HEI update

HEALTH EFFECTS INSTITUTE

Chicago skyline along Lake Michigan, viewed through Henry Moore's sundial sculpture *Man Enters the Cosmos*.
PHOTO COURTESY OF CHOOSE CHICAGO

Sign Up Now for HEI's 2018 Annual Conference

With an innovative and wide-ranging mix of topics including urban design, diabetes, and traffic-related pollution — along with new scientific methods and best practices — an intriguing agenda is planned for HEI's 2018 Annual Conference, to be held at the Drake Hotel in Chicago, Illinois, from April 29 through May 1.

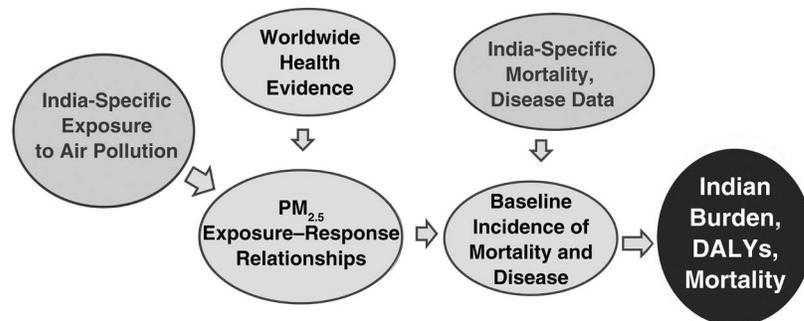## Major HEI Report Estimates India's Health Burden from Wide Range of Sources of Air Pollution

In early January, HEI published Special Report 21, *Burden of Disease Attributable to Major Air Pollution Sources in India*, providing the first comprehensive analysis of the sources of fine particulate matter air pollution in India and their impacts on health.

The study takes advantage of India's growing network of air pollution monitors and enhanced satellite data, and is the first to estimate the exposure state by state throughout India from different air pollution sources: biomass burning, transport, coal, and more. It then builds on Indian health evidence and data from the multi-institutional Global Burden of Disease project to identify current and future nationwide burdens of disease attributable to each major source across India.

The analysis shows that in 2015, household burning of biomass was the largest contributor to outdoor air pollution and health impact, followed closely by burning of coal by power plants and industry. Emissions from agricultural burning of crop residues, various sources of anthropogenic dusts, transport, other diesel, and brick kilns also contribute significantly. The report identifies in detail the increasing health challenges posed

Burden of Disease Estimation

India-Specific Exposure to Air Pollution

Worldwide Health Evidence

India-Specific Mortality, Disease Data

$PM_{2.5}$ Exposure–Response Relationships

Baseline Incidence of Mortality and Disease

Indian Burden, DALYs, Mortality

Overview of the methods for estimation of the burden of disease in India. DALYs = disability-adjusted life-years, or years of healthy life lost to illness, disability, or premature death. (From HEI Special Report 21)

Also in This Issue

"Street Canyons" Study Adds a Dimension to Exposure Modeling

With rapid urbanization, high-density, high-rise megacities have become very common globally. So far, models to estimate exposure to air pollution have been largely two-dimensional. HEI recently published Research Report 194, *A Dynamic Three-Dimensional Air Pollution Exposure Model for Hong Kong*, which discusses a study led by Benjamin Barratt of King's College London, United Kingdom.

Barratt and his team developed a dynamic three-dimensional land-use regression (LUR) model for Hong Kong and used it to estimate exposure to traffic-related air pollution at upper building stories as well as at street level. The investigators developed different exposure models with increasing complexity (e.g., incorporating infiltration of outdoor pollutants, vertical gradients at higher floors, and time–activity patterns). Those

models were applied in an epidemiological study using an existing elderly cohort of 66,000 Hong Kong residents to evaluate the potential impact of exposure measurement error on mortality estimates.

Barratt and colleagues found that associations were fairly similar when comparing results from the complex models to the two-dimensional models. Neither the incorporation of vertical gradients nor that of dynamic components, including outdoor pollutant infiltration, into the exposure estimates resulted in meaningful or consistent changes in the associations with all-natural-cause, cardiovascular, and respiratory mortality in the cohort.

In its independent review of the study, the HEI Review Committee concluded that Barratt and colleagues conducted a novel study — one of the first to integrate vertical gradients and time–activity patterns into an

A street canyon formed by large residential towers in the Kowloon district of Hong Kong. (From HEI Research Report 194)

air pollution exposure model. The extensive air quality measurements, the development of exposure models using state-of-the art approaches, and the application of those

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Technical sessions are as follows:

Pre-Conference Workshop: Causal Modeling in Air Pollution Research and Policy

Recent years have seen a growing interest in the application of modeling methods to systematically explore causal relationships between air pollution and health. This session will bring together experts in causal modeling to introduce different methods, provide critical perspectives on their potential contributions and limitations, and discuss their interpretation within the broader context of how to understand whether an exposure is or is not causing effects. Open to all conference attendees.

Ozone: Global Pollutant, Personal Effects

Ozone is a secondary pollutant that is regulated through the National Ambient Air Quality Standards (NAAQS), which are reviewed every five years; the next ozone review is due to start soon. This session will discuss challenges in controlling ozone levels, including atmospheric transport across continents and climate change, and the current science-based evidence that will contribute to the ozone health assessment. The session will end with a discussion of challenges facing those who must work to implement the ozone NAAQS.

A Special Event: Keynote Address on the Future of the Car and Urban Mobility

The conference's first evening will be highlighted by a keynote address on the rapidly changing nature of transportation — with shared ride services, electric and autonomous vehicles, and more — by Venkat Sumantran, chairman of Celeris Technologies and coauthor of *Faster, Smarter, Greener: The Future of the Car and Urban Mobility.*

Health Effects of Traffic-Related Air Pollution

This session will discuss important factors related to the design and interpretation of health studies of traffic-related air pollution (TRAP). It is intended to aid the scope of a new systematic review to update HEI's 2010 review of the health effects of TRAP. We

will introduce the Traffic Review Panel and announce new HEI studies on TRAP, taking into account other factors, such as noise, socioeconomic status, and green space.

Air Pollution and Diabetes: What Is the Evidence?

Diabetes and obesity, as well as air pollution, are known risk factors in the development of cardiovascular and respiratory diseases. Air pollution is associated with development of diabetes in adults, and there is some evidence that early-life exposure in children may be associated with diabetes later in life. This session will discuss the evidence, who is most susceptible, and what mechanisms are behind these observations.

Can We Rely on Environmental Health Research?

Awareness has grown during the last decade that many scientific studies have not been reproducible and the problem seems to be particularly widespread in certain fields. Environmental standards are health based, and there have been long-standing debates about replicability and reproducibility (including data access, analysis, and quality) of the studies underpinning regulations. Questions about reproducibility have been discussed in scientific journals and are reflected in congressional efforts at transparency. This session will describe these issues and present examples of the best practices being undertaken to strengthen confidence in scientific results.

The Power of Place: Pathways to Healthy Urban Living

More than half of the world's population now lives in urban areas, and this number is expected to increase because of continuing population growth and urbanization. Air pollution and noise, along with interrelated factors such as physical inactivity, lack of green space, stress, and socioeconomic deprivation, are associated with adverse health. This session will explore how integrated urban design, transport planning, and new mobility and transportation technologies can improve city residents' health and reshape cities in the future. HEI

Conference program updates, registration, and hotel information are available at *www.healtheffects.org/annual-conference*.

Energy Research Program Launched

Diverse Stakeholders Inform Strategy for First Year

HEI kicked off its new Energy Research Program with a public meeting on January 17. Hosted by HEI's new Energy Research Committee, the meeting brought together a wide range of stakeholders to discuss recommendations for Year 1 of the program, which will explore potential health effects associated with oil and natural gas development from unconventional resources.

George Hornberger,
VANDERBILT UNIVERSITY

and future research challenges and opportunities. These reviews will summarize what is known and what knowledge gaps remain, and the Committee will then plan accordingly for original research, which will begin in Year 2.

"The new, independent Energy Research Program will bring credible science to bear on discussions of the potential for population exposure and health effects associated with the development of oil and natural gas from unconventional resources," said HEI Vice President Bob O'Keefe. "This effort represents a significant expansion of HEI's model to address questions involving not only oil- and gas-related emissions to air, but also releases to water and other potential points of exposure that might have health effects. The launch of this program is a testament to the value of the HEI model and our unique ability to offer trusted science to shed light on key national priorities."

The Energy Research Committee defines and oversees the multidisciplinary research program in collaboration with HEI staff. To ensure the highest scientific quality and integrity of the research program, the Committee consists of members who were chosen because they are internationally recognized experts in one or more subject areas relevant to the Committee's work, have demonstrated their ability to

Kevin Teichman of the U.S. Environmental Protection Agency, left, with Ted Russell and Judy LaKind, both of the HEI Energy Research Committee.

From left: Shari Dunn-Norman and Elaine Faustman, both of the HEI Energy Research Committee, and Nicole Deziel of the Yale School of Public Health.

conduct and review scientific research impartially, are independent of sponsor organizations, and have been vetted for conflicts of interest. HEI is pleased to announce the first seven members of the Energy Research Committee:

George Hornberger, Vanderbilt University, Director, Vanderbilt Institute for Energy & Environment, Nashville, Tennessee (Chair)

Shari Dunn-Norman, Missouri University of Science and Technology, Rolla, Missouri

Elaine M. Faustman, University of Washington–Seattle

Howard Hu, University of Toronto, Ontario, Canada

Judy S. LaKind, LaKind Associates, LLC, and University of Maryland–Baltimore

Armistead (Ted) G. Russell, Georgia Institute of Technology, Atlanta, Georgia

Stefanie Ebelt Sarnat, Emory University, Atlanta, Georgia HEI

For more information about the Energy Research Program, visit *www.healtheffects.org/energy*.
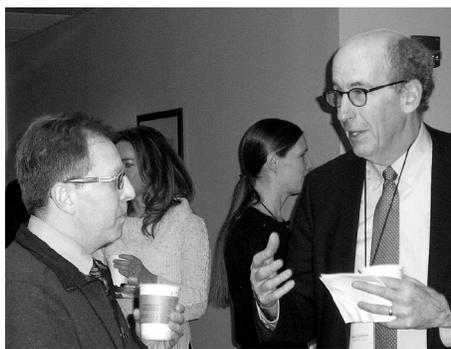

From left, Elena Craft and Cloelle Danforth, both of the Environmental Defense Fund, with Martha Rudolph of the Colorado Department of Public Health and Environment.

Ten speakers from federal and state government, nongovernmental organizations, community groups, industry, and academia engaged in a productive exchange with the Committee and other meeting participants about HEI's plans for its systematic review of the health literature, its review of the exposure literature,

Donna Vorhees, HEI Director of Energy Research, with Adam Pacsi of Chevron.

Aubrey Miller, National Institute of Environmental Health Sciences (left), with HEI President Dan Greenbaum.

by the many sources of air pollution in India, but it also highlights the significant progress that could be made under both current and future control policies.

The study was conducted collaboratively by the Indian Institute of Technology Bombay, HEI, the Institute for Health Metrics and Evaluation at the University of Washington, Seattle, and the University of British Columbia. It is the second major publication of HEI's Global Burden of Disease from Major Air Pollution Sources (GBD MAPS) project (described at *www.healtheffects.org/global/global-burden-disease*).

The GBD MAPS team publicly presented the report at a packed workshop in New Delhi, India, on January 11 (see "Communicating the Science," page 5).

This new report, published after rigorous analysis and peer review, builds on the recently completed, comprehensive, India-wide GBD analysis released in November 2017: *India: Health of the Nation's States,* which identified air pollution, both outdoors and in households, as the second most serious risk factor for public health in India, after malnutrition, contributing to 6.4% of all healthy years of life lost in 2016.

Air Pollution in India: A Nationwide Challenge

India has some of the highest levels of outdoor air pollution in the world. Even as there has been growing attention to the air pollution levels in Delhi, HEI's new report highlights the levels of air pollution across the entire country.

The premature mortality attributed to air pollution in India contributed to more than 29 million healthy years of life lost; overall, air pollution contributed to nearly 1.1 million deaths in 2015. Given that most Indians live outside the major cities, most (75%) of this burden falls on the populations in rural areas.

India has begun to implement clean fuels and pollution control programs for households, power plants, vehicles, and other sources. Nevertheless, as the Indian population grows and ages and as economic activity continues to expand, the health impacts from air pollution will increase, with rising numbers of people becoming susceptible to the heart and lung diseases that are tied most closely to air pollution exposure.

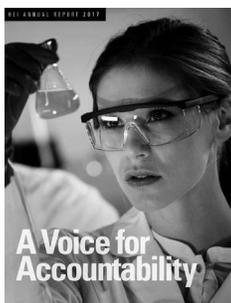### Significant Opportunities for Improvement

The GBD MAPS study evaluated three future scenarios with differing policies for energy use and pollution control. According to its analysis of a 2050 scenario with no further control actions, the health burdens would increase to more than 73 million healthy years of life lost and more than 3.6 million deaths in 2050. However, the study analyzed two scenarios with increasing levels of emissions reduction and concluded that the most stringent control actions could avoid more than 1.2 million annual deaths in 2050 if implemented. The specific actions analyzed for each major sector are described in detail in the report.

"Looking ahead," said HEI President Dan Greenbaum, "the opportunities for innovative and cost-effective actions to control air pollution — some of which are already beginning — provide an opportunity to address these potential health burdens before they grow substantially, even while improving the efficiency of the economy." HEI

A summary of the study is available in Hindi and English at *www.healtheffects.org/publication/gbd-air-pollution-india,* along with the full report.

Annual Report for 2017 Now Available

The 2017 Annual Report, *A Voice for Accountability,* describes the HEI model for delivering high-quality, impartial, and relevant science to inform public policy decisions about air quality and public health. The report outlines HEI's latest initiatives, including new reports from accountability studies examining whether regulations achieved their aims of improving air quality and public health; further efforts to make data underpinning HEI studies freely available; the Institute's recent analyses in the developing world, particularly in China and India, as part of its Global Burden of Disease from Major Air Pollution Sources project; and the launch of HEI's Energy Research Program to study the potential impact on health from unconventional oil and natural gas development. HEI

models to an existing Hong Kong elderly cohort for epidemiological analyses were strong aspects of the study. On the other hand, the investigators encountered many challenges in the study and had developed approaches to compensate for those challenges in a variety of ways; however, the impacts of some of the workarounds on the results were not fully explored. Sensitivity analyses revealed the influence of substituting the modeled two-dimensional LUR estimates for missing measurements at lower floors and assuming that the air was well mixed at heights above 20 meters. The Committee thought more insights were gained from the vertical gradient model than from the dynamic component of the model because the latter was based on aggregated survey data, which makes interpretation difficult.

The Committee noted that based on this and other work, it appears that the addition of a vertical gradient improves exposure model performance, although the added value may be modest, depending on the pollutant and the study area. HEI

Research Report 194 is available for downloading, free of charge, at *www.healtheffects.org/publications.* For more information, contact Hanna Boogaard *(jboogaard@healtheffects.org).*

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Communicating the Science

Shaikh at Pacific Basin Consortium

HEI Director of Science Rashid Shaikh delivered a plenary lecture on "Air Pollution and Health — Epidemiology to Drive Policy" at the *17th International Conference of the Pacific Basin Consortium for Environment and Health,* cohosted by the Public Health Foundation of India. The conference, titled "Environmental Health and Sustainable Development," was held at the India Habitat Centre, New Delhi, India, in mid-November. The meeting brought together scientists, engineers, policy makers, industry representatives, government officials, and students to present research in areas relevant to human and environmental health and examine ways to address environmental issues. Shaikh presented findings from a range of HEI studies, including HEI's principal studies of particulate matter and health, and the 2011 Indian results of the HEI Public Health and Air Pollution in Asia (or PAPA) program. He also chaired a symposium featuring U.S. and Indian experts on measuring and controlling ambient air pollution.

Joint Workshop on India Pollution Findings

In January, HEI Special Report 21, *Burden of Disease Attributable to Major Air Pollution Sources in India* (see related story, page 1), was the focus of a joint scientific workshop in New Delhi, India, cosponsored by the Health Effects Institute, the Public Health Foundation of India, and the Indian Institute of Technology Bombay (IIT Bombay). HEI Principal Scientist Katy Walker welcomed the

From left, Kalpana Balakrishnan, Michael Brauer, and Chandra Venkataraman at the meeting in Delhi, India.

nearly 50 scientists, discussing the history of HEI's Global Burden of Disease from Major Air Pollution Sources project, its major goals, and scientific partnerships. The Special Report's main contributors presented the study's methods and results: Kalpana Balakrishnan of Sri Ramachandra Medical College & Research Institute, who chaired the workshop; Chandra Venkataraman of IIT Bombay; and Michael Brauer of the University of British Columbia and the Institute for Health Metrics and Evaluation. HEI

HEI in the News

Findings on the health impact of India's domestic air pollutants detailed in HEI Special Report 21, *Burden of Disease Attributable to Major Air Pollution Sources in India* (see related story, page 1) attracted wide media coverage. Some examples:

NDTV (New Delhi Television)

"Domestic Biomass Burning Deadliest Air Pollution Source in India: Study" (January 12, 2018)

The Times of India

"Chulhas Linked to 25% of Pollution-Related Deaths in India" (January 12, 2018)

CNN

"75% of India's Air Pollution-Related Deaths Are Rural, Study Finds" (January 15, 2018)

Financial Times

"Home Fuel Blamed for 25% of India's Air Pollution Deaths" (January 11, 2018) HEI

Greenbaum on Expert Team for National Academies' "Grand Challenges" Initiative

HEI President Dan Greenbaum is among a group of experts in diverse disciplines who are guiding a U.S. initiative to identify the greatest future challenges for environmental engineering and research.

The group's recommendations will appear in a forthcoming study from the National Academies of Sciences, Engineering, and Medicine titled *Grand Challenges and Opportunities in Environmental Engineering for the 21st Century,* which, according to an official statement, is designed to "identify high priority societal challenges for the next several decades that will require the expertise of environmental engineering to resolve or manage." The study also will describe how these fields — and colleges and universities — might evolve to better address such challenges.

Greenbaum has been lending his expertise on urban air pollution and planning to the development of the set of challenges to be included. Once the analysis is released, he and other committee members will share and discuss the challenges identified with a range of professionals — educators as well as practitioners — involved in environmental engineering and science. These meetings are open to the public. HEI

An electronic version of the final report will be available to download at *www.nap.edu* upon completion of the study. For further information visit *http://nas-sites.org/dels/eechallenges/faq-about-the-study/*.

Ole Raaschou-Nielsen, a professor at the Danish Cancer Society Research Center in Copenhagen, Denmark, and colleagues will evaluate effects of traffic-related air pollution and other factors on myocardial infarction, stroke, diabetes, and related biomarkers in Denmark. They will make use of various cohorts, including an administrative cohort covering the entire Danish population in the period 1993–2018. They will assess traffic-related air pollution using the AirGIS dispersion model for pollutants, including PM_{10}, $PM_{2.5}$, NO_2, black carbon, and ultrafine particles, which can help distinguish different sources. In addition, they will assess noise using the Nordic Prediction Method, which incorporates detailed information about street and building geometry, among many other features. They plan to assess numerous other factors, including SES, stress, and comorbidities.

These studies are expected to start this spring and be completed within four years. The investigators have been invited to present posters at the 2018 HEI Annual Conference in Chicago with details of their study plans. HEI

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New Studies to Assess Adverse Health Effects of Traffic-Related Pollution

HEI will fund three studies in a new research program aimed at assessing adverse health effects from exposure to traffic-related air pollution. The program's request for applications (RFA 17-1), issued in January 2017, solicited studies that would consider such health effects and disentangle them from spatially correlated confounding or modifying factors — most notably, traffic noise, socioeconomic status (SES), and the built environment, including green space.

The response to the RFA was strong: HEI received 51 preliminary applications. The HEI Research Committee then invited 11 full applications. These were reviewed and scored by an ad hoc panel of experts, after which the Research Committee reviewed and discussed the top-ranked ones. Important criteria in deciding which studies to recommend for funding were the novelty of the approach, responsiveness to objectives of the RFA, the overall design, and the likelihood that the study will accomplish its proposed aims.

The studies recommended by the Research Committee were approved by the Board of Directors. They are described below.

Meredith Franklin, an assistant professor at the University of Southern California, and her colleagues will build on the Children's Health Study (CHS) in Southern California (the subject of a previous HEI study led by Frank Gilliland; see HEI Research Report 190). The goal of the study is to evaluate the adverse effects of non-tailpipe emissions and of noise on children's respiratory health. They will make use of "Cohort E," which is the most recent CHS cohort, with children ages 5–15 recruited from 2002 to 2012, and with longitudinal data on asthma and lung function. They will develop a new exposure model for non-tailpipe PM metals using compositional data from existing PM filters at 200 locations in 8 CHS communities, along with data on intersections, freeway on/off ramps, and road slopes. They will use a dispersion model to estimate exposure to tailpipe emissions. For noise, they will use the Federal Highway Traffic Noise Model. In addition, they plan to assess several other factors, such as SES, green space, genetic ancestry, and stress.

Payam Dadvand, assistant professor, and Jordi Sunyer, professor, both at the Barcelona Institute for Global Health (ISGlobal, previously CREAL), Spain, and colleagues will set up a new cohort of healthy pregnant women in Barcelona, Spain, from 2018 to 2020. They will assess birth weight, fetal growth trajectories, and placental function for each pregnancy. Exposure to traffic-related air pollution will be estimated using hybrid models, including land-use regression and dispersion models for various pollutants. In addition, personal measurements for NO_2 as well as home outdoor measurements for NO_2, $PM_{2.5}$, and traffic noise will be obtained. Data on time–activity patterns will be collected and used in combination with exposure measurements to estimate dose of inhaled pollutants. The statistical analyses will aim at disentangling the roles of noise and socioeconomic status, and will include metrics for green space, physical activity, diet, and stress.