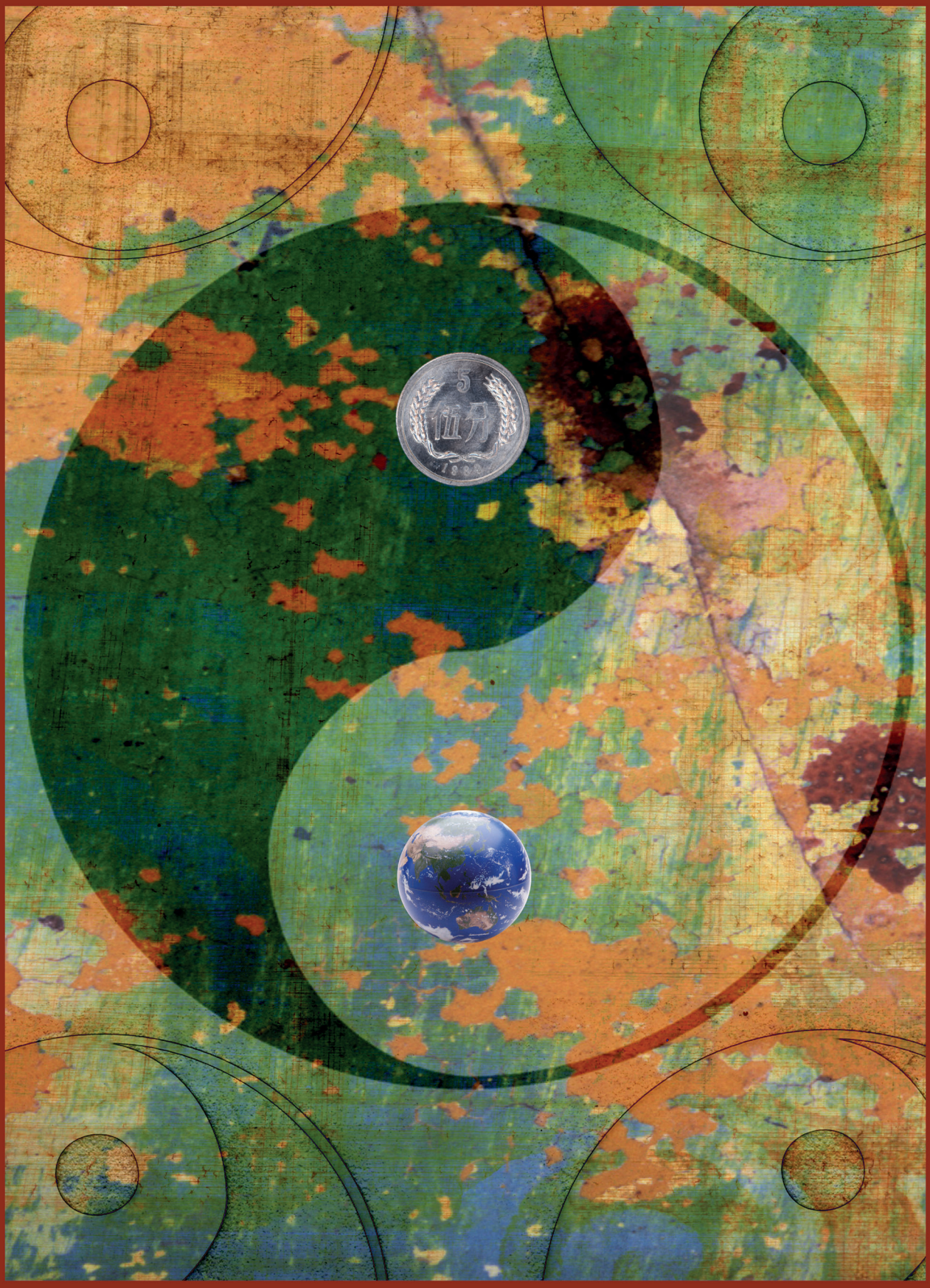
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Economy and Environment
China Seeks a Balance

Nearly 50 years ago, Chairman Mao Zedong introduced a Five-Year Plan (FYP) for the Chinese economy based on the Soviet model of heavy industry. At the time, China was almost 100% agrarian, with the exception of a few factories in the northeast built by the Japanese during their World War II occupation. But in the following decades, massive state-owned factories operating largely without pollution controls sprouted across the country. The fuel that powered this industrial makeover—that still powers nearly 70% of Chinese industry—is coal, one of the country's most abundant resources and the world's dirtiest source of energy. By the 1960s, China was among the most polluted nations on earth, its rivers and groundwater fouled by industrial chemicals and the air in its cities blackened with soot.

Today, China's environment is still highly degraded, but there is room for optimism. An environmental infrastructure that began emerging in the late 1970s now employs over 130,000 people, according to the 2001 *China Environment Yearbook*, a Chinese government publication. Thanks to some rudimentary pollution controls, air quality has improved in a number of major cities. Rural villagers increasingly have access to ventilated stoves that reduce indoor air pollution, and the country is steadily shifting away from coal toward natural gas and other gas fuels. Furthermore, China's 1978 move from a centrally planned to a more market-based economy has helped lift 60% of the population out of poverty, according to government sources. Poverty is widely recognized as the greatest threat to health and the environment.

Chinese authorities recently announced they will commit an unprecedented sum toward environmental protection. The central government's latest FYP for the economy, the tenth to date, devotes over the plan's duration approximately 1.3% of China's gross domestic product (GDP)—about Y700 billion, or US$85 billion—to its environmental provisions. This FYP has an ambitious environmental agenda: reduce the annual population growth rate to less than 0.09%, halt ecological deterioration, increase forest coverage and urban green space, and reduce emissions of major pollutants to 10% below 2000 levels.

The extent to which China follows through on the environmental promise remains to be seen. As in other countries, corruption is endemic in China. Vaclav Smil, a professor of environmental studies at the University of Manitoba, Canada, predicts that much of the money committed to environmental remediation will be absorbed by a bureaucracy that he says is "merely feeding itself." Like other experts, Smil questions the accuracy of China's official GDP figures, and hence the monetary value of the environmental commitment. The central government has a notorious reputation for inflating indicators of economic growth. The real GDP, he suggests, is likely to be as much as a third less than figures released by officials in Beijing. Nevertheless, he concedes that the environmental intentions of most Chinese officials are probably genuine. "They know they have severe problems," he says.

The Costs of Pollution

According to the 1997 World Bank report *Clear Water, Blue Skies: China's Environment in the New Century*, the damages caused by pollution and degraded resources consume up to 8% of China's GDP, roughly equal to the annual growth of the country's economy. This figure is the most current such estimate available.

Despite recent improvements, 9 of the 10 cities with the world's worst air pollution are found in China, and respiratory diseases linked to poor air are the leading cause of death among both children and adults, according to a November 1999 report by the World Resources Institute, *Urban Air Pollution Risks to Children: A Global Environmental Health Indicator*.

Water pollution is a serious public health hazard in China, perhaps even more so than polluted air, some experts say. Nearly half of China's 1.3 billion people drink water contaminated with chemicals and biological wastes, and chronic water shortages plague much of the population. A popular saying in the country's developed eastern region is "The house is new, the money is enough, but the water is foul, and life is short."

Resource degradation is a massive problem in China. Nearly a third of the total landmass is denuded of trees, a consequence of overlogging and erosion. According to the Chinese State Environmental Protection Administration (SEPA), the country's deserts—now covering 2.4 million square kilometers—are expanding by 3,000 square kilometers per year. Because of desertification, sandstorms are rising in frequency and intensity. Spring winds passing over the Gobi and Takla Makan Deserts in Mongolia and China, respectively, produce enormous clouds of swirling dusts that travel throughout Asia and the world.

Dust storms that invade Chinese and other Asian cities can produce near-apocalyptic conditions. As choking sands reduce visibility to as little as 50 meters, residents are forced indoors, and local economies can be shut down for days at a time. High levels of ambient dusts are a serious health and environmental hazard, linked to respiratory problems and contamination from toxicants and pathogens bound to airborne particles. Dust storms also erode topsoil, which robs the ground of its fertility, in addition to blocking sunlight and affecting climatological patterns.

Logging and erosion also leave the land more vulnerable to the effects of floods, which occur with devastating frequency in China. Eroded banks turned the Yangtze River flood of 1998 into a cataclysmic event that killed thousands and left millions more homeless and vulnerable to infectious diseases.

Challenges of the New Economy

On a fundamental level, the new FYP's goals pose enormous challenges, in part because of a growing disconnect between the central and local governments. Since the late 1970s, small profit-based township and village enterprises (TVEs) have led to a diffusion of industry throughout the country. According to Jennifer Turner, coordinator of the China Environment Forum of the Environmental Change and Security Project at the Washington, D.C.–based Woodrow Wilson International Center for Scholars, the proliferation of these profit-based businesses was broadly encouraged by

PhotoDisc, Matt Ray/EHP

Pollution gridlock. Emission controls are improving, but China is still home to 9 of the 10 cities with the world's worst air quality.

the central government as a means of soaking up excess labor in the countryside and limiting the urban migration of rural peasants. TVEs, many employing fewer than 10 individuals, now account for more than 30% of rural income, Turner says.

Unlike state-owned factories, which are fewer in number and accountable to central authorities, TVEs are chiefly accountable to the marketplace. Therefore, market forces and the efforts of local officials, not mandates from Beijing, drive the environmental performance of TVEs. The responsibility of local governments over environmental protection is also growing as the Chinese economy becomes increasingly decentralized. In this new era, regionalized economic development is becoming the new driver for environmental change.

Experts expect that, in time, market pressures also will favor energy efficiency and pollution controls among both TVEs and pollution sources in general. But at the outset, these advanced systems clearly face an uphill battle, says Robert Taylor, the lead energy economist with the East Asia Energy and Mining Unit of the World Bank, based in Washington, D.C. Factory managers often view environmental technology as a low priority, he says. And domestic banks are wary of environmental projects because they create high transaction costs and generate low short-term returns.

Furthermore, Smil says, local officials will bend over backwards to accommodate TVEs because they provide employment and taxes. "If you're a local official, you don't want to interrupt TVEs or burden them with environmental controls," he says. "If you do that, they will just move to the next county." The key is to somehow convey the long-term profit and environmental benefit of environmental technology to entrepreneurs who may initially view these tools with skepticism. Eventually, experts say, market forces should enhance environmental benefits. But these successes will likely hinge on the strengths of local economies. Those that do well are more likely to invest in environmental quality than those that do not.

In the meantime, TVEs in many ways surpass state-owned factories as the main source of China's industrial pollution. "Just about all of the wastes from the TVEs are dumped indiscriminately," Smil says. "In some places you can walk down the street and every five hundred meters you see another shed full of young girls making electronics, bikes, everything for the Western markets. All that electroplating, the chromium, the rest of that waste, just goes into local rivers. No one spends money to control pollution. That's why you get such a good price."

In some areas, especially in the northwest, contamination from TVEs, state-owned factories, and other sources is exacerbated by chronic water shortages. According to the World Resources Institute, over half of China's cities can't provide sufficient water to their populations. The problem is getting worse because the cities are growing so rapidly. Recent government policies have allowed rural peasants to gain residency in cities like Beijing and Shanghai, leading to huge influxes in population. Already lacking in infrastructure, treatment capacity in the cities is stretched to the hilt. "Most of the new buildings are connected to sewers, but there isn't any treatment," Smil says. "So about eighty percent of the sewage goes straight into the receiving waters."

Urban Air Quality

Making definitive statements about environmental trends in China is tricky because the country is so big. Smil admits he's exasperated by pessimists who claim things are getting much worse and optimists who claim they are getting much better. "There isn't any [one] China," he says. "China is 1.3 billion people; there are hundreds of Chinas. Are things getting better or worse? They are getting better and worse at the same time."

A demonstration of this point can be made with urban air quality. A heavy government emphasis on industrial particulate matter (PM) reduction since the mid-1980s has improved urban air with respect to this pollutant. But according to Jonathan Sinton, a scientist at Lawrence Berkeley National Laboratory in Berkeley, California, industrial growth since the market reforms may be increasing ambient levels of sulfur dioxide (SO_2) because most factories have yet to install desulfurization technology.

The cost of coal. The majority of China's energy needs are still met by heavily polluting coal-fired generating plants such as this one on the Yangtze River in Dukuo, Sichuan.

Top to bottom: Digital Vision; © Dennis Cox/ChinaStock

Furthermore, the growth of the Chinese vehicle fleet has increased urban levels of airborne nitrogen oxides (NO_x), which are direct precursors to smog.

Scientists have studied China's urban air (but not rural or indoor air) since the mid-1980s, when the first air monitoring devices were installed in some of the country's major cities. At first, monitoring data were limited to total suspended particulates (TSP), SO_2, and NO_x. Later, additional pollutants including PM_{10} and $PM_{2.5}$ were also added. These smaller particles are considered to be the most hazardous because they persist in the environment and burrow deep into the lungs. Today, air monitoring is common in dozens of Chinese cities, and the data are regularly posted on state websites and in newspapers.

Most studies of ambient urban air quality conducted to date focused exclusively on TSP. A compilation of air quality statistics in Chinese urban areas (in press in *Chemosphere*) by Keith Florig, a senior research engineer in the Department of Engineering and Public Policy at Carnegie Mellon University in Pittsburgh, Pennsylvania, showed that annual average TSP levels across 140 cities fell from a mean of 500 μg/m^3 in 1986 to 300 μg/m^3 in 1997. Florig cautions that particulate levels in many of China's cities remain extremely high, however. For instance, 10% of industrialized northern cities, which are closer to the deserts, have ambient TSP levels that exceed 500 μg/m^3, well over the annual average standard for industrial areas of 300 μg/m^3. Some 90% of these same cities exceed China's ambient air quality standard for residential areas of 200 μg/m^3.

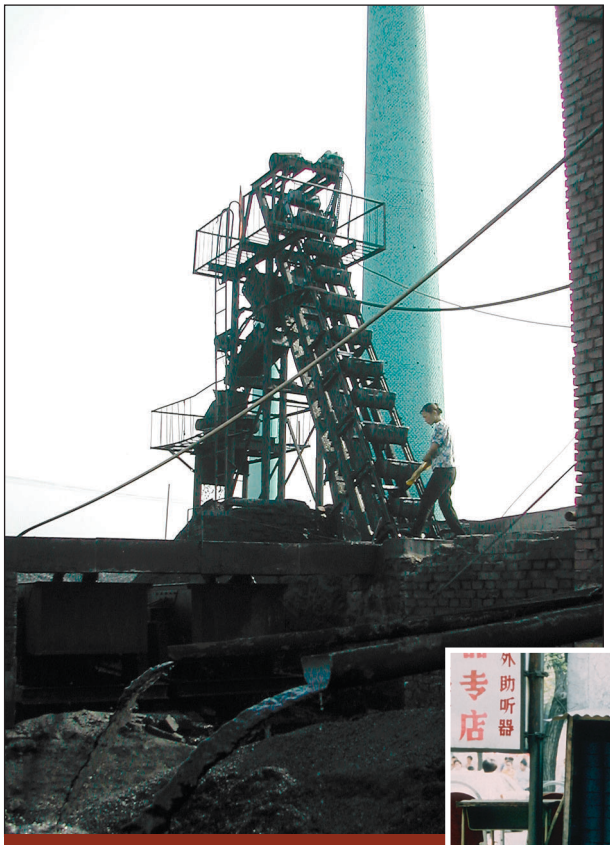
According to Florig, TSP reductions have been achieved by "plucking the low-hanging fruit" in terms of lessening residential and industrial emissions by employing the most basic and simplest cleanup technologies. Typical approaches include the use of stack filters that trap up to 60% of particulates from boiler emissions, conversion of raw coal to coal briquettes (which release less fly ash when burned), central heating systems for urban buildings, and in some cases residents' use of bottled gas instead of coal. Greater reductions can be achieved by more advanced technologies, which are more expensive, and by switching away from coal altogether.

Another possible contributor to improved air quality, says David Fridley, a staff scientist at Lawrence Berkeley National Laboratory, is a remarkable drop in coal use from 1996 to 1999. According to Fridley, government figures indicate a 24.7% drop in "final coal consumption" (meaning coal used directly as fuel), despite a 35% rise in GDP during this time period. According to Fridley, the magnitude of the drop in consumption during the same time period is reduced to 13% if final consumption changes are combined with reductions in "transformation uses," meaning coal used to fuel secondary power sources like electricity. The reduction in coal consumption is attributed by Fridley mainly to economic reforms that closed tens of thousands of inefficient factories and mines, a continuing emphasis on industrial efficiency, the use of cleaner natural gas, and the elimination of government subsidies for coal, which effectively raised the fuel's price.

What air quality studies are just now beginning to address are the impacts of China's growing demand for vehicles, which grew by 30% annually between 1995 and 2000 thanks to a quadrupling of per capita income, according to an article in Issue 3 (1999/2000) of the *China Environment Series*. China's vehicle fleet is still extremely small by U.S. standards—just one car for every 70 urban residents, compared to one car for every 2 urban Americans, according to Robert Paaswell, director of the Region II University Transportation Research Center at the City College of New York. Nevertheless, environmental effects from vehicles are expected to rise sharply in the coming years. And experts say vehicle exhausts are already the most important sources of NO_x and carbon monoxide in urban air.

Respiratory diseases linked to air pollution are still the leading causes of death in China. Adults die most often because of chronic obstructive pulmonary disease and children because of pneumonia. Air pollution causes millions of Chinese to suffer from chronic ailments including heart disease, cancer, decreased immune function, and fatigue. But according to Florig, data gaps make it difficult to evaluate how changing urban air quality is affecting human health. Only a few such studies have been conducted to date, and there is no national repository for environmental health statistics in China. Researchers are typically confined in their efforts to localized assessments.

For instance, in a study published in the January 2000 issue of the Chinese-language *Journal of Environment and Health*, Xiaoming Zhang and colleagues at the Sanitation and Anti-Epidemic Station in Xiamen performed an analysis of respiratory disease in the city of Chengde from 1983 to 1997, when the introduction of centralized heating greatly reduced TSP exposures from household solid fuel burning. No indoor TSP levels are reported in the study. However, the researchers report



The coal conundrum. At a coke plant in Jiexiu City, Shanxi province, (above) a woman watches coal rocks being rinsed by water. Many of the plants, which produce coal bricks (right), are closing because of the cost of complying with new environmental regulations, leaving thousands unemployed.

Top to bottom: Ray Cheung; Andrea Hricko

that wintertime outdoor TSP levels fell from 3,000 μg/m^3 before centralized heating was introduced to roughly 200 μg/m^3 after its introduction. During this same period, annual mortality rates from respiratory diseases decreased from 811 per million to 237 per million.

Junfeng (Jim) Zhang is director of the International Environmental Health Center at the Environmental and Occupational Health Sciences Institute, part of the University of Medicine and Dentistry of New Jersey and Rutgers University in Piscataway, New Jersey. He and his colleagues at SEPA and the U.S. Environmental Protection Agency (EPA) have recently studied the effects of air pollution on children's respiratory health in four major Chinese cities: Lanzhou in north central China, which has heavy ambient particulate levels from its proximity to the northern deserts; Chongqing in southwest China, where the local coal is high in sulfur and poor in quality; Wuhan in central China, a typical industrial Chinese city; and Guangzhou, a coastal city near Hong Kong with a lot of vehicles. Their results, to be published in the October 2002 issue of *Environmental Health Perspectives*, show that respiratory symptoms including cough, wheeze, phlegm production, and bronchitis are linked more to PM than they are to SO_2 and NO_x.

Rural risks. Evidence suggests that adverse health effects from rural exposures such as indoor cooking with biomass may exceed those is urban areas.

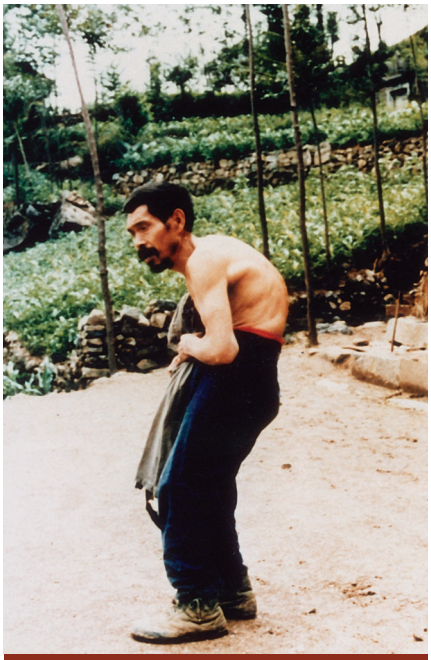
The data on asthma are ambiguous with respect to exposure. "Pollution levels from those cities are up to one hundred times greater than those found in North America and Western Europe," Zhang says. "But the asthma rates were low: two to three percent compared to ten percent in the West. The other symptoms we evaluated are all higher in prevalence than those found in Western cities." According to Smil, these seemingly anomalous asthma results may reflect the effect of affluence on Western children, whose immune systems may be weaker than those of children living in less hygienic environments.

Chris Nielsen, executive director of the China Project at the Harvard University Center for the Environment in Cambridge, Massachusetts, says the pervasive shortage of environmental health data can make it difficult for policy makers in China to target specific sectors for mitigation. Nielsen and colleagues are collaborating with researchers at Tsinghua University in Beijing to augment the existing data with statistical models. One model, based on what he calls the "intake fraction approach," is being used to estimate human health effects from exposure to a range of industrial pollution sources. "The model allows you to calculate the amount of pollution emitted from a particular source that actually reaches the lung," he explains. "We think it will allow us to get a preliminary handle on the health effects that can be attributed to different pollution sectors in China."

Rural Air Quality

Air data from China's rural areas are virtually nonexistent. However, anecdotal evidence suggests that the magnitude of public health effects from rural air quality may exceed that of the cities. The main source of rural air pollution is indoor burning of coal and biomass such as wood and cow dung. This is a particularly high-risk source of exposure because it produces high levels of particulates in the range of 2.5–10.0 μm, the size believed to be most hazardous to health.

In some regions of China, coal is rendered even more dangerous by the presence of toxic contaminants that poison rural villagers. For instance, Robert Finkelman, a senior scientist at the U.S. Geological Survey in Reston, Virginia, and Baoshan Zheng, a scientist with the Institute of Geochemistry of the Chinese Academy of Sciences in Guiyang, have documented evidence of severe heavy metal toxicity among villagers from Guizhou province. According to Finkelman, the coal in this region is highly concentrated in fluorine and arsenic, the latter at levels as high as 35,000 parts per million.



Hidden hazards. Coal contaminants, some of which cause effects on bones and cancer, may be difficult for villagers to detect.

Finkelman says arsenic in coal is usually identifiable by the presence of sulfide minerals that villagers can easily detect. But in Guizhou, the metal is bound in the organic fraction and hidden from view. Villagers therefore have no way to tell if the fuel is contaminated. "Many villagers in Guizhou have clinical manifestations of metal exposure," he says. "We are seeing extensive occurrence of keratosis and Bowen's disease, which is a precancerous condition related to arsenic exposure." Finkelman and Zheng are currently analyzing coal samples from locations all over China for 50 trace elements, including a wide range of carcinogenic compounds. "We expect to have a comprehensive database within a year," he says.

So-called "smoky coal," a low-quality product that releases large amounts of mutagens, is common in Yunnan province, where it is linked to high rates of lung cancer, particularly among women in Xuan Wei county. These women have among the highest lung cancer rates ever recorded: 125.6 cases per 100,000 women, compared to Chinese and U.S. national averages of 3.2 and 6.3 per 100,000, respectively, according to the U.S. EPA.

The discovery of Xuan Wei's tremendous cancer burden finally sparked action from the central government in the mid-1980s. A national stove improvement and dissemination program, launched in 1984 and coordinated by the Chinese Ministry of Agriculture, sought to provide ventilated coal stoves to rural villagers through a mix of government- and market-sponsored programs.

Sinton and Kirk Smith, chair of the Department of Environmental Health Sciences at the University of California at Berkeley, recently evaluated the program's success in 3,000 Chinese households. Sinton says it's too early to report on results. But based on his own observations, he suggests the program may not be as helpful as one would hope. "People tend not to use the improved stoves because they're not portable," he says, referring to Chinese families' tendency to cook in a number of different rooms. "You'll go into a house and see a very nice new stove sitting there unused and a small portable coal stove which is used all the time. These stoves emit horrific levels of fine particulates all over the house."

The situation may be more positive in other areas of China, though. Robert Chapman, a medical officer at the EPA's Office of Research and Development in Research Triangle Park, North Carolina, has recently finished a study showing that ventilated stoves sharply cut lung cancer rates in Xuan Wei. Data measured in this study and published in the 5 June 2002 issue of the *Journal of the National Cancer Institute* show that stove improvements reduced the risk of lung cancer by up to 46%. Chapman, a 20-year veteran of lung cancer research in Xuan Wei, says he believes ventilated stoves will cut the risk of exposure wherever they are used. But he acknowledges the current results can't be extrapolated definitively to other Chinese regions. "We suspect there is something unique about the coal in Xuan Wei—lung cancer consistently shows up higher there than in other parts of China. But we haven't had the resources to compare combustion products in Xuan Wei coal with those from coal burned in other areas."

Moving away from Coal

China's leaders increasingly cite the environment when discussing the need to reduce reliance on coal as the country's principal energy source. For instance, in a speech given to an international group of energy executives on 11 September 2001 in Beijing, Li Yanmeng, director-general of China's Department of Basic Industries, said, "Too much coal is directly used for end-use consumption . . . and energy efficiency and environmental protection measures have lagged far behind advanced world standards and cannot meet the needs of sustainable development."

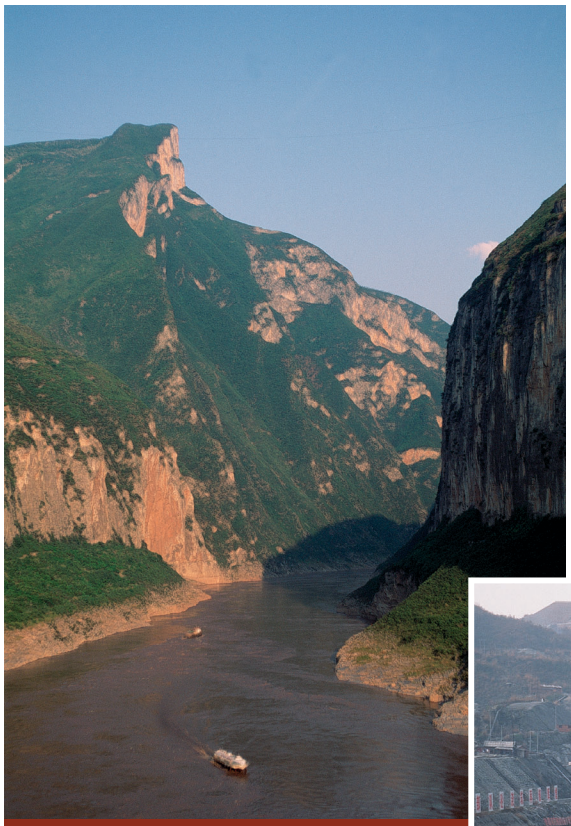
In the same speech, Yanmeng acknowledged that coal will supply the bulk of China's energy needs into the foreseeable future. But he also referred to ongoing efforts to replace coal with cleaner energy sources under the FYP. To an extent, reforms in the coal sector have been driving this shift for years, says Jeffrey Logan, a senior research scientist at the Joint Global Change Research Institute in College Park, Maryland, an independent group of climate scientists. For instance, the removal of price controls and subsidies on a glutted coal market during the early 1990s caused prices to surge, making alternative energy forms more attractive. The last several years have witnessed a decline in coal use for energy from 76% in 1990 to 67% in 2000, according to Chinese government sources. During the same period, the combined use of oil, natural gas, hydropower, nuclear power, and wind and solar energy increased by nearly 10%.

But experts believe that, with rapid economic growth, coal use will rise to earlier levels unless China moves quickly to develop alternatives. According to Sinton, an internal debate among Chinese officials makes the direction of China's energy policies hard to predict. The debate is essentially about whether to continue relying on coal, consuming more of it using clean-coal technologies, or relying more on imported oil and gas and on renewable energy.

Recently, estimates of China's domestic natural gas supply, once thought highly limited, were buoyed by the discovery of new fields in the western part of the country. A 2,500-mile pipeline extending from the remote far western region of Xinjiang to the eastern city of Shanghai is expected to augment China's natural gas infrastructure, which now serves mainly residential cooking and heating in major cities. This US$5.6 billion project will be financed in part by three foreign companies—Royal Dutch/Shell Group, Russia's gas monopoly Gazprom, and ExxonMobil Corporation—who have each agreed to a 15% stake. Chinese planners hope that by 2020 natural gas will supply 10% of China's energy needs, compared to 3% today. According to Logan, gas technologies are up to 20% more efficient than those run by coal. Also, for every 30 billion cubic feet of natural gas used in place of coal, carbon dioxide emissions decline by approximately 20 million tons. This is of key importance because carbon dioxide is the principal greenhouse gas behind global warming. China is currently the world's second largest emitter of greenhouse gases after the United States, but is expected to be the largest source within a few decades.

The wave of the future? The need for energy to fuel China's vast economic growth has led to oil prospecting, such as that taking place in the Takla Makan Desert.

As for oil, China's own oil fields have been steadily dwindling for years. Imports, which now supply a third of the country's energy needs, are expected to rise to 50% by 2020, making China the largest oil importer in the world. Much of the current supply, almost all of it consumed by the transportation sector, is imported from Middle Eastern, Asian/Pacific, and African countries. Ray Cheung, a reporter with the *South China Morning Post* in Hong Kong, says U.S. naval superiority in Middle Eastern waterways could stifle imports in the event of a confrontation, suffocating the Chinese economy



Collision course? China's natural environment and its need for energy are meeting head-on in the controversial Three Gorges Dam hydroelectric construction project.

and throwing the country into chaos. Therefore, for its own energy security China is increasingly looking for oil sources beyond U.S. control. On 28 September 2001, a deal signed with the Russian government paved the way for joint oil exploration and development in the Irkutsk–Sakha region of eastern Siberia, nearly 1,000 miles from the Chinese–Russian border. If all goes as planned, a 2,400-mile pipeline from this region will deliver 30 million tons of oil to China annually within four years.

Of course, increased reliance on oil still presents significant environmental problems, particularly from the perspective of vehicular air pollution and greenhouse gases. The cleanest power derives from wind, solar, and water power, which are expected to contribute a small but significant portion of China's energy mix in the near term. Exploiting China's hydroelectric resources can involve some substantial environmental trade-offs. In the most egregious example, the highly controversial Three Gorges Dam, if completed, will provide 18.2 gigawatts of power, 3–4% of China's total annual electricity needs, by 2009, according to Logan. This level of power is roughly equal to that provided by 50 million tons of coal. The costs, both monetary and environmental, are huge, though: roughly US$24 billion and the displacement of as many as 1.9 million people and a world-class ecological treasure along the dam's 350-mile upstream reservoir on the Yangtze River.

According to Turner, China's renewable energy sector is grappling with market distortions that stifle its growth. Most renewable energy projects in China are small in scale and coordinated by the central government. But the growth of renewables on a national scale is impeded by what Turner refers to as "tied bilateral aid." This occurs when foreign sources provide renewable technology but then insist on exclusive ongoing rights to sell the requisite machinery. These arrangements slow the domestic market by forcing the Chinese out of the manufacturing loop. "For large-scale grid-connected renewables, you need a commercial market that is competitive and self-sustaining," she explains.

Toward the Future

In the long run, it's important that these kinds of trade issues be resolved. China needs foreign assistance to confront its environmental challenges, but on terms that allow for sustainable development. Taylor points to a proliferation of energy service companies (ESCOs) as a market opportunity benefiting Chinese and foreign investors alike. Launched with assistance from the World Bank, ESCOs are independent companies that help Chinese factories buy, install, and maintain energy-efficient technology. In turn, the ESCOs are paid with the resulting financial savings. "There are over a dozen of these companies now, all profitable, most staffed by Chinese nationals," Taylor says.

China's recent entry into the World Trade Organization might also facilitate environmental protection, says Turner. Membership could, for instance, enhance the transparency of China's environmental laws, lead to the closure of heavily polluting state-owned facilities, and enable China to protect its natural resources by limiting certain types of agriculture. Rice farming, for example, draws heavily on China's limited water resources, particularly in the west. This could provide a market opportunity for American farmers who are able to grow rice in the United States with ease. "If Chinese farmers could switch away from rice, they could switch to vegetables, which require less water," Turner explains. "The trick is to [convince] the local government."

China is also experimenting with market instruments for environmental protection that are sophisticated even by Western standards. A new system for regulating industrial pollution, known as "total emissions control," switches the emphasis from the rate of discharge to the total amount discharged. This approach opens up possibilities for market-based emissions trading programs, such as those used increasingly for greenhouse gas trades among companies in the United States and Europe.

Ultimately, Western governments and industries would be wise to help China on its path to a cleaner environment. As an enticement, the market opportunities are potentially huge. And with nearly a quarter of the world's population affected, the consequences of success or failure will be truly global.

Charles W. Schmidt

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