HEALTH IMPACTS

AIR POLLUTION AND HEALTH IMPACTS

The morbidity and mortality burden of outdoor air pollution is particularly costly in terms of work days lost, lost productivity, and loss in terms of gross domestic product (GDP). Since, most of the pollution related deaths occur within a year or two of exposure, reducing PM pollution from sources like transport and industries has immediate benefits for health and national economy. The direct link between emissions, outdoor air pollution, and human health has been extensively documented - most notable for chronic obstructive pulmonary disease, lower respiratory infections, cerebrovascular disease, ischemic heart disease, and cancers of trachea, bronchitis, and lung, all of which result in premature mortality [1]. Epidemiological studies conducted under the public health and air pollution in Asia (PAPA) program also highlighted the linkages between outdoor air pollution and premature mortality, hospital admissions, and asthma cases[2].

Research has linked regulated air pollutants such as ozone and particulate matter (PM) to respiratory illness and heart disease and other health problems. More investigation is needed to further understand the role poor air quality plays on health to support development of more sustainable and integrated air quality management strategies. Some of the research goals of the Breathe Easy Jakarta program include:

- Understand the link between health effects and exposure to individual pollutants and multipollutants.
- Develop models and methods to characterize multipollutant exposures.
- Understand and provide recommendations for emissions, exposures and health effects from multipollutants from nearby sources such as highways, industry, railyards, and ports.

Pollutant[3]	*Health and Other Effects*
Ozone	Ozone in the air we breathe can harm our health. People most at risk from breathing air containing ozone include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from ozone exposure. Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and airway inflammation. It also can reduce lung function and harm lung

[1] The Global Burden of Disease 2010: Generating Evidence and Guiding Policy. Institute for Health Metrics and Evaluation, Seattle, USA @ http://www.healthmetricsandevaluation.org/gbd
Outdoor Air Pollution and Health in the Developing Countries of Asia: A Comprehensive Review, Special Report 18 (2010), Health Effects Institute (HEI), Boston, USA @ http://www.healtheffects.org

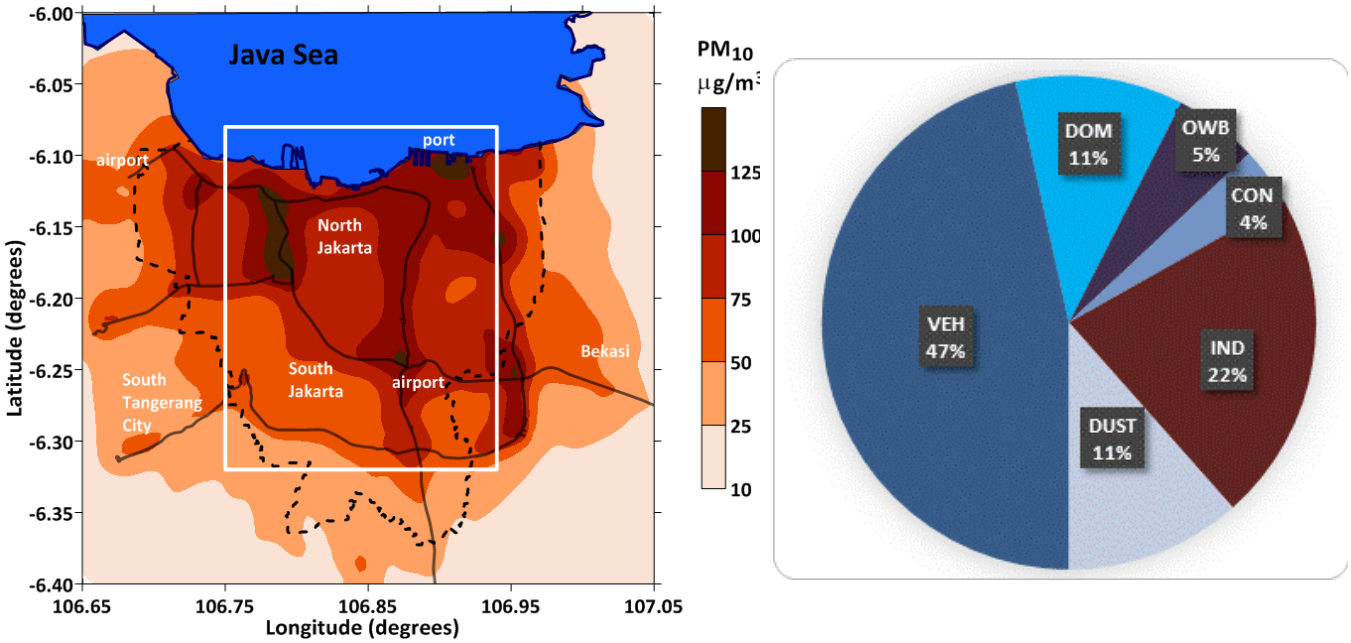
[2] PAPA program implemented by HEI @ http://cleanairinitiative.org/portal/whatwedo/projects/PAPA

[3] Source: https://www.epa.gov/air-research/research-health-and-environmental-effects-air-quality

Pollutant[3]	*Health and Other Effects*
	tissue. Ozone can worsen bronchitis, emphysema, and asthma, leading to increased medical care.
Particles	Particulate matter contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into your lungs, and some may even get into your bloodstream. Fine particles (PM2.5) are the main cause of reduced visibility (haze), including many of our treasured national parks and wilderness areas.
Carbon Monoxide	Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain. At very high levels, which are possible indoors or in other enclosed environments, CO can cause dizziness, confusion, unconsciousness and death. Very high levels of CO are not likely to occur outdoors. However, when CO levels are elevated outdoors, they can be of particular concern for people with some types of heart disease. These people already have a reduced ability for getting oxygenated blood to their hearts in situations where the heart needs more oxygen than usual. They are especially vulnerable to the effects of CO when exercising or under increased stress. In these situations, short-term exposure to elevated CO may result in reduced oxygen to the heart accompanied by chest pain also known as angina.
Sulfur Dioxide	Short-term exposures to SO_2 can harm the human respiratory system and make breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to effects of SO_2. SO_2 emissions that lead to high concentrations of SO_2 in the air generally also lead to the formation of other sulfur oxides (SOx). SOx can react with other compounds in the atmosphere to form small particles. These particles contribute to particulate matter (PM) pollution: particles may penetrate deeply into sensitive parts of the lungs and cause additional health problems.
Nitrogen Oxides	Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO_2. NO_2 along with other NOx reacts with other chemicals in the air to form both particulate matter and ozone. Both of these are also harmful when inhaled due to effects on the respiratory system.

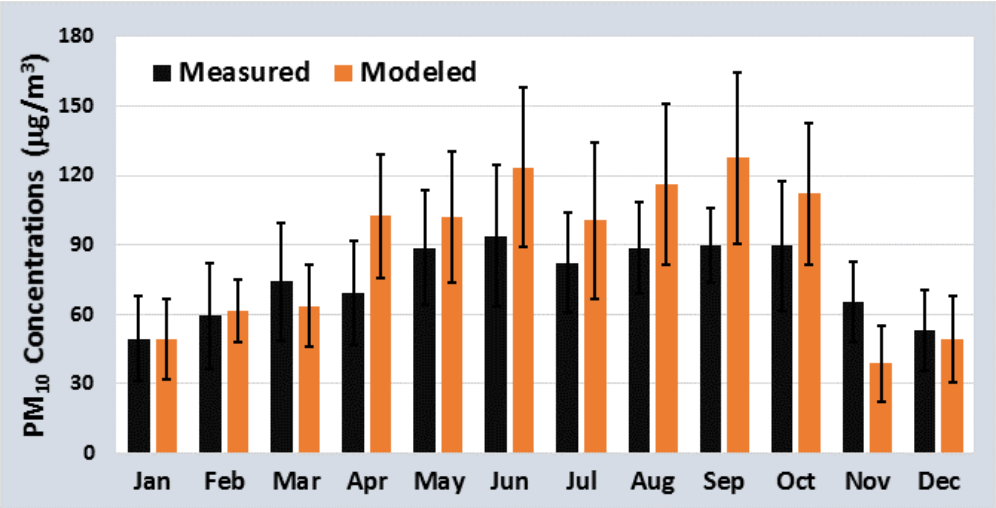
In addition to developing an emissions inventory for the Greater Jakarta Region (see "Emissions Inventory" fact sheet), we also modeled the ground level concentrations of PM2.5 to quantify the health impacts of the growing air pollution. Of all the pollutants, the public health concerns are focused on PM 2.5, which contributes to a host of respiratory and cardiopulmonary ailments. We utilized the Atmospheric Transport Modeling System (ATMoS) dispersion model, using local specific meteorological data[4] to better understand the dispersion of emissions. The model allows for multi-pollutant analysis in which each of the primary emissions are modeled separately due to differences in their physical and chemical characteristics and aggregated for total PM pollution over the city. This includes chemical conversion of SO2 to sulfates and NOx to nitrates[5].

MODELED ANNUAL AVERAGE PM10 CONCENTRATIONS (2012 – BASE YEAR); PERCENT SECTORAL CONTRIBUTIONS FOR THE DESIGNATED URBAN AREA (WHITE BOX) AND A COMPARISON OF THE MODEL EXTRACTED DATA WITH AVERAGED DKI STATION MEASUREMENTS



[4] This model was previously utilized for a number of urban air pollution modeling studies in Asia. The ATMoS model formulation, manual, and application reports are available @ http://www.urbanemissions.info
A summary of the meteorological data is presented in Chapter 2, is collated from NCEP reanalysis fields for 2012 and processed through WRF 3.5.1 meteorological model for data at final resolution

[5] These rates are specified in the model input file and user has an option to either use the default value or change it accordingly. No chemical transformation is applied to direct PM emissions.



Notes: The pie graphs are shares based on the data extracted for the white box. TR = transport (including road, rail, and air); RD = road dust; DOM = domestic (including household and kiosks); OWB = open waste burning; IND = manufacturing industries; CON = construction activities.

KEY FINDINGS

Using the established concentration-response functions, modeled PM2.5 concentrations, and gridded population, health impacts were estimated for the city. We estimated for the Greater Jakarta region, due to prevalent particulate pollution in the city,

- 3700 premature deaths
- 260,000 asthma attacks
- 85,000 emergency room visits and
- 65 million respiratory symptom days

For comparison[6], one study estimated 7,350 to 16,200 premature deaths per year for the city of Delhi in 2010. For cities similar in size to Jakarta, the estimated premature mortality was 3,600 for Pune, 3,950 for Chennai, 3,700 for Hyderabad, and 4,950 for Ahmedabad. An international study, estimated 14,700 premature deaths for Dhaka, 14,100 for Cairo, 11,500 for Beijing, and 11,500 for Delhi for the year 2000[7].

BREATHE EASY JAKARTA

Supported by: **United States Environmental Protection Agency**

Implementing partners:

[6] All the case study reports are available @ http://www.urbanemissions.info

[7] Other case studies included estimations conducted using the BenMAP tools @ https://www.epa.gov/benmap