution. The study addresses the health effects associated with short- and long-term exposures to $PM_{2.5}$ constituents and source components. It also examines the epidemiologic literature on associations of $PM_{2.5}$ mass, its constituents, and/or $PM_{2.5}$ mass source-specific attributions with the most severe adverse health effects, notably mortality and hospital admissions, with a view to understand which $PM_{2.5}$ mass components are most associated with those health effects.

The report notes that $PM_{2.5}$ derived from fossil-fuel combustion, particularly coal and traffic, have shown the most-consistent associations with mortality from cardiovascular disease, especially ischemic heart disease. In contrast, respiratory disease mortality is less consistently associated with $PM_{2.5}$, its constituents, or specific source components.

The analytical work supports the need for LMICs' air-pollution control efforts to prioritize fossil-fuel burning sources—notably coal-burning power plants and traffic—for measuring the concentrations of the components of their particulate mix, as a basis for defining

economically efficient abatement strategies that take into account the concentrations and specific toxicities of major components, and to focus on reducing pollution from fossil-fuel combustion.

Report titled "The Global Health Cost of Ambient $PM_{2.5}$ Air Pollution."

This analytical work estimated the economic cost of the health damages caused by ambient $PM_{2.5}$ pollution in 2016. As many as 4.1 million people died from ambient $PM_{2.5}$ air pollution in 2016, according to the Global Burden of Disease (GBD). This report estimated that the global cost of health effects (mortality and morbidity) from outdoor $PM_{2.5}$ exposure is $5.7 trillion, equivalent to 4.8 percent of global GDP in 2016. About 87 percent of the total cost is from premature mortality and 13 percent from morbidity.

The health cost is highest in the South Asia region at 7.3 percent of GDP; followed by the East Asia and Pacific region (5.7 percent); the Europe and Central Asia region (4.5 percent); the Middle East and North Africa region (3.6 percent); the North America region (3.3 percent); the Sub-Saharan Africa region (3.0 percent); and the Latin America and Caribbean region (2.3 percent).

The study also highlights the disparities in GLM on air pollution between low-income and high-income countries, signaling the need for strengthened GLM in developing countries to determine more accurately exposures to pollution in such countries. Examination of the WHO database on ambient air-quality monitoring found that there is only one monitor per 54 million people in low-income countries in contrast to one monitor per 300,000 people in high-income countries. The report is available at https://documents1.worldbank.org/curated/en/202401605153894060/World-The-Global-Cost-of-Ambient-PM2-5-Air-Pollution.pdf.

RESEARCH ON LAND-BASED POLLUTION AND IDENTIFICATION OF TOXIC CONTAMINATED SITES

As economies develop, their industrial footprints grow. Industrial activities often lead to an increase in toxic waste and polluted lands. Although this is well known, lack of data tends to beget lack of attention. Accordingly, the PMEH has worked to increase identification of toxic sites and research the health and economic impacts of these sites. By helping to identify toxic sites and create guidelines for data collection, the PMEH is strengthening the link between toxic waste, on the one hand, and the economic impacts associated with negative health outcomes, on the other hand. Providing greater clarity about, and more evidence regarding, this link is crucial to empowering officials to make decisions to lessen the negative environmental outcomes of industrialization.

The PMEH's analytical work on land-based pollution has two components: The Toxic Sites Identification Program focused on the global database of toxic contaminated sites

and identifying toxic contaminated sites in Bangladesh and Tanzania. This program also supported other countries in identifying toxic sites and increased governments' capacity to develop plans addressing land-based pollution. The Health and Economic Impacts of Land-Based Pollution component identified knowledge gaps and improved methods for assessing the health and economic impacts of contaminated sites and land-based pollution.

Outcomes of PMEH-supported work during 2020 on this topic included the following:

- Support for the creation and improvement of the first global toxic-site database. The database will increase understanding of drivers of chemical pollution in LMICs. This database will also allow officials to make informed decisions on remediation interventions.
- Baseline mapping reports in Bangladesh and Tanzania
- Guidance manuals assessing exposure and health outcomes from artisanal gold mining, lead-acid battery recycling, and small tanneries

As part of its activities relating to the Global Toxic-Sites Database, the PMEH conducted training sessions to demonstrate the use of the database and site-screening tools, with the participation of different stakeholders. The tools of the database are currently used in projects supported by the European Commission and the United States Agency for International Development.

With PMEH support, Bangladesh and Tanzania have improved their knowledge of existing toxic sites and their impact on public health, having screened over 200 suspected toxic sites. Through this work, Bangladesh has identified lead-acid battery manufacturing and repair, and gold recycling, as of significant concern, while Tanzania was able to single out gold mining as a significant concern. Bangladesh is now creating pollution-control measures to be applied to various industries.

PMEH-supported research on land-based pollution was presented in a report titled "Risk Analysis Approaches to Evaluating Health Impacts from Land-Based Pollution in Low- and Middle-Income Countries."

Pamela R. D. Williams, Katherine von Stackelberg, Mayra G. Guerra Lopez, and Ernesto Sánchez-Triana. 2021. "Risk Analysis Approaches to Evaluating Health Impacts from Land-Based Pollution in Low- and Middle-Income Countries." ***Risk Analysis***. doi:10.1111/risa.13699

Land-based pollution in LMICs has become an increasing issue of concern due to widespread environmental contamination from active and legacy operations, particularly informal activities such as used lead-acid battery recycling, artisanal and small-scale gold mining, and small-scale tanneries. The overall magnitude and scale of the public health problem arising from these sources remains highly uncertain and poorly characterized.

This report highlights the types of industries contributing to land-based pollution in LMICs and describes key findings and knowledge, as well as data gaps that have hindered a fuller understanding of land-based pollution. The report also discusses how several risk-assessment and risk-management approaches might be useful in a resource-constrained context. This review concludes that a combination of risk-analysis approaches may be worthwhile, but more work is needed to determine which methods or tools will be most informative, technically feasible, and cost-effective for identifying, prioritizing, and mitigating land-based pollution in LMICs.

Report titled "A Systematic Framework for Collecting Site-Specific Sampling and Survey Data to Support Analyses of Health Impacts from Land-Based Pollution in Low- and Middle-Income Countries."

Katherine von Stackelberg, Pamela R. D. Williams, and Ernesto Sánchez-Triana. 2021. "A Systematic Framework for Collecting Site-Specific and Survey Data to Support Analyses of Health Impacts from Land-Based Pollution in Low- and Middle-Income Countries." *International Journal of Environmental Research and Public Health* 18: 4676.

The rise of small-scale and localized economic activities in LMICs has led to increased exposures to contaminants associated with these processes and the potential for adverse health effects in exposed communities. Different approaches are used for evaluating the magnitude of exposures and health impacts associated with land-based pollution in LMICs, including risk assessment and epidemiology. However, neither of these two approaches by itself is practical or sufficient to quantify the actual impact.

This report proposes a more pragmatic framework for uniform sampling guidelines and household surveys to support community health impact analyses associated with land-based pollution sources. The framework is applied to three industries that have been identified as key in LMICs: artisanal-scale gold mining, used lead-acid battery recycling, and small tanneries.

PMEH-supported research on land-based pollution also resulted in the following five additional reports in 2020:

Report titled "Data Gaps and Needs Assessment: Assessing Human Health Impacts from Land-Based Pollution in Low- and Middle- Income Countries."

Land-based pollution from active or legacy operations has become an increasing issue of health and economic concern in many low- and middle-income countries. Populations living in or near these sources of contamination have experienced elevated exposure and adverse health effects, with children particularly vulnerable to environmental hazards.

This study summarizes key findings from existing studies on land-based pollution in LMICs and highlights the important knowledge and data gaps that have hindered researchers'

and practitioners' ability to adequately characterize and quantify public health impacts associated with these sources of pollution. The report also provides recommendations for addressing study limitations and filling data gaps via the development of more uniform study designs and sampling protocols.

Report titled "Framework for Sampling and Assessment of Environmental Health Impacts of Toxic Contaminated Sites for Small-Scale Leather Processing Facilities."

Tanneries are arguably among the most polluting industries, with low- and middle-income countries hosting about half of the leather-tanning industries worldwide and producing about 60 percent of all global leather needs. Throughout the tanning process, large volumes of chemicals are used and discharged as solid and liquid waste, including the heavy metal chromium. Exposure to chromium has been associated with several health effects, including cancer, liver damage, and different forms of irritation. It is estimated that about 16 million people are at risk from exposure to chromium. With small-scale industries and the informal sector playing a large role in leather and tanning industries, pollution control and regulations are lacking.

The primary objective of this framework is to guide research to assess the relationship between environmental contamination, exposure, and health outcomes related to a subset of contaminants originating from tanning activities for particularly vulnerable populations (for example, children) and the general population within a single household in the vicinity of tanning activities in LMICs. This study can also assist in building local capacity to conduct environmental assessments following a consistent methodology to facilitate comparability across tanning sites in different geographic areas.

Report titled "Framework for Sampling and Assessment of Environmental Health Impacts of Toxic Contaminated Sites for Recycling of Used Lead-Acid Batteries."

Lead exposure was responsible for more than 900,000 deaths in 2019 worldwide due to the long-term effects of lead exposure on health. It is estimated that 1 in 3 children have high blood lead levels, equivalent to 800 million children globally. More than 84 percent of the health impacts of lead exposure have occurred in lower- and upper-middle income countries. In LMICs, small-scale informal industries operate with few pollution controls, disposing of chemicals directly to land, water, and air. Small-scale used lead-acid batteries (ULAB) are known to generate significant amounts of lead waste and other metals through smelting processes.

The primary objective of this framework is to guide research to assess the relationship between environmental contamination, exposure, and health outcomes related to a subset of contaminants originating from ULAB activities for particularly vulnerable populations (for example, children) and the general population within a single household in the vicinity of ULAB sites in LMICs. This study can also assist in building local capacity

to conduct environmental assessments following a consistent methodology to facilitate comparability across ULAB sites in different geographic areas.

Report titled "Framework for Sampling and Assessment of Environmental Health Impacts of Toxic Contaminated Sites for Small-Scale Artisanal Gold Mining."

Artisanal gold mining occurs informally and therefore relies on low technologies and extraction methods that lack pollution controls. As a result, even though artisanal gold mining produces only 20 percent of the world's gold, such mining releases more mercury than any other sector and represents the largest source of mercury emissions, at nearly 38 percent. In Africa alone, it is estimated that gold production from large- and small-scale artisanal mining is responsible for nearly 45 percent of all mercury emissions. Exposure to mercury has been associated with several long-term health impacts, including impacts to the nervous, digestive, and immune systems. Young children and pregnant women are the most vulnerable, with exposure to this metal causing both physical and mental disabilities.

The primary objective of this framework is to guide research to assess the relationship between environmental contamination, exposure, and health outcomes related to a subset of contaminants originating from artisanal/small-scale gold mining (ASGM) activities for particularly vulnerable populations (for example, children) and the general population within a single household in the vicinity of ASGM sites in LMICs. This study can also assist in building local capacity to conduct environmental assessments following a consistent methodology to facilitate comparability across ASGM sites in different geographic areas.

COMPETITIVE, PROSPEROUS CITIES

This PMEH activity explored the link between pollution, pollution management, and city competitiveness and produced knowledge outputs and tools to support policy makers regarding pollution management and city competitiveness. The activity consisted of three components: (a) empirical analysis at the global level; (b) deep dives into the drivers of city competitiveness in relation to pollution; and (c) decision management, planning, and implementation.

As part of the first component, the work resulted in the following published articles:

Maria E. Soppelsa, Nancy Lozano-Gracia, and L. Colin Xu. 2020. "The Effects of Pollution and Business Environment on Firm Productivity in Africa." *International Regional Science Review.* https://doi.org/10.1177/0160017620931572.

This article explores the links between city competitiveness and air pollution and business environment. Because competitive cities not only attract more productive firms but also facilitate their business, this report looks at firm performance as a proxy for city

competitiveness. We particularly focus on African firms because this region is developing quickly, experiencing increasing pollution levels and the effects of agglomeration economies. The article reports two interesting results. First, the negative association between air pollution and firm performance is present at lower-than-expected levels of pollution. Second, the effects of capacity agglomeration on labor productivity growth are stronger in this region than in other regions. These findings suggest that cities in this region should address pollution issues soon, as they continue to grow fast, and pollution levels are becoming an increasing concern.

Matthew E. Kahn, Nancy Lozano-Gracia, and Maria Edisa Soppelsa. 2020. "Pollution's Role in Reducing Urban Quality of Life in the Developing World." *Journal of Economic Surveys* 35 (1): 330–47.

This report surveys the recent literature exploring the consequences of urban pollution in the developing world for a city's productivity and its residents' quality of life. The environmental Kuznets curve literature predicts that developing nations will experience significant environmental degradation as a byproduct of economic development. In contrast, the recent literature reviewed in this article reverses this logic by arguing that geographic areas featuring lower levels of pollution will experience economic growth through improvements in health and human capital. In an economy where pollution reduces worker productivity, inhibits child development, and repels the skilled from living in such an area, those cities featuring less pollution have a competitive advantage in attracting and retaining skilled workers. Given the central role that human capital plays in urban economic growth, such cities will be more likely to achieve sustainable long-term growth.

In addition, three papers were published in the World Bank's Working Paper Series:

"Does Pollution Hinder Urban Competitiveness?"

This survey paper explores the links between city competitiveness and pollution and identifies areas where further work is needed to better understand such links. It focuses on three main questions: First, why does pollution inhibit urban competitiveness? Second, why is this effect likely to grow in importance over time? Third, why have cities been slow to adopt cost-effective regulatory strategies? The authors found that pollution can affect human capital, which in turn influences city competitiveness. Pollution can also affect a city's economic activity by making it more specialized in certain sectors. The paper concludes that—and emphasizes that—pollution is not a necessary path to development.

"Pollution and City Competitiveness: A Descriptive Analysis"

This paper offers a global cross-city analysis that compares cities across the world with respect to their competitiveness and their air-pollution levels. The analysis suggests that most cities often follow a particular path with respect to the relationship between air-

pollution levels and city growth. At first, when cities are at the earlier stages of development, pollution is often low. As cities start developing and transitioning to heavier industrial activity, pollution levels start to rise. When cities learn to manage pollution, its level starts to decrease. However, no absolute typology emerges regarding city competitiveness and pollution, indicating that other paths of relationship between air-pollution levels and city growth are possible.

"The Effects of Pollution and Business Environment on Firm Productivity in Africa"

This analytical paper explores the links between city competitiveness, air pollution, and business-environment characteristics. The analysis found different patterns of links when looking at firms across the world versus those patterns of links when looking specifically at African firms. Results show that compared to other regions, African cities experience the negative effects of air pollution even when pollution levels are relatively low, suggesting pollution is becoming an important concern for African cities.

As part of the second component, deep dives were conducted in Dhaka, Bangladesh; Monrovia, Liberia; Uganda; and Zanzibar, Tanzania.

For Dhaka, the team worked with researchers at University of California, San Diego (UCSD, and Innovations for Poverty Action (IPA) on the design of a research experiment to assess the impact of air pollution on worker productivity in Bangladesh. The listing survey was conducted in two locations: Narayanganj (350 factories) and Kamrangirchar (430 factories). The experiment then focused on 40 firms in Kamrangirchar. The data collection could not be completed due to the closing of factories because of COVID-19. However, initial findings suggest that there is evidence of the links between air pollution and worker productivity.

In Monrovia, the team conducted a qualitative assessment to evaluate the different vectors of pollution and its relationship with market performance/productivity. The results of the analysis identified four main vectors of pollution: (a) the poor management of solid waste, (b) unsuitable water and sanitation infrastructure, (c) food waste, and (d) traffic and congestion. The challenges faced by the market and the vendors are rapidly increasing as the market continues to quickly expand beyond its official borders. Additionally, there are weak institutional capacities and infrastructures to address the issues.

The work in Uganda focused on collecting two different datasets:

(a) Firm data: A survey collected data on small manufacturing firms to determine their characteristics and obtain estimates at the firm level of productivity.

(b) Air-pollution data: More than 30 static monitors were deployed throughout Uganda collecting $PM_{2.5}$ and PM_{10} measures every 60 to 90 seconds for a period of six months. These static monitors were complemented by 10 mobile monitors (boda bodas) collecting the same measures by following different routes, each of them for approximately two days.

Both datasets were linked to assess whether exposure to pollution affects firm productivity, and hence, city competitiveness. This work was done in partnership with researchers at USC and BRAC Uganda. The analysis finds that there are clear patterns of temporal and geographical variation in pollution levels. Pollution peaks during high-traffic hours, signaling that vehicles are the main polluters in Uganda. Moreover, pollution decreases during the wet season in all Ugandan regions. When combined with firm-level data, the analysis finds a clear positive relationship between firm density and pollution levels (more firms clustering in more-polluted areas). This relationship seems to be stronger when focusing on large firms. Additionally, firms tend to locate on medium and large roads. Monitors located closer to firms on larger roads report higher levels of pollution than those located on small roads, hinting that firms located on large roads are more affected by higher pollution in their surroundings. The resulting pollution dataset has been submitted to the World Bank Data Catalog and is publicly available.

In Zanzibar, the research focused on the impact of pollution and cleanliness perception on tourism. A survey collected data on four main regions: Nungwi, Jambiani, Kiwengwa, and Stone Town, interviewing tourists, residents, and business providers. The analysis found that overall cleanliness perception affects tourists' willingness to return to Zanzibar, and street cleanliness perception affects their willingness to recommend the island to friends and family. Furthermore, more than half of both locals and providers agreed that the level of cleanliness in Zanzibar has not changed or gotten worse in the last 10 years, Additionally, the analysis—focused on the links between tourism activity and the natural environment—found that tourists for whom the main attractions are activities in nature have a higher probability of recommending Zanzibar as a destination. The survey dataset has been submitted to the World Bank Data Catalog and is publicly available.

As part of the third component, the work resulted in key tools for decision management, including the following:

A support tool was developed based on the findings from the deep dives, the framework for pollution management and city competitiveness, the identification of best-practices cities and their actions, and the review of toolkits. This support tool should be used for decision-making, planning, and implementation for reforms related to reducing pollution and increasing competitiveness.

The team also prepared a final report that ties together the findings and conclusions from this program. This report first looks at the global analysis, highlighting the key takeaways from the analytical papers and policy note. The final report focuses on the four deep dives, providing a summary of the main issues each of the cities faces and which institutions and regulations are in place to help manage pollution. Finally, the report includes the aforementioned support tool for decision-making to help policy makers tackle the pollution challenge. The team also developed a PowerPoint presentation for dissemination, highlighting the key takeaways from this activity.

DISSEMINATION AND AWARENESS RAISING

FIRST INTERNATIONAL DAY OF CLEAN AIR

The World Bank participated in the first International Day of Clean Air for blue skies, which took place on September 7, 2020 (https://spark.adobe.com/page/BmkQBuhjMNjHx/). With the international community's increasing interest in clean air and emphasizing the need to make further efforts to improve AQ to protect human health, the UN General Assembly designated September 7 as the "International Day of Clean Air for blue skies."

The launch and observance of the first ever International Day of Clean Air for blue skies saw broad-based support from the UN family and partner organizations. The theme of the first International Day of Clean Air for blue skies was "Clean Air for All."

Research findings were presented during Clean Air Day events including a webinar, Building Back Better: Why We Must Address Air Pollution to Tackle Public Health and Climate Change, organized by the Stockholm Environment Institute (SEI). Further information can be found at https://www.sei.org/events/building-back-better-why-we-must-address-air-pollution-to-tackle-public-health-and-climate-change/.

INFORMATION SESSIONS AND WORKSHOPS

The following workshops and presentations related to AQ were held:

Presentation on "Health Effects of Dust, Species and Components of Particulate Matter," together with New York University and University of California, Davis, researchers, during a workshop titled "Evaluating the Short-term Health Effects of Desert and Anthropogenic Dust."

Presentation on "Performance of Satellite Observations for Air Quality Monitoring in Low- and Middle-Income Countries," during a session titled "Ambient Air Quality Monitoring, Modelling and Forecasting—the Next Stage."

PUBLICATIONS AND REPORTS

The following publications are briefly described in the earlier Research and Analytics—Air Quality section of this Annual Report:

- "Evaluating the Use of Satellite Observations to Supplement Ground-Level Air Quality Data in Selected Cities in Low- and Middle-Income Countries." *Atmospheric Environment* 218 (1). https://doi.org/10.1016/j.atmosenv.2019.117016.
- "Opportunities and Challenges for Filling the Air Quality Data Gap in Low- and Middle-Income Countries." *Atmospheric Environment* 215. 116794. https://doi.org/10.1016/j.atmosenv.2019.06.032.
- "The Global Health Cost of Ambient $PM_{2.5}$ Air Pollution" https://documents1.worldbank.org/curated/en/202401605153894060/World-The-Global-Cost-of-Ambient-PM2-5-Air-Pollution.pdf.

The following two additional publications are briefly described in the preceding Competitive, Prosperous Cities section of this Annual Report:

- "The Effects of Pollution and Business Environment on Firm Productivity in Africa." *International Regional Science Review.* https://doi.org/10.1177/0160017620931572.
- "Pollution's Role in Reducing Urban Quality of Life in the Developing World." *Journal of Economic Surveys* 35 (1): 330–47.

FINANCIAL OVERVIEW

The PMEH Multi-donor Trust Fund was established in November 2014. Donors include Germany's Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU); Norway's Ministry of Foreign Affairs; and the United Kingdom's Department for International Development (DFID) and Department for Business, Energy & Industrial Strategy (BEIS).

The PMEH was initially convened as a six-year multi-donor trust fund; however, the PMEH Steering Committee extended the program by one year to allow certain countries enough time to complete air quality monitoring and other program components.

The PMEH program has seven countries participating in programs on climate and AQM, as well as components for analytics and dissemination activities. Relevant expenditures by component are identified below.

TABLE 1. PMEH CONTRIBUTIONS AS OF DECEMBER 31, 2020

Donor	Contributions Paid by Donors *(US$)*
Norway: NORAD/Ministry of Foreign Affairs	9,384,927
United Kingdom: DFID	4,526,280
United Kingdom: BEIS—Department of Business, Energy & Industrial Strategy	2,463,945
Germany: BMU	8,408,000
Total	**24,783,152**

TABLE 2. PMEH EXPENDITURES AND COMMITMENTS AS OF DECEMBER 31, 2020

Expenditure Category	Expenditures + Commitments by December 31, 2020 (US$)
China—Hebei region: Climate and Air-Quality Management	2,110,543
Egypt—Cairo: Climate and Air-Quality Management	811,667
Ghana—Accra: Climate and Air-Quality Management	805,283
India—Climate and Air-Quality Management	2,042,078
Nigeria—Lagos: Climate and Air-Quality Management	3,218,365
South Africa—Johannesburg: Climate and Air-Quality Management	1,076,120
Vietnam—Hanoi: Climate and Air-Quality Management	1,047,503
Subtotal Component 1	**11,111,559**
2.1 Air-Quality Monitoring and Health Risks and Effects	1,342,906
2.2 Land-Based Pollution	
2.2.1 Toxic-Site Identification	990,603
2.2.2 Land-Based Pollution: Health and Economic Effects	1,020,334
2.3 Pollution Management and the Making of Prosperous Cities	993,987
Subtotal Component 2	**4,347,830**
Component 3 Dissemination	**2,678,769**

NOTES

1 Soppelsa, Maria E., Nancy Lozano-Gracia, and L. Colin Xu. 2021. "The Effects of Pollution and Business Environment on Firm Productivity in Africa." *International Regional Science Review* 44 (2): 203–28.

2 World Bank. 2020. "Pollution Management and the Making of Prosperous Cities." https://openknowledge.worldbank.org/handle/10986/34643.

3 IHME (Institute for Health Metrics and Evaluation). 2020. ***State of Global Air 2020.*** Data source: IHME. 2020. ***Global Burden of Disease Study 2019.*** https://www.stateofglobalaire.org/

4 World Bank 2020. ***Ghana Country Environmental Analysis.*** Washington, DC: World Bank. https://elibrary.worldbank.org/doi/pdf/10.1596/33726.

5 World Bank. 2020. ***Ghana Country Environmental Analysis*** (abstract). Washington, DC: World Bank. https://elibrary.worldbank.org/doi/pdf/10.1596/33726.

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12 AERONET stations.

13 Nguyen, Thanh T. N., Hung Q, Bui, Ha V. Pham, Hung V. Luu, Chuc D. Man, Hai N. Pham, Ha T. Le, and Thuy T. Nguyen. 2015. "Particulate Matter Concentration Mapping from MODIS Satellite Data: A Vietnamese Case Study." Environmental Research Letters 10 (9).

14 Ly, B. T., Y. Matsumi, T. Nakayama, Y. Sakamoto, Y. Kajii, and T. D. Nghiem. 2018. "Characterizing $PM_{2.5}$ in Hanoi with New High Temporal Resolution Sensor." ***Aerosol Air Qual. Res***. 18: 2487–97; Nguyen, Thanh T. N., Hung Q, Bui, Ha V. Pham, Hung V. Luu, Chuc D. Man, Hai N. Pham, Ha T. Le, and Thuy T. Nguyen. 2015. "Particulate Matter Concentration Mapping from MODIS Satellite Data: A Vietnamese Case Study." Environmental Research Letters 10 (9); Nguyen, Nhung Thi Trang, Christian Schindler, Dien Minh Tran, Chau Quy Ngo, Hoang Tu Le, Hanh Thi Phan, Nguyen Thuy Linh, Thanh Thi Nhat Nguyen, and Nino Küenzli. 2018. "Short-Term Effects of Ambient Air Pollution on Cardiovascular Diseases and Respiratory Disease in Northern Vietnam." ISEE Conference Abstract. ***Environmental Health Perspectives*** https://ehp.niehs.nih.gov/doi/abs/10.1289/isesisee.2018.P03.1610

15 Larsen, B. 2021. "Economic Assessment of the Costs of Air Pollution in the Hanoi Capital Region and the Red River Delta." Draft Policy Note. Washington, DC: World Bank.

POLLUTION MANAGEMENT & ENVIRONMENTAL HEALTH

The Pollution Management and Environmental Health (PMEH) multi-donor partnership, established in 2014 and administered by the World Bank, supports countries in managing air quality and toxic sites and generates cutting-edge knowledge and guidance to reduce pollution for public health, poverty reduction, economic growth, and environmental and climate co-benefits.

Check out the latest program updates, resources, and more at **www.worldbank.org/pmeh**

Website: **www.worldbank.org/pmeh**
Contact: **PMEH@worldbank.org**