## Heavy Regional Haze Leads to Reductions In China's Crop Production

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Feeding the world by cleaning the air: study ties heavy regional haze to reductions in China's crop production

A new study suggests that cleaning up the air may help to feed the world.

Published in the November 23 issue of Proceedings of the National Academy of Sciences, the study found that heavy regional haze in China's most important agricultural areas may be cutting food production there by as much as one-third. Covering a million square kilometers or more, the haze scatters and absorbs solar radiation, reducing the amount of sunlight reaching key rice and winter wheat crops. That decreases plant growth and food production.

"For crops that are irrigated and fertilized, there is often a direct correlation between how much is grown and how much sunlight reaches those crops," said Dr. William L. Chameides, professor in the School of Earth & Atmospheric Sciences at the Georgia Institute of Technology. "In China there is a significant amount of haze that reduces the sunlight reaching the surface by at least five percent, and perhaps as much as 30 percent. The optimal yields of crops in China are likely reduced by the same percentage."

Chameides says the NASA-funded study provides China -- and other nations with similar issues -- another option in the struggle to feed their growing populations. It is believed to be the first work quantitatively to assess the direct impact of regional haze on the yields of these crops.

"China is already losing 10, 20 or even 30 percent of its crop production to haze," he said. "Controlling the sources of the haze represents a potential way to increase crop production because the technology exists to control air pollution."

The estimates of crop production losses are based on detailed long-term measurements at Nanjing, 200 miles southwest of Shanghai, but are extrapolated to other areas of China. They consider only the direct effects of haze on sunlight, and do not include the indirect effects on sunlight potentially caused by haze interacting with clouds or the toxic effects of air pollutants that also reduce crop growth.

Extensive studies by agricultural researchers have documented the relationship between crop production and the sunlight received.

The haze affecting China is made up of aerosols composed of solid and liquid particles of varying sizes. The aerosols likely result from the burning of coal, biomass and other fuels, though scientists lack detailed information on their origins. Large-scale regional hazes exist in other developing countries, suggesting food production may be similarly reduced in India and African nations that are also struggling to feed their people.

"Any economically developing or developed country will have these large regional hazes associated with burning," Chameides explained. "Burning fossil fuels, burning wood and burning biomass for clearing fields causes production of a significant amount of haze that leads to a reduction in the solar radiation reaching the earth's surface."

The same effect has been measured on the East Coast of the United States, though China's haze levels are roughly twice as bad. Records suggest that China's haze problem has worsened over the past 20 years, a time of massive industrialization.

The study, for which Chameides is the lead investigator, found that the regional haze affects approximately 70 percent of crops grown in China. The haze tends to be worst in the eastern part of the country that includes the most productive and heavily cultivated areas. It can be measured year-round.

The study produced two different estimates of sunlight reduction, one based on direct measurements and one based on a model of China's atmosphere. Data based on direct measurements suggest an even larger effect than the 5-30 percent crop reduction calculated by the model.

The work gives policymakers better information on which to base environmental decisions, Chameides said. Researchers have long known that air pollution harms human health and damages crops, but the complexity of those factors has made it difficult to quantify the true cost. Reductions in crop production tied directly to haze-induced sunlight reductions provide the kind of cause and effect that can be used in balancing food production against the costs of improving environmental quality.

"In tallying up the balance sheet, policymakers want to make sure they have everything in each column," he explained. "This is something new that goes on the side of why it pays to clean up air pollution. In countries like China, I think this could be quite significant."

Crop reductions predicted by the study provide a lower limit of the effects caused by air pollution. Adding to the direct effect of reducing sunlight are indirect effects, such as aerosol-induced cloud cover and increased reflectivity, which further reduce the sunlight reaching plants. Finally, harm from growth-stunting ozone, acid deposition and other air pollutants also worsen the impact of poor air quality.

There are many potential sources for the haze. The coal China uses to fire much of its industry produces soot and fine

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particles. Fuel for cooking and home heating also tends to be dirty. Agricultural practices involve burning crop debris at the end of the growing season. And China gets hit each spring with dust from desert regions in the western part of the country.

The research was done as part of the China-MAP project, supported by the U.S. National Aeronautics and Space Administration (NASA) as part of its long-term climate studies. The study was done by a consortium of groups that included the Chinese Academy of Meteorological Sciences, the U.S. National Center for Atmospheric Research and the Abdus Salam International Centre for Theoretical Physics in Italy in addition to Georgia Tech.