HEI HEALTH EFFECTS INSTITUTE

update

WINTER 2019

UPCOMING HEI REPORT, DATA SET, AND WEBINAR

Have Vehicle Emissions Changed?

Measuring Progress in Hong Kong and Baltimore, Maryland, Tunnels

Traffic emissions are a key source of urban air pollution, and exposure to traffic-related air pollution is associated with various adverse health effects. Emissions from motor vehicles have decreased over the past few decades because of new fuels, changes in engine designs, and improved emission-control technologies. One approach to evaluating the decline in emissions is to repeatedly measure air quality in traffic tunnels and relate the emissions changes over time to changes in vehicle fleets. The forthcoming Research Report 199, *Real-World Vehicle Emissions Characterization for the Shing Mun Tunnel in Hong Kong and Fort McHenry Tunnel in the United States*, describes such a study by Xiaoliang Wang and colleagues from the Desert Research Institute.

Wang and his team characterized real-world mobile-source emissions of more than 300 pollutants in the two tunnels. About 55,000 vehicles pass through each tunnel per day, an average that has not changed much since previous studies were conducted in 2003–2004 in Hong Kong and in 1992 in Baltimore. The Hong Kong tunnel has

Continued on page 2

The Space Needle and Mt. Rainier are iconic features of the Seattle skyline.

PHOTO: VISIT SEATTLE

Sign Up Now for HEI's 2019 Annual Conference

This spring HEI invites you to the Pacific Northwest for its 2019 Annual Conference, happening May 5–7 in Seattle, Washington. A multinational audience of scientists, institute sponsors, and policy makers will join HEI at the W Seattle Hotel, where lively sessions will feature the latest research on air pollution and health. Topics include the following:

New Mobility: Changing Health?

Mobility systems are undergoing a paradigm shift and have the potential to significantly change the way people travel. Rideshare businesses are expanding, and innovations and investments in electric and autonomous vehicles are increasing. In response, the relationship between transportation and air quality is also expected to change, but the actual path that change will take is not yet known. Session presenters and a panel will explore the likely impact of emerging mobility trends on current and future air quality and health.

Continued on page 5

Also in This Issue

one bore in each direction with about an equal number of diesel and gasoline vehicles passing through and a smaller but growing number of liquefied petroleum gasoline (LPG) vehicles. The Baltimore tunnel has two bores in each direction, one

The Fort McHenry Tunnel in Baltimore, Maryland.
MARYLAND TRANSPORTATION AUTHORITY

that allows only light-duty vehicles (mostly gasoline) and one where heavy-duty vehicles (mostly diesel) are also permitted. By measuring different proportions of the various vehicle types at different times and in different bores, investigators estimated diesel versus nondiesel (gasoline and LPG) emissions.

The investigators used the data from the 300-plus pollutants to derive pollutant-specific emission factors for the diesel, nondiesel, and total fleets. They then compared their results for the major traffic-related air pollutants with data from previous studies in the same tunnels and tunnel studies in other locations. In addition, they conducted source apportionment to tease apart various source contributions (such as from brake and tire wear), and compared the emission factors measured in the tunnels to emission factors from mobile-source emission models used in the regulatory processes of the Hong Kong Environmental Protection Department and U.S. Environmental Protection Agency.

Wang and colleagues found that average emissions from gasoline and diesel vehicles for most pollutants were lower in both tunnels compared with earlier studies in the same tunnels. A notable exception for the Hong Kong tunnel was that average emissions of certain pollutants related to LPG were higher for the nondiesel fleet because the fraction of the fleet that uses LPG fuel had increased since the earlier study. The overall declining emissions trends were supported by the various comparisons with other tunnel studies and by the comparisons with the regulatory models. The investigators also highlighted sources of uncertainty in their results and made suggestions for future research.

In its independent review of the report, the HEI Review Committee appreciated Wang and colleagues' comprehensive set of emissions measurements and emission factors for the two tunnels. Major contributions of this study were that it included the assessment of emission trends over time, compared measured and modeled emission estimates, and synthesized the results from these multiple data sources. The Committee thought that even though the analyses identified uncertainties in some of the results, the major conclusions of the study — that motor vehicle emissions as a whole are declining — were sound.

The data collected in the current study will be made available online. Any researcher who is interested can download and use them to track changes in motor vehicle emissions and to update emissions models used in the regulatory process.

The Shing Mun Tunnel in Hong Kong, China.
PRATH/SHUTTERSTOCK

The study by Wang and colleagues and the resulting data set will be featured in an upcoming HEI public webinar. Please check the HEI website for an announcement and how to register. HEI

Research Report 199 will soon be available for downloading, free of charge, at *www.healtheffects.org/publications*. For more information on the study, contact Allison Patton (*apatton@healtheffects.org*).

New Annual Report Now Available

Our Annual Report on fiscal year 2018, *Promoting Dialogue, Building Trust*, describes how HEI provides a balanced forum where diverse stakeholders find common ground to discuss the Institute's high quality, impartial, and relevant science informing public policy on air quality and public health. The report highlights HEI's latest achievements and initiatives, including:

- "Accountability" studies examining whether air quality regulations achieved their aims,
- progress in studies on the health effects of low levels of air pollution,
- new research HEI is funding to study traffic-related pollution,
- HEI's new Global Health Science initiatives, and
- the strides HEI's Energy Research Program is making to study the potential exposures and impact on health from unconventional oil and natural gas development. HEI

The Annual Report is available for downloading at *www.healtheffects.org/about/annual-report*.

Attention Scientists: RFA Reminder

HEI is currently seeking preliminary applications for the 2019 Walter A. Rosenblith New Investigator Award. Successful candidates will be promising scientists at the assistant professor or equivalent level who are conducting research on air pollution and health. Applications are due by April 15, 2019. For more information and to apply, visit *www.healtheffects.org/research/funding*.

In addition, HEI will soon open its search for investigators who are "Applying Novel Approaches to Improve Long-term Exposure Assessment of Outdoor Air Pollution for Health Studies." This request for applications (RFA 19-1) will solicit studies to advance exposure assessment for air pollution and health using sensors, satellite data, and other approaches. Check for updates at *www.healtheffects.org/research/funding*.

Two Studies Examine Secondary Organic Aerosols

HEI will soon publish two studies that have investigated the reactivity and early biological effects of different secondary organic aerosols (SOAs) generated in an environmental chamber. SOAs are a form of fine particulate matter created in the atmosphere from photochemical reactions among volatile compounds. The chemistry involving their formation is highly complex and depends on many factors, such as temperature, humidity, sunlight, and the concentration of nitrogen oxides (NO_x) as well as other pollutants emitted from natural and human sources.

Although SOAs are not regulated directly under the National Ambient Air Quality Standards, they account for a large fraction of particulate matter less than 2.5 µm in diameter ($PM_{2.5}$) in many areas of the United States; they influence both climate and human health.

These new HEI studies were conducted by recipients of the Walter A. Rosenblith New Investigator Award. Both studies explored the ability of SOAs to generate reactive oxygen species (ROS), which can be analyzed using the dithiothreitol (DTT) assay, indicating the oxidative stress (or oxidative potential) of the biological system. However, each study had a unique focus and design, summarized below.

HEI Research Report 197, *Cellular and Acellular Assays for Measuring Oxidative Stress Induced by Ambient and Laboratory-Generated Aerosols*

For this study, Nga (Sally) Ng of the Georgia Institute of Technology and colleagues used SOAs generated from six volatile organic compounds. Three were derived from anthropogenic sources (*m*-xylene, naphthalene, and pentadecane) and three were derived from biogenic sources (isoprene, α-pinene, and β-caryophyllene). SOAs were generated in an environmental chamber in the presence of sunlight and ammonium sulfate, which acts as "seed" onto which the semivolatile compounds condense.

Ng tested different conditions (including varying humidity, NO_x levels, and redox-active metals). In addition, she studied ambient $PM_{2.5}$ collected in the Atlanta metropolitan area. All the samples were collected on filters and extracted in aqueous solution. Ng measured the oxidative potential of the extracts in the DTT assay, and the production of ROS and two inflammatory mediators (IL-6 and TNF-α) in alveolar macrophages (obtained from mice) that were grown in culture. Using the dose–response relationship observed in such experiments, she calculated several metrics to quantify the oxidative stress response.

HEI Research Report 198, *Understanding the Early Biological Effects of Isoprene-Derived Particulate Matter Enhanced by Anthropogenic Pollutants*

Jason Surratt of the University of North Carolina at Chapel Hill and colleagues focused on SOAs derived in an atmospheric reaction chamber from the photochemical oxidation of isoprene and those from downstream oxidation products of isoprene (epoxides and hydroperoxides). They measured the SOAs' oxidative potential in the DTT assay and their ability to alter gene expression in a human bronchial epithelium cell line.

Surratt used two methods to expose the cells to the SOAs: a 1-hour direct exposure in an Electrostatic Aerosol in Vitro Exposure System followed by incubation in fresh medium for 9 hours, at which time the extracellular medium was collected for analysis; or resuspension exposure for 9 hours, followed by the analysis. The former method was used only for isoprene-derived SOAs. The study of gene expression focused on three inflammation- and oxidative stress-related genes — interleukin 8, prostaglandin-endoperoxide synthase 2, and heme oxygenase 1 — as well as on two panels of genes: a panel of 84 human oxidative stress-associated genes and a panel of 249 human inflammation-associated genes.

Committee Assessment of Studies

In its independent review of the two studies, the HEI Review Committee concluded that both investigators had conducted systematic and comprehensive research addressing an important question, namely, the role of SOAs and intermediates in producing biological responses. The two studies used different methods and approaches for their analyses, but the Committee thought that they both point to future directions for research on SOAs. HEI

Research Reports 197 and 198 will soon be available for downloading, free of charge, at *www.healtheffects.org*. For more information contact Rashid Shaikh, *rshaikh@healtheffects.org*.

Symposium Shares Initial Findings and Progress of HEI Energy Research

In early December, HEI's Energy Research Program coordinated a symposium as part of the Society for Risk Analysis 2018 Annual Meeting in New Orleans, Louisiana.

Presenters summarized preliminary findings from the HEI Energy Research Committee's review of what scientists currently know about potential human exposure and health effects from unconventional oil and natural gas development. They described the Committee's approach to planning for population-level exposure research to address important knowledge gaps.

Two HEI staff members, Donna Vorhees and Anna Rosofsky, and two members of HEI's Energy Research Committee, Judy LaKind and chair George Hornberger, organized the symposium. They provided three presentations about literature on exposure, risk assessment, and epidemiology, and a final talk summarizing the Committee's research planning to date and attributes of research that HEI anticipates funding in the future.

The Committee will finalize its reviews of the literature and, informed by them, issue a solicitation for population-level exposure research later this year. HEI

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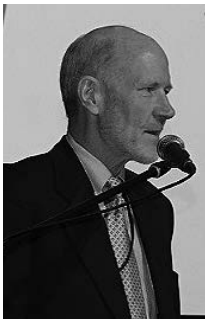
HEI at Better Air Quality Conference

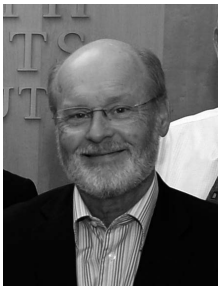
HEI's Global Health program focuses on bringing the latest science on air quality and health to inform environmental policy in developing Asia. As part of this effort, HEI presented its most recent results at the 2018 Better Air Quality (BAQ) conference in Kuching, Malaysia, in November. The meeting is hosted every two years by Clean Air Asia, a premier institute focused on Asian air quality that brings together government officials, researchers, industry experts, and nongovernmental organizations from more than 50 countries and 200 cities around the world.


Robert O'Keefe.

HEI Vice President Bob O'Keefe delivered an opening keynote address presenting study findings on India and China from HEI's Global Burden of Disease from Major Air Pollution Sources (GBD MAPS) project and its forthcoming *State of Global Air 2019* study, highlighting the health impacts of coal and other major sources across Asia. The GBD MAPS analysis aims to provide a comprehensive understanding of the impact of air pollution sources on human health as a means to foster priority-based air quality management. HEI staff scientist Pallavi Pant presented a detailed overview of GBD MAPS and discussed results from India and China, including the key role of household air pollution, agricultural burning, and other country-specific sources.

The conference also served as the venue for O'Keefe to pass along the gavel after nine years of service as Chair of the Board of Clean Air Asia (CAA). CAA is the network of cities, countries, scientists, and other stakeholders from across Asia dedicated to improving air quality and health. In recognition of his service, O'Keefe was named as CAA's Chair Emeritus. HEI

Frampton Thanked for Exemplary Service


Mark Frampton.

After serving with distinction on the HEI Review Committee for the past nine years, Mark Frampton stepped down in January. Frampton is Professor Emeritus of Medicine and Environmental Medicine at the University of Rochester Medical Center in upstate New York. His research focuses on pulmonary medicine and the effects of air pollution on health. He has conducted extensive research on the effects of inhalation of ultrafine particles on endothelial function in healthy and susceptible people. He has performed research on air pollutants such as ozone and nitrogen dioxide and has also studied man-made nanoparticles

Over the years Frampton has participated in numerous panels and advisory groups for the U.S. Environmental Protection Agency (EPA) and the American Thoracic Society. Recently the EPA appointed him a member of the newly constituted Clean Air Act Science Advisory Committee.

Frampton was one of the three investigators for the HEI Multicenter Ozone Study in oldEr Subjects (MOSES). On the Review Committee, he helped review numerous toxicological biomarker studies.

"Dr. Frampton's deep insights into mechanisms of disease and human physiology will be missed on the Review Committee," said HEI Director of Science Rashid Shaikh. "He has been a highly valued member of the Committee, and we will miss his considered opinions and judgments." HEI

HEI Cosponsors Workshop in Shanghai

Scientists Focus on Key Issues for Planning Chinese Air Pollution Epidemiology Research

As China moves aggressively to reduce high levels of air pollution, Chinese scientists in government and leading academic institutions are conducting the research needed to support and inform policy action. In October, leading investigators shared their findings at an International Symposium on Air Pollution and Health hosted by Fudan University (Shanghai), which cosponsored the event with Oxford University (UK), the Chinese University of Hong Kong, and the Health Effects Institute.

The workshop brought together Chinese researchers who lead the major air pollution epidemiological cohort studies in China with international experts. They reviewed the growing body of evidence on ambient and household air pollution and mortality in China, discussed the influence of those findings on current estimates of the global and Chinese burden of disease from air pollution, and identified key research questions for the future. More than 10 research projects were represented.

High on the list of future research priorities were identifying and quantifying the effects of major air pollution sources and components, and what HEI has termed "accountability research" (*www.healtheffects.org/accountability*), measuring the health effects of actions taken to improve air quality in China and tracking the progress of ongoing policy measures in reducing exposure to air pollution. Participants agreed on the need to coordinate analyses among Chinese studies, and to further coordinate them with research initiatives in high-income, low-exposure settings, such as HEI's research program "*Assessing Health Effects of Long-term Exposure to Low Levels of Ambient Air Pollution*."

A workshop report is being prepared for submission to a leading peer-reviewed journal and a symposium is planned for the August 2019 meeting of the International Society for Environmental Epidemiology. The organizers plan to convene such workshops periodically as new studies are published and new projects are launched. HEI

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HEI is a nonprofit organization funded jointly by government and industry to research and evaluate the health effects of air pollution. An overview of HEI, information on its current research program, and all published HEI reports are available for downloading, free of charge, from the website.

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Health Effects of Early-Life Exposure to Air Pollution

Evidence for potential impacts of prenatal and early-life air pollution exposure on health is rapidly increasing, and some birth outcomes are currently being considered for inclusion in Global Burden of Disease estimates. Experts will provide an overview of the state of knowledge on various birth and other childhood health outcomes, consider methodological issues unique to this topic, and discuss longer-term consequences of early-life exposures for adult health.

Global Health: Building Science for Informed Action

In regions where air pollution levels are high, local data on exposures, sources, and related health effects are often limited. While current health burden estimates draw primarily from studies conducted in North America and Europe, efforts are underway to generate locally relevant air quality and health data in developing countries. This session will explore data, methods, and technology developments to characterize air pollution and its sources and health effects in these countries.

Where There's Wildfire, There's Smoke

Wildfire smoke is increasingly recognized as an important source of air pollution, and the frequency and intensity of wildfires are likely to increase with climate change. Wildfires and wildfire smoke composition are complex and dynamic, making exposure characterization difficult. Increasing evidence links air pollution from wildfire smoke to adverse health effects, in particular respiratory morbidity. Scientists and officials on the front line of these discussions will explore perceptions and realities about wildfires and their global impacts.

How Low? Testing Health Effects at the Lowest Levels of Air Pollution

Although ambient air pollution levels are declining in high-income regions, epidemiological studies report associations with health effects at levels below current standards, raising questions about even lower standards. HEI is in the midst of funding three studies investigating the health effects of low-level exposure in very large populations in the United States, Canada, and Europe. This session will present the results currently available from those studies and their strengths and weaknesses identified by an independent HEI Review Panel, and discuss implications for future risk assessment and regulation.

Seattle's Public (Pike Place) Market, in operation since 1907.
JACK SULLIVAN / ALAMY STOCK PHOTO

The HEI Strategic Plan 2020–2025

The Institute's draft blueprint for the future, the *HEI Strategic Plan for Understanding the Health Effects of Air Pollution 2020–2025*, will be presented and discussed. Conference participants are encouraged to suggest and comment on upcoming policy decisions for which enhanced science will be needed and on priorities for HEI's research programs and other activities during the next five years.

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

Finding Solutions for the 21st Century

Greenbaum Serves on National Academies' Committee on Grand Challenges for Environmental Engineering

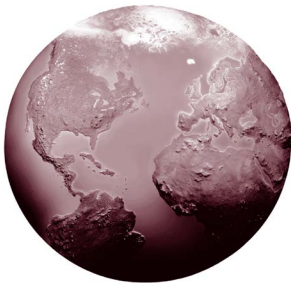
In December, in Washington, D.C., HEI President Dan Greenbaum participated in the widely followed release of a new report, *Environmental Engineering for the 21st Century: Addressing Grand Challenges*, issued by a committee of the National Academies of Science, Engineering, and Medicine on which he had served. The report noted that over the next several decades, as the global population grows, society will be faced with pressing challenges such as providing reliable supplies of food and water; reducing climate change and adapting to its impacts; and building healthy, resilient cities. These challenges call for new and expanded roles for environmental engineers. Thus the report recommends that the environmental engineering field evolve its education, research, and practice "to advance practical, impactful solutions for society's multifaceted, vexing problems."

Environmental engineers have a long history of addressing and making progress on important environmental health issues such as waterborne disease, urban smog, and heavily contaminated sites. Despite that progress, the report points out that pollution and waterborne disease persist around the globe, and billions of people suffer from inadequate access to clean water, food, sanitation, and energy. Meanwhile, human pressures on the environment are accelerating. By 2050, the world's population is anticipated to increase by 2.6 billion people, and climate change and increasing urbanization are adding new stressors to the environment and existing infrastructure.

The report identified five grand challenges that environmental engineers are uniquely poised to help advance:

- Facilitate a sustainable supply of food, water, and energy
- Curb climate change and adapt to its impacts
- Design a future without pollution and waste
- Create efficient, healthy, and resilient cities
- Foster informed decisions and actions

Greenbaum led the committee's work on ideas for developing efficient, healthy, and resilient cities, and spoke about the related needs for research at the December workshop. The report is available at *www.nap.edu/catalog/25121*.



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WINDOW ON TOMORROW

Building the HEI Strategic Plan 2020–2025

Quality science to inform decisions does not just happen — it takes a careful strategic effort, drawing from the best minds in policy and science to ensure that the most relevant answers can be produced in time for key upcoming decisions.

Nowhere is this attention to strategic thinking more important than in the *HEI Strategic Plan for Understanding the Health Effects of Air Pollution*, the document that HEI crafts every five years with its sponsors, the scientific community, and the broader community of environmental and other stakeholders.

"The Plan, which HEI has developed and implemented each five years for the past 25 years, provides an invaluable guide for focusing the Institute's resources. This is all the more necessary as each dollar invested in targeted science becomes more scarce," said HEI President Dan Greenbaum, "and it is out of this plan that HEI's focused requests for applications, special scientific reviews, and other targeted projects evolve."

HEI has now launched its efforts to develop the HEI Strategic Plan for 2020–2025, building on and seeking to enhance the foundation set during the previous five years in these four areas: Assessing the Health Outcomes of Air Quality Improvements (Accountability); Multipollutant Exposure, Epidemiology, and Toxicology Research; Transportation and Urban Health; and Global Health.

"We are also scanning the regulatory arena to identify the range of decisions likely to occur during the next five years. This way, our Plan is as well tuned as it can be to the needs of tomorrow, not just today," Greenbaum added.

To ensure the most responsive Plan, HEI is already undertaking key consultations:

- *Fall–Winter 2018–2019:* HEI senior staff meets with sponsor groups and other stakeholders to gather ideas.
- *March 2019:* The HEI Research Committee and sponsors meet to discuss future research needs.
- *Spring 2019:* HEI presents the first draft of the Strategic Plan at the HEI Annual Conference in May for further input.
- *Summer 2019:* HEI revises the draft Plan and sends it to sponsors, stakeholders, and members of the scientific community for comments and suggestions.
- *Fall–Winter 2019–2020:* A final Plan is formally adopted by the HEI Board of Directors.

Most important to the new Strategic Plan will be getting your ideas. Please look for and comment on the Plan as it is developed — and get in touch even earlier with your ideas by contacting Greenbaum (*dgreenbaum@healtheffects.org*), Vice President Bob O'Keefe (*rokeefe@healtheffects.org*), or Director of Science Rashid Shaikh (*rshaikh@healtheffects.org*). HEI