WORLD BANK GROUP

POLLUTION MANAGEMENT & ENVIRONMENTAL HEALTH

2018
Annual Report

The Pollution Management and Environmental Health (PMEH) multidonor 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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CONTENTS

OVERVIEW

2018 saw more than 900 people from the health, climate, and air pollution communities gather for the First WHO Global Conference on Air Pollution and Health at the World Health Organization headquarters in Geneva. The conference concluded with a Geneva Action Agenda to Combat Air Pollution to scale up efforts and mobilize action globally. The aspirational goal is to reduce the number of deaths from air pollution by two-thirds by 2030.

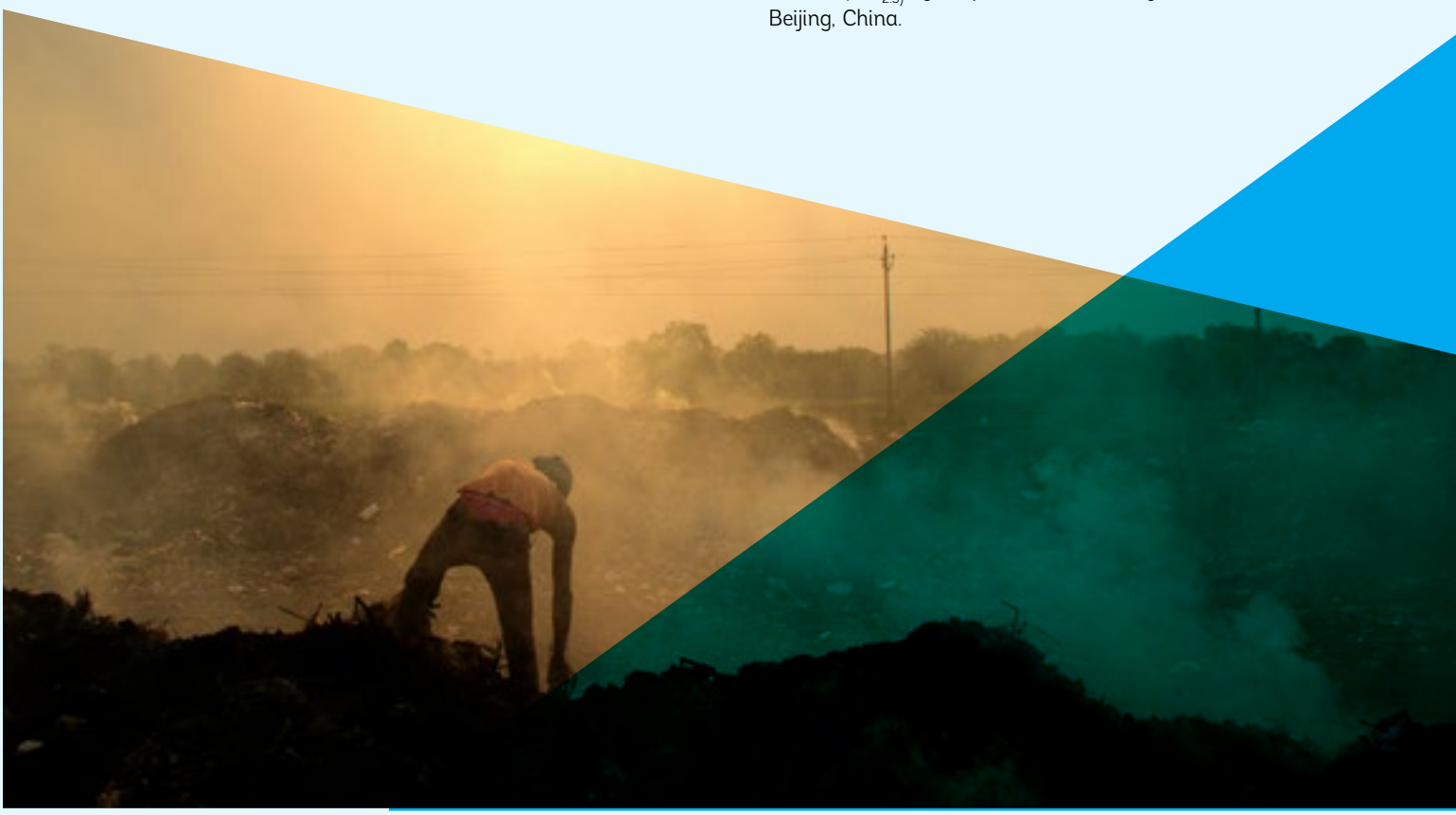
The conference's overarching message was the recognition that addressing air pollution requires multisectoral efforts that build upon synergies between human health, climate change, and growth priorities. The Pollution Management and Environmental Health (PMEH) multidonor partnership is increasingly working to make these links, both with its analytical work and in countries. PMEH focuses on air quality management, toxic-site management, competitive cities, and research to support these areas. PMEH supports South-South cooperation and knowledge exchange, and currently implements technical assistance for air quality management and climate change mitigation in China, Egypt, Ghana, India, Nigeria, South Africa, and Vietnam.

Here are some highlights of PMEH work this year:

CONTRIBUTION TO AIR QUALITY MANAGEMENT PLANNING IN SEVERAL COUNTRIES

The program has been working closely with countries that are in different stages of designing their own air quality management (AQM) plans or regulatory architecture to control and manage pollution. PMEH has brought in international experts to identify the measures that are most cost-effective for reducing air pollution, to train local technicians on lab protocols, and to identify gaps that need to be addressed for effective implementation of the plans.

- In China, PMEH technical assistance and analytical work have supported the Chinese government's Hebei Pollution Prevention and Control Implementation Action Plan. PMEH helped define the scope and content of the regional program, as well as the lending program to support its implementation, by identifying the cost-effectiveness of interventions. These interventions have informed and supported the Chinese government in reducing fine particulate matter ($PM_{2.5}$) by 34 percent over four years in Beijing, China.



- In Cairo, PMEH has informed the government regarding the extent of the transport sector's impact on pollution, as well as the health impacts of pollution. This support is assisting the government of Egypt to design and implement policy reforms and investments as part of a full-scale AQM plan for Cairo.

- The Accra Metropolitan Assembly successfully launched the first AQM plan for the Greater Accra Metropolitan Area on August 15, 2018, based on the technical and advisory support of the U.S. Environmental Protection Agency, World Health Organization (WHO), Climate and Clean Air Coalition, PMEH, and other bilateral and multilateral agencies.

- In India, PMEH so far has concentrated its attention on providing extensive support to the design and development of the National Clean Air Program. PMEH brought international expertise to inform the program.

- In Lagos, PMEH is supporting the state government in establishing an Air Quality Monitoring and Particulate Matter Sampling Network as a first step toward creating a full-scale AQM plan.

CUTTING-EDGE RESEARCH

Analytical work is ongoing in all participant countries focusing on applying AQM modeling techniques, combining data from regional and city contexts, and studying co-benefits between environmental health, local pollutants, and climate change. At a global level, technical research is focused on the following: (a) understanding the potential for use of satellites for air quality measurements in low- and middle-income country (LMIC) contexts, (b) understanding better the health impact of combustion-based pollutants versus natural dust, (c) understanding better the health effects of source-related components and species of particulate matter, and (d) harmonization of air quality monitoring methods and procedures in LMICs.

Various manuals have been prepared, including guidance manuals for assessing exposures and health outcomes at contaminated sites in LMICs for (a) small-scale artisanal gold mining, (b) used lead acid battery recycling, and (c) small-scale tanneries.

PMEH's competitive and prosperous cities component produced a survey paper and analytical report on pollution and city competitiveness. Deep dives exploring pollution's impact on a city's competitiveness were completed for Bangladesh (air pollution), Senegal (water pollution), and several African cities (solid-waste pollution).

The online introduction to air pollution course on the World Bank's Open Learning Campus has been well received and continues to be useful to professionals in a range of countries interested in learning more about air pollution and ways to reduce it from a policy and decision-making perspective.

PMEH MANAGEMENT

PMEH operations in implementing countries are supported by the PMEH Secretariat in Washington, D.C., which coordinates between stakeholders, including implementing countries and donor countries; manages internal planning and reporting functions; and promotes global and technical cross- collaboration within the World Bank.

A few changes were made in mid-2018 that bear mentioning: PMEH's Secretariat staffing was restructured so that it is now composed of a program manager, coordinators for air quality management and toxics, an operations analyst, and a specialist in financial management. Regarding operations in countries, task teams are established and activities under way in all participant countries.

In 2018, the Steering Committee collectively decided to extend the closing date of the trust fund to 2021 to allow sufficient time for completion of important efforts in some of the countries. It also decided to omit the program on marine litter, since that topic will be addressed in the context of a new multidonor trust fund called PROBLUE, which will have a component on marine-litter management and plastics waste.

This report highlights PMEH's work in 2018. These gains would not have come about without the PMEH program and the multidonor trust fund that underpins it. Therefore, it is timely to again thank PMEH donors for supporting the program and its impactful interventions. Their ongoing commitment to PMEH is critical in our collective effort to monitor and reduce air pollution, mitigate climate change, manage toxic sites, and produce new research with direct application to pollution in LMICs.

STRENGTHENING AIR QUALITY MANAGEMENT

Air Pollution Impacts

Poor air quality is a growing challenge in the context of sustainable development, particularly related to health in cities and urban areas, and efforts across sectors to improve air quality are needed. Air pollution is an impediment to national sustainable development, affecting, among others, the economy, worker productivity, today's and future generations' health care expenses, and tourism. Promoting air quality is a priority task for protecting public health. Better air quality also provides co-benefits for the climate, ecosystem services, biodiversity, and food security.

Tackling air pollution is essential for national sustainable development and increasingly a priority for governments across the globe.

The 2015 WHO resolution on addressing the health impact of air pollution notes that "Air pollution is a cause of global health inequities, affecting in particular women, children, and old persons, as well as low-income populations who are often exposed to high levels of ambient air pollution, or live in homes that have no other choice than to be exposed to air pollution from cooking and heating, and that improving air quality is among the measures with the greatest potential impact on health equity."

Tackling air pollution is essential for national sustainable development and increasingly a priority issue for governments across the globe. This section covers progress made between July 2018 and June 2019 in China, Egypt, Ghana, India, Nigeria, South Africa, and Vietnam—the seven initial countries of the PMEH air quality management component (see table 1 for each country's city or region of focus). The scope of the activities being implemented in the seven countries includes analytical work for collection and processing of air quality data; source apportionment assessments to identify pollution sources (for example, if they come from transport, industry, power stations, agriculture, or households); and their relative contribution to pollution concentrations. PMEH also provides support with analytical work on air quality modeling, chemical-composition analysis, emissions inventory, source apportionment, health-impact assessments, and cost-effectiveness analysis.

Table 1. Countries and Cities Participating in the PMEH Air Quality Management Program

Country	Region
China	Cities of Beijing, Tianjin, Hebei, and surrounding provinces (the expanded Jing-Jin-Ji metropolitan region, the national capital region of China)
Egypt	Greater Cairo area
Ghana	Greater Accra metropolitan area
India	City of Delhi and the National Capital Region
Nigeria	City of Lagos
South Africa	Cities of Ekurhuleni, Johannesburg, and Tshwane
Vietnam	Greater Hanoi metropolitan area, including city of Hanoi and Bắc Ninh and Hưng Yên provinces

Country Updates

The PMEH program has been working closely with countries who are in different stages of designing their own air quality management plans or regulatory architecture to control and manage pollution. PMEH has brought in international experts to identify the most cost-effective measures to reduce air pollution, trained local technicians on lab protocols, and identified gaps that need to be addressed for effective implementation of the plans. Below are short overviews of progress from the seven countries in which the PMEH is supporting air quality management (AQM) efforts.

GHANA

The Accra Metropolitan Assembly successfully launched the first AQM plan for the Greater Accra Metropolitan Area on August 15, 2018, based on the technical and advisory support of the U.S. Environmental Protection Agency, PMEH, and other bilateral and multilateral agencies. PMEH is supporting the government of Ghana to refine and start implementing this AQM plan in collaboration with other international partners. PMEH is supporting source-apportionment analysis, which includes the use of black-carbon monitors to help understand what portion of particulate pollution black-carbon comprises, as well as to identify the main sources of black-carbon emissions.

PMEH also assessed the installed capacity for air quality monitoring and AQM laboratory needs. Ghana's Environmental Protection Agency (EPA Ghana) presented the first Accra emission inventory and an analysis of the benefits of implementing a package of measures for air quality improvement. The EPA Ghana analytical laboratory staff also presented the first results of several organic species that have been measured quantitatively in Accra air samples. This analysis will help enable future identification of sources of air pollution through source-apportionment studies. PMEH is committed to help enhance and refine Accra's AQM plan, including improving the air quality monitoring systems in coordination with other partners.

SOUTH AFRICA

The Greater Johannesburg Metropolitan Area (GJMA), which consists of three municipalities including the City of Johannesburg, benefits from accessing the South African Air Quality Information System (SAAQIS), a web-based reporting and information-sharing system linked to more than 110 monitoring stations across the country. The three GJMA municipalities maintain a network of more than 20 stations for monitoring ambient air quality, with a mix of continuous air quality monitoring instruments at different sites. In 2018, PMEH conducted a very detailed gap analysis to identify the strength of South African AQM planning capabilities as well as the current needs to achieve its air pollution objectives.

EGYPT

During 2018, PMEH assessed Egypt's installed capacity for monitoring air quality and determined that Egypt has developed the strongest network for monitoring air quality on the African continent, with over 90 monitors, 45 of which are in the greater Cairo area. The World Bank has worked with the Egyptian Environmental Affairs Agency to complete a Policy Options Study, Cost of Environmental Degradation Study, and Health Impact Assessment. Additional reports completed during fiscal year (FY) 2018 include (a) *The Role of Vehicles in Ambient Air Pollution in Greater Cairo: The Effectiveness of Metro Line 3 and Fuel Price Hikes in Reducing Congestion and Particulate Air Pollution*, and (b) *The Effect of Particulate Air Pollution Shocks on Acute Respiratory Diseases in Egypt: A Case-Crossover Study*.

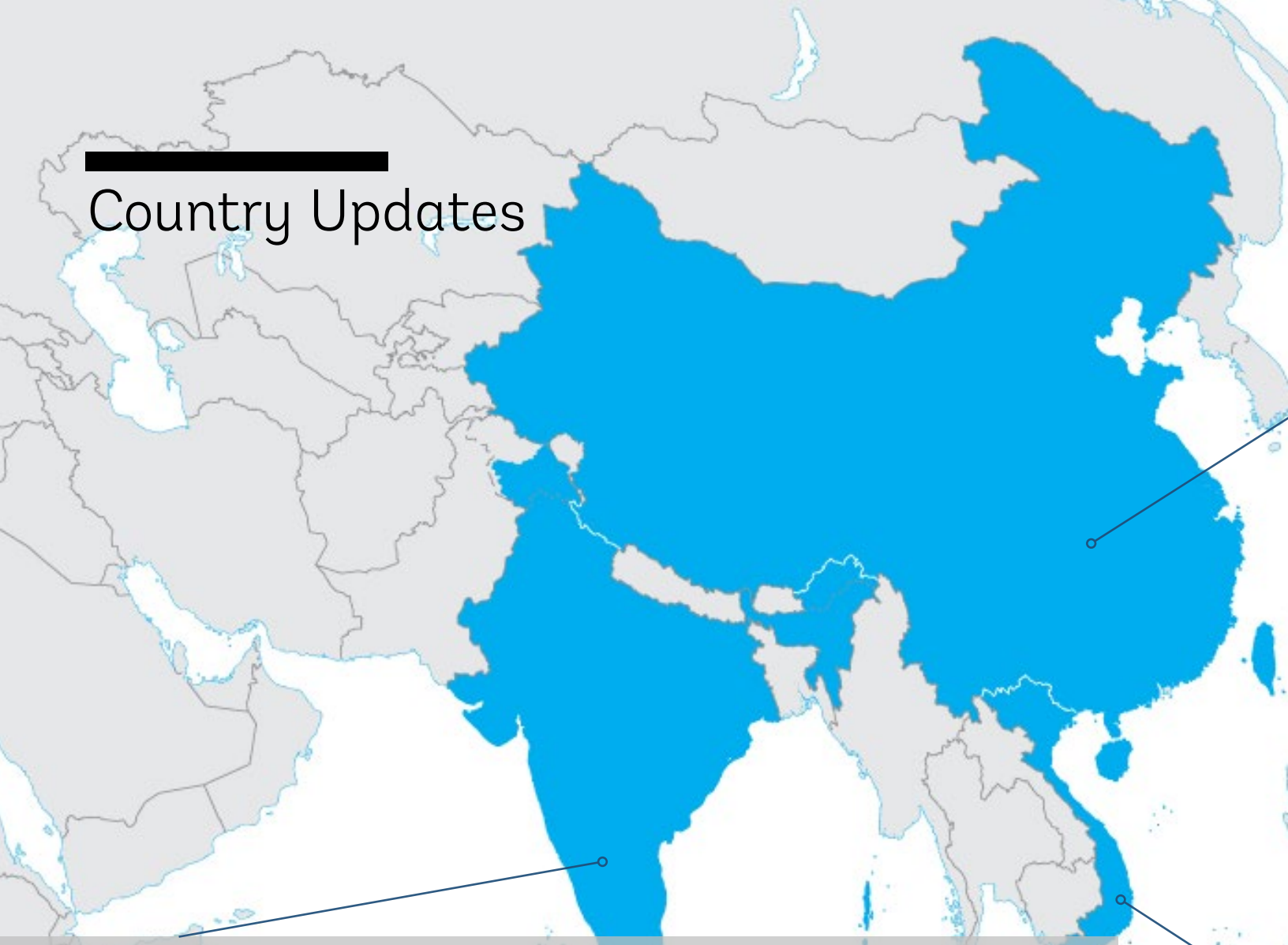
PMEH is supporting the government of Egypt to design and implement policy reforms and investments as part of a full-scale AQM plan for Cairo. PMEH experts are utilizing cutting-edge machine-learning technology to quantify how the number of cars on the roads affects air quality. The government of Egypt has requested that more emphasis be given to technical assistance in advancing the analytical work and modeling based on the existing monitoring data. An ongoing discussion with the government of Egypt about a possible lending operation on AQM was triggered by the PMEH-supported work. Egypt is now also looking to review the existing emissions inventory, as well as expanding it with a module on mobile sources and geological dust.

NIGERIA

PMEH is supporting the Lagos state government to establish networks for monitoring air quality and sampling particulate matter in Lagos as a first step toward creating a full-scale AQM plan. To implement these activities, a Lagos state PMEH steering group has been established that includes the heads of all relevant state departments. PMEH has supported the development of draft protocols that include standard operating procedures for monitoring stations, species to be monitored, frequency of monitoring, quality-assurance and quality-control requirements, and data management and local capacity-development plans.

PMEH has also helped the Lagos state government collect data to populate a model that can be used to better understand how air pollutants travel from their sources and how they contribute to ambient air quality. In addition, Lagos state has approved a budgetary allocation to support construction of civil works for the preparation of six sites for monitoring air quality in Lagos. PMEH is committed to providing technical assistance and support for strengthening air quality monitoring systems, emissions inventories, and source-apportionment analysis.

Country Updates



INDIA

During FY2018, PMEH evaluated the needs for air quality monitoring equipment for India and found that cities like Delhi have a comprehensive network for monitoring air quality in operation. PMEH has therefore concentrated its attention on providing extensive support to the design and development of the National Clean Air Program (NCAP) and represented the only international organization invited to the First National Consultation on NCAP with Indian state governments. The NCAP sets a medium-term target of 20–30 percent reduction of $PM_{2.5}$ and PM10 concentrations by 2024 from an initial 2019 level baseline. PMEH brought expertise from China, Europe, Latin America, and the United States. Bank representatives, including staff and international consultants, participated in all the workshops held as part of the consultation. The PMEH experts provided substantive inputs and comments on the NCAP drafts.

The PMEH program also supported work on a forecasting system with the Delhi Pollution Control Committee (DPCC), which will allow the DPCC to implement emergency response plans. PMEH international specialists have worked with the DPCC to develop a model that will inform the design of potential interventions that could be implemented prior to the yearly pollution spike in the surroundings of Delhi, especially in the months of October to December. PMEH continued supporting the implementation of the NCAP at the national level and will also work with state governments, particularly Bihar and West Bengal, to design and implement AQM programs to reduce air pollution.

CHINA

PMEH's technical assistance and analytical work has supported the Chinese government's Hebei Pollution Prevention and Control Implementation Action Plan, which coordinates prevention and control of greenhouse gases (GHG) and air-pollutant emissions from industrial enterprises and mobile sources, strengthens area pollution control, and establishes pollution-warning systems and planning tools. PMEH supported the adoption of cost-effectiveness analysis in its AQM planning. This analysis helped define the scope and content of the regional program and was instrumental in the Bank's approval of two loans to support its implementation. Since 2018, PMEH has been supporting the development of a new AQM modeling system for the expanded Jing-Jin-Ji region (Beijing, Hebei, Tianjin, Inner Mongolia, Shanxi, Henan, and Shandong) that will continue supporting cost-effective AQM interventions within 26 prefectures and two cities (Beijing and Tianjin).

PMEH-supported analytical work has also been instrumental in identifying key sources of air pollution and GHG emissions. For instance, analytical work informed the government's expansion of soil testing for formula-fertilizer application. Ammonia emissions from fertilizers were identified as main sources of secondary particle matter. Through sharing of international experience with PMEH support, Hebei's government stepped up its actions to expand soil testing and promote formula fertilizer. In addition to contributing to reduce air pollution, this also results in cost savings for farmers, reduced fertilizer use, and lower risks of agricultural lands' contamination. PMEH also supported knowledge exchanges through which Chinese officials learned about Germany's approach to reducing emissions from the iron and steel sector. The exchanges contributed to the piloting in 2018 of ultra-low emissions standards for industrial pollutants in the iron and steel sector in Hebei. The experience led to the adoption of similar standards nationwide in 2019. In Beijing and its surrounding Jing-Jin-Ji region, air pollution has been among the worst in the world; however, improvements in air quality over the past few years offer hope for the future and for other cities around the world. In Beijing itself, the annual average concentration of $PM_{2.5}$ decreased from 89.5μg/m^3 in 2013 to 58μg/m^3 in 2017.

VIETNAM

PMEH is supporting the Ministry of Environment and Natural Resources in the Greater Hanoi Metropolitan Area to develop an understanding of emissions sources to create a cost-effective, full-scale AQM plan that can be implemented at the city level. In the first half of 2018, PMEH and the government of Vietnam held a multisector technical workshop in Hanoi, where the PMEH team presented the preliminary results of the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model. Climate co-benefits are fully integrated into the model, including mitigation of short-lived climate pollutants.

The model and subsequent AQM plan will include the CO_2-equivalent emissions reductions. PMEH, with the government and other partners, is developing modeling work to allow for the analysis of cost-effective pollution-abatement options at the city and regional/urban agglomeration levels. Based on PMEH's technical assessment and the recent substantial upgrading of Hanoi's network for monitoring air quality through support from the French Development Agency, PMEH is supporting activities to improve the emissions inventory and source-apportionment analysis, which will inform the development of a Vietnam GAINS model.

PMEH, and several other organizations have supported governments to include a strong climate change component with a number of interventions to mitigate climate change.

Climate Co-Benefits

Since many of the air pollutants that have negative health impacts share common sources with greenhouse gases, including short-lived climate pollutants, solutions to improve air quality can lead to the reduction of other greenhouse gas emissions and vice versa. This program supports policy makers to make an explicit link between air pollution, public health, and climate change mitigation. The demonstrated links between the sources of air pollutants and greenhouse gas emissions, alongside cost-effective actions to mitigate them both, enable improved policy action in recipient cities and the countries in which those cities are located. As described in the previous section, PMEH in Vietnam has a strong climate change component. PMEH's work in China, India, South Africa, and Vietnam uses the GAINS model that includes the monitoring of short-lived climate pollutants. As part of the work plan for Accra, Ghana, several organizations such as the Climate and Clean Air Coalition have supported the government to include a climate change component with several interventions to mitigate climate change.

THE GAINS MODEL

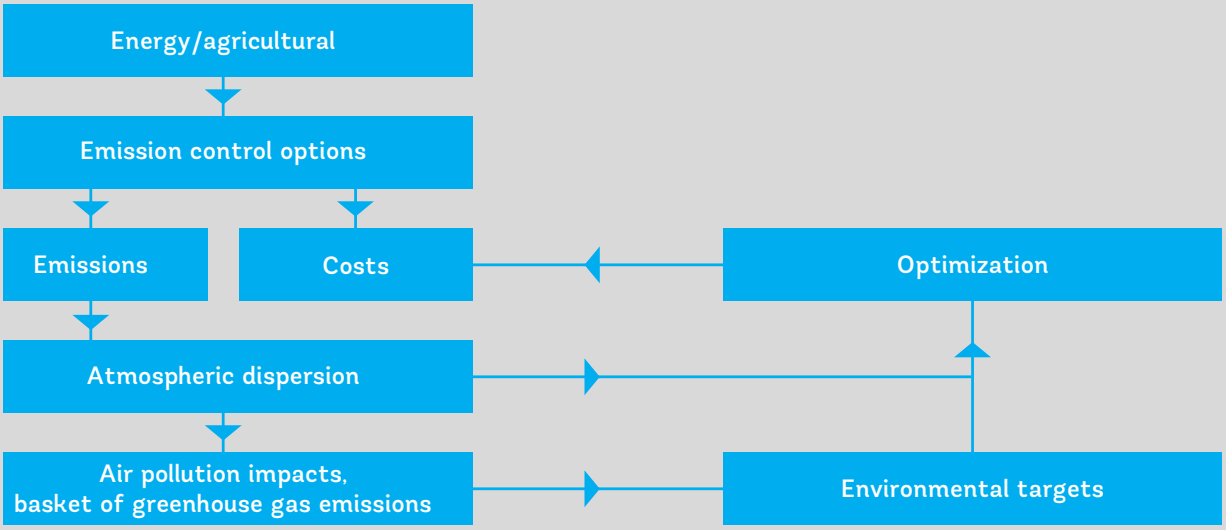
The GAINS (Greenhouse Gas and Air Pollution Interactions and Synergies) model explores cost-effective multi-pollutant emission-control strategies that meet environmental objectives on air quality impacts (on human health and ecosystems) and greenhouse gases.

GAINS brings together data on economic development (including energy and agricultural projections that typically originate from external supply-demand models); the structure, control potential, and costs of emission sources; the formation and dispersion of pollutants in the atmosphere; and an assessment of the environmental impacts of pollution.

The model allows simulation of the impacts of policy actions that influence future driving forces (for example, energy consumption, transport demand, and agricultural activities). The model also allows simulation of dedicated measures to reduce the release of emissions to the atmosphere, on total emissions, resulting air quality, and a basket of air quality and climate-impact indicators. GAINS addresses air pollution impacts on human health from fine particulate matter and ground- level ozone, vegetation damage caused by ground-level ozone, the acidification of terrestrial and aquatic ecosystems, and excess nitrogen deposition to soils, in addition to the mitigation of greenhouse gas emissions.

GAINS assesses, for each of the source regions considered in the model, more than 1,000 measures to control emissions to the atmosphere. It computes the atmospheric dispersion of pollutants and analyzes the costs and environmental impacts of pollution-control strategies. In its optimization mode, GAINS identifies the least-cost balance of emission-control measures across pollutants, economic sectors, and countries that meet user-specified air quality and climate targets. The flow of information in the cost-effectiveness analysis of the GAINS model is shown in figure 1.

Figure 1. Flow of Information in the Cost-Effectiveness Analysis of the GAINS Model



Bringing Back the Blue Skies in China and Contributing to Global Efforts to Mitigate Climate Change

The $PM_{2.5}$ air pollution in China's Hebei region has been reduced by 34 percent in the past four years.

The program is making significant contributions to the blue skies in Jing-Jin-Ji.

The Beijing-Tianjin-Hebei region of China, known as Jing-Jin-Ji, has the country's worst air quality, with an annual average fine particulate matter concentration far exceeding the national $PM_{2.5}$ standard and the WHO $PM_{2.5}$ standard. Particularly during winter, the region is often engulfed in heavy smog lingering for days and posing a serious health threat.

Concerned with the adverse health and environmental consequences from severe air pollution, the government of China declared a "war on air pollution" in 2014. PMEH's technical assistance and analytical work supported the Chinese government's Hebei Pollution Prevention and Control Implementation Action Plan, including helping design pollution reduction and abatement measures. PMEH's involvement led to the World Bank approving two $500 million Program for Results loans to China to support implementation of the action plan. The Program for Results instrument is a lending tool that aims to link loan disbursements to tangible results on the ground.

For the past year, PMEH has been supporting the development of a new air quality management modeling system for the expanded Jing-Jin-Ji region (Beijing, Hebei, Tianjin, Inner Mongolia, Shanxi, Henan, and Shandong), which will extend support for cost-effective AQM interventions within 26 prefectures and two cities (Beijing and Tianjin). In Beijing and the surrounding Jing-Jin-Ji region, air pollution has been among the worst in the world; however, improvements in air quality over the past few years offer hope for the future and for other cities around the world. Owing to the efforts of the Chinese government and with the support mentioned, air pollution in the Hebei region has been reduced by 34 percent in the past four years.

PMEH helped define the scope and content of the regional Jing-Jin-Ji program, as well as identify cost-effective interventions that have been supported by the World Bank's lending program. A specific example is that, under the guidance of PMEH and the Bank team, Hebei's government has identified enforcement and data quality as among the most cost-effective measures that would warrant effective implementation of other measures across sectors. Technical guidance was provided to Hebei on enhancing the quality of its emissions-monitoring data through implementing standardized procedures and operation protocols at both the provincial- and prefecture-level continuous emissions monitoring systems. Data quality and enforcement have been enhanced through these procedures and protocols without significant investment. Another example is the government's expansion of soil testing for formula-fertilizer application. Ammonia emissions from fertilizers were identified as one of the main precursors of secondary $PM_{2.5}$. Through sharing of international experience with PMEH support, Hebei's government stepped up its actions to expand soil testing and promote formula fertilizer. This also results in cost savings for farmers, reduced fertilizer use, and lower

risks of contamination of agricultural lands. Since Hebei's first air quality action plan was implemented effectively, the province reduced its $PM_{2.5}$ level by approximately 40 percent in 2017, compared with its 2013 level. PMEH provided important technical guidance to this process and contributed to the improvement of regional air quality.

Building on lessons learned from European countries—obtained through knowledge exchanges facilitated by PMEH—the Hebei Ecology and Environment Bureau (EEB) in 2018 started piloting ultra-low industrial air pollutant emission standards in its iron and steel sector. In 2019, similar standards were rolled out nationwide. This is a scale-up of commitment from Hebei's own power sector to the iron and steel sector. Hebei's iron and steel production accounts for half of global production. Other provinces and private businesses in general are closely following the development of the sector's air pollution policy.

Building upon the productive dialogue with the Chinese government, the World Bank was invited to provide policy recommendations regarding the midterm review of the 13th Five-Year Plan's implementation. The Five-Year Plan is China's most important strategic development planning, which includes key targets and guidance for the country's priority agenda. Co-supported with other resources, the Bank provided recommendations to the National Development and Reform Commission and the Beijing Municipality in July 2018. A key recommendation to the national-level government was that evidence-based policy making would need to be strengthened to better inform a cost-effective plan for air quality management.

There is great pride in, and country ownership of, the successes in air pollution reduction in China's Jing-Jin-Ji region. The general manager of Qingyuan's Heat and Power Plant, Zhu Zhenhua, says with pride, "Our new desulfurization tower uses the most advanced wet electrostatic precipitator technology with 95 percent removal efficiency. We have met the highest ultra-low emission standards in Shandong Province." The deputy general manager of the Shandong Transportation New Energy Company, Han Shaoqing, observes, "We are the first company in China to use highway land resources for large-scale solar power production." According to Bank estimates, the scaled-up green finance investments under the lending operations have leveraged five times the World Bank loan. The lending operations are making significant contributions to the blue skies in Jing-Jin-Ji. They are also having important climate change benefits with reduction of CO_2 emissions by 105.81 million tons and reduction of coal use by 72.3 million tons, according to the Innovation Center for Clean-air Solutions report.

The general manager of Qingyuan's Heat and Power Plant, Zhu Zhenhua, says with pride: "Our new desulfurization tower uses the most advanced wet electrostatic precipitator technology with 95 percent removal efficiency. We have met the highest ultra- low emission standards in Shandong Province."

RESEARCH AND STRENGTHENED ANALYTICS

PMEH's research-based component—aimed at conducting research and strengthening analytics for improved pollution management and environmental health—focuses on enhancing new academic and scientific knowledge, as well as researching and developing science-based solutions to tackle and reduce pollution levels in low- and middle-income countries. Below are highlights of the following research areas:

1. **Improving air quality monitoring and estimation of the health risks and effects of ambient air pollution in LMICs**
2. **Assessing the impacts of contaminated toxic sites on human health and the economy in LMICs**
3. **Pollution management and the making of prosperous cities**

Air Quality

Air pollution is recognized today as a major health risk. Exposure to air pollution, both ambient and household, increases a person's risk of contracting a disease such as lung cancer, stroke, heart disease, and chronic bronchitis. According to the World Health Organization, in 2016, 7 million deaths were attributable to air pollution. Air pollution is especially severe in some of the world's fastest-growing urban regions. However, air pollution is also a problem outside cities. Billions of people around the world continue to depend on burning solid fuels such as wood, charcoal, coal, and dung in their homes for cooking and heating. Consequently, the health risk posed by air pollution is greatest in developing countries. Children under age 5 in lower-income countries are more than 60 times as likely to die from exposure to air pollution than children in high-income countries.

Air pollution is not just a health risk; it's also a drag on development. By causing illness and premature death, air pollution reduces the quality of life. By causing loss of productive labor, it also reduces incomes in these countries. Air pollution can have a lasting effect on productivity in other ways as well, for example, by stunting plant growth and reducing the productivity of agriculture, and by making cities less attractive to talented workers, thereby reducing cities' competitiveness.

Although ambient air pollution is a major health risk and leading cause of disease and death in LMICs, many cities in these countries lack reliable air quality monitoring data to provide the basis for informing decision making and action to reduce air pollution and its health impacts. Even where some data are available, they are often unreliable because of inadequate methods and protocols and/or lack of quality assurance and control. The potential role of emerging technologies, notably satellite, for estimating air quality in LMICs is a subject of increasing attention and requires further evaluation in light of the limitations and opportunities associated with the use of this technology. Related to the challenges associated with generating ground-level data in LMICs, there are also methodological challenges to reliably estimating health impacts of air pollution at country and global levels.

The objective of the PMEH-funded research on air quality is to develop knowledge and guidance for improvement of air quality monitoring and estimation of health risks and effects of ambient air pollution in LMICs. The three focal areas of the research are (a) harmonization of air quality monitoring methods and procedures, (b) pilot studies on integration of satellite-derived and ground-level air quality measurements, and (c) improving estimation of health impacts of ambient air pollution in LMICs.

Major outputs from this component in FY2018 are listed below as items 1–6..

1. Strengthening the foundations for estimating ambient air pollution's impacts in LMICs. A report titled *Assessing the Global Burden of Disease Estimates: Strengthening the Foundations for Estimation of Health Impacts of Ambient Air Pollution in Low- and Middle-Income Countries* reviews estimates of health impacts (mortality) of ambient air pollution in the Global Burden of Disease (GBD) studies of 2010, 2013, and 2015. Key findings of the report include the following: (a) Mortality changes from GBD 2010 to GBD 2015 were due to significant improvements in both dose-response functions and exposure methodology; (ii) compared to countries with good coverage of ground-level monitoring (GLM), such as OECD countries and China, for example, there was significantly greater uncertainty in health estimates in LMICs because of a lack of GLM to help calibrate satellite data and higher $PM_{2.5}$ levels; and (c) important uncertainties exist in applying integrated exposure response functions globally, since they assume equal toxicity and no effective modification of pollutants.

The report points out the need for (a) greater transparency and documentation in GBD efforts, (b) reporting country-specific uncertainty bounds for mortality estimates, (c) reliable GLM of $PM_{2.5}$ and species in LMICs, (d) stronger quality assurance and quality control of air quality monitoring, and (e) primary epidemiologic research in LMICs with different mixes of $PM_{2.5}$, dust, and baseline conditions.

2. Based on the above work, a journal article was developed, accepted for publication, and published in the October 2018 issue of the peer-reviewed journal *Environmental Research*. The article, "Assessing the Recent Estimates of the Global Burden of Disease for Ambient Air Pollution: Methodological Changes and Implications for Low- and Middle-Income Countries," is currently accessible on a subscription basis and will become "open access" following the journal's mandatory embargo period.

3. Implications of exposure to dust on the burden of diseases from air pollution. This report highlights the far-reaching impacts of dust storms on the immediate vicinity of the origin of the storm and 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, and biological materials (bacteria, pollen, fungi, and viruses), as well as pollutants such as pesticides, heavy metals, and dioxins, which affect dust toxicity. Furthermore, dust particles may provide a core for attachment of gases that ultimately become fine particles. The report highlights challenges associated with estimating health impacts of immediate and downwind exposures to dust, and specifically of determining the independent effect of dust. These challenges include lack of, or limited, GLM to measure concentrations and exposures, variations in methods used for measuring dust-related contribution to particulate matter, and 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 effects of dust on mortality and morbidity in quantitative estimates of global burden of air pollution, and that evidence to date also supports risk estimates for dust that are generally similar to that of $PM_{2.5}$.

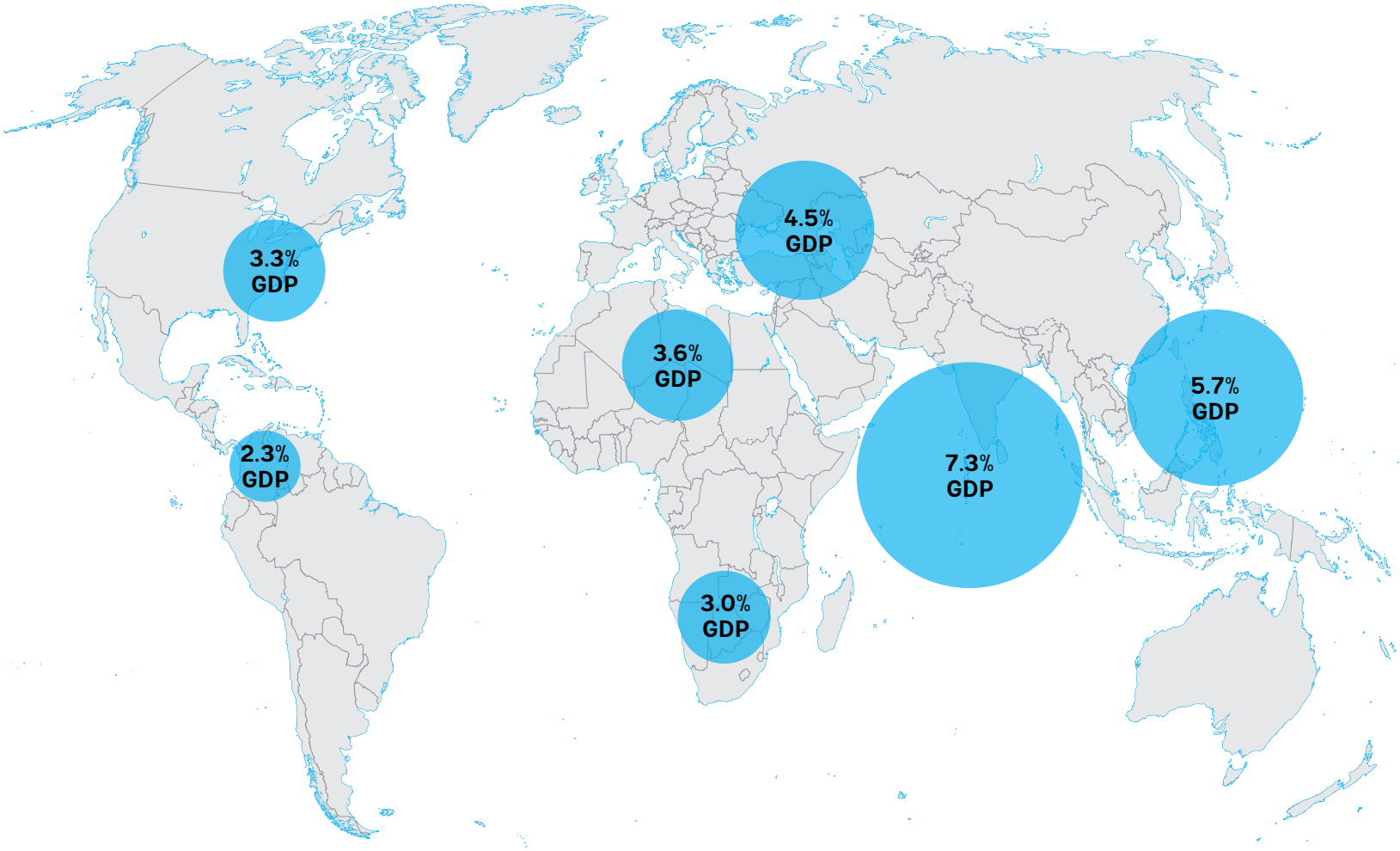
4. Health effects from Exposures to Constituents and Sources of Fine Particulate Matter Air Pollution. This analytical work addresses health effects associated with short- and long-term exposures to $PM_{2.5}$ constituents and source components. This work also examines the epidemiologic literature on 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, these include mortality and hospital admissions that have been associated with $PM_{2.5}$ mass components, with a view to understanding which components are most significantly associated with those health effects. The report, based on a review of short- and long-term studies, showed that $PM_{2.5}$ derived from fossil-fuel combustion, particularly coal and traffic, has been shown to have 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 review supports the need for LMICs in particular to begin measuring the concentrations of the components of their particulate-pollution 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.

5. Global Cost of Ambient $PM_{2.5}$ Air Pollution. This analytical work provides estimates of the economic cost of the health impacts of 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 GBD 2016. This makes ambient $PM_{2.5}$ the seventh-largest health risk factor of global deaths among dozens of risk factors assessed by the GBD 2016. The GBD study estimates health effects from nationwide population exposure to ambient $PM_{2.5}$. Nationwide exposure is estimated from a combination of satellite imagery, chemical-transport modeling, and ground-level particulate matter measurements. The health effects of ambient $PM_{2.5}$ exposure can be monetized to provide an estimate of the social cost

of $PM_{2.5}$. Valuation of mortality follows the welfare approach or value of statistical life (VSL). Valuation of morbidity, measured as days of illness, is valued at wage rates, but morbidity constitutes a minor part of total cost.

This analytical work estimates that the global cost of health effects from ambient $PM_{2.5}$ exposure was $5.7 trillion dollars. This was equivalent to 4.8 percent of global GDP in 2016. The cost was found to be highest in South Asia at 7.3 percent of GDP, followed by East Asia and the Pacific (5.7 percent), Europe and Central Asia (4.5 percent), Middle East and North Africa (3.6 percent), North America (3.3 percent), Sub-Saharan Africa (3.0 percent), and Latin American and the Caribbean (2.3 percent) (figure 2).

Figure 2. Cost of Health Impacts from Ambient $PM_{2.5}$ Exposure



Furthermore, the study highlights the disparities in GLM between low-income and high-income countries, signaling the need for strengthened GLM in developing countries to more accurately determine exposures to pollution in such countries. Based on the 2016 version of the WHO global ambient air quality database, the report found 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.

6. Harmonization of Air Quality Monitoring Methods and Procedures in LMICs. This background report examines strengthening of air quality monitoring in developing countries, and in particular the standardization and harmonization of air quality monitoring protocols and procedures in those countries. The report examines air quality monitoring experiences in developed countries and draws lessons from the experiences in outlining a comprehensive approach to air quality monitoring in developing countries. The report proposes typologies of developing countries according to their institutional capacity for, and engagement in, air quality monitoring as a basis for developing context-appropriate guidance and protocols for air quality monitoring in developing countries.

Identification of Toxic Contaminated Sites

A number of low- and middle-income countries face challenges associated with known and suspected contaminated and toxic sites. To help address these challenges, PMEH supports research activities aiming to (a) strengthen tools and approaches to identify toxic sites, and (b) estimate the health and economic impacts of land-based pollution.

TOXIC SITES IDENTIFICATION PROGRAM

The broader objective of this component is to improve existing evidence and methodologies regarding the health and economic impacts and remediation alternatives related to toxic land pollution and to increase government's capacity to improve national/local land-based pollution action plans in LMICs.

Following a gap analysis on current and emerging human health impacts associated with land-based pollution in LMICs, in 2018 PMEH supported analytical work compiling existing and international methodologies for environmental sampling designed to assess potential impacts on human health.

Three guidance manuals have been produced to present methodologies and protocols to conduct environmental sampling in different media (soil, dust, water, and agricultural products) and biological sampling designed to link to health outcomes, bringing a different perspective from conducting a diagnostic for the purpose of remediation:

1. **Small-scale artisanal gold mining**
2. **Used lead acid battery recycling**
3. **Small-scale tanneries**

These guidance manuals constitute knowledge-management tools to build capacity in LMICs. Combined with a home-survey questionnaire, also developed for the purpose of this research, the results (pollutant concentrations in various media) and health outcomes will inform how to adapt exposure factors in risk-assessment models.

In addition, PMEH is supporting the development of the following applied research:

Assessing Current and Emerging Threats to Human Health from Land-based Pollution in LMICs. The rise of small-scale and localized industries, particularly in LMICs, including artisanal small-scale gold mining (ASGM), used lead acid battery (ULAB) recycling, and small tanning facilities, has led to the potential for increased exposures to contaminants associated with these processes and resulting adverse health effects. The report provides an overview of a set of protocols identifying the most appropriate and cost-effective sampling and analysis methods; sample sizes for each type of contaminant and environmental medium (such as soil, dust, water, air, and food); biological sampling data (for example, biomonitoring); household-survey data; and health-outcome data based on a cost-effective integration of epidemiology with risk assessment.

Improving Children's Futures Through the Global Elimination of Lead Paint. The objective of this research is to provide policy makers with information about the health, environmental, and economic impacts of lead, as well as strategies to eliminate lead poisoning. The publication focuses on the effects of children's exposure to lead, given that they are especially vulnerable to the adverse health effects of lead exposure, and no safe blood lead level has been identified. Low-level lead exposure during early childhood causes a multitude of cognitive and behavioral effects that persist into adulthood, affecting the financial future and stability of families, communities, and countries.

Cost-Effective Interventions to Reduce Exposure to Mercury. This research provides policy makers with evidence about the significant and long-lasting impacts of mercury pollution and presents evidence-based recommendations to design policies, mobilize investments, and strengthen institutional capacity to tackle mercury pollution, particularly from artisanal small-scale gold mining where miners use mercury to extract gold from ore. The research identifies proven, cost-effective interventions to reduce mercury exposure in ASGM and provides recommendations that recognize varying levels of institutional capacity to tackle mercury pollution.

Assessing Current and Emerging Threats to Human Health from Land-based Pollution in LMICs. This research identifies and prioritizes the primary knowledge and data gaps that would benefit from further research or data collection to adequately characterize population-level health impacts related to exposure to toxics.

Reports and publications continue to be finalized, and PMEH is deepening established partnerships with a range of technical experts, external peers, and institutions, including but not limited to the World Health Organization, the Climate and Clean Air Coalition, and the U.S. Environmental Protection Agency.

PMEH will pursue the ongoing contaminated toxic site (CTS) identification in Tanzania and will proceed with CTS identification and analysis in Bangladesh. The team is ready to expand the Toxic Sites Identification Program (TSIP) to other countries.

Lessons learned from activities conducted in 2018 regarding land pollution will complement the analytical work with detailed field assessments to refine exposure factors and health-related costs.

IMPROVING TOXIC SITES IDENTIFICATION

Technical assistance supported by PMEH aims to identify contaminated sites in selected countries, better characterize the extent and severity of land-based pollution, and increase the capacity of national or subnational authorities to identify, characterize, prioritize, and manage toxic sites according to their health and environmental effects. As part of the process of enhancing and expanding the utility of the TSIP database developed by Pure Earth, PMEH is working on collecting complementary information about polluting facilities. This effort has included the production of baseline reports of contaminated land in both countries as well as the revision of the Initial Site Screening (ISS) Protocol.

A peer-review process took place on both the Initial Site Screening Protocol and the CTS database. The ISS Protocol and the CTS database were upgraded and will be made available online worldwide in 2019.

Research in Tanzania complemented previous assessments of contaminated sites, and provided an overview of existing data and information on chemical contamination of land and water and associated impacts on public health. It also highlighted gaps in available knowledge and recommended solutions to mitigate pollution and potential public health risks. PMEH is continuing to support the upgrading of the contaminated and toxic sites database, as well as the assessment and indexing work of additional contaminated toxic sites.

To date, 91 sites have been assessed using the revised ISS Protocol, and 167 more will be screened in the coming months. Site-related information for all 91 sites has been updated in the TSIP database. PMEH has achieved progress regarding the production of knowledge that will improve the understanding of contaminated toxic sites and their consequences on human health.

Competitive, Prosperous Cities

The research activities to be implemented as part of this component are organized into three areas:

1. **Conducting a global-level empirical analysis of factors affecting cities' competitiveness**
2. **Conducting deep-dive studies in a number of cities to examine the drivers of city competitiveness in relation to pollution**
3. **Developing a tool to inform and support decision management and planning processes in LMIC cities with a pollution problem**

In 2018, the following PMEH-supported papers were completed:

- Survey paper — "Does Pollution Hinder Urban Competitiveness?" This paper surveys the recent literature exploring the causes of urban pollution in the developing world and the implications of such pollution for a city's competitiveness. Within a system of cities, cities compete for jobs and people. Cities that specialize in heavy industrial activity will gain from a manufacturing boom but are more likely to be polluted than a city that specializes in the service economy or one that makes investments in regulations to reduce the social costs of power generation, transportation, and household services. The paper explores 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?

- Descriptive paper — "Pollution and City Competitiveness: A Descriptive Analysis." This paper focuses on the relationship between air pollution and city competitiveness. The paper's particular emphasis is on the links between air pollution and city growth, and how these links correlate with city competitiveness. Although high-income cities are usually better at managing pollution, the analysis finds successful examples of fast-growing lower-income cities that are able to tackle this issue. Evidence shows that cities can be competitive and still be able to manage pollution, as long as they have a proactive attitude and focus on developing a green agenda to support this journey.

- Analytical paper — "The Effects of Pollution and Business Environment on Firm Productivity in Africa." This paper 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, the paper looks at firm performance as a proxy for city competitiveness. The paper focuses on African firms because this region is developing quickly, and experiencing increased pollution levels and the effects of agglomeration economies. The analysis finds two interesting results. First, the negative association between air pollution and firm performance can be seen at lower-than-expected levels of pollution. Second, the effects of capacity agglomeration on labor-productivity growth are stronger compared with other regions. These findings suggest that cities in this region should address pollution issues soon, as they continue to grow fast and pollution levels become an increasing concern.

Two additional reports have been completed:

- *Framework for Pollution Management and City Competitiveness.* This framework enables analysis of how pollution and city competitiveness boost each other, with the aim of institutionalizing these interactions and facilitating future assessments. The report also features examples of cities that have enhanced their competitiveness by implementing environmental programs that are part of a wide green-economy strategy; cities that have started environmental programs as sectoral approaches but have been the catalyzers of ambitious green-economy strategies; and cities that have implemented smaller sectoral programs but have been effective in enhancing competitiveness.

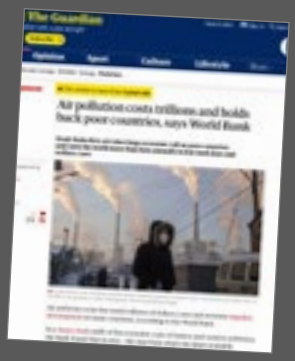
- *Compendium of Cities' Best Practices and Cases of Competitive Cities that Have Been Successful in Managing Pollution.* This compendium aims to identify gaps in the implementation of toolkits and manuals available to city policy makers for advancing city competitiveness while integrating pollution management. This review identifies a clear need for a toolkit that presents a methodology for city competitiveness reforms that incorporates pollution management, is anchored in existing city competitiveness engagements, and links planning, budgeting, and implementation.

The final support tool will be developed with the inputs and recommendations coming from the "deep dive" reports. Ongoing deep-dive work in Kampala, Uganda, is gathering primary data on air pollution and firm productivity to assess the links between the two, and through that, the impact on city competitiveness. The deep dive in Dhaka, Bangladesh, includes gathering primary data through an experimental process to assess the impact of air pollution and heat on workers' productivity. Further deep dive work is planned to take place in Monrovia, Liberia, and Zanzibar. Eleven out of 16 deliverables in this component are complete.

PMEH IS BUILDING ON ITS ACCOMPLISHMENTS

Work done in previous years by PMEH led to building partnerships within and outside the Bank to strengthen responses to pollution challenges. These partnerships and new ones continue to be strengthened.

Work done with PMEH support has provided new evidence on the health impacts of air pollution and translated the health impacts into economic costs to demonstrate the burden that societies bear because of air pollution. As governments face a wide array of competing development challenges, monetizing the costs of pollution can help them decide how to allocate scarce resources to better the lives of their citizens.



PHEM outputs have received extensive coverage in globally recognized news media, including the BBC, *Financial Times, The Guardian,* Xinhua, *Times of India, El País* (Colombia), and others.

PMEH has helped support client dialogues in countries across World Bank regions, including Afghanistan, Bangladesh, Bulgaria, Iran, India, Nepal, Nigeria, Qatar, Saudi Arabia, and Vietnam. The Bank's team working on indoor air pollution has drawn on the findings of PMEH-supported work to strengthen the economic case for investing in clean cooking and heating.

A Closer Look at Satellite Data — Key Findings

The World Bank, together with the U.S. Environmental Protection Agency and the U.S. Department of State, organized a session at the UN Global Science, Policy and Business Forum on the Environment (The Forum), in Nairobi, Kenya, in the lead-up to the third session of the UN Environment Assembly. The session, targeted to policy makers in developing countries, discussed a draft report on *Filling the Gaps: Improving Measurement of Air Quality in Low- and Middle-Income Countries*. The draft report highlighted the role of various technologies, including low-cost sensors, satellite-based measurements, ground-level measurements, and data-management strategies in generating reliable estimates for action to address ambient air quality in developing countries.

Following the conclusion of a successful competitive procurement process (July 2018), a study on the potential of application of satellite measurements for air quality monitoring in LMICs was launched. This study aimed to improve knowledge on how 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. The approach was designed around three key tasks. (1) Review the literature on approaches used to combine satellite observations with GLM measurements of $PM_{2.5}$; (2) Test 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 in three individual pilot cities starting with Ulaanbaatar, Mongolia; Lima, Peru; and Delhi, India. (3) Apply the methods to additional cities in LMICs to understand the typical problems experienced using satellite data for $PM_{2.5}$ monitoring in LMICs, the consequence of these individual problems, and recommended actions that LMICs can employ to address each problem. The initial set of cities tested was selected based on availability of GLM data sets such as $PM_{2.5}$ monitoring data from U.S. diplomatic facilities, OpenAQ1, and field campaigns. Results and lessons learned from testing the AOD algorithms in the initial cities will subsequently be applied in additional LMIC cities that will be analyzed.

During the reporting period, two reports were produced based on tasks 1 and 2. Many different conditions common in LMICs—including mountainous terrain, 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, the establishment of GLM networks that include adequate quality assurance and quality control and follow standard operating procedures to ensure that data are of sufficient quality would likely enable a better understanding of human exposure to air pollution specific to an individual city. Specifically, for countries with no GLM data available, satellite estimates of surface $PM_{2.5}$ concentrations based on chemical-transport models are available at relatively low spatial resolution but may have errors in the range of 22–85 percent. For countries with some GLM data of variable quality, it is possible to develop bias estimates (or an estimate of the difference between a typical satellite measurement and a GLM measurement); however, without improvement in the quality assurance procedures in these countries, it will not be possible to ascertain that the bias-corrected estimate is truly more accurate than the raw satellite estimate.

For countries with routine, high-quality GLM data available, satellite data may be calibrated through either statistical methods or using atmospheric models to improve surface $PM_{2.5}$ estimates or to potentially provide higher-resolution data than those available through GLM networks alone. However, such routine, high-quality GLM data are not available in most LMIC cities.

There is impetus around the world to move to satellite monitoring; however, the findings show that this should only be done in certain places and is not a replacement for ground-level monitoring. When these results were shared at the WHO First Global Conference on Air Pollution and Health, they generated a great deal of discussion and interest. Several participants shared that their countries had planned to substitute GLM with satellite-based monitoring, but that the evidence presented at the conference provided robust arguments to prioritize the expansion and strengthening of GLM.

Children's Higher Air Pollution Exposure

Exposure to pollutants in the air threatens the health of people of all ages, in every part of the world, in both urban and rural areas, but it affects the most vulnerable among us—children—in unique ways. **Children are at greater risk than adults from the many adverse health effects of air pollution, owing to a combination of behavioral, environmental, and physiological factors.** Children are especially vulnerable during fetal development and in their earliest years while their lungs, brains, and other organs are still maturing. Children breathe faster than adults, taking in more air and, with it, more pollutants. Children live closer to the ground, where some pollutants reach peak concentrations. They may spend much time outside, playing and engaging in physical activity in potentially polluted air. Newborn and infant children, meanwhile, typically spend most of their time indoors, where they are more susceptible to household air pollution, since they are near their mothers while they cook with polluting fuels and devices. Health conditions in children associated with indoor air pollution include acute lower respiratory infections, chronic bronchitis, chronic obstructive pulmonary disease, some forms of cancer, cataracts, tuberculosis, low birth weight, perinatal mortality, otitis media, cardiovascular disease, and asthma.

Among children, latent disease mechanisms have more time to emerge and affect their health. In the womb, fetuses are vulnerable to the mother's exposure to pollutants. Exposure before conception can also impose latent risks on the fetus. Children's bodies, and especially their lungs, are rapidly developing and therefore are more vulnerable to inflammation and other damage caused by pollutants. The consequences of their exposure—through inhalation, ingestion, or in utero—can lead to illness and other health burdens that last a lifetime. Children depend entirely on us—adults—to protect them from the threat of unsafe air.

Globally, one in every eight deaths was attributable to breathing dirty air, which was a total of 7 million deaths in 2016. Below are facts that attest to the significant burden imposed by air pollution on young children.

- 543,000 deaths in children under 5 years of age and 52,000 deaths in children ages 5 to 15 years were attributed to the joint effects of ambient air pollution (AAP) and household air pollution (HAP).
- Together, HAP and AAP cause more than 50 percent of acute lower respiratory infections (ALRIs) in children under 5 years of age in LMICs.
- Premature birth is the only factor that kills more children under 5 globally than acute respiratory infections.
- AAP was responsible for approximately 261,000 deaths from ALRI and almost 24 million disability-adjusted life-years (DALYs) among children under 5 years old.
- HAP was responsible for approximately 403,000 deaths from ALRI and 37 million DALYs among children under 5 years of age.
- In the Africa Region, acute respiratory infection is the leading cause of death of children under 5 years of age.

Source: WHO, Air Pollution and Child Health: Prescribing Clean Air (2008).

COMMUNICATIONS AND KNOWLEDGE MANAGEMENT

In 2018, PMEH shared its knowledge, tools, and analyses through a wide range of channels, including local, regional, and global events; social media; and online feature stories and report dissemination.

First WHO Global Conference on Air Pollution and Health

THE CONFERENCE

From October 30 to November 1, 2018, a World Bank team, including staff from the health, environment, and climate change global practices, participated in the First WHO Global Conference on Air Pollution and Health: Improving Air Quality, Combatting Climate Change—Saving Lives, which took place at the World Health Organization headquarters in Geneva.

The three-day air pollution conference was organized by WHO in collaboration with the World Bank, United Nations Environment Programme (UNEP), World Meteorological Organization (WMO), Climate and Clean Air Coalition (CCAC), Secretariat of the UN Framework Convention on Climate Change (UNFCCC), and United Nations Economic Commission for Europe (UNECE). This was the first such global conference; 600 people were expected, but 900+ showed up from various fields, including health, air pollution, climate change, national and local governments, civil society organizations and think tanks, and international organizations.

The first two days of the conference targeted practitioners in air pollution and health, presented evidence, and identified gaps and solutions. The final day focused on building support at a high political level with the aspirational goal of reducing the number of deaths from air pollution by two-thirds by 2030. Several countries, cities, mayors, nongovernmental organizations, and international finance institutions announced voluntary commitments, launching new initiatives and financial support to tackle air pollution while promoting health. The overarching message from the conference was the recognition that addressing air pollution requires multisectoral efforts that build upon synergies between human health, climate change, and growth priorities. The conference concluded with a Geneva Action Agenda to Combat Air Pollution to scale up efforts and mobilize action globally. Individuals involved with the PMEH program provided inputs to the action agenda.

The conference ended with nearly 70 entities committing to actions to reduce deaths from air pollution. The World Bank committed to several steps ranging from screening all projects for pollution prevention and supporting strengthening and establishment of air quality monitoring in client countries to promoting actions that promote synergies between air pollution reduction and climate change mitigation.

The Bank hosted a side event at the conference: *Connecting the dots—integrating air quality, climate and health policies*, which previewed the forthcoming World Bank report on costs and benefits of air quality improvement policies and measures and examined synergies and trade-offs between air pollution and climate change mitigation. The event was chaired by the Bank's Environment and Natural Resources Practice Manager, and a presentation was delivered by a World Bank's lead economist in the Climate Change Group. Discussants were: Sergio Sanchez (Vice Minister for Environment, Mexico), Marcelo Mena (former Minister of Environment Chile, now Practice Manager, Climate Change, WB), and Carlos Dora (WHO BreatheAir Initiative/Columbia University).

PRESENTATIONS DELIVERED BY BANK STAFF

1. "Why Universal Health Coverage Has Not Yet Focused on Air Pollution," keynote presentation by Tamer Rabie.
2. "Critical Interventions to Reduce Urban Air Pollution," by Ernesto Sánchez-Triana
3. "Climate-Smart Health Care: Low-Carbon and Resilient Strategies for the Health Sector," by Tamer Rabie
4. "Health Effects of Dust, Species, and Components of PM," by George Thurston (New York University)
5. "Skills for Addressing Air Pollution and Health in All Policies—Communications, Public Health, Campaigns, and Negotiation," by Sonu Jain.
6. "Performance of Satellite Observations for Air Quality Monitoring in Low- and Middle-Income Countries," by Yewande Awe
7. "Connecting the Dots Integrating Air Quality, Climate, and Health Policies," by Grzegorz Peszko
8. "Integrating Air Quality, Climate, and Health Policies," keynote presentation by Benoit Blarel

NEW OPPORTUNITIES FOR COLLABORATION

In addition to the major commitments made by the Bank and nearly 70 other entities, the Bank explored new areas of collaboration with WHO and other partners. Priorities for collaboration between the Bank and WHO were identified and included case studies in priority cities, generating data available to all, and setting up an informal working group on the economics of air pollution.

Participation in Other Events

AIR QUALITY MANAGEMENT SYMPOSIUM, LAGOS, NIGERIA

The PMEH program supported an air quality management symposium in Lagos, Nigeria. The two-day symposium covered topics including air quality management, ambient monitoring, laboratory analysis, source and receptor modeling, and quality assurance. It engaged technical representatives from various national ministries and from five states across Nigeria, including FCT Abuja, Kaduna, Anambra, Kano, and Rivers.

UN GLOBAL SCIENCE, POLICY AND BUSINESS FORUM, NAIROBI, KENYA

The World Bank, together with the U.S. Environmental Protection Agency and the U.S. Department of State, organized a session at the UN Global Science, Policy and Business Forum on the Environment (The Forum), in Nairobi, Kenya, in the lead-up to the third session of the UN Environment Assembly.

The session, targeted to policy makers in developing countries, discussed a report on *Filling the Gaps: Improving Measurement of Air Quality in Low- and Middle-Income Countries*, which was initiated during a Filling the Gaps workshop organized in Washington, D.C., by the World Bank, with PMEH support, and the U.S. Environmental Protection Agency. The draft report highlights the role of various technologies, including low-cost sensors, satellite-based measurements, ground-level measurements, and data-management strategies, in generating reliable estimates for action to address ambient air quality in developing countries.

FILLING THE GAPS WORKSHOP, WASHINGTON, D.C.

The World Bank, together with the U.S. Environmental Protection Agency, organized a technical workshop titled Filling the Gaps: Improving Measurement of Air Quality in Developing Countries. Participants at the workshop explored a spectrum of technical strategies, ranging from satellite remote sensing and ground-level monitoring to emerging air sensors, to increasing the availability of air quality data and supporting countries' policy needs. The meeting culminated with the initiation of a draft white paper aiming to provide preliminary guidance for developing countries on the application of various data and methods for the design and implementation of air quality policy, particularly those data and methods focused on improving public health. Workshop participants included practitioners from governments; other international experts on air quality monitoring and satellite and remote-sensing technologies; and representatives of the private sector, multilateral organizations, and academic institutions engaged in air quality monitoring-related activities.

The workshop included participants from developing countries (Bolivia, El Salvador, India, Kenya, Mexico, Nigeria, Peru, Senegal, South Africa, Vietnam, and Zimbabwe) and developed countries (Canada, Germany, and the United States). Feedback from developing country participants and state-of-the-art experience in applying various measurement technologies reinforced the need for standardized and harmonized technical guidance on air quality measurement for developing countries. Contributors also pointed to the need for continued research relating to the application of satellite and remote-sensing technologies for measuring ground-level air quality, particularly in

developing countries, which often lack reliable monitors with which satellite data can be calibrated. Presentations, agenda, description of sessions, and additional information can be found at the webpage dedicated to the workshop.

Prior to the Filling the Gaps workshop, a technical presentation was organized jointly by PMEH and the Environmental Health and Pollution Management Global Solutions Group to present the findings of the report on strengthening foundations for estimation of health impacts of ambient air pollution in LMICs, based on an assessment of Global Burden of Disease estimates.

Online Introduction to Air Quality Management Course

The World Bank's Environment and Natural Resources Global Practice worked with the U.S. Environmental Protection Agency to develop an online training course for development professionals, government officials, and other partners who want to learn about the fundamentals of air quality management planning. The course is self-paced and provided through the World Bank Open Learning Campus platform, with free and open access to the public.

The course has been very well received. More than 400 individuals have taken the course's introduction to air pollution, developed with PMEH's support.

Information Sessions and Workshops

Awareness-raising and communications-related activities continue to play a key role in bringing PMEH issues to the public, environment and health practitioners, and policy makers.

In Washington, D.C., at the World Bank headquarters, there have been multiple two-hour and half-day presentations on PMEH's work in China and Ghana, and on toxic-site identification, as well as mini-workshops for global audiences. About 14 lunchtime information sessions on specific in-country PMEH activities have been held with video conferencing and options for remote access. As previously noted, a side event and nine presentations on PMEH activities and research findings were shared with global audiences at the First WHO Global Conference on Air Pollution and Health in Geneva.

PMEH supported a technical workshop on health and air quality in Nigeria attended by 55 policy makers, professionals, and researchers. PMEH also supported a study tour to Rome in May 2018 by high-level Lagos state government officials to discuss how health data can inform pollution-mitigation efforts, with the aim of integrating the findings of the Health Impact Assessment conducted in Lagos into the city's AQM plan.

In India, the National Clean Air Program conference was held April 19–20, 2018, in which more than 385 people participated from 20 states and most critical non- attainment cities. As a result of this conference and technical assistance, the program's scope was refined. PMEH supported workshops in Ghana to launch the air quality management plan in August 2018, reaching 300 participants. Workshops were also held in Egypt to build awareness of AQM issues. Because of these activities, the number of participants with increased awareness of AQM issues from PMEH-organized events during the period covered in this report was more than double the initial target.

PMEH Website

New articles, videos, and documents were posted on the PMEH website in 2018. PMEH's web pages have attracted more than 70,000 views, which is 30,000 more than the target for 2018 and almost 4.4 times the number (18,000) reported in the FY2017 annual report.

FINANCIAL OVERVIEW

The PMEH multidonor trust fund was set up in November 2014 with Norway's Ministry of Foreign Affairs as the initial donor. In October and November 2015, both DFID and DECC (now BEIS) of the United Kingdom joined the trust fund. In December 2016, Germany's Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety joined. PMEH, initially established as a six-year multidonor trust fund and then extended by one year, is scheduled to close in December 2021. PMEH has seven country programs on climate and air quality management, all of which are active and receiving funds. It also has components for contaminated toxic sites, research, and dissemination and awareness raising. Relevant expenditures by component are listed in table 2.

Table 2. PMEH Financial Report 2018

Expenditure Category	Total Expenditures as of November 2018 (US$)
1. Air Quality Management Component	
1.1. India: Climate and Air Quality Management	150,923
1.2. China: Hebei region: Climate and Air Quality Management	1,513,488
1.3. Egypt—Cairo: Climate and Air Quality Management	238,947
1.4. Ghana—Accra: Climate and Air Quality Management	120,119
1.5. Nigeria—Lagos: Climate and Air Quality Management	714,646
1.6. South Africa—Johannesburg: Climate and Air Quality Management	127,297
1.7. Vietnam—Hanoi: Climate and Air Quality Management	307,041
2. Research on Pollution Management	
2.1. Air Quality Monitoring and Health Risks and Effects	797,924
2.2.1 Land-Based Toxic Pollution Research on Health and Related Economic Effects	480,031
2.2.2 Identification of Toxic Contaminated Sites	720,693
3.3. Pollution Management. & the Making of Prosperous Cities	300,051
3. Dissemination and Awareness Raising for Improved Program/ Project Development Support	989,106

Of the $47.5 million committed by donors, $22.7 million has been received. Donor pledges and disbursements are summarized in table 3. PMEH activities continue to generate cofinancing through partnerships.

Table 3. PMEH Contributions, Summary

	TOTAL as of November 2018 (US$)
A. Actual funds received from donors	**22,711,989**
Norway: Ministry of Foreign Affairs	7,313,764
United Kingdom: Department for International Development	4,526,280
United Kingdom: Department of Business, Energy & Industrial Strategy (BEIS) (1st tranche of promissory note)	2,463,945
Germany: Federal Ministry for Environment, Nature Conservation, and Nuclear Safety	8,408,000
B. Other Adjustments	**459,581**
Administrative fees to World Bank Central Units (–)	(286,080)
Other Receipts (+)	308,550
Investment Income (+)	437,110
D. Total Funds Available (A + B)	**23,171,569**

Sources and Credits

Sources

Global Burden of Air pollution Cost (page 17-19) from the World Bank
Child exposure to air pollution facts (page 21) from the WHO https://www.unpei.org/sites/default/files/publications/InvestingEnvironmentalWealthPovertyReduction.pdf

POLLUTION
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