Still a lot to learn about India's deadly air pollution

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Credit: Josh Apte

What exactly is the relationship between exposure to air pollution and its effect on human health? How much cleaner would the air have to be to reduce the health burden of dirty air? Can cities be designed so as to minimize the flow of air pollution?

There is still a lot that scientists don't know about air pollution, but the severe pollution common in much of India offers scientists an opportunity to better understand its causes and effects. The Department of Energy's Lawrence Berkeley National Laboratory researcher Josh Apte is developing some unique approaches to studying air pollution in India and hopes to apply what he learns to developing global strategies for combating it.

Although India uses the same air monitoring techniques that are standard throughout the world to measure ambient air pollution in major cities, such techniques don't give residents or scientists enough actionable information, in Apte's judgment. "A big limitation with ambient monitoring is it doesn't tell you what people actually breathe," he said. "It gives you some indication of the overall level of air pollution in a city, but it doesn't tell you where the hot spots are, and it doesn't tell you the locations where people are getting the bulk of air pollution exposure."

Air pollution is the number five risk factor for premature death in India, causing three times as many deaths as AIDS and malaria combined. "One thing we can say with quite a bit of certainty is that air pollution is a major risk for premature death in India," Apte said. "Air pollution now kills more people than poor water and sanitation, which historically has been a major cause of death in India."

Specifically, the pollutant that is most harmful to human health is fine particulate matter, or PM2.5, for particles that are less than 2.5 micrometers in diameter. These particles are not visible to the naked eye and can be inhaled deeply into the lungs. The U.S. Environmental Protection Agency considers an annual average concentration in excess of 12 micrograms per cubic meter of PM2.5 to be a health concern, whereas average annual levels in India are on the order of 50 to 150 micrograms per cubic meter, according to Apte.

The primary sources of PM2.5 in India are similar to those of other countries—vehicle tailpipes, power plants, and certain industrial processes. Indian cities and rural areas also have significant unregulated sources, including brick kilns, diesel backup generators, trash burning, and wood-burning cookstoves.

To better measure the types and levels of pollutants that people are breathing, Apte hired an auto-rickshaw and drove it around the roads and highways of New Delhi for four months. The vehicle was outfitted with sensors placed at face height to more precisely measure what a person would inhale. He took two- to three-hour trips every day during the morning and evening rush hours.

Apte, Berkeley Lab researcher Thomas Kirchstetter, and a group of international collaborators collected more than 200 hours of real-time measurements of three types of pollutants: PM2.5, black carbon, and ultrafine particles. "The levels of air pollution are truly astounding," he said. "These are some of the highest levels of air pollution that have ever been measured in traffic anywhere in the world."

Concentrations of PM2.5 were 50 percent higher on the road than in the ambient air. Concentrations of black carbon and ultrafine particles were 3.6 and 8.4 times higher, respectively. Videos he made while driving through traffic clearly show how a large polluting truck passing by can immediately cause sensors to spike. "Fifty percent is a big increase when you consider that the baseline is already very high," he said.

The results from the auto-rickshaw study were previously published in *Atmospheric Environment*. Since then he and other Berkeley Lab researchers have been working on creating a global map showing mortality caused by ambient air pollution and what happens to mortality rates when air pollution is dramatically reduced. "If we have the goal of ultimately removing the burden of disease from ambient air pollution, we need to know how much cleaner we will need to be and what areas of world should be areas of focus," Apte said.

Eventually he hopes to have a real-time map of pollution in Indian cities to decipher how spatial patterns of air pollution vary around cities. "There's a lot we don't know when just looking at air pollution at single points of space," he said.

Apte believes that understanding how urban form is related to air pollution can be a promising way to ultimately design cities of the future to minimize both sources of air pollution and exposure to it. "If we can engineer strategies for 'smart cities' to protect public health, I think it's a tremendous opportunity when we think about the growing cities in Asia," he said.

More information: Paper: eetd.lbl.gov/node/55616

Provided by Lawrence Berkeley National Laboratory

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