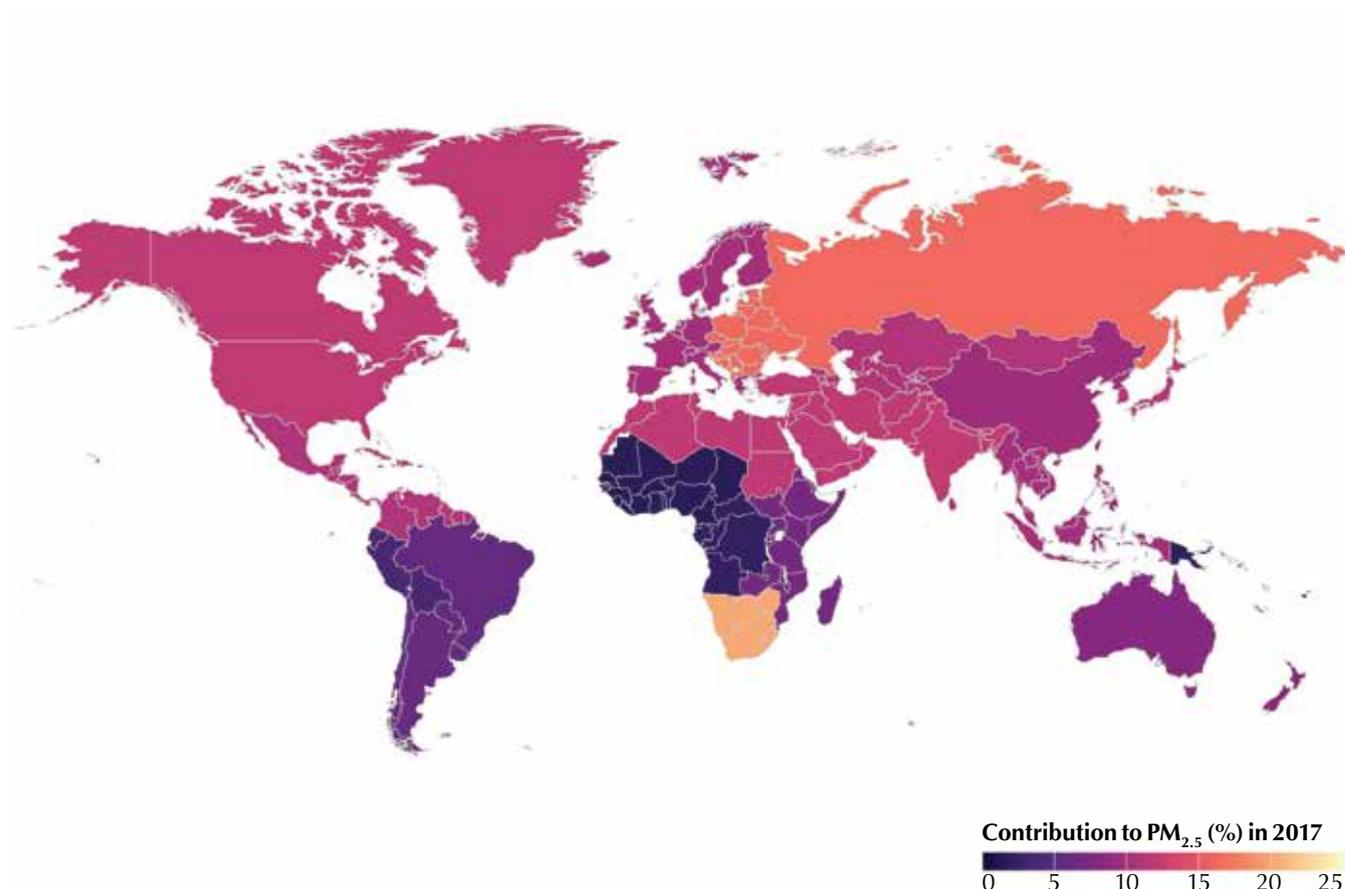


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Study provides first comprehensive global estimates of PM_{2.5} sources and cause-specific disease burden

Global, regional and national results will help inform policies



The contribution of coal combustion to population-weighted PM_{2.5} by region in 2017

“Exposure to air pollution has long been associated with mortality and shortened life expectancy and has been acknowledged as one of the main risk factors that affect people’s health worldwide,” according to the Health Effects Institute (HEI). “Among all air pollutants, fine particulate matter (PM_{2.5}) has been identified as a substantial public health concern.”

Prior assessments have published information on the impacts of outdoor PM_{2.5} and other air

pollutants on air quality and health, HEI explained, but they have not provided detailed information on which sources of air pollution are the biggest contributors to health burden.

Consequently, HEI undertook the Global Burden of Disease from Major Air Pollution Sources (GBD MAPS) project, designed to determine which air pollution sources or fuels contribute most to outdoor PM_{2.5} concentra-

tions and their associated health burden. The study was intended to have a global scope, whereas two previous HEI GBD MAPS studies were conducted in China and India.

The global study was conducted by Dr. Erin McDuffie and Dr. Randall Martin of Washington University in St. Louis, Missouri, US and Dr. Michael Brauer of The University of British Columbia in Canada and their colleagues. HEI

has now published the study report and a summary statement, including findings about the study from an independent review panel.

A multi-step process

The HEI summary statement explained that McDuffie and her colleagues began by expanding and updating the only available global emissions inventory to generate monthly emissions data for 1970 to 2017 for seven key atmospheric pollutants (nitrogen oxides, carbon monoxide, sulfur dioxide, ammonia, nonmethane volatile organic compounds, black carbon and organic carbon); eleven anthropogenic sectors (including agriculture, energy, industry and transportation); and four fuel categories (coal, biofuel, liquid fuel and a remaining category that included industrial processes such as fugitive emissions).

Next, they used the emissions data in an updated global air quality model and combined those results with satellite data to model outdoor PM_{2.5}. They also compared the modeled concentrations of outdoor PM_{2.5} with measurements made at many stations in different countries to confirm the model gave realistic values. Further, they calculated average exposures to outdoor PM_{2.5} for all the people living in different countries and world regions for the source sectors and fuel categories. Lastly, they applied relationships between air pollution and health at different ages to calculate the number of deaths that were related to the outdoor PM_{2.5} sources.

The first comprehensive estimates

In describing the results, the HEI summary stated “the study provides the first comprehensive estimates of source contributions to PM_{2.5} levels and cause-specific disease burden at global, regional and national levels to help inform policy.” The summary also noted that, “major sources of PM_{2.5} varied substantially by coun-

try.” Study findings included the following:

- Energy generation (including both electricity and residential cooking and heating) was the largest source sector.
- Combustion of fossil fuels (coal, oil and natural gas) contributed to an estimated one million deaths globally in 2017 and 800,000 of those deaths were in South Asia or East Asia.
- Fossil fuel combustion accounted for 27.3% of all deaths from outdoor PM_{2.5}. Of that percentage, 50% was due to coal and the other 50% to a combination of liquid fuel and gas.
- Biofuel and remaining emissions from fossil fuels and other sources also had substantial contributions that exceeded those of fossil fuels in some places.
- Agriculture was an important contributor to health burdens from exposure to outdoor PM_{2.5} in some regions due to emissions of ammonia, which is a precursor to PM_{2.5}.
- International shipping and agriculture sectors had higher impacts than are widely recognized.
- Windblown dust was the source sector that had the most variation.

Findings of an independent review panel

HEI also had the investigator’s report independently reviewed and included those findings in the summary statement.

The review panel concluded the study’s strengths were its global perspective, application of standardized methods across countries and the availability of data and code.

Strengths of the approach included the most recent updated emissions data available; current methods for modeling air pollution sources

and combining the models with observations to assess and improve model performance; and methods consistent with GBD methods to allow comparisons with previous GBD MAPS research.

The reviewers also agreed with the investigators that “several sources of uncertainty likely vary in magnitude by location and source sector that warrant further investigation.” These include the assumption that all particle mixtures have equal effects on mortality; the quality and quantity of emissions and air quality data in different regions; and the method to exclude emission from source sectors one by one.

In particular, the assumption that all particles are equally toxic could have important implications for policy given that natural sources with high uncertainty in emissions estimates appear to dominate anthropogenic sources in several

The Health Effects Institute (HEI) is a nonprofit corporation and an independent research organization. Established in 1980, it aims to provide “high-quality, impartial and relevant science on the effects of air pollution on health. Its research is selected, overseen and peer reviewed by leading subject matter experts on environment and health without involvement of HEI’s public or private sponsors.

It is jointly funded by the United States Environmental Protection Agency (EPA) and other public and private organizations in the United States and around the world.

HEI has funded more than 340 research projects in North America, Europe, Asia and Latin America, the results of which have informed decisions regarding carbon monoxide, air toxins, nitrogen oxides, diesel exhaust, ozone, particulate matter and other pollutants.”

regions, for example, windblown dust in the western sub-Saharan region of Africa.

Valuable additions to our understanding

“Overall,” the review panel found, “the major conclusions of the analysis, especially at the global scale are valuable additions to our understanding of how the range of different sources of air pollution contribute to exposure and health burdens. The results and new datasets will support the active development of finer scale air quality management strategies that focus on specific source sectors.”

“Our key objective,” McDuffie said, “was to identify major sources of PM_{2.5} pollution and to understand how these sources change around the world. In some countries, our results are some of the first pieces of information they have on the major sources in their region.”

All input data, results and visualizations have been made publicly available (at www.gbdmaps.med.ubc.ca) to allow for future extensions and comparisons by other researchers, and to support the active development of finer scale air quality management strategies that focus on specific source sectors.

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