

## SCIENCE AND GOVERNMENT

# Revolutionizing China's Environmental Protection

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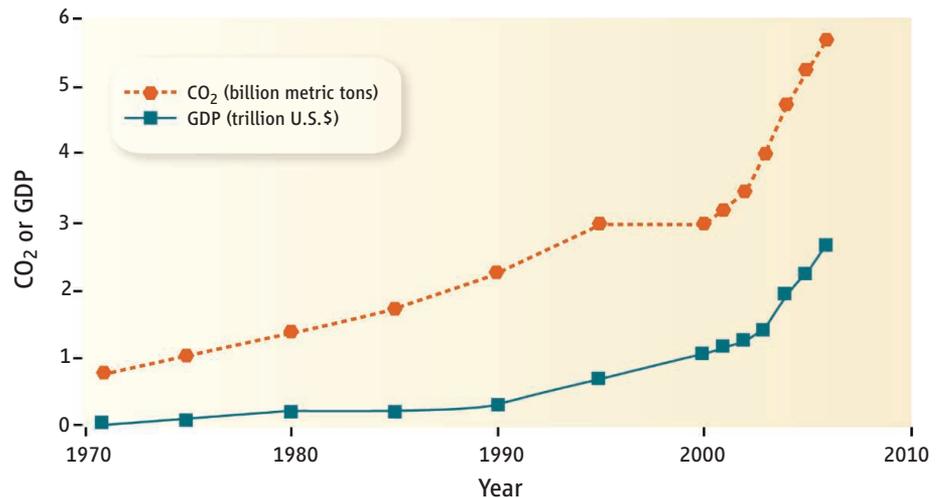
China's economic growth in the past three decades has been the fastest among major nations, with an almost 10% annual increase in gross domestic product (GDP) (see figure, right). However, its environmental degradation has also accelerated, and its environmental sustainability index is near the bottom among the countries of the world (1).

Environmental crises in China have ranged from algal blooms, chemical spills, and droughts to flash floods and sandstorms. Two-thirds of China's 656 cities (with 390 million people) suffer shortages of water for domestic and industrial use, and pollution aggravates that water scarcity. China has 16 of the world's 20 cities with the worst air pollution. These environmental problems cause health suffering, economic losses, and social conflicts (2, 3). For instance, China's State Environmental Protection Administration (SEPA) reported that pollution in 2005 alone cost more than U.S.\$200 billion (~10% of GDP). Although global effects of other countries' pollution increase these problems in China, China's environmental woes in turn affect the rest of the world (2). For instance, China's CO<sub>2</sub> emissions from fuel combustion have been increasing rapidly (see chart, right) and CO<sub>2</sub> from fuel combustion and cement production are now the world's highest (4), although China's per capita contribution is still far below that of many developed countries—because China has the world's largest population.

It is commendable that China has established impressive environmental goals and has tried to protect the environment. But the forces of environmental destruction have overwhelmed protection efforts and have made many of the goals empty slogans. For example, China has invested billions of dollars in combatting water pollution in its third-largest freshwater lake, Taihu Lake. Yet it simultaneously

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China's growth in gross domestic product (GDP) and CO<sub>2</sub> emissions from fuel combustion (4–6, 13).

permitted hundreds of factories to undo that investment by pouring pollutants into the lake, resulting in algal blooms and lack of water for millions of people.

China has once again proclaimed a goal of turning the tide of environmental degradation (7) with its 11th Five-Year Plan (2006–10), but it also aims to continue fast growth in its GDP (8). Heavily polluting factories still rise rapidly. Although specific solutions to many specific environmental problems have been proposed, a key unanswered question is how to achieve fundamental improvement. We suggest a reform of China's administrative system and a change in its model of economic development.

## Reforming the Administrative System

Economic performance is still China's main or sole criterion for selecting and promoting government leaders (e.g., provincial governors and mayors), although 2 years ago the central government called for incorporating environmental performance into the process. Ironically, when environmental disasters occur, environmental protection agencies often bear the blame. For example, after the chemical spill in the Songhua River in 2005, the director of SEPA was sacked. If China's government does not weight environmental performance equal to economic performance in selecting officials, environmental degradation will continue.

China's growth has created severe environmental problems that will require fundamental changes in China's administrative system and its model of economic development.

Although more than 100 environmental laws and regulations exist in China, they are often ignored by local government leaders. The maximum fines allowed for environmental violations are so small that polluting enterprises prefer paying the fines to adopting environmentally friendly technologies. Because environmental protection agencies lack the money, staff, and power to override local leaders and to shut down polluters, many environmental regulations are not enforced. China has the world's largest foreign reserve (U.S.\$1.4 trillion), but its budget for environmental protection is only a small fraction of that in the U.S.A. China currently has three times the United States' population, but SEPA has only one-eighth of the employees of the U.S. Environmental Protection Agency.

Establishing a new, high-level, authoritative national organization that coordinates all relevant ministries and agencies for economic development and environmental protection could reduce conflicts among them. Consolidating ministries and agencies for protecting different components of the environment (e.g., air, forest, land, and water) could also strengthen the effectiveness of China's environmental protection.

## Changing the Development Model

Rapid growth in GDP has been China's main goal during the past three decades. The domi-

nant development model has been inefficient resource use and high pollution to achieve high GDP. As do many other countries, China overstates its GDP, because it fails to subtract economic and other costs of environmental degradation. In fact, the environment is often put on the wrong side of the balance sheet when calculating GDP; polluting the environment and cleaning up the mess are both considered to be contributing to GDP, rather than subtracting from it.

To more accurately measure the country's growth, China decided to develop Green GDP in March 2004. For Green GDP, the economic costs of environmental impact and ecological destruction are subtracted from traditional GDP. With collaboration between SEPA and the National Bureau of Statistics (NBS), China released its first report on Green GDP (2004) in November 2005 (9). Even though the report vastly underestimated air and water pollution costs, those estimated costs (U.S.\$64 billion, or ~3% of GDP in 2004) still shocked many government officials.

Unfortunately, SEPA's and NBS's marriage to produce joint reports on Green GDP has ended. Although the second annual report has been completed and SEPA hoped to release it to the public, NBS has refused to do so. NBS's stated reason is the inaccuracy of estimation methods, but it is widely believed that pressures from some government officials' concern over high economic costs played an important role.

By developing a Green GDP, China was far in advance of most other countries, including the U.S.A. It is regrettable that, when China was so close to taking a leadership role, China's NBS backed down. Although estimating Green GDP poses technical challenges, refusing to release those estimates will not help improve the evaluation methods. Stronger support for greening GDP from the State Council and the Politburo of the Communist Party (China's highest executive and decision-making bodies) may prompt NBS to release the second annual report and to continue the effort to evaluate economic losses from environmental damage.

Besides greening GDP, other measures are needed to shift China's economic development model toward high efficiency and low pollution. Those measures range from investment in environmentally friendly enterprises, reform of land ownership, loans with low interest rates to those enterprises, taxes on polluting enterprises, and eco-compensation (payments to those protecting environmentally sensitive areas) to green insurance (insurance companies cover the cost of environmental damage and push for better environmental

protection) (10). Developing more environmentally friendly technologies for domestic use and export would increase employment and economic efficiency while reducing environmental damage.

Changing the development model requires changes in attitudes toward the environment. Many people still hope that the path followed by developed countries (pollute first, control later) will work for China, but that hope is risky because China suffers from two new disadvantages: Natural resources are more limited today (11), and fewer countries accept pollution transfers. Even if pollution can be controlled later, we foresee that many plant and animal species that provide essential ecosystem services to humans (e.g., the wild rice variety that helped revolutionize rice production) will become extinct. Furthermore, environmental impacts on human health and socioeconomic well-being will be much greater, as China's population is now much larger than the populations of developed countries when they suffered severe air and water pollution.

Environmental protection should be treated as an integral part of sustainable economic development. Because humans and the environment are coupled systems (12), there are complex interactions and feedback between humans and the environment, and negative impacts may not show up until decades later. For example, the 1998 flash floods that affected 240 million people are now recognized to have been the result of long-term deforestation and soil erosion (2).

### Concluding Remarks and Outlook

Although it will not be easy to make these fundamental changes, there is hope that they can happen. Environmental catastrophes have awakened some government officials and the public. For instance, the 1998 floods (2) stimulated large-scale conservation programs (e.g., natural forest conservation and grain-to-green programs) (12), the 2005 chemical spill in northeast China prompted examination of locations of major chemical plants, and the 2007 algal blooms led to closure of many polluting factories along lakes. Environmental issues will also be topics of many high-level meetings such as the upcoming 2008 National People's Congress.

Environmental awareness has been increasing among China's populace. The public demands the right to speak out about environmental issues and to be engaged in environmental actions. Text messages via mobile phones and the Internet have proved to be effective new tools for China's environmentalists. Within a few days in May 2007, a million text messages were sent to

residents and officials to protest a planned U.S.\$1.4 billion chemical plant near the center of Xiamen City. This first-time use of massive text messaging for environmental protection forced the city government to halt the plant construction.

China's environmental revolution can also benefit from developed countries. Although those countries have exacerbated many of China's environmental problems, they have also been increasingly providing environmentally friendly technologies, investing in clean energy industries, and helping China raise pollutant emission standards. Much more can and should be done. With 590,000 foreign firms invested in China, these firms and their countries have the leverage and responsibility to help China in its efforts to become a green nation.

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### Supporting Online Material

[www.sciencemag.org/cgi/content/full/319/5859/37/DC1](http://www.sciencemag.org/cgi/content/full/319/5859/37/DC1)

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