



Measuring the Costs of Air Pollution and Health in China

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China's rapid economic growth, accompanied by industrialization and rapid urbanization, has come at a high social cost: over 50 percent of China's urban population is exposed to annual average levels of particulate matter (PM) that are over four times the annual average levels in U.S. cities. Chronic exposure at these levels is likely to produce significant long-term health effects, including respiratory illness, heart disease, and premature mortality.

The findings from a recent study by the World Bank that involved researchers from ► China's State Environmental Protection Agency, the ► Chinese Academy for Environmental Planning, two Norwegian research institutes (CICERO and ECON), and RFF reveal the serious nature of the problem along with the potential benefits of reducing PM levels in China.

The study estimated that approximately 350,000 lives were lost due to air pollution in Chinese cities in 2003 and that air pollution resulted in over 250,000 new cases of chronic bronchitis. The value of lives lost was equivalent to 4 percent of China's GDP. Reducing air pollution levels to those experienced in the United States 20 years ago would save over 200,000 lives annually.

The purpose of the study was to apply international methods of estimating the health effects of air pollution to cities in China. Specifically, the study estimated premature deaths and cases of chronic bronchitis associated with PM levels in Chinese cities in 2003, compared to background levels. One reason for doing this was to establish a framework that could be used to make similar computations in future years. These could be used, for example, as an input to China's Green National Accounts—accounts that consider the negative externalities associated with production as well as the value of goods and services produced.

Maureen L. Cropper

A second reason was to compute the benefits of reducing air pollution to lower levels, specifically to the World Health Organization's (WHO) interim annual average PM10 (particles 10 micrometers or less) standard for developing countries and to the Chinese Class I standard in 2003. (Please see the sidebar below for a more detailed description of the study process.)

The Social Costs of Pollution

The study findings showed that between 120,000 and 560,000 deaths in urban areas of China in 2003 were attributable to air pollution, with a mean estimate of 350,000 deaths. To put this number in domestic perspective, this is over twice the number of deaths from lung cancer in the United States in 2008. But the social costs of air pollution extend beyond mortality: between 240,000 and 300,000 new cases of chronic bronchitis were associated with 2003 air pollution levels, compared with background air pollution concentrations.

The Hard Findings from a World Bank Study on Air Pollution in China

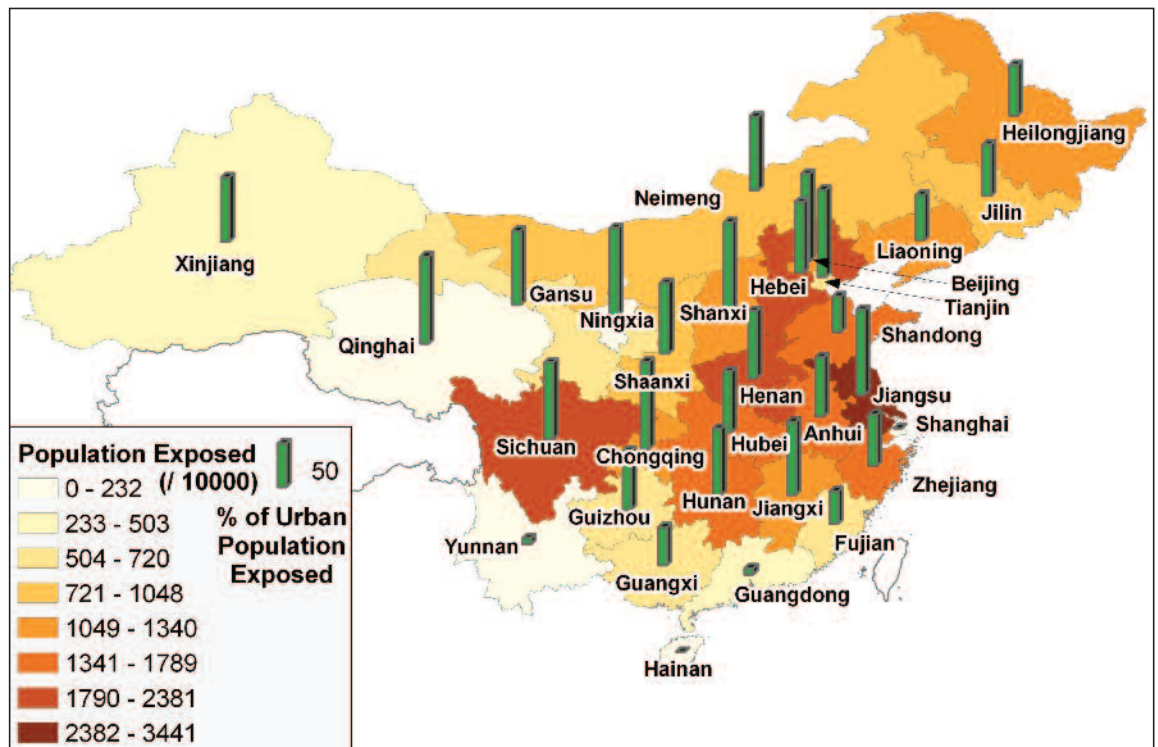
In 2003, an international team of researchers from China, Norway, and the United States was formed with the intention of assessing current environmental damages from air and water pollution in China and developing the tools that would enable these damages to be calculated on a continuing basis, at both the national and provincial levels.

The study began by estimating the air pollution exposure of over 500 million people living in 660 Chinese cities in 2003. According to study estimates, 63 percent of the urban population was exposed to annual average

PM10 greater than 100 µg/m³ (micrograms per cubic meter) and 13 percent to annual average PM10 greater than 150 µg/m³. (In contrast, in the United States in 2002, 90 percent of monitoring stations reported annual average PM10 levels below 35 µg/m³.)

The map below shows, by province, the number of people and the percent of the population exposed to annual average PM10 greater than 100 µg/m³. Provinces with the highest percent of the urban population exposed to PM are also the provinces with the highest ambient PM10 levels. PM levels are higher in the north of China (that is, north of the Yangtze River) than in the south, due to reliance on coal for home heating and also for meteorological and topographic reasons.

FIGURE 1. Urban population exposed to annual average PM10 greater than 100 µg/m³ in 2003. (Courtesy World Bank/DECRG)





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The study also computed the benefits of reducing 2003 pollution levels to lower levels—to $70 \mu\text{g}/\text{m}^3$ (the WHO interim standard for developing countries) and to $40 \mu\text{g}/\text{m}^3$ (the Chinese Class I standard in 2003). We estimate that reducing annual average PM_{10} to $70 \mu\text{g}/\text{m}^3$ in all cities above that level would save about 100,000 lives and result in 140,000 fewer cases of chronic bronchitis annually. Reducing annual average PM_{10} to $40 \mu\text{g}/\text{m}^3$ would save about 200,000 lives and result in 215,000 fewer cases of chronic bronchitis annually.

Comparing the benefits of pollution control to the costs requires “monetizing” the benefits (giving them a dollar value). In cost-benefit analyses of environmental programs conducted in the United States and the European Union, mortality risks are typically valued using the “value of a statistical life” (VSL)—the sum of what people would pay to reduce their risk of dying by small amounts that, together, add up to one life saved. Part of RFF’s contribution to this study was to conduct original research to estimate what people in China would pay to reduce their risk of dying.

Studies conducted in Shanghai, Nanning, and Jiujiang estimated that the VSL in China is approximately 1.5 million yuan, or about \$220,000 at current exchange rates. Using this number to value the 350,000 lives estimated to be lost due to air pollution suggests that this amounts to about 4 percent of GDP. Reducing air pollution levels to $70 \mu\text{g}/\text{m}^3$ (the interim WHO standard), would yield benefits equivalent to 1 percent of GDP in terms of reduced premature mortality as well as yield benefits from reduced chronic bronchitis, as well as heart attacks and strokes, which we did not quantify.

Which pollution control measures should be adopted in China and where they should be adopted should depend in part on a comparison of costs and benefits. The contribution of this study was to estimate the health impacts of air pollution in China using a bottom-up analysis, which can be used to compute the benefits of pollution control measures at the city level, as well as produce national results.

There are significant social benefits to be gained from controlling PM in China. As the country moves forward in developing effective air quality policy, studies like ours can provide a means of benchmarking this progress. ■