

Ozone pollution in India kills enough crops to feed 94 million in poverty

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Smog in India. Ozone, the main component of smog, is a plant-damaging pollutant formed by emissions from vehicles, cooking stoves and other sources. New research shows that ozone pollution damaged millions of tons of wheat, rice, soybean and cotton crops in India in 2005. Credit: Mark Danielson/Flickr

In one year, India's ozone pollution damaged millions of tons of the country's major crops, causing losses of more than a billion dollars and destroying enough food to feed tens of millions of people living below the poverty line.

These are findings /of a new study that looked at the agricultural effects in 2005 of high concentrations of ground-level ozone, a plant-damaging pollutant formed by emissions from vehicles, cooking stoves and other sources. Able to acquire accurate crop production data for 2005, the study's authors chose it as a year representative of the effects of ozone damage over the first decade of the 21st century.

Rising emissions are causing severe [ozone pollution](#) in some of India's most populated regions. Pollution in Delhi, the nation's capital, has reached levels comparable to Beijing, one of the most polluted cities in the world, according to India's Air Monitoring Center.

The main component of smog, ozone at ground level can cause leaf damage that stifles plant growth, injuring and killing vegetation. There are currently no air quality standards in India designed to protect agriculture from the effects of ground-level ozone pollution, according to the new study. Ground-level ozone is formed when nitrogen oxides, carbon monoxide and volatile organic compounds react with sunlight after the chemicals' release from vehicles, industry, or burning of wood or other plant or animal matter.

According to the new study published Aug.14 in *Geophysical Research Letters*, a journal of the American Geophysical Union, surface ozone pollution damaged 6 million metric tons (6.7 million U.S. tons) of India's wheat, rice, soybean and cotton crops in 2005.

India could feed 94 million people with the lost wheat and rice crops, about a third of the country's poor, according to Sachin Ghude, an atmospheric scientist at the Indian Institute of Tropical Meteorology (IITM) in Pune, India and lead author of the new study. There are about 270 million Indians that live in poverty, according to the study.

Wheat – one of the country's major food sources – saw the largest loss

by weight of the four crops studied in the new paper, with ozone pollution damaging 3.5 million metric tons (3.8 million U.S. tons) of the crop in 2005. Another major food source, rice, saw losses of 2.1 million metric tons (2.3 million U.S. tons), according to the new study.

Cotton – one of India's major commercial crops—lost more than 5 percent of its 3.3 million metric ton (3.6 million U.S. tons) annual output in 2005, costing the country \$70 million, according to the new research.

Policy implications

Ghude said the new paper, which is the first to quantify how much damage India's ozone pollution has caused the country's major crops on a national level, could help policymakers craft new ozone pollution standards.

It could also help India, a country with a high rate of poverty, as the country implements a new law that subsidizes grain for two-thirds of the country's residents, he said. The new food security bill requires the country to provide 61.2 million metric tons (67.5 million U.S. tons) of cereal grains – that include wheat and rice – to India's poor each year at a subsidized rate. The new study found that the 5.6 million metric tons (6.2 million U.S. tons) of wheat and rice lost to ozone pollution was equal to 9.2 percent of the new law's subsidized cereal requirement.

"The (amount of lost wheat and rice) are what surprised me," said Veerabhadran Ramanathan, a professor of climate and atmospheric sciences at Scripps Institution of Oceanography, at the University of California San Diego and a co-author of the new study.

Under the new law, residents who qualify to receive cereal at the subsidized rate can purchase 60 kilograms (132 pounds) of grain per year. Based on these numbers, the 5.6 million metric tons (6.2 million

U.S. tons) of wheat and rice lost could therefore feed 94 million people in India, according to the study.

Calculating ozone damage

The researchers calculated the amount of total crop damage from ozone pollution by comparing emissions estimates from 2005 with data about how much ozone each of the four crops could withstand. Plants start to exhibit damage when they are exposed to ozone levels that reach 40 parts per billion or above, according to previous research.

A computer model used by researchers calculated ozone levels during crop growing seasons that were more than 40 to 50 parts per billion over most of the country. The team ran the model with different emissions estimates to come up with an average amount of each crop that was lost due to ozone pollution.

India's economic loss from ozone's harm to crops amounted to \$1.29 billion in 2005, the study found. Declines in rice and wheat crops made up the majority of the loss, accounting for a combined \$1.16 billion in losses, according to the new research.

Despite air quality standards passed in the 1980s to curb industrial and vehicle emissions, cities in India are some of the most polluted in the world, according to the World Health Organization. The number of vehicles on the road in India has nearly tripled in the past decade, with 130 million vehicles on the road in 2013 compared to 50 million in 2003, according to the International Council on Clean Transportation.

Long-term measurements of surface ozone over India – measured on the ground or by aircraft—are not available, making it difficult to get a clear picture of how [ozone levels](#) in the country have changed, Ghude said. But satellite-based studies show ozone has increased over the country in

the last two decades, Ghude said. Warmer temperatures that are expected with climate change could also increase ground-level ozone, according to previous research.

Ramanathan said that unlike most studies, which look at the effect emissions will have on agriculture decades in the future, the new study examined how ozone emissions are already affecting crops in India. He said the new study could help spur interest in the issue and help policymakers enact new air quality standards or mandate use of new technology to cut emissions.

More information: [onlinelibrary.wiley.com/doi/10 ...
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