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CHINA ENVIRONMENT SERIES

9

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金木水火土

China Responds to Environmental Health Challenges

Surf and Turf: Threats from Aquaculture and Animal Husbandry

Guangdong: Protecting Ecological and Human Health?

Clean Water, Clean Coal: Reports From the China Environmental Health Project

Plus: Notes From the Field, Spotlight on NGOs

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COVER PHOTO

A fisherman examines his net for fish after casting it in the polluted waters of a tributary of the Huai River in Shenqiu County (Henan Province). After an hour's work, he was able to catch ten small bait fish with blisters on their bodies. It is reported that in communities along the Huai—one of China's most polluted rivers—there is a higher than normal rate of cancer, tumors, spontaneous abortions and diminished IQs.

Photo Credit: Stephen Voss, who can be reached at: steve@stephenvoss.com or www.stephenvoss.com

ABOVE PHOTO

A victory with no winner. After three years of fruitless appeals to the government to close the highly polluting Dianhua Paper Mill in eastern Inner Mongolia, Damulinzabu (pictured) led a group of seven herders in August 2002 in filing a lawsuit against the mill. The mill's untreated emissions contaminated the area's groundwater, decimated the surrounding grasslands, and sickened villagers. In 2004, Damulinzabu and his fellow plaintiffs were the first Mongolian herders to win such a suit. While the factory has moved, it left behind a thick black foul-smelling pool forcing villagers to abandon the area.

Photo Credit: Palani Mohan (Getty Images) for Circle of Blue.
See a summary of the desertification story on page 62, which the China Environment Forum helped produce for Circle of Blue. Full story available at www.circleofblue.org.

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CHINA ENVIRONMENT SERIES

THE CHINA ENVIRONMENT FORUM

For ten years the China Environment Forum (CEF) has implemented projects, workshops, and exchanges that bring together U.S., Chinese, and other Asian environmental policy experts to explore the most imperative environmental and sustainable development challenges in China and to examine the opportunities for business, governmental, and nongovernmental communities to collaboratively address these issues. The networks built and knowledge gathered by meetings, publications, and research activities have established CEF as one of the most reliable sources for China-environment information and given CEF the capacity to undertake long-term and specialized projects on topics such as environmental health, food safety, water management, nongovernmental organization (NGO) development, and municipal financing for environmental infrastructure. The Wilson Center's Asia Program periodically cosponsors meetings with the China Environment Forum. The China Environment Forum meetings, publications, and research exchanges over the past year have been supported by generous grants from the U.S. Agency for International Development, Rockefeller Brothers Fund, Waters Corporation, and the U.S. Environmental Protection Agency. Jennifer L. Turner has directed the China Environment Forum since 1999.

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Population growth. Water scarcity. Degraded ecosystems. Forced migration. Resource depletion. Pandemic disease. Since 1994, the Environmental Change and Security Program (ECSP) has explored the connections among these major challenges and their links to conflict, human insecurity, and foreign policy. ECSP brings policymakers, practitioners, and scholars from around the world to Washington, D.C., to address the public and fellow experts on environmental and human security. ECSP publishes and distributes 7,000 free copies of two annual journals—the *Environmental Change and Security Program Report* and the *China Environment Series*—in addition to publishing original research. ECSP's core activities are made possible by the generous support of the U.S. Agency for International Development's Office of Population and Reproductive Health. ECSP also receives support from the UN Environment Programme, the Carnegie Corporation of New York, and private individuals. ECSP is directed by Geoffrey D. Dabelko and is housed in the Woodrow Wilson Center's Division of International Security Studies, headed by Robert S. Litwak.

THE ASIA PROGRAM

The Asia Program was created in 1977 and has grown over the past two decades into one of the Wilson Center's largest and most active programs. It strives to provide a forum for examining current and important Asia-related policy questions in their broad historical and cultural context. The Asia Program's activities focus on China, Japan, the Koreas, South Asia, and Southeast Asia. Since 1999, Robert M. Hathaway has directed the Asia Program.

CONTENTS

CHINA ENVIRONMENTAL HEALTH PROJECT SPECIAL REPORT

SPOTLIGHT ON NGO ACTIVISM IN CHINA

FEATURE BOXES

INVENTORY OF ENVIRONMENTAL AND ENERGY PROJECTS IN CHINA

Available online at www.wilsoncenter.org/cef

FOREWORD

Jennifer L. Turner, Editor

In terms of environmental news stories coming out of China, this year of the fire pig would not appear to be a particularly lucky one. This year, China most likely surpassed the United States as the leading emitter of greenhouse gasses in the world (although the latter remains a bigger emitter per capita); the central government admitted that China had not met the previous year's laudable energy efficiency goals; Lake Taihu (the country's third largest lake) turned a florescent green with a toxic algae; an environmentalist who had for years had been advocating Lake Tai's protection was arrested and subsequently sentenced to three years in prison; the International Olympic Committee announced that while Beijing's air is cleaner than seven years ago it may not be good enough for endurance sports at next year's Olympic Games; and huge riverbank landslides occurred near the Three Gorges Dam, prompting the Chinese leadership to announce the need to relocate an additional 3 million people. What is striking about these stories is that most were reported in the Chinese as well as the western news media, which I see as a positive sign. Memories of the cover-ups surrounding the 2005 Songhua River benzene spill and fears of social instability from expanding protests over pollution problems nationwide have led to a somewhat more transparent discussion of environmental problems in China

The *China Environment Series* (*CES*) has never been a headline-chasing journal, rather one that attempts to delve into China's environmental and energy challenges more deeply and highlight promising trends and opportunities for collaboration with China on these issues. In this spirit, this *CES* delves into the issue of environmental health, which parallels a major new China Environment Forum (CEF) initiative—the **USAID-supported China Environmental Health Project** (CEHP), which began in October 2006. Our primary task under CEHP is helping Western Kentucky University scientists **Chris Groves** and **Wei-Ping Pan** do community outreach and disseminate information regarding their environmental health work on coal in Anhui Province and on karst water issues in China's southwest. Under CEHP the CEF team has been producing numerous research briefs on environmental health issues in China that are posted on our website. Moreover, this year most of our monthly CEF meetings have focused on environmental health and/or "green" public participation in China. Please see the special report in this issue for more information on CEHP activities.

Another new CEF initiative—Bridge to Safety: U.S.-China Partnerships on Food Safety—began in the fall of 2007, thanks to a grant from **Waters Corporation**. Under this initiative we are putting on a series of meetings and creating a special report focused on China's food safety challenges, which are not simply due to poor food processor monitoring, but also linked to the country's growing pollution problems. This year also marked the beginning of what CEF hopes is an ongoing partnership with **Circle of Blue** (www.circleofblue.org) to design and produce multimedia web-based stories on freshwater challenges in China. This issue's Feature Box, "Driving Through the Desert of Sand," introduces the first of these collaborative stories.

For those of you who are wont to skip around journals, I would strongly recommend you to at least first read the opening feature article by **Xiaoqing Lu** and **Bates Gill**, for it anchors *CES 9* by providing an important overview of current policymaking, NGO activities, and scientific research around the issue of environmental health in China. They see incredible challenges for China to address environmental health problems, but provide some direction on important next steps. **Kaleb Brown** and **Stephanie Renzi** take their environmental health analysis down to the provincial level, pondering whether Guangdong has the potential to be a vanguard for addressing pollution and related human health threats in China. My assistant **Linden Ellis** and I wanted to refocus some of the current attention on China's food safety problems away from exports to what we believe are

bigger environmental and health concerns within China stemming from unsustainable and unsafe practices in the country's animal husbandry and aquaculture sectors, areas ripe for international cooperation to make China's food production more sustainable and safe.

Air pollution, being perhaps the most visible of China's environmental problems, figured prominently among our commentary writers, and they all highlight research that begins to fill the major environmental health research gaps identified by Lu and Gill in the opening feature article. In the first commentary, **Chad Futrell** describes not merely the ecological and human health problems stemming from China's rapid desertification, but also illustrates how growing sandstorms are sparking regional cooperation. In a similar vein, **Christine Loh** discusses how the dire air quality problems in the Pearl River Delta are catalyzing cooperation between the Hong Kong and Guangdong governments. **Kong Chiu**, **Yu Lei**, **Yanshen Zhang**, and **Dan Chen** introduce the applied studies the U.S. Environmental Protection Agency has been doing in China to link energy and greenhouse gas reduction measures to concrete health benefits. **Chris Nielsen's** piece describes the extensive air and health work being carried out by the Harvard China Project, research that lays the foundation for stronger air pollution policies in China. **H. Dean Hosgood, III** introduces some vital research taking place around what is the fourth largest cause of death in China—indoor air pollution. **Peter Koehn** rounds out the air pollution discussion pondering the health benefits of reemphasizing bicycle use in China.

While air pollution is clearly a major health threat in China, a larger one is most likely the growing water crises—from both scarcity and pollution. Two pieces in this issue focus on water. First **Laurel Meng Lelan Miller** and **Samantha Jones** delve into the sources and health threats of Beijing's increasingly contaminated groundwater, on which the city depends for nearly 70 percent of its drinking water. **Baohua Yan** presents an intriguing story of how environmental education at a school for migrant children can plant the seeds for addressing water pollution in marginalized communities in China.

I am pleased to include three commentaries that look at Chinese NGOs—long a major focus of *CES*. **Wu Fengshi's** article on the growing involvement of grassroots groups in HIV/AIDS policymaking highlights the potential of other health groups becoming active in environmental health issues. Drawing on her work with Greenpeace China, **Jamie Choi** discusses the deleterious impact of the electronic-waste trade and "recycling" on communities in southern China. In his commentary, **Wen Bo** introduces some Chinese activism calling for more transparency in the construction of nuclear power plants, which he believes is laying the groundwork for an emerging anti-nuclear movement. Other articles focusing on China's green civil society are scattered throughout the publication in the Spotlight on NGO Activism Boxes—succinct stories and anecdotes that provide important insights into grassroots and international NGO activism in China. In this issue we highlight **Pesticide Eco-Alternatives Center**, **Green Camel Bell**, **Green Anhui**, **Shanghai Green Oasis**, **Green Hanjiang**, **Tai Lake Defenders**, **A Child's Right**, **China's Roots & Shoots Program under the Jane Goodall Institute**, **Natural Resources Defense Council's China Program**, and the **International Institute for Rural Reconstruction**. Please do take a peek at our Feature Boxes, which are short nuggets of information on various organizations (e.g., International Energy Agency's China activities) and issues (e.g., air pollution in Urumuqi, green banking, and tiger protection).

Our **Inventory of Environmental and Energy Projects in China**, which has been a core activity of CEF throughout our ten years of activities, has become so big that this year we focused only on the international NGO groups. Please view it on our website and we promise to compile extensive Chinese NGO and U.S. government inventories next year.

In addition to all of the dedicated contributing authors, I wish to express my gratitude to my new assistant and *CES* managing editor **Linden Ellis**, who kept her sense of humor as we juggled our editing, research, and meeting activities. I also am indebted to my ever-growing battalion of research interns—**Natalie Baer**, **Debbi Lee**, **Samantha Jones**, **Mayu Suzuki**, and **Yang Yang**—who helped immensely in editing, coauthoring on boxes, and researching extra facts for this publication. I close with the grateful acknowledgement that this issue of the *China Environment Series* was made possible by generous support from the **Rockefeller Brothers Fund** and the **U.S. Agency for International Development**.

FEATURE ARTICLE

Assessing China's Response to the Challenge of Environmental Health

By Xiaoqing Lu and Bates Gill

China is facing major environmental challenges and the government now is undertaking a significant reevaluation of its response. China's booming growth over the past two decades resulted in a wide range of devastating consequences for the environment that are having an increasingly adverse effect on the nation's economy, public health, and social stability. Escalating environmental threats to human health afflict many parts of China. However, the health impacts of environmental pollution may be most severe in southern China—a hotspot for poorly regulated but very high-paced industrial development—and among rural citizens throughout the country who lack resources and healthcare coverage to treat pollution-induced illnesses. As the Chinese leadership gradually awakens to the tension between economic growth and environmental protection, they must prioritize the human health impact of China's environmental crisis, which has been largely ignored. Major gaps include insufficient intergovernmental coordination on environmental health issues and a noted lack of nongovernmental organization and public involvement in addressing the issue. Some promising international research initiatives are being undertaken, which could address the severe lack of environmental health data. Ultimately what is needed is a comprehensive, interagency and collaborative strategy to stop China's environmental health crisis from getting worse.

CHINA'S WORSENING POLLUTION PROBLEM

The magnitude of the pollution problem in China is alarming. While rapid economic development and urbanization in the past 27 years have lifted hundreds of millions of Chinese out of poverty, it has also created tremendous pressures on the environment. According to the newly released report, *OECD Environmental Performance Review of: China*, air pollution in some Chinese cities reaches levels that are among the worst in the world; energy intensity is about 20 percent higher than the OECD average; and about a third of the watersheds are severely polluted. Challenges with waste management, desertification, and protection of nature and biodiversity persist (OECD, 2007). In a stern statement in July 2007, the vice minister of China's State Environmental Protection Administration (SEPA) admitted that China's approach of growth through industrialization had pushed the environment "close to its breaking point" ("Taking the waters," 2007).

The deteriorating environment througout the country has resulted in heavy economic losses. China's first research report on a "green national economy," by the Chinese Academy for Environmental Planning and the National Bureau of Statistics, indicates China may have suffered a total loss of $64 billion from environmental pollution in 2004, or more than 3.05 percent of the country's gross domestic product (GDP)("Pollution costs," 2006). A study that would have presented a higher economic cost and a more detailed picture of pollution-induced GDP loss, or the so-called "green GDP," has been indefinitely postponed, reportedly due to pressure from local officials and fear of social backlash ("China postpones," 2007).

Chinese authorities are generally aware of the economic cost of environmental pollution, and have tried to initiate a shift towards a more sustainable development track. Beijing-endorsed concepts, such as "harmonious society" and "scientific development" are in part reflections of this new commitment. Concern for the environment is now incorporated into economic decision-making at the central level. For example, the Chinese government has made it a compulsory target to cut chemical oxygen demand (COD) and sulfur dioxide (SO_2) emissions

by 10 percent during the 11th Five-Year Program (2006-2010) ("Keep the green," 2007). SEPA has recently unveiled a set of tough new rules to tackle worsening lake pollution while lambasting the country's "bumpkin policies," or sub-national government protectionist practices, which encourage local officials to turn a blind eye to the environment in order to pursue economic profits ("New rules," 2007). Unfortunately, central mandates often go unmet or are simply ignored at provincial and local levels, where high-growth policies typically trump environmental concerns.

MOUNTING ENVIRONMENTAL HEALTH CONCERNS

To date, the impact of environmental degradation has been measured mostly in terms of economic losses, while the impact of pollution on human health has not received the attention it deserves. The nation's health is clearly threatened by growing environmental risks. Yet, due to years of neglect, lack of political will, and an absence of resources for research, there are limited data and studies on the actual health impact of environmental pollution, as well as quantified links between environment and health.

Environmental pollution undermines the nation's health by contributing to increases in cancer and birth defects, or by damaging the human body's immune system, rendering citizens more vulnerable to various other health risks. Millions of people in rural and urban China suffer from health problems caused primarily by the deteriorating environment. Anecdotal evidence suggests pollution and environmental degradation have led to chronic health problems, such as gastric disorders, diarrhea, asthma, bronchitis, and conjunctivitis, as well as acute poisoning and death. A soon-to-be-published report by the World Bank indicates that approximately 500,000 people die each year as a result of air pollution in China ("China blames," 2007).

Air Pollution-Caused Health Effects

Air pollution is a major hazard affecting the nation's health, especially in urban areas. Due to massive and unclean use of coal as China's primary energy source, air pollution has become one of the most visible and dangerous environmental problems in China, home to 16 of the world's 20 most air polluted. Satellite data has revealed Beijing has the planet's worst level of nitrogen dioxide (NO_2), which can cause fatal damage to lungs. Recent air monitoring in 522 Chinese cities found 39.7 percent of them had either medium or serious air pollution ("39.7% of Chinese," 2006). SEPA announced that China was the world's largest source of sulfur dioxide in 2005 and a mere two years later the country overtook the United States as the world's largest carbon dioxide emitter, with a recorded emission of 6,200 million tons of carbon dioxide—the main greenhouse gas ("China overtakes," 2007).

China's severe air pollution has undoubtedly contributed to a jump in chronic lung diseases—usually associated with the elderly—among young people. Other rising health problems associated with deteriorating air quality include respiratory inflammation, asthma, and chronic obstructive pulmonary disease. An estimated 200 Chinese cities fall short of the World Health Organization (WHO) standards for the airborne particulates responsible for respiratory diseases, which are becoming a leading cause of death in China (WWI, 2006).

Exposure to polluted air also has led to a stunning number of premature deaths. A recent study conducted by the Chinese Academy on Environmental Planning blamed air pollution for 411,000 premature deaths—mostly from lung and heart-related diseases—in 2003 ("Satellite data reveals," 2005). Data from the Chinese Ministry of Science and Technology indicate that 50,000 infants may die as a result of air pollution every year ("Choking on Growth," 2004).

Water-Associated Illness and Death

Illness and death caused by worsening water pollution is another major concern. Contamination is widespread in Chinese rivers, lakes and reservoirs, mainly in areas adjacent to industrially developed cities and towns in the southern part of the country. According to SEPA statistics, 70 percent of China's rivers and lakes are polluted to some degree and 28 percent are too polluted even for irrigation or industrial use. Ninety percent of the water under Chinese cities is too polluted to drink. A Beijing-based environmental group, Friends of Nature, revealed that one-quarter of the Chinese population, or at least 320 million Chinese, are drinking unsafe water ("Unclean drinking water," 2007). The majority of the affected population resides in rural China, where the environmental and public health infrastructures remain underdeveloped.

Inadequate treatment of industrial, municipal and agricultural wastewater intensifies China's

BOX 1. Cancer Villages in Southern China

By ELIZABETH VAN HEUVELEN

According to a Ministry of Health survey, cancer topped the list of the ten most lethal diseases for urban and rural residents in China last year.[1] This study follows on the tails of a report released last year by China's State Environmental Protection Administration (SEPA) which states that more than half of the country's 21,000 chemical plants are located along the Yangtze and Yellow Rivers near water supply sources.[2] Together, these reports partially explain the marked spike in the number of China's "cancer villages" located along some of China's biggest, and most polluted rivers.

One such "cancer village" is Shangba, a town of 3,000 along the Bai River in southern China's Guangdong Province. Between 1987 and 2005 more than 250 people died of cancer and many villagers and environmentalists blame the upstream Dabao Mountain Mine for the surge in cancer cases.[3] The mining operation stripped the top of the Dabao Mountain bare, creating massive soil erosion and allowed the mine's wastewater to flow freely into the nearby Bai River, polluting it with heavy metals. The wastewater eventually passes through local farmland and villages, contaminating the soil and crops, posing a serious health threat, as well as destroying the livelihoods of the farmers, who can no longer sell contaminated crops at the markets. [4]

After much perseverance, the residents of Shangba were finally able to draw the attention of the news media and the Guangdong provincial government to their plight. Since 2003, Shangba's pollution problems have been raised at the annual provincial People's Congress, which finally sparked action in 2006.[5] Under the supervision of the People's Congress, the province, the Shangba village government, and the responsible mining companies established a fund to construct a reservoir, which began construction in August of 2005.[6]

While the Shangba reservoir offers village residents hope they will finally have access to clean water, the toxicity of the Bai River still spreads. Experts estimate the toxins in the river spread 50 kilometers downstream, but with heavy rains, as far as 100 to 200 kilometers, thereby presenting a significant health threat to numerous villages and thousands of residents.[7] Furthermore, experts at the Huanan Agricultural University conducted tests on the water, showing that even after the river water was diluted 10,000 times it still contained dangerously high levels of toxins.[8]

The town of Zhaiwan along another river, coincidently also named Bai, in Hubei Province shares a similar story. After much news media attention for its astronomical cancer rate (80 times the national average), the town, with the help of the city government and $30,000 from the World Bank, drilled a 120-meter well, costing 1.3 million Yuan ($169,000).[9] Like the Shangba case, while Zhaiwan residents obtained safe water, the river remains very contaminated due to illegal paper mills and chemical factories in the basin and many other villages downriver still consume the contaminated water.[10]

The prospects for cleaning up Hubei's Bai River are further complicated by the fact much of the pollution originates in Henan Province, where officials are not as willing to crack down on toxic factory emissions.[11] The lack of a basin-wide strategy to protect the water means people both up and downstream face toxic water and elevated risk of pollution-induced cancer. Moreover, the upstream pollution ultimately undermines the efforts that towns like Zhaiwan have taken to ensure the safety of their citizens.[12]

A similar scenario has played out in the village of Huangmengying in Shenqiu county, Henan Province. In this town of only 2,400, 114 residents died of cancer between 1990 and 2004.[13] The village is located along the Shaying River, the biggest tributary of the Huai River—China's most polluted river. Since the early 1990s, the water in the Shaying has begun to turn black from severe pollution, and in the village of Huangmengying there has been a dramatic increase in the instances of colitis, as well as rectal and esophageal cancer.[14] According to the director of the Shenqiu county's Ecological and Environmental Scientific Research Center (under its Communist Party People's Consultative Committee), not only is there serious pollution along the Shaying River, but the groundwater also has been seriously contaminated by pollution. Moreover, the center's researchers have uncovered 20 other clear cases of cancer villages along the river, affecting nearly 50,000 people.[15]

In towns such as Shangba, Zhaiwan, and Huangmengying, the health care costs associated with cancer pose serious obstacles to effective treatment, with many citizens either foregoing medical care due to the high costs, or taking on enormous debts to obtain treatment. With the cost of cancer screening out of reach for many rural citizens, early detection is unlikely, and many cancer patients only learn of their conditions when there is little that can be done for them medically without incurring severe financial burdens.

BOX 2. Unrest Spurred by Environmental Health Concerns

By ELIZABETH VAN HEUVELEN

Over the past few years, lax enforcement of environmental pollution laws and the daunting health consequences resulting from unchecked pollution have catalyzed a growing number of incidents of social unrest in China. While a majority of the environmental protests have taken place in rural areas, there are signs urbanites also may be willing to stand up and forcefully demand improvements in the quality of their environment. As of May, the State Environmental Protection Administration (SEPA) had received 1,814 petitions from citizens "appealing for a better environment" since January, up 8 percent from the same time last year.[16] And in 2006, SEPA's Minister Zhou Shengxian reported that in recent years the number of "mass incidents" stemming from pollution which is increasing by 29 percent per annum, thereby having a "serious affect on social stability," with statistics citing the occurrence of more than 50,000 disputes resulting from environmental pollution between mid-2005 and mid-2006.[17]

Such protests are occurring not only because of environmental degradation, but because citizens feel they have no other options to get government response and compensation for their pollution-related injuries. In August of 2005, violent protests broke out in Meishan in Zhejiang Province over high levels of lead emitting from a battery factory that poisoned local children.[18] In November of 2006, mass riots broke out in a town in Sichuan after a three year-old boy ingested pesticides, was refused medical care and later died.[19]

With increasing environmental degradation and ensuing public health threats, such incidents in rural areas are likely to become more commonplace. Furthermore, with greater access to technology such as cell phones, SMS text messaging, and the Internet, it is likely that protests will become larger and better organized.

A peaceful protest of between 7,000 and 20,000 people in the city of Xiamen in Fujian Province in early June 2007 attests to the power of technology to organize such protests. The incident was sparked in response to the proposed construction of a chemical plant charged with manufacturing paraxylene and teraphalic acid, two chemicals linked to birth defects and cancer.[20] The plant, in violation of a national law that stipulates no chemical plant shall be built within ten kilometers of urban areas, received permission in spring of 2007 from the State Development and Reform Commission to be constructed immediately adjacent to a neighborhood of 100,000 people, and a mere 14 kilometers from the city center.[21] The required environmental impact assessment (EIA) of the plant was not made public and was even unavailable to members of the Xiamen Chinese People's Political Consultative Conference (CPPCC). Community members near the planned site and 105 members of the CPPCC expressed outrage in March 2007 by sending a letter to the city government urging them to relocate the project due to the potential health hazard.[22]

Beginning in late March, a text message was circulated to residents of Xiamen describing the potential health threats the chemical plant posed, some versions of which included a message encouraging participation in a protest in front of the municipal government building on June 1. In anticipation of a large protest, the local government announced on May 30 that it would postpone the project pending further environmental review, but this did little to quell the citizen's demand for the project to be cancelled altogether.[23] The text message, eventually reaching more than one million people, led to a mass gathering in front of the municipal building.[24] Video of the nonviolent protest was broadcast in real time on the Internet and clips became available later on YouTube. While the environmental review of the chemical plant in Xiamen is still pending, the incident demonstrates the potential for combining the powers of technology and citizen discontent, a model that will surely be duplicated and will pose serious challenges to the Party's promotion of a "harmonious society."

mounting water quality crisis. There are approximately 21,000 chemical factories located along China's rivers and coastline. More than half of them are located along the two most important rivers—the Yangtze and Yellow—upon which tens of millions of Chinese depend for their drinking supplies and livelihood ("Chinese chemical threats," 2006). Contaminants from upstream facilities pose health threats to many locals along the rivers, who rely on the polluted water for drinking and irrigation. As a result, China now is home to a growing number of what have been called "cancer villages."("China's 'cancer villages'," 2007). (See Box 1).

One of China's worst cases of river pollution was the November 2005 explosion at a state-owned petrochemical plant in the northeastern province of Jilin that spilled over a hundred tons of carcinogenic chemicals, including benzene and nitrobenzene, into the Songhua River. The river flows from Jilin to neighboring Heilongjiang Province, where it supplies drinking water for the provincial capital city of Harbin. After several days of cover-up and denial, the city had to shut down its water system for four days to prevent benzene exposure to its 3.8 million residents. The Songhua spill is not an isolated incident. Less than a week later, officials in southern China's Guangdong Province announced a major toxic spill from a smelter into the Bei River, threatening water supplies in the provincial capital city, Guangzhou.

Severe water pollution also aggravates China's natural water scarcity. China has the second lowest per capita water resources in the world, less than one-third of the global average. Lack of sufficient and clean water has exacted a costly toll on the nation's public health, particularly due to polluted water contaminating soil and food. In communities along China's major rivers—the Huai, Hai and Yellow—there appears to be a higher than normal rate of cancer, tumors, spontaneous abortions and diminished IQs (Economy, 2004). The OECD (2007) estimates 30,000 Chinese children, mainly in rural areas, die from illnesses linked to consuming dirty water.

In addition to air and water pollution, health hazards caused by other pollutants in the environment have increasingly been reported in recent years. According to China's Ministry of Land and Resources, more than 10 percent of China's arable land, or about 12.3 million hectares, is contaminated by pollution due to excessive fertilizer use, polluted water, heavy metals and solid waste ("10% of arable," 2007). And the situation is worsening. Compounded by shrinking agricultural acreage, arable land pollution poses a severe threat to the nation's food production, food security, and human health.

An Issue of Domestic and Global Concern

Despite the lack of official data on the exact health impact of pollution, it is virtually certain that China's deteriorating environment has led to life-threatening conditions for many of its residents. Environmental health hazards are especially acute in rural China, where 90 percent of the population does not have any medical insurance. The Chinese leadership has begun to take health care insurance reform more seriously, but continues to grapple with government- versus market-based solutions for the effective delivery of health care.

In China's rural areas, individuals are far less likely to see healthcare workers who might be able to identify environmentally induced health problems. Pollution-caused illness affects the nation's public health record, damages workforce productivity, and drives up healthcare costs. The 2007 OECD report, citing earlier statistics from the World Bank, predicted by 2020 China will have 600,000 premature deaths per year in urban areas and 20 million cases of respiratory illness each year due to pollution. The overall cost of health damage from air pollution will equal 13 percent of the country's GDP (OECD, 2007).

Environmental health hazards also spur social discontent in China. The Chinese Ministry of Public Security announced in 2006 that public order disturbances rose by 6.6 percent during 2005 to 87,000 separate incidents (CECC, 2006). Many of these social disturbances can be attributed to public anger at worsening pollution and intensifying health threats posed by pollution. As Beijing places a greater priority on reducing the number of "mass incidents"—an official euphemism for riots, protests and collective petitions—the pressing challenge of environmental health needs to be urgently and effectively addressed. (See Box 2).

Mounting environmental health concerns are not just China's problem. As China aspires to become a responsible and more prominent global player, its growth and stability, in part based on the nation's public health conditions, are important to the world. Moreover, some of China's pollution-related health hazards have begun to spread into other countries. For example, in recent years, Chinese sandstorms—

caused by worsening desertification in northern and western China—have blown particulates over to Japan, Korea, and even the west coast of the United States. Also, poor environmental health records exacerbate the spread of infectious diseases worldwide. According to the World Bank, the outbreak of severe acute respiratory syndrome (SARS) in 2003 was most potent in areas where levels of air pollution were the highest (Economy, 2004). Other water-borne diseases and illness caused by soil deterioration and erosion in China inevitably affect neighboring countries through transboundary rivers. Thus, emerging, complex environmental health problems in China are of significant interest to the international community.

CHINA'S RESPONSE

While Chinese leaders and policymaking community appear to understand the deleterious economic impact of pollution, few seem to have grasped the grim picture of pollution's toll on human health. For example, though the Chinese government has passed numerous resource protection and pollution control laws and regulations, few have a clear action plan in response to the challenge of environmental health. Overall, awareness and understanding of the health impact of pollution remains low within the Chinese government at both central and local levels.

Uncoordinated Bureaucratic Response

Two of China's agencies—SEPA and Ministry of Health (MOH)—and their provincial and local branches bear the main responsibility for enhancing environmental health conditions. Although China has improved its use of pollution control technologies and policies, the response from SEPA and MOH, along with local bureaus, to emerging environmental health threats has been extremely limited and uncoordinated.

SEPA—China's Weak Environmental Watchdog

SEPA is the chief government agency responsible for environmental protection. It has corresponding bureaus at the provincial, prefecture, and county levels. SEPA takes charge of environmental protection work nationwide, which mainly includes pollution control, protection of natural ecology, and environmental monitoring. However, due to SEPA's low political standing and small staff, it is difficult for the agency alone to bring adequate political and scientific attention to environmental health problems.

Over the past years, SEPA has participated in many environmental assistance programs with bilateral and multilateral aid agencies and international NGOs. But environmental health threats have rarely been the focus of environmental assistance to China. One notable exception includes the studies undertaken by the U.S. Environmental Protection Agency's (EPA) Integrated Environmental Strategies (IES) initiative, which began work in China in 1999. Under IES, the EPA, SEPA and various research centers have worked to estimate how the implementation of clean energy and transport technologies and policies could benefit local air pollution and related human health problems, as well as lower greenhouse gases (Green, Hildebrandt, & Turner, 2002). The first two studies focused on Shanghai and Beijing and a broader national study is currently underway. The results of the Shanghai study prompted the municipal government to strengthen energy efficiency and air pollution measures in the Tenth Five-Year Plan, which underscores the value of generating more environmental health studies for policymakers. One goal of the ongoing national study is to examine policies and measures that will help China simultaneously meet the Eleventh Five-Year Program's 20 percent energy intensity reduction target and 10 percent SO_2 reduction goal.

In addition to the IES work, SEPA and EPA began a collaborative project on hazardous waste management in 2006, and in 2007 the two countries agreed to cooperate on farm chemical pollution control ("China, U.S. ink," 2007). Yet, SEPA's work with international partners is far behind the curve of widespread and worsening environmental health threats across the country. Chinese universities in China have also been undertaking environmental health research with some U.S. counterparts, which may mark an important turning point in the generation of crucial data on pollution-health linkages. (See Box 3).

SEPA has ongoing consulting and training activities with other international partners. For example, SEPA, under the auspices of the Forum on China-Africa Cooperation (FOCAC) and with guidance from the Chinese Ministry of Commerce, has convened four training meetings for some 150 African officials and experts, providing information and generating exchanges on such topics as environmental management, environmental law, and environmental impact assessments. In another example, SEPA holds an annual consultation meeting on

BOX 3. **Environmental Health Research Initiatives**

Western Kentucky University's China Environmental Health Project (CEHP). The purpose of CEHP is to develop U.S.-Chinese partnerships to build the capacity of Chinese scientists, university students, local governments, civil society organizations, and citizens to understand and find solutions to two pressing environmental health threats: (1) coal emissions on the eastern coast, and (2) degraded water in the karst regions of southwest China. For 15 years, scientists at Western Kentucky University (WKU)—together with Chinese university counterparts—have been undertaking applied research and training projects focused on enhancing Chinese infrastructure and technical capacity to find solutions to safe drinking water challenges in southwest China's limestone karst regions and to monitor emissions from coal burning on the urbanized east coast. (*Editor's Note: See the special report in this issue of the* China Environment Series *for more information on CEHP*).

The Social Science Research Council's (SSRC's) China Environmental Health Initiative (CEHI). Under this initiative, which was launched in 2007, SSRC is conducting a review of current knowledge on the relationship between environment and health in China, and of responses by government agencies at various levels, as well as nongovernmental and international organizations and the news media. The goals are to identify ways in which existing research can better inform policy and practice, to identify areas in which multi and interdisciplinary research is needed, and to develop ways to build research capacity in this area. This review process will result in an international conference and a series of workshops to be held in spring 2008. Other activities under the initiative include:

- Building an international network of scholars, policymakers and practitioners working on environment and health within and outside China and to facilitate the exchange of information among them.

- Creating the Resource Hub—a comprehensive web-based database that will house information on individuals and institutions working on environment and health in China, as well as include bibliographic resources. The hub is scheduled to launch by the end of 2007.

- In collaboration with the Yunnan Health and Development Research Association, CEHI is developing a bilingual website to introduce international experience and research on environment and health, including: (1) articles on conceptual, methodological and data issues; (2) insights from different disciplinary and geographical perspectives; and (3) links to relevant international agreements, national laws and policies. It will also feature articles on various aspects of environment and health in China, including air and water pollution, food and drug safety, and other issues. The website is under construction and scheduled to launch in fall 2007.

- CEHI will also collaborate with the Yunnan Health and Development Research Association to produce a series of special issues of the association's journal focusing on environment and health.

Harvard University's China Project. This project is an interdisciplinary research program crossing the schools of Harvard University and collaborating with Chinese universities and research institutes to build fundamental scholarship and research capacities relating to atmospheric environment. An ongoing initiative of the China Project, coordinated with Tsinghua University, focuses on the case city of Chengdu to explore confluences of urban transportation, land use planning, vehicle emissions, and effects of mobile-source air pollution on human health and the economy.

Cornell University and Beijing University's Beijing Olympics Transportation and Human Health Study. Cornell and Beijing universities have already carried out one study of air quality and human health in Beijing prior to the Olympic games. They will carry out similar studies during and after the Olympics. This study is part of a Beijing EPB's Regional Air Pollution Control research efforts linked to the Olympics.

regional environmental concerns with counterparts from Japan and South Korea. Nevertheless, these international exchanges do not yet appear to focus with any specificity on pollution-induced health problems in China, which could be a fruitful area of exchange for all countries involved.

China's Ministry of Health

MOH is the highest administrative entity in charge of health-related matters in China primarily through its Center for Disease Control and Prevention (CDC), which does focus on illness associated with pollution. MOH Vice Minister Chen Xiaohong includes environmental health issues within his portfolio, but his ministry and China's CDC tend to deal primarily with the consequences of environmental pollution on health, rather than taking a more proactive and preventative position.

> **Environmental health hazards are especially acute in rural China, where 90 percent of the population does not have any medical insurance.**

Competition or Collaboration?

In February 2007, MOH and SEPA jointly issued a document to establish a mechanism for collaboration on environment and health (Zhao, 2007). In August 2007, the two agencies announced planned actions under this agreement, including: (1) creating a leadership group with a joint secretariat chaired by MOH and SEPA ministers; (2) establishing an expert advisory committee to help guide the creation of thematic working groups; (3) conducting joint environmental health monitoring, surveying and research; and (4) handling public environmental emergencies jointly. The creation of such an inter-agency mechanism holds promise of promoting better data generation, education, and training. Nonetheless, due to the complexity of engaging two separate bureaucracies to cooperate, translating the new plan into real action, particularly at local levels, remains challenging.

SEPA and MOH are not alone in regulating environmental health issues. For example, they must share responsibilities with several other government units for waste management, an environmental problem receiving much less attention than air and water pollution.[25] The main agency responsible for municipal waste—perhaps China's largest waste challenge—is the Ministry of Construction, which supervises and administers the collection, storage, transport, cleaning, and disposal of solid waste generated by cities. The Ministry of Commerce oversees the recycling of paper and cans, while the Ministry of Water Resources handles the treatment and disposal of contaminated bottom sediment dredged from rivers.

Due to bureaucratic stovepiping and turf battles, environmental and health officials, as well as officials from other agencies, rarely work together. The bureaucratic disconnect is also reflected at local levels. Both a lack of awareness and unclear bureaucratic lines of authority regarding the nexus between environment and health have meant an ineffective government response in tackling the health challenge posed by pollution. China lacks a powerful national body capable of enforcing, coordinating and monitoring efforts to enhance environmental health conditions at central and local levels.

Discussions in Beijing in August 2007 suggest that efforts are underway to establish a larger inter-agency process to address environmental health problems, drawing in other agencies in addition to MOH/CDC and SEPA, including the Ministry of Water Resources and Ministry of Construction. This more ambitious process of collaboration, before the State Council in the fall of 2007, would lay out a 10-year plan focusing on environmental health, which would include research and regulatory responses in such areas as: (1) air pollution and health, (2) water pollution and health, (3) the impact of climate change on health, and (4) health problems associated with inadequate solid waste treatment.[26] It remains to be seen whether this initiative is approved, and whether it can overcome the typical challenges plaguing inter-agency processes in China.

The main research arm within MOH tasked with environmental health research is the Institute for Environmental Health and Related Product Safety (IEHS) of the Chinese CDC. IEHS provides scientific evidence and technical support for formulating policies and regulations on environmental health, conducting environmental health-related studies

and surveys, and implementing international cooperation programs. Notably, as China's national professional entity for environmental health and related matters, IEHS operates under two different bureaucracies—MOH and SEPA. With their separate mandate on environmental health, MOH and SEPA might exert uncoordinated control over the work of IEHS. This reflects the still low understanding among environmental and health officials of their responsibilities and effective ways to collaborate. In addition, while funding currently is sufficient to support IEHS staff and initiate new projects, officials there are concerned that they lack proper skills and technologies to carry out advanced research, monitoring, and assessments of environmental health risks.

IEHS is involved in a number of collaborations with foreign partners. For example, IEHS has been working with the Partnership for Clean Indoor Air (PCIA) on indoor air pollution issues. Under the umbrella of PCIA, IEHS is working on an EPA-funded project to promote efficient coal and biomass usage throughout rural Guizhou and Gansu provinces. The goal of this joint project is to reduce the health impacts of indoor air pollutants in poor rural areas of China. The IEHS has also successfully applied jointly with Yale University to the U.S. National Institutes of Health to establish a five-year, $1 million program of training and exchanges between IEHS and Yale University environmental health experts. In another example, IEHS is working with the Global Environment Fund to carry out research in seven Chinese counties to assess the impact of climate change on the health of vulnerable populations such as children and the elderly. IEHS has also collaborated with Indiana University to assess the environmental presence of heavy metals on the health of senior citizens in China. In November 2007, IEHS will serve as host for an international conference on environmental health co-sponsored by MOH and SEPA.

At the local level, since 2001, the Shanghai CDC has been partnering with the one of the largest state environmental health programs in the United States—the Environmental Health Investigations Branch of the California Department of Public Health—to carry out the Shanghai-California Environmental Health Training Program. Through training, research collaborations, and capacity building activities this program has promoted public health action in Shanghai. (*Editor's Note: See Feature Box on this initiative in this CES issue*). This highly successful program underscores a promising area of international collaboration to build up the capacity of local-level health agencies to address environmental health challenges in China.

Disconnect Between Central and Local Levels

The responsibility for implementing central mandates on the environment and environmental health falls largely on local officials, and there exists a substantial disconnect between central and local officials in terms of awareness and policy implementation.

Beijing has passed a series of tough measures and standards, and pledged significant amounts of funding in order to curb pollution. For example, new standards were issued, effective July 1, 2007, for drinking water—the first new standards for drinking water issued since 1985—which raised the number of indicators measuring the safety of drinking water from 35 to 106. In principle, local officials are informed of new mandates and are often required to attend workshops and other training sessions to learn about them and their proper implementation. Yet, while local environmental agencies may be willing and able to implement stricter rules, their political leaders are often reluctant to invest in environmental protection, preferring instead the political and financial rewards inherent in stoking economic and industrial growth. Local offices of SEPA have particular problems owing to lack of adequate resources and bureaucratic influence, due to interests from powerful sources, such as local developers, businesses, and senior local officials who have far greater standing and political clout. Due to such disconnects between central mandates and local implementation, Beijing's clean-up initiatives often leave pollution and pollution-related health threats unabated.

Lack of Effective Public Participation

Another missing factor in China's response to the challenge of environmental health is public participation. Although environment-related citizen groups form the largest sector of civil society organizations (CSOs) in China today, the government's wary attitude toward CSOs and onerous registration requirements for such groups cause CSOs pursue relatively safe areas of work (e.g., environmental education and recycling). There are few grassroots groups working on environmental health-related issues, for such work generally puts the CSOs in opposition to local government-owned industries. For example, over the past two years, two Chinese

environmental activists have been arrested for seeking greater transparency on water pollution issues that were causing severe ecological and human health problems (Oster, 2007; Buckley, 2005). Some Chinese CSOs engaged in environmental health include: (1) the Green Volunteers League of Chongqing, which investigated pollution and health problems in a rural community in Sichuan Province; and (2) the Huai River Defenders, which conducted a survey in China's most polluted river basin, the Huai, and found elevated levels of tumors, cancers and skin problems. Also notable is the Pesticide Eco-Alternatives Center, an environmental CSO carrying out research and outreach projects on pesticide problems and advocating alternative pest control methods with the goal of protecting human and ecological health threats from farm chemicals. The overall number of these groups remains very small. Additionally, their capacity is limited due to lack of funding, government support, and interest from the donor community.

Notably, one Hong Kong CSO, Civic Exchange, has been active in carrying out research and surveys on air pollution and environmental health in the Pearl River Delta Region. Civic Exchange has served as a catalyst for Hong Kong scientists to push stricter emission standards and more cross-border collaboration (Turner & Ellis, 2007). This CSO offers an intriguing model for how some mainland green groups could undertake environmental health work.

In recent months, Chinese authorities have tightened controls on CSOs in environment, health and other sectors, due to its suspicion that some groups might act as a proxy for western foreign policy. The mistrust has largely stemmed from the "color revolutions" in such places as Georgia, Ukraine and Kyrgyzstan. The combination of tight government control and low CSO capacity makes it extremely difficult for such groups to become effective watchdogs vis-à-vis local governments, or key actors for tackling environmental health threats. Without such groups, the Chinese public, as the primary victim of environmental health hazards and one of the most interested parties to see a greater focus on cleaning up environmental health threats, has yet to gain a greater voice in environmental decision-making.

Future Challenges and Opportunities

The disparity between China's intensifying challenge of environmental health on the one hand, and the inadequacy of the governmental and non-governmental programs on the other, is alarmingly large and may be growing wider. Several important changes in direction will be needed to improve the country's meager record in addressing its environmental health challenges.

> **"In communities along China's rivers…there appears to be a higher than normal rate of cancer, tumors, spontaneous abortions, and diminished IQs.**

Increasing Transparency and Accountability

As the impact of pollution on human health becomes more obvious and widespread in China, more effort should be undertaken to collect and analyze accurate data in order to determine the real impact of environmental conditions on human health as well as to assess the effectiveness of various government programs. The Chinese government should allow increased transparency regarding the health impacts of pollution. Local officials should be held accountable for the environmental record in their jurisdiction. Efforts to make environmental improvement a greater part of local officials' performance reviews and promotion prospects must be strengthened and enforced.

Interagency Collaboration and Better Environmental Governance Mechanism

Confronted with rising incidents of environmental health cases, China needs a comprehensive, interagency and collaborative strategy to stop the situation from getting worse. SEPA and MOH, as well as their local branches, need to work closely together to formulate joint and comprehensive strategies in order to enhance the country's environmental health conditions. This collaboration mechanism should also include other relevant government agencies, such as Ministry of Agriculture, Ministry of Construction, Ministry of Land and Resources, and others. Ultimately, a supra-ministerial body or working group—led at the vice-premier level—will

be needed to bring greater political clout to the interagency effort and insure well-coordinated and effective policies are put in place and enforced.

Expanded Public Participation in Decision-making

Local government pressure—ranging from harassment to arrests—on CSOs working on anti-pollution or anti-dam campaigns underscores how such groups are not yet partners for solving the country's growing pollution and health woes. Civil society groups should be encouraged to participate in environmental health-related programs and decision-making. In China, CSO experience in addressing public health challenges such as HIV/AIDS has demonstrated that Chinese civil society groups can be highly effective in mobilizing communities, increasing awareness, developing solutions, and implementing programs—acting essentially as service providers, rather than strictly as advocacy groups (Thompson & Lu, 2006). The central government has become progressive over the past few years in advocating public participation in environmental policy decision-making and these policies need to be better promoted at the local level.

Stepping Up International Cooperation

As China's environmental health threats have significant international implications, the international community should step up its cooperation with China to address the challenge. One highly promising WHO/UNEP effort is the Regional Initiative on Environment and Health in Southeast and East Asian Countries.[27] This forum has been planned since 2004 and began to actively bring environmental and health ministers from Asia together in 2006. The objective of this regional forum is to strengthen the cooperation of the ministries responsible for environment and health within countries and across the region by providing a mechanism for sharing information, improving policy and regulatory frameworks, and promoting the implementation of integrated environmental health strategies and regulations. China's MOH and SEPA are participating in this initiative and evidently working on a national environmental health action plan. This forum could provide an important catalyst for MOH and SEPA to become better integrated on environmental health issues if Beijing is serious about enhancing inter-agency collaboration in its response to this emerging challenge.

A handful of U.S. universities are undertaking work on environmental health with Chinese counterparts, which represents a promising trend for generating crucial data for better policymaking. In terms of the United States, besides the few EPA projects, environmental health has not featured prominently in Sino-U.S. environmental collaboration. The EPA projects, like all U.S. government environmental initiatives in China suffer from little funding and low prioritization. The new U.S.-China Strategic Economic Dialogue presents an opportunity to reinvigorate bilateral energy and environmental collaboration. Any new collaboration in these areas should endeavor to include the component of environmentally induced health problems. Addressing China's growing environmental health challenges calls for an increase in collaboration between China and its international partners, including the United States.

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25. For more information on the magnitude of waste problems and their impact on health in China see a collection of research briefs on the China Environment Forum's website, which were produced under the China Environmental Health Project: http://www.wilsoncenter.org/index.cfm?topic_id=1421&fuseaction=topics.item&news_id=224052.

26. Authors interview with Jin Yinlong, Director of Institute of Environmental Health and Related Product Safety (IEHS) at Chinese Center for Disease Control, Beijing, China, August 2007.

27. For more information on this forum see: http://www.rrcap.un p.eorg/envhealth/index.cfm.

FEATURE BOX

Rapid Translation of Environmental Health Research Into Policy and Action

THE SHANGHAI-CALIFORNIA ENVIRONMENTAL HEALTH TRAINING PROGRAM

By Rick Kreutzer

Over the past six years, the Shanghai-California Environmental Health Training Program has accelerated public health action in Shanghai, China through training, research collaboration, and capacity building activities. The program has resulted in better public health surveillance, more research opportunities and new policy initiatives to improve the Shanghai municipal region and national health.

China's economic reforms have sparked rapid growth that has brought millions out of poverty, but have also created major environmental degradation and growing social inequities. Growing health problems stemming from pollution, infectious diseases, and lack of access to health care are major challenges facing China's public health agencies, even those in wealthy Shanghai. To address the growing health challenges in the Shanghai region, the Shanghai Center for Disease Control and Prevention (CDC) was created in 1998. Three years later (2001), with support from the Fogarty International Center of the U.S. National Institutes of Health (NIH), the inter-governmental Shanghai-California Environmental Health Training Program was formed as an innovative partnership between the Shanghai CDC and one of the largest state environmental health programs in the United States, the Environmental Health Investigations Branch (EHIB) of the California Department of Public Health (DPH).

This inter-governmental agency relationship is unique in supporting sustained long-term institutional collaboration that can achieve more rapid translation of research into policy and action than inter-academic center collaborations. The Shanghai CDC, with a similar-sized population base and technical responsibilities, shares much in common with the California DPH. Both agencies must address many of the same kinds of environmental concerns and threats, and thus benefit from the unique perspective each brings to the environmental health training collaboration.

Recent renewal of the program for another five years will allow it to build upon its recent successes. During the first funding cycle, the program had three components: (1) U.S.-based training for selected representatives of the Shanghai CDC; (2) conferences on environmental and occupational health issues, mainly China-based; and (3) enhancements to Shanghai CDC institutional capacity.

TRAINING

Although this program offered participants academic training opportunities at the University of California, Berkeley, it focused primarily on government-to-government training and research collaboration. Trainees with backgrounds in epidemiology, toxicology, and laboratory sciences came to the United States for six months to observe and to participate in EHIB's large-scale epidemiological studies and learn about its approach to planning, implementing, and evaluating environmental health programs. Efforts were made to offer trainees on-the-job technical, regulatory, and policy experience of direct value to China in its effort to address increasing environmental health threats.

Ten trainees—scientists and mid-level managers in the Shanghai CDC—have participated in the program to date. All have returned home to implement new programs or assume additional leadership responsibilities. They have conducted individual projects that build understanding and foundations for collaboration, such as:

- Reviewing human subjects rules and procedures for research in Shanghai;
- Comparing applications of the precautionary principle in U.S. and Chinese environmental health policies;
- Comparing laboratory safety protocols and standard operating procedures as well as quality assurance and control procedures between California DPH and Shanghai CDC laboratories;
- Studying environmental quality and health indicators and identifying data sources, data characteristics, accessibility, and utility of selected indicators for Shanghai;
- Studying the World Health Organization's "Healthy City" Program approaches and methods in support of Shanghai's efforts to become the largest Healthy City project in the world;
- Assessing the quality and availability of clinic records, diagnostic procedures and biomarkers to support a collaborative study on autism;
- Developing methods to measure algal toxins in environmental media;
- Evaluating options for distance learning/training hardware and web services at Shanghai CDC; and,
- Planning interagency training for emergency preparedness and response in anticipation of the 2008 Olympics and 2010 World Expo.

In addition to generally enhancing research capacity, these training activities have resulted in the Shanghai CDC strengthening its cancer registry, creating a food-borne surveillance system, publishing six journal articles, and improving English language skills among trainees.

ENHANCEMENTS TO CAPACITY

Through the training, research collaborations, and conferences, the program has identified priority needs of the Shanghai CDC and resources have been directed to enhance its capacity. For example, a website has been constructed to serve as both an aid to trainees and as a public overview to the project (www.cal-china.org). In an effort to increase international access to Chinese public health scholarship and to enhance the quality of that scholarship, the program supports translating all abstracts of the *Chinese Journal of Environmental and Occupational Medicine* into English. In addition, the journal, with support from the program, will resubmit an application for indexing in the PubMed research database, which was rejected in May, 2006.

> **"Growing health problems stemming from pollution, infectious diseases, and lack of access to health care are major challenges facing China's public health agencies, even those in wealthy Shanghai.**

During the Severe Acute Respiratory Syndrome epidemic, the program's U.S. sponsors coordinated discussions between the Shanghai CDC management and U.S. experts about Shanghai clinic and hospital reporting systems, data management, and training to improve the Shanghai CDC's capacity to respond to future disease outbreaks. As a result, the Shanghai CDC created protocols to direct staff in dealing with large acute outbreaks and has established an Infectious Disease Prevention and Control Management Office that coordinates activities at community clinics, district CDCs, and the Shanghai CDC.

Another important initiative of the program has been to examine the utility and feasibility of integrating Shanghai municipal clinical services systems and Shanghai CDC research and data collection systems with a carefully designed biological specimen bank. The proposed integrated clinical services-research system would link detailed individual and family health data and clinical specimens with additional biological specimens (e.g., blood, urine, and sputum) collected and stored for purposes of genomic, proteomic, metabolomic, and environmental health analysis. The result will be one of the world's largest biomonitoring programs.

FUTURE PROJECTS

During the next project period, existing program components will be maintained. In addition, the program will develop a series of seminars to be held in Shanghai to increase interaction on focused topics among California and Shanghai health researchers. The program also will creates a separate grant-making infrastructure to award start-up grants for selected Shanghai CDC research proposals that address important environmental and occupational health issues and build stronger research collaboration with California researchers. Finally, the program will support Shanghai CDC's effort to become a center for web-based distance training, offering a broad training curriculum and virtual meeting forum to district and local CDCs in Shanghai as well as to other adjoining Chinese provinces.

The Shanghai-California Research Training Program provides an opportunity for scientists and policymakers to share experience and information with colleagues around the world and to build new institutional capacity to address the formidable problems facing them. The program has become a vehicle to translate environmental and occupational health research more rapidly into public health policy and action.

For more information please see www.cal-china.org, or contact Rick Kreutzer (rick.kreutzer@cdph.ca.gov) or John Petterson (iai@san.rr.com).

FEATURE ARTICLE

Surf and Turf

Environmental and Food Safety Concerns of China's Aquaculture and Animal Husbandry

By Linden J. Ellis and Jennifer L. Turner

In the summer of 2005, China's largest pork-producing province, Sichuan, experienced an unprecedented human outbreak of the pig pathogen Streptococcus suis. *The 215 cases totaled more than all of previous human cases worldwide (Greger, 2007). A year later,* The Economist *reported how hundreds were sickened in Shanghai from eating pork doctored with fat-reducing chemicals or injected with water to raise the weight of the carcass ("An Old Worry," 2007). In the summer of 2007, the Jiangsu government banned hairy crab farming in and around Yangcheng Lake, for excessive nutrient production from the farms had created algae blooms that were threatening Suzhou's drinking water (Yan, 2007). In the village of Cang Dong, Hainan, the stench of a pig farm of 10,000 animals prompted protests when it was built only two miles from the village (Greenhouse, 2006). These stories all touch on health and environmental problems stemming from raising animals in high-density conditions. The emergence of livestock factory farms, known as concentrated animal feeding operations[1] (CAFOs), and intensive aquaculture production are integral parts of China's livestock revolution that began in the late 1970s to meet the demands of the country's growing population. China's poorly regulated "protein factories" pose considerable environmental and human health dangers from the relative ease of pathogenic and bacterial contamination between animals raised and slaughtered in dense quarters, the fragmentation and lack of transparency of the market, and the waste they generate. The growing Chinese food safety scares—both domestically and internationally—are catalyzing new regulations and more opportunities for international cooperation, which could help address environmental and health problems stemming from China's aquaculture and CAFOs.*

UNANTICIPATED OUTCOMES OF THE LIVESTOCK REVOLUTION

Food security has long been a challenging priority facing China, as the country with the highest population, but only 7 percent of the arable land and a quarter of the per capita freshwater resources globally. The household responsibility system, initiated in 1979 under the free market reforms, was one of the earliest Chinese government experiments to address this problem. It granted farmers a right to make profits on food produced after fulfilling grain targets for the state. These reforms aimed to encourage greater agricultural output to feed the country and helped catalyze broader economic reforms. Output of grains, fruits and vegetables boomed, fueled increasingly by heavy application of pesticides and fertilizers. To meet the growing demand for meat, dairy, and eggs in China, both central and local governments began to encourage livestock factory farms, or CAFOs. By the mid-1990s, China's CAFOs supplied 15 percent of the country's pork, 40 percent of its chickens, and 25 percent of its eggs (Lei, 2006). In the past two decades CAFOs have helped supply the 200 percent increase in China's per capita meat consumption, which in turn has sparked more industrialization of its production. Not surprisingly, livestock farming is now China's fastest growing sector in agriculture.

In the 1980s, aquaculture became a major target of rural development. Of China's total seafood output, 64 percent comes from aquaculture, making

TABLE 1: Percent of China's Meat and Animal Products from CAFOs

	2003	2004	2005
Pork	28.39	32.86	37.22
Eggs	59.87	63.32	68.24
Chicken	74.23	72.96	75.22
Beef	27.58	27.83	30.82
Milk	53.33	52.90	54.36
Mutton	43.58	39.78	41.38
Total % of all Animals Raised on CAFOs	47.83	48.28	51.21

Note: In this chart, a CAFO is defined as a farm having an output of greater than 50 pigs, 500 egg-laying chickens, 2,000 meat chickens (broilers), 10 beef cows, 5 milk cows, or 30 sheep. This data was gathered through a September 14, 2007 interview with Professor Bingsheng Ke, director of the Research Centre for Rural Economy in Beijing.

it the only country in the world where aquaculture outstrips wild catch ("China Industry," 2006). Since 1978, China's aquaculture production has increased 490 percent, making it the largest producer of farmed seafood in the world, accounting for 57 percent of global output ("Development plan," 2003; "Farming fish," 1994).

This development has not come without costs. In fact, pollution from China's CAFOs and aquaculture production poses a major threat to water, soil, and air quality, which in turn represent major threats to human health and agricultural production. Factory farms and aquaculture hold the promise of great profits, but the emergence of severe acute respiratory syndrome (SARS) and avian influenza, as well as the increasing human infections of *Streptococcus suis,* raise concerns about how extreme densities of animals could enable such diseases to mutate rapidly and spread to human populations.

SLIPPERY MENACE

China has a 2,000-year history of cultivating fish, making it the first civilization to do so. Thus, seafood is already a staple in the Chinese diet and domestic consumption is projected to rise 40 percent by 2020 ("China industry," 2006). Aquaculture—including a wide variety of freshwater and saltwater finfish, shellfish, crustaceans, and aquatic plants—is a vibrant industry. Carp is the main cultivated freshwater species, and within mariculture (a.k.a. saline aquaculture) shellfish are the dominant market. Local governments promote aquaculture as a poverty alleviating industry and have therefore subsidized production of lucrative species such as tilapia. China supplies 70 percent of the tilapia imports to the United States and is also its fourth largest supplier of shrimp (Bean & Wu, 2006). Statistics on aquaculture production focus on output rather than on farm structure and numbers, but the sector is spread throughout the country, with particular density in the southeast, and is predominantly made up of small fishponds run by private individuals.

Due to the ability of fish to retain pollution in their flesh, food safety has become a major challenge for Chinese aquaculture. International concern about food safety has cost China's aquaculture dearly, as countries ban species they discover to be contaminated. Two major cases include the 2005 eel bans in Japan and the 2003 shrimp bans in the European Union—both devastated these important aquaculture sectors in China. In 2007, the industry was hit again by a U.S. ban on 5 types of Chinese seafood.[2] Chinese consumers also are increasingly concerned about the safety of the fish they eat due to water pollution, dangerous farming practices, and poor processing in the aquaculture industry. In terms of ecological impacts, the rapid development of China's aquaculture industry has seriously polluted rivers, lakes, and coastal waters and the huge demand for fishmeal is driving stock depletion in the oceans.

FEARSOME FARM ANIMALS

With many other attention-grabbing industrial pollution accidents and scandals, waste from China's 14,000 pig, cattle, and poultry factory farms that hold 1,000-plus animals each, go largely unnoticed in the news media. The size of China's animal farms varies widely, but farms remain predominantly small scale.[3] Nevertheless, much of the meat and animal products consumed in China come from CAFOs, even if they make up a small percentage of the total farms. For example in 2003, only 4 percent of China's farms produced 50 or more pigs per annum. However, that 4 percent produced 28 percent of the country's total pork output (Li, 2005). Even more impressively, 4 percent of Chinese broiler chicken farms produced 84 percent of chicken output in 2003 (Li, 2005). In 2005, 38 percent of China's pig output came from farms with 50 or more, and 75

percent of broiler chickens came from farms with an output of 2,000 or more birds.[4] Table 1 provides insights into an increasing dependence on CAFOs, which are now the fastest growing sector in China's agriculture.

In 2003, it was estimated that 90 percent of the animal farms in China lacked any kind of pollution controls and less than 10 percent had conducted an environmental impact assessment (EIA) (Wang, 2003). China's CAFOs produce 40 times more nitrogen pollution and 3.4 times the solid waste of industrial factories. Due to high-stress conditions forced upon the densely populated animals, veterinary compounds, such as antibiotics and sometimes heavy metals, must be applied to keep animals alive and growing. Much of these find their way into soil, human drinking water, and meat.

China's CAFOs also have global implications, as their numbers swell worldwide. First, there is evidence that the conditions of animal farms help spread diseases, such as avian influenza. Since 1983, China has been exporting live animals as far away as the Middle East, sending 1.5 million live animals to this region in 1996 alone. Thus, pathogens in China's farms are of grave concern to world health. Second, China's weak meat and regulations affect international markets through exports. For example, 35 percent of China's pork production went to Hong Kong in 2003, tying the city's tourism industry and food safety to the quality of China's farms (Li, 2005). Third, CAFOs contribute increasingly to global warming. Dense populations of animals generate large quantities of greenhouse gases, such as nitrous oxides, carbon dioxide from daily respiration, and methane from meal digestion, exacerbated by the grain diets of CAFO-raised animals. According to the FAO, in 2004 China produced 12.19 million tons of methane through enteric fermentation (herbivore digestion) and manure, as compared with North America's 8.44 million tons (Steinfeld et al., 2006). In addition, large quantities of chemical fertilizer manufactured in China, used primarily to produce grain consumed by confined animals, account for 20 percent of industrial energy consumption in China derived from coal. For example, in Chongqing alone (a municipality producing approximately 5 percent of China's fertilizer), fertilizer production uses 1 million tons of coal annually, "resulting in the emission of nearly 2 million tons of carbon dioxide and thousands of tons of sulfur oxides, nitrogen oxides, and particulates" ("Clean power projects," 2007).

ENVIRONMENTAL HEALTH IMPACT OF ANIMAL PRODUCTION IN CHINA

CAFOs impact human health from the facility to the table, both as a result of consuming the product and by simply being nearby. CAFOs pollute soil, water, air, food, and livelihoods with organic, inorganic, and pathogenic pollutants. Within China, animal husbandry practices that compromise human health have been particularly rampant due to the structure of production. Although animal density per square kilometer of agricultural land in China is considered high by OECD standards, few individual facilities hold as many animals as those in the United States.[5] Most of China's animals are raised by millions of medium-scale family operations that are difficult to manage and monitor effectively. Such farms often feed what is necessary—including industrial compounds and manure—to their animals in order to reap the highest profit with little knowledge of post-production consequences. For example, the OECD reports that in locations where there is no latrine "…human excrement, food waste and waste from other animals is often disposed of in the pigsty, where it will be consumed by the pigs" (OECD, 2007, p.100). In June 2007, *China Dialogue* reported 80 percent of chickens that die of disease in China's CAFOs end up in the human food chain, either directly through vendors and food processors, or through pigs that are fed the diseased birds (Jiang & Tang, 2007). According to anecdotal evidence from Sichuan, one of the provinces with the highest pig densities, farmers often simply medicate sick pigs to make them look better and then sell them immediately to slaughter.[6] Such corner-cutting practices are all too common because the government provides little insurance or compensation strategies for farmers who lose stock or market share from diseased animals.

CAFOs and Inequity

Economic Effects and Poverty

The consequences of the above examples of dangerous lapses in food safety and pollution do not fall evenly across China's population. The poor and migrant workers tend to frequent very cheap street vendors, and are therefore the most likely to consume animals that were sick or died of natural causes prior to slaughter. Air pollution from CAFOs impacts nearby villagers, particularly sensitive groups such as children and the elderly.

Ammonia emissions are one such air pollutant, with emissions rising from 9.7 teragrams (Tg) to 11.7 Tg between 1990 and 1995 (Steinfeld et al., 2006). China's limited arable land means soil degradation from CAFOs has a massive economic impact on poor farmers. High levels of nutrients, particularly nitrogen, released from CAFOs acidifies the soil, causing plants to divert more energy to absorbing nitrogen than growing, thus reducing crop yields of poor farmers. The FAO estimates that 23.6 percent of agricultural land in Asia, mostly in eastern China and around major Asian cities, is overloaded with nutrients from chemical and organic fertilizers and thus unable to absorb the prodigious amounts of waste produced by CAFOs (Steinfeld et al., 2006). Airborne nitrogen—95 percent of the nitrogen in manure exposed to air—settles onto ground as far as 80 to 160 kilometers from a CAFO.

The growing level of organic pollution from CAFOs and aquaculture ponds is also partially to blame for the toxic marine algae blooms, called red tides, which have affected much of the east coast of China since the 1990s. The *People's Daily* reported as of the year 2000, the country had suffered $240 million in direct damages from red tides ("China closely," 2000). Other types of algae blooms also proliferate with the increased nutrient content of the water, creating vast "dead zones" in lakes, rivers, and coastal waters where almost nothing can survive in the low levels of dissolved oxygen. Aquaculture farmers and fisherman suffer disproportionately from such environmental disasters. Government clean-up efforts often are equally damaging to the poor. For example, when the Jiangsu government banned hairy crab farming on Yangcheng Lake, as mentioned at the beginning of this paper, no compensation was offered to the farmers (Yan, 2007). In August of 2007, *Xinhua* announced that by the end of 2008 all fish farms would be removed from China's three largest lakes—the Dianchi, Chaohu, and Taihu—to prevent reoccurrences of economically damaging and toxic algae blooms ("Central China," 2007). Notably, when the government culls herds of livestock to contain disease, the animal owners are seldom compensated, which discourages them from reporting the outbreaks.[7]

Health Impact on Farm Workers

Employees are another group vulnerable to CAFO pollutants. Air emissions from CAFOs contain several airborne pollutants, such as hydrogen sulfide, ammonia, and endotoxin, which pose threats to workers within the facilities and to surrounding communities. CAFO workers in the United States face at least a 25 percent chance of getting respiratory diseases such as asthma, bronchitis and acute lung infection, and a 30 percent chance of pulmonary mycotoxicosis, an acute, but not fatal, respiratory illness (Donham et al., 2007). They also face the possibility of death from asphyxia or respiratory arrest. Studies conducted in the United States show that community residents within a two-mile range of a CAFO experienced greater risk of respiratory diseases ("Iowa concentrated," 2002).

Indirect Impacts on Vulnerable Groups

In rural areas, 300 million Chinese lack access to safe water and runoff from agriculture and animal production are major sources of this problem. The next section discusses direct impacts of CAFO waste on water, but contamination also stems from the inputs into CAFOS—namely feed stock and water. China is the world's second largest producer and consumer of corn, with 93 percent of it going to animal feed (Li, 2007). Currently, China is an enormous importer of animal feed, especially corn. Yet, as animal production rises in China, the profits from producing corn also rise, encouraging Chinese farmers to divert precious land resources from human food production to resource intensive animal feed production, thus threatening food security. Shallow-rooted monoculture corn production requires heavy pesticides, fertilizers (particularly nitrogen), and water applications, which increase toxic soil runoffs and create algae blooms in lakes (Steinfeld et al., 2006).

Water wastage and pollution from cleaning and processing CAFO animals is another indirect impact on the environment and communities near the facilities. China's growing water scarcity, with only one-quarter of the world's per capita average, should encourage researchers to consider water conservation and recycling options for CAFOs, particularly in the urban northeast. In addition to supplying the animals with drinking water, water is required for washing carcasses, cooling facilities, cleaning animal pens, and liquefying waste to compost it. According to Danielle Nierenberg (2005), author of *Happier Meals: Rethinking the Global Meat Industry,* eight ounces of beef can require up to 25,000 liters of water. Poultry processing tends to be even more water intensive per unit of weight than red meat, as water is used for defeathering as well. FAO estimates one bird requires an average of 420 gallons of water (Steinfeld et al.,

> **In Guangdong, swine farms alone are estimated to produce 72 percent of the nitrogen and 94 percent of the phosphorus emissions in the province's waterways.**

2006). Animals raised in industrialized systems can require as much as seven times the water as those raised in extensive or free-range systems, for animal feeds have much less water content than wild forage (Steinfeld et al., 2006).

Organic Pollutants

Organic waste is an unavoidable part of animal husbandry; however, with high animal density, this waste can become dangerously concentrated. Consumption of organic waste in contaminated food or water can lead to fatal bacterial infections and diseases, such as *E. coli* and *Salmonella*. Bacteria are concentrated in manure, and are especially common in CAFO manure because of the animals' high levels of stress and high carbohydrate diet. A study found grain-fed cattle, such as those confined in feedlots, shed significantly higher numbers of virulent *E. coli* than animals that ate roughage (Gilbert et al., 2005). These pathogens can be passed to humans when untreated manure is applied to vegetable crops or when fecal matter contaminates meat during slaughter, as will be discussed under the food safety section below. This is particularly likely in a CAFO setting due to higher than normal levels of bacteria in the intestines of the stressed animals and the high volume and speed of slaughter. According to the Hebei CDC, *Salmonella* accounts for 97 percent of China's 300 million cases of food-borne illnesses (Hebei CDC, 2006).

Organic Water Contamination

Only about five percent of animal waste is treated in China (Lei, 2006). Excess waste from over-saturated fields, with naturally high levels of nitrogen and phosphorus, ends up primarily in water, where it poses a number of human and environmental health risks. When untreated animal waste is applied to fields, 40 to 60 percent of the nitrogen leaches out of the soil and into water (Steinfeld et al., 2006). Heavy rains or accidents can cause lagoons where liquefied animal waste from CAFOs is stored to eventually break or leak into the surrounding soil and watersheds, releasing dangerous levels of trace heavy metals and bacteria into drinking and irrigation water. In Guangdong, swine farms are estimated to produce 72 percent of the nitrogen and 94 percent of the phosphorus emissions in the province's water systems (Steinfeld et al., 2006).

Health affects from nitrogen leaching into wells and surface water include increased the risk of some types of cancer, miscarriage, and "blue-baby syndrome," an often fatal type of congenital heart disease in infants. Animal waste runoff in drinking water can expose humans to bacterial infections, such as *Escherichia coli (E. coli)*, *Salmonella*, *Campylobacter* (the leading cause of diarrhea), *Clostridium botulinum*; animal to human viral diseases; and livestock intestinal parasites, such as *Giardia* (Steinfeld et al., 2006).

Runoff of uneaten food and effluent from fish farms also represents a growing problem in China. In the past, freshwater fish fed off naturally occurring organic material in ponds. As farming has intensified in China manufactured feed has become necessary, leading to more uneaten food, effluent and pollutants. One study cited by the U.S.-based NGO Food & Water Watch estimates that 155 square miles of shrimp ponds in Thailand produce more phosphorous waste, an organic compound in waste and decomposing feed, than three million people ("Suspicious shrimp," 2006).

Eutrophication, or high nutrient concentrations in an ecosystem, and algae blooms, which strip the water of oxygen necessary for life, made the news in 2007 as China's three largest lakes—Dianchi, Chaohu, and Taihu—became unsafe for drinking because of toxic blue-green algae outbreaks. Before this crisis, agricultural runoff—including CAFO waste—was responsible for 70, 60 and 35 percent, respectively, of the pollution in those lakes (Lei, 2006). Waste from CAFOs is also severely impacting the water quality of the Yangtze River, which accounts for 35 percent of China's total freshwater resources ("Report: Yangtze," 2007). The resulting mass die offs of oxygen starved fish and plants throughout China's freshwater ecosystems exacerbate biodiversity losses and food insecurity (Wang, 2003). Moreover, nutrient runoff from CAFOs into the South China Sea is wreaking havoc on sensitive coastal ecosystems such as mangroves, sea grass, and coral reefs (Steinfeld et al., 2006).

BOX 1. Major Food Safety Scares in China and the United States

United States or U.S. Products	Year	China or Chinese Products
August: Castleberry canned food recalled for possible botulism contamination, which can cause paralysis and death.[12]	2007	July: Chinese spices blamed for 54 cases of salmonella in the United States.[13]
July: China bans chicken and pork imports from several U.S. companies for various contaminants including salmonella, a feed additive Ractopamine, and anti-parasite drug residues.[14]		April 30: *The New York Times* reported that melamine scrap, believed to have sickened 14,000 U.S. pets, is commonly used in fish feed in China.[15]
February: Peter Pan and Great Value peanut butter recalled after being linked to a salmonella outbreak, affecting 628 people.[16]		April 26: U.S. Wal-Mart stores remove Chinese catfish due to antibiotic contamination.[17]
February: 52,650 pounds of chicken breast strips contaminated with potentially fatal *Listeria monocytogenes* recalled. [18]		March: The Ministry of Health reported in that 196 people died of food poisoning in China in 2006.[19]
December: *E-coli* contamination on iceberg lettuce sickens 71, including 53 hospitalizations and 8 cases of kidney failure.[20]	2006	November: 11 out of 15 samples of Mandarin fish from China tested positive for malachite green in Hong Kong.[21]
September: *E-coli* tainted baby spinach sickens over 200 and kills 3, including a 2-year old.[22]		November 22: Carcinogens (chloramphenicol, malachite green, and furazolidone) found in turbot in Shanghai. Turbot sales were subsequently banned or suspended in Shanghai, Beijing, Shenzhen, and Taoyuan. Turbot is a species of flatfish with low disease resistance that requires considerable and careful veterinary input; 100 percent of the Shanghai fish tested positive.
September: Bolthouse Farms Carrot Juice linked to 4 cases of botulism poisoning.[23]		October: Taiwan bans imports of hairy or mitten crabs from China due to traces of carcinogens.[24]
August: Carcinogenic bromate levels in Wegmans bottled water found to be double U.S. allowable levels.[25]		September: 330 people sickened by clenbuterol—a steroid that promotes weight gain in animals—on pork in Shanghai[26]
December: *Listeria monocytogenes* found on strawberries used to make smoothies in California.[27]		August: 87 people diagnosed with meningitis after eating raw or undercooked Amazonian snails in Beijing.[28]
September: *Listeria monocytogenes* contamination in 18,510 pounds of Allison's packaged barbeque beans with beef and chicken salad recalled.[29]	2005	256 food poisoning incidents reported to the Ministry of Health, 7 percent of which involved more than 100 people.
April: *Listeria monocytogenes* recall of turkey, pork, sausage, and salmon after regular USDA sampling found contamination.[30]		Malachite green found in Chinese farm- raised eels. China's three main eel export markets of South Korea, Japan, and Hong Kong (totally $860 million in 2004) suspend their imports.[31]

September: Recall of 59,000 pounds ground beef by Wisconsin company after contamination with *E. coli.*[32]	**2004**	The Chinese Ministry of Agriculture reported that between 20,000 and 40,000 people fall ill from food poisoning in China every year, which some Chinese experts believe is only 10 percent of the real number.[33]
August: Recall 406,000 pounds ground beef by Illinois company after contamination with *E. coli.*[34]		171 babies in Anhui Province became malnourished from fake milk power; 13 of these babies died. [35]
May: 13 million pounds of almonds recalled, 22 people infected with salmonella.[36]		The Chengdu Quality Inspection Department released figures stating that less than 23 percent of pickled vegetables in Sichuan met provincial regulations for pesticides residues. Some factories were spraying 99 percent strength of the pesticide dichlorvos on the pickled vegetables every two to three days to prevent pest damage while in the processing plants.[37]
February: 700 sickened, 4 deaths linked to *E. coli* contamination of Jack-in-the-Box hamburger.[38]	**2003**	Chloramphenicol found in Chinese frozen shrimp shipments to the United States.[39]
April: ConAgra ground beef contaminated with E. coli, 19 million pound recall. 29 people sick in 8 states.[40]	**2002**	Discovery of chloramphenicol, a potent antibiotic and source of aplastic anemia, in Chinese shrimp and crayfish results in an EU ban.[41]

Organic Soil Contamination

Animal manure is an excellent source of fertilizer. The Alaska Cooperative Extension Service says that the organic matter in animal manure increases water holding capacity, lessens erosion, "…improves soil aeration, and has a beneficial effect on soil microorganisms and plants" (Purser , 2000). While CAFO waste tends to contain higher levels of pathogens and other additives, many economic and environmental gains could be realized through better integration of animal husbandry and other agricultural sectors, such as using animal waste as organic fertilizer for corn, or using free-range chickens to control pests on crops.

Yet such integration has been slow to progress due to three factors. First, most agricultural land is divided into small plots, whereas CAFOs produce bulk amounts of manure; too much for a single farm to use. Second, location of farms is another constraint to integration, 80 percent of the large- and medium-sized CAFOs are located near major cities in the demand centers of the east coast, rather than in rural areas where manure could be spread on land more efficiently. The combination of the first two factors provides strong incentives for large CAFOs to store their waste, rather than distribute it to small farms because of the comparative cost of transportation and low volume of sales. Third, anecdotal evidence suggests that local Ministry of Agriculture's extension services have invested heavily in chemical fertilizers and pesticides, and thus push sales of them to farmers.[8] Thus, costs and overwhelming volume, combined with the ready availability of cheap chemical fertilizer, result in low utilization of CAFO waste.

Whatever the reason, most Chinese farmers today depend on chemical fertilizers as opposed to animal manure. According to a report from *China Watch*, in Zhejiang Province only 6.2 percent of manure from CAFOs is applied to farmland. There are 437 animals per square kilometer in China, and each animal's waste requires approximately three acres of farm land to be safely absorbed, thus a large amount of chemical fertilizers could be replaced by CAFO waste (Nierenberg, 2001; OECD, 2007, p.103).

Inorganic Pollutants and Harmful Additives

Raising carnivorous species, such as salmon and shrimp, tends to produce some of the most

detrimental environmental impacts because of the amount of antibiotics and waste they produce. All animals require carefully manipulated diets to survive, let alone grow, under high-density conditions, particularly since confined animals cannot select their own food based on their nutritional requirements. These man-made diets can include harmful additives such as antimicrobial drugs; fungicides (for fish); low quality protein (such as the coal-based melamine found in pet foods); and cosmetic components (such as carcinogenic Sudan Red, a dye to make egg yolks darker, and arsenic or mercury, which makes meat redder). When farmers and feed producers cut corners to reduce costs, these kinds of potentially harmful substances can enter the food chain.

Duck farm in China's Sichuan Province, in which ducks are raised completely and entirely on raised platforms with net floors with no access to water for swimming. Photo Credit: Humane Society and Compassion in World Farming

Antibiotics and Hormones

The practice of feeding antibiotics and hormones to stock animals is well established in the West as preventative medicine and to increase weight gain. There is ample evidence that these additives remain in meat and animal waste, leaching into soil and water surrounding these facilities. In China, however, growth hormones and antibiotics are banned in pork and poultry, the biggest waste producers. Bingsheng Ke, director of the Research Centre for Rural Economy in Beijing, maintains small farms do not use antibiotics due to the prohibitive cost and the largest farms avoid them for quality control reasons.[9] Despite the ban, antibiotic resistance is a huge problem in China because of past excessive use of antibiotics and, potentially, current infringements. The U.S. Embassy in Beijing commented in 2001 that "China feeds 6,000 tons of antibiotics each year to its livestock, with Chinese animals receiving a much higher per-head dose than their developed country counterparts" ("Beijing environment," 2001). In August 2007, China announced it would be producing special hormone-free pork for all Olympic athletes to prevent false-doping cases at the Olympics, calling into question the supposedly hormone-free nature in the rest of China's meat supply (Buckley, 2007).

Compared to terrestrial farms, antibiotics in aquaculture are relatively well documented. These substances—either applied directly to the water or passing through the animals' digestion systems—are not biodegradable and persist in the surrounding environment threatening wild fish stocks and drinking water ("Suspicious shrimp," 2006; "Drugs used," 2007). When humans regularly consume antibiotics with their meat or in their water, drug resistant strains of bacteria appear in communities. In 2007, *Environmental Health Perspectives* published 2 articles on drug resistance from CAFOs. The first proved that antibiotic-resistant *Campylobacter*, a type of bacteria that in rare cases can be fatal, persists in poultry meat, even after factories had ceased using the antibiotic (Price et al., 2007). The other article demonstrated how antibiotic-resistant *Enterococci*, a type of bacteria responsible for various infections including meningitis, remained in swine waste in the local waterways (Sapkota et al., 2007).

Heavy Metals

Animal farm manure produces a considerable amount of heavy metals, including copper, zinc, selenium, cobalt, arsenic, iron and manganese, which potentially threaten food and environmental safety. These are generally added to the animal's diets to increase weight gain and reduce disease; however significant amounts go through the animals and into the surrounding environment. Arsenic, a carcinogen, is of particular concern. The metal is traditionally fed to animals, especially poultry and swine, to enhance the red coloring of the meat, help control disease, and increase weight gain. One study of pig farms in the Beijing area, conducted by Yan-xia Li and Tong-bin Chen, predicted that pig manure alone could potentially raise the levels of arsenic in Beijing's topsoil to the maximum permissible level within 93 years (Li & Chen, 2005). In their study of 29 CAFOs surrounding Beijing, all had some level of arsenic in the manure, with two producing more than the legal limit of 75 mg/kg. Once applied to

soil, the carcinogenic arsenic in manure converts to its inorganic water-soluble form and regularly seeps into drinking water. Thus, even before the arsenic exceeds emission standards it could threaten human health and the environment.

Food Safety

In March 2007, the Ministry of Health reported that 196 deaths from food poisoning in China in the year 2006, but because of underreporting, the true number is likely to be much higher (Luan, 2007). Regulation of food safety has long been a problem in China due to weak monitoring capacity, strong local government protectionism of industries, and few consumer protection watchdogs. CAFOs pose special threats to food safety via including waste contaminating crops on surrounding land, unsafe inorganic compounds persisting in the meat, and contamination from processing or improper storage. Aquaculture in particular is challenging because of a strong preference for live and undercooked fish in China, increasing the risks to consumers and highlighting the need for timely monitoring and testing (Bean & Wu, 2006).

Further, heavy metals persist in all meat, but particularly in fish. Mercury from China's coal-fired power plants is a high-profile example of how water pollution links to food safety. Consuming fish is the most common way to ingest mercury because it accumulates in the flesh of the animal. Mercury exposure can cause miscarriages, harms brain development and damages the endocrine system, kidneys and other organs. Statistics on mercury in Chinese fish are scarce, but Chinese coal is believed to be responsible for mercury contamination in fish as far away as the western United States, pointing to a strong possibility of mercury contaminated fish within China ("China's mercury," 2006).

Another worrisome additive is melamine, an industrial compound made from coal. This contaminant in pet food was responsible for pets falling ill and swine culls in the United States at the beginning of 2007.[10] In China, this industrial compound made from coal was commonly added to stock, including fish and swine, animal feed because it is a cheap way to increase the nitrogen reading of the food, making it appear to have more protein. In 2007, international pressure caused China to ban melamine additives ("Animal feed," 2007).

In the processing stage, meat can become contaminated with organic material, such as *E. coli*. When many animals are slaughtered in one location, bacteria and fecal matter can get onto the meat, even in the comparatively hygienic facilities in the United States. As mentioned above, CAFO-raised animals have unusually high levels of pathogenic bacteria, which can potentially contaminate meat.

China's State Food and Drug Administration was established in 2003 to combat the considerable governmental inefficiency in regulating food and drug safety. After 2003, the central government began passing more regulations on food quality monitoring and hygiene licensing, especially of exports.[11] Under the Eleventh Five-Year Program (2006-2010) the State Council issued the "National Food and Drug Safety Plan" that aims to establish a food safety guarantee system in China. Nevertheless, food safety rests essentially in the hands of local government enforcers, which in the case of aquaculture, often lack the motivation or capacity to strictly monitor. According to Lei Jilin in an interview with *Xinhua*, the local government agencies entrusted with monitoring fish-related food safety are either doing their jobs poorly or not at all ("Cancer-causing," 2006). The Shanghai food quality inspections appear to be the most successful, as they are often the first to discover large safety mishaps. Further complicating the food safety issue and eroding consumer trust is the fact that, while investigations are publicly announced, the findings of the investigations of farms and market studies are often not publicized.

Epidemic Disease

Disease, and fear of disease, is a huge driving force behind CAFO reform around the globe though results of CAFO safety research are still debated, particularly with regards to avian influenza. One 2004 estimate, estimated farm animal disease is costing China over $23.8 billion annually (Li, 2005). In China and elsewhere, the desire to improve disease prevention and monitoring of CAFOs caused the industry to move away from small-scale, integrated, more environmentally sound animal husbandry, to large CAFOs with few high-value breeds. For example, in response to bird flu outbreaks, the Chinese government has mandated all poultry be confined, which essentially eliminates small-scale farms and family chicken coops—hurting many rural poor. Promoting large CAFOs is based on the theory that confined animals are better monitored and their owners better informed on safe animal management.

The opposing view—supported in part by the fact that only 6 of the 48 Chinese farms hit by avian

influenza were small scale—is that large CAFOs actually play an active role in both the development and the spread of pandemic human diseases such as avian influenza (Li, 2005). While the FAO initially condemned untraceable small-scale farms, in September 2007 they declared "excessive concentrations of animals" were contributors, if not catalysts, for pandemic disease. Dr. Michael Greger argues in his book, *Bird Flu: A Virus of Our Own Hatching* (2006), that the dense, heavily-medicated factory farms encourage viruses to mutate into more dangerous varieties, some of which can infect humans.[42]

The practice of shipping live animals facilitates the rapid spread of disease across the world. Some of the first global avian influenza scares revolved around the disease's appearance in the Middle East, a live animal export hub for China. Further exacerbating the problem are poor farming practices such as feeding animal waste and by-products to other animals. Qinghai Lake, the migratory bird gateway between Europe and Asia where thousands of migratory birds fell ill in 2005, also happens to be the home of several large carp farms and feed manufacturing facilities that may have used or produced poultry litter-based fish feed (Feare, 2006). Signs of these disease-spreading phenomena in China are particularly visible in the swine industry, where a recent nationwide outbreak of the highly pathogenic "blue-ear syndrome" caused record losses to the swine industry. (See Box 2).

Streptococcus suis, bacteria that cause meningitis both in pigs and their human handlers, is one of particular importance in China. In one publicized case, 40 people died of *Streptococcus suis* in rural Sichuan Province in 2005, an outbreak which Deputy Minister of Commerce Huang Hai said "was found to have direct links with the foul environment for raising pigs" ("China drafts," 2005). Rural citizens are mainly impacted by CAFO waste and they are the most vulnerable due to limited resources to afford the often substandard healthcare available.

In addition to these high profile disease outbreaks, dense populations of animals pass other microbial diseases to farmers on a regular basis. For example, one study states that farmers have a 35.3 and a 13.8 percent chance of catching H1N1 and H1N2 influenza from swine, respectively (Donham et al., 2007). Part of the concern related to the spread of disease is the use of antibiotics in CAFOs to increase weight gain and reduce stress-related deaths among livestock. Many studies have shown that significant amounts of antibiotics pass through the animals and into the surrounding environment.

EFFORTS TO CREATE A NEW KIND OF LIVESTOCK REVOLUTION

Current politics in China view CAFOs as the solution to land constraints and rising demand for protein. As proof of the central government's commitment to the industry, the State Council endorsed the Ministry of Agriculture's "Propositions on Accelerating the Nation's Animal Husbandry Industry" in 2001. The Chinese government's priority for food security has led it to commit considerable resources to agricultural and fish research that has produced some promising new options for feeds, fish species, and farming practices. Such research holds the promise of promoting ecologically safer farms that may also help protect human health. The growing food safety problems with China's exports is spurring more attention to better monitoring and regulating of all food production sectors, which could help improve the quality of CAFO and aquaculture management and lessen their environmental impacts. Strikingly, aside from the animal waste to biogas sphere, there are not many international efforts to address environmental and health consequences of China's multiplying CAFOs and aquaculture, which makes them a highly promising area for collaboration.

Domestic Policies Targeting CAFOs and Aquaculture

Similar to other policy areas in China, there is political overlap with insufficient coordination between the Ministry of Health, the Ministry of Agriculture (MOA) and the State Environmental Protection Administration (SEPA) in the sphere of animal husbandry and aquaculture regulation.

China's MOA began providing loans to farmers in the 1990s to promote cleaner production in CAFOs. Moreover, MOA also has carried out various demonstration projects on eco-agriculture, biogas from animal waste, and promotion of organic fertilizer. Confusingly, in 1998, the responsibilities of rural and agricultural environment management were transferred from MOA to the smaller and less well-funded SEPA. In 2000, SEPA set up the Division of Rural and Agriculture Environment, which has a mandate over pollution from livestock operations. Although it was not achieved, the

A pig looks out the window of a Beijing CAFO. It takes approximately 3 months for a pig of this variety to meet the 100kg slaughter-weight on a highly manipulated diet. Photo Credit: Humane Society and Compassion in World Farming

Tenth Five-Year Plan for environmental protection included the ambitious goals to utilize 70 percent of China's livestock and poultry waste as fertilizer by the end of 2005 (Gao, 2003).

In 2003, SEPA issued "Discharge Standards of Pollutants for Livestock and Poultry Breeding" that specify the minimum distance between CAFOs and residential areas and water supplies (Wang, 2003). The standards focus on chemical oxygen demand (COD) and biochemical oxygen demand (BOD) emissions and odor control, but neglect the issue of trace metals in the manure (Li & Chen, 2005). Another law (GB284-84) limits the arsenic concentration in sewage applied to farmland to 75 mg/kg (Li & Chen, 2005). Farming zones are now an increasing trend in China. In order to discourage small and decentralized farms, the government instituted animal farm zones or parks areas where government subsidies encourage large agriculture to develop. In 2003 alone China constructed 20,000 such zones (Li, 2005).

Most promising is China's first Animal Husbandry Law, which went into effect in 2006. This law focuses on encouraging large-scale farming, maintaining genetic integrity, ensuring product safety, and protecting the environment through zoning laws ("Important legal," 2006). Following the law, the government has taken steps to address rising concerns about food safety including allocating $1.16 billion in August 2007 to address food safety monitoring infrastructure, which could strengthen the regulation of CAFOs and aquaculture (Juan, 2007).

Biogas

The development of biogas—energy derived from the methane inherent in animal waste—in China promises to deal with the major pollution from CAFOs while also providing much-needed energy and a safe form of fertilizer. A biogas digester is a cost-effective waste treatment facility that cleans liquid runoff with secondary products: clean energy and safe solid fertilizer. Biogas projects range from small initiatives promoted by international and Chinese NGOs in poorer rural areas to more extensive national and provincial government programs.[64] In China there are growing biogas projects conducted privately by the owners of CAFOs in reaction to public outcry. Some of these are subsidized by the MOA or local governments. Such facilities could offset costs by using the methane energy to power the facility; but the low cost of energy in China does not make this a strong incentive for companies.

Hainan Island has become one of the more progressive provinces, using subsidies to encourage the development of animal biogas processors to limit the growing problem of water and air pollution from CAFOs while also supplying energy to its poor rural areas (Greenhouse, 2006). MOA has helped encourage this development under its National Plan for Rural Biogas Construction (2003-2010). *Xinhua* reported that nationwide 18 million processors had been built through government subsidies by the end of 2005 ("More methane," 2007), yet this incentive policy neglects large-scale animal operations near urban areas, which are the primary source of animal methane.

New programs and investment into large biogas infrastructure could be developed out of China's membership in the international Methane2Markets (M2M) Partnership. M2M is an international initiative advancing cost-effective, near-term methane recovery and use as a clean energy source. The members of this partnership—which include national governments, private sector entities, development banks, NGOs, and financial and technical experts—are catalyzing methane capture projects from agriculture (animal waste management); coal mines; landfills; and oil and gas systems.

One significant project partially linked to M2M is FAO's Livestock Waste Management in East Asia Project (LWMEAP, 2004), conducted in partnership with the governments of China, Thailand, and Vietnam. This project was created in 2004 to develop policies to balance the location of livestock operations with land resources and to encourage

BOX 2: The Case of the Disappearing Fire Pig: Boom in Hi-Tech Farms, But Where Have All the Pigs Gone?

Hong zhu nian kuaile! Happy year of the fire pig! Pork is the staple of Chinese cuisine, with each of China's 1.3 billion people consuming a fifth of a pound of pork a day.[43] Even the character for home, *jia* (家), is a roof over a pig. However, 2007—the year of the fire pig—has not been auspicious either for pigs or the people that depend on them.

Panic erupted in Hong Kong in late 2006 when pig carcasses floated down the Pearl River and the mainland government remained suspiciously silent. In mid-summer of 2007, the rising price of pork led to fears of social instability. China's official news media has linked the high prices to a new and highly pathogenic form of a relatively common pig ailment, "blue ear syndrome" (i.e., porcine reproductive and respiratory syndrome). Blue ear killed over a million pigs in 2006 in China and more than 18,000 in the first five months of 2007, excluding the tens of thousands culled to prevent the spread of the disease.[44] By July of 2007, pork prices were 85.8 percent higher than the previous year and were blamed for overall inflation in China.[45]

FRAMED?

However, for all the hype, the impact of the epidemic remains unclear. Based on the 2006 USDA estimate for the number of pigs in China—678 million animals—and the rather high *China Daily* death estimate of over a million, blue ear killed a grand total of 0.15 percent of China's pigs last year.[46] Confusingly, the *China Daily* reported that the number of live pigs in stock dropped 15 to 20 percent in May 2007 alone.[47] Even assuming that the number of reported blue ear victims is close to accurate, there still would appear to be another reason for the decline in pork.

Insisting that the disease is contained, the Chinese government has refused to provide samples to international health organizations. This secrecy could be because the disease is worse than reported, or simply that the state fears losing patents to a vaccine that could be worth $265 million next year.[48] Blue ear and other diseases are probably not the only causes for the rising prices. In 2006, low prices of pork combined with rising prices of feed and veterinary medicine encouraged farmers to decrease their stock. According to *The New York Times*, the price of feed has risen one-quarter since 2006, possibly due to demand from biofuel.[49]

While the overall number of blue ear deaths may not be that great, they could be decimating the livelihoods of vulnerable rural farmers. One recent *Reuters* report described how one Chinese farmer's herd of 45 animals was culled (after the government issued vaccines did not work) with no compensation, leaving the farmer in debt.[50] Throughout China, a total of 175,000 animals were culled in the first 8 months of 2007; if all of them were from similarly small farms, nearly 4,000 farms may have been ruined.[51] Perhaps it is the permanent loss of such small- and medium-scale farmers who in 2005 managed 70 percent of China's pigs that has produced the current crisis. It also may not be far fetched to blame the drop in pork availability to a failure in the government-distributed vaccines.

It is also possible that a different disease is frustrating veterinary know-how, and blue ear is simply a convenient scapegoat. Much of China, particularly Sichuan Province and the east coast, carries extreme densities of pigs where diseases can form, mutate and spread rapidly. China's farms have bred and hosted many other crippling pig diseases in recent years including an outbreak of *Streptococcus suis* type II, a bacterial meningitis-like disease with no visible symptoms in pigs, that killed 39 people in China in 2005. Blue ear is a relatively common disease in pigs but it seldom infects humans,[52] however such diseases can mutate. For example, in 2004, the Harbin Veterinary Research Institute presented some disturbing evidence that avian influenza was found in China's pigs.[53]

THE GOVERNMENT'S PROGRESSIVE RESPONSE

The Chinese government has taken creative measures to combat blue ear disease, including offering insurance for sows and subsidies for raising pigs, in addition to supplying $36.5 million to offer free vaccinations.[54] Inspection teams comprised of officials from 7 central ministries were organized to monitor the disease and work with farmers to develop policies that would encourage them to produce more.[55] Towards the end of August 2007, the government printed 600,000 blue ear informational handbooks that 251 experts dispersed during rural visits to educate farmers on the disease. Moreover, the central government passed a law to punish farmers for not reporting outbreaks or refusing to vaccinate their animals.[56] According to *The Washington Post*, the Chinese government has been making regular public announcements since 2006 reporting on the spread of the disease.[57]

So important is the price of pork in China that there is even a strategic pork reserve of frozen and live pigs that Ministry of Commerce holds to release in times of scarcity—a safeguard that has not yet been used. In 2007, China's central government moved to phase out corn-based ethanol programs within five years, reverting instead to crops such as cassava and sweet potato, to protect prices of feed stock staples.[58]

The Chinese government is sensitive to rising pork prices, for this meat is the primary source of protein for low-income Chinese, and rising prices have the potential to spur unrest in the country. The *Asia Times* reflected that spikes in food prices occurred in 1989, just preceding the Tiananmen Incident.[59] Thus, local governments are subsidizing pork for low-income urbanites, and the Ministry of Education called on schools to subsidize pork prices on campuses (some canteens are cutting quantity to maintain stable costs). Moreover, central officials are responding quickly to quell consumer fears on the safety of pork, which is a real danger due to the high incentives for farmers to market sick pigs.[60] On 15 August 2007, the Ministry of Commerce reported that pork prices had finally come down 1.5 percent from the previous week due to the diligence of the government and producers.[61]

"So important is the price of pork in China that there is even a strategic pork reserve of frozen and live pigs that the Ministry of Commerce holds to release in times of scarcity.

IMPACT ABROAD

As of yet, the scarcity of pork in China does not directly affect the tables of the United States, but blue ear disease could spread rapidly, affecting global supply. It has already appeared in Vietnam and Myanmar.[62] Spreading inflation, and resulting social instability, is another concern domestically and abroad, with Chinese food prices accounting for all but 0.9 percent of the drastic August 6.5 percent year-on increase of China's consumer price index.[63] As the China scrambles to slow the climbing prices domestically, the price of exports is creeping up. China is the fourth largest exporter of pork, so continued increases in its export prices are eventually likely to affect world prices for pork.

integrated farming practices to reduce environmental impact (Steinfeld et al., 2006). This $24 million, five-year project—supported by the Global Environment Facility (GEF), the World Bank, and the U.S. Environmental Protection Agency's AgStar program—is in the planning stages. The project will include conversion to biogas and integration of fishponds and CAFOs.

Development of Safer and More Environmentally Friendly Feeds

Feed is a major source of concern and an integral part of intensification. In aquaculture, the feed is added directly to the water and thus pollutes it with extra nutrients and additives, including antibiotics and fungicides to protect fish from disease. In July 2007, *The Washington Post* reported that Traditional Chinese Medicine was sometimes used on fish struggling to survive in China's polluted waters (Cha, 2007). New feeds may help lower some of the waste emissions on fish farms and lessen the industry's unsustainable consumption of fishmeal from the high seas. Some new feeds being developed include:

- *Yeast-based feed.* Chinese researchers have been experimenting with a yeast-based protein supplement to replace more than half the fishmeal in aquaculture feed preparations ("Farming fish," 2004).
- *Soy-based feed.* As of 2007, China's aquaculture industry uses 4.5 to 5 million metric tons of soy meal a year ("US soymeal producers,"2007). Some species, such as tilapia, one of China's staple fish, can tolerate 50 percent soy in their diets ("US soymeal producers," 2007). Other high value fish can tolerate only 10 percent soy. Even a small reduction in fishmeal dependence will relieve some stress on global oceans.

The U.S. Department of Agriculture currently is working with MOA and the American Soybean Association on a three-year (2006-2008) soybean-based fish feed pilots within the watershed of Lake Tai, which in the summer of 2007 was plagued by a toxic green algae, caused in part by agricultural and CAFO runoff.

Genetically modified (GM) feed grains are another potentially useful, if controversial, innovation. In September 2007, the Chinese Academy of Agricultural Sciences released a corn genetically modified to produce the enzyme phytase for field testing. Phytase helps animals, particularly pigs, digest phosphorus, a common pollutant of CAFOs. In addition to reducing nutrient pollution, a member of the research team claimed that commercializing this corn could save up to 450 million Yuan ($60 million) per year in energy costs because it would eliminate the need for industrial production of phytase to add to animal feed, an energy-intensive endeavor (Jia, 2007).

A shed of egg laying hens in a CAFO in northeast China. Photo Credit: Humane Society and Compassion in World Farming

A safer feed change would be to increase the ratio of forage to grain in the diet of confined animals. Forage, such as alfalfa and hay, is easier for pigs and especially cattle to digest and therefore produce less waste and healthier meat.

Better Farming Methods and Integration

Polyculture

Farming integration can potentially lessen the pollution of CAFOs in a major way. One method to better integrate farms is to place them in rural areas where there is more land to spread the manure. Polyculture—such as combining aquaculture with other CAFOs to help process waste—is another means to better structure farms. Agricultural experts have demonstrated that herbivorous fish species are fully capable of safely processing waste from pigs, cattle and poultry by ingestion.

Integrated polyculture systems between fish species and crops, once the norm in China, are a more sustainable solution to aquaculture in general. One living example is the rice-field carp of Qingtian, Zhejiang. In Qingtian, terraced rice patties were stocked with carp by naturally flowing river water. In recent years farmers have intensified carp production

with the addition of manufactured fish feed and by erecting concrete barriers to deepen their ponds. The damming of such rivers to create carp pools has led to problems of eutrophication, interrupted water supply to farms and communities, and diseased fish (Edwards, 2007). In order to encourage a return to a more environmentally friendly integrated polyculture system, the government could develop new certifications for organic rice-patty carp, which could help the Qingtian farmers create lucrative markets in the nearby tourist centers of Hangzhou and Suzhou.

Free-Range Systems

Allowing farm animals to roam free in China is only a partial solution to China's animal husbandry problems. China lacks vast land resources for grazing animals and the government has thus far proven ill equipped in guiding the many medium-sized free-range family farms to safe practices. Moreover, if not properly managed, free-range animals are sources of different types of environmental damage such as increased soil erosion and desertification—a major problem in the ecologically fragile grasslands in China's north, which are also threatened by over extraction of water for agriculture, industrial pollution, and mining.

Increasing free-range animal production could vastly improve food and environmental safety. Free-range animals, especially chickens, can thrive on non-arable land, such as rocky hillsides, that are not suitable to growing crops. Further, if well managed, free-range animals are healthier and less susceptible to disease, thus requiring fewer feed additives. In terms of environmental impacts free-range animals require less water for cleaning, spread their manure naturally over the land, and require less feed as they can forage for part of their diet. This type of animal production is most successful with native species, so as not to be reliant upon imported species of reduced gene pools. Dr. Peter Li of the University of Houston has noted that Chinese, particularly in the south, have a taste preference for free-range animals and native species, allowing farmers to ask higher prices for animals requiring fewer inputs (Li, 2005).

Such free-range systems must be carefully monitored to prevent excessive environmental damage. A land rotation system is important to allow vegetation to grow back so that soil erosion is reduced and manure absorption is maximized (Li, 2005).

Some research points to health benefits to humans from eating free-range animals. One study comparing the nutrition of free-range chicken eggs to industrial eggs found that the former had: one-third less cholesterol, one-quarter less saturated fat, two-thirds more vitamin A, two times more omega-3 fatty acids, three times more vitamin E, and seven times more beta carotene (Long & Alterman, 2007). Obviously, there are advantages to a country where obesity is expanding rapidly to consume less cholesterol and fat. In addition to these health benefits, such free-range chickens eat insects that might otherwise become pests.

Other Possibilities

Building a streamlined manure distribution infrastructure is key to mitigating the impacts of CAFOs. Part of the challenge to distributing manure is that farm land is often divided into small parcels making distribution to each farmer tedious and expensive. Animal farmers would be able to increase their profits if they could promote and distribute manure as fertilizer to rural farmers at a fraction below the cost of chemical fertilizers. For such a strategy to work, local government agricultural extension offices would have to be brought on board, for today they generally still prioritize the selling of chemical fertilizers (Hamburger, 2002).

Instrumental to making such a manure distribution system work would be moving animal farms further away from east coast city centers and closer to mass rural transportation routes where manure can be distributed to agricultural land. However, this increased distance between major markets and meat production can be risky. Either the meat will be transported live—which apart from being inhumane can increase the chances of contaminating the meat during butchering, facilitate pathogens rapid movement across the country—or it will be transported butchered on China's under developed cold-chain system, introducing potential bacteria contamination. In both circumstances, greater amounts of fossil fuels will be necessary for the transportation. Additionally, farms moved into the countryside are less scrutinized by the urban civil society, and thus perhaps more environmentally damaging and prone to unsanitary practices.

Another way to improve CAFOs environmental records would be to process and treat waste, perhaps by running it though sewage treatment plants. This is only possible if current water pollution control laws are fully enforced, which to date has rarely been done vis-à-vis CAFOs.

Better Species Selection

Identifying and cultivating high-efficiency species with higher survival rates and faster growth rates is another area of research that may reduce the need for chemicals to sustain profitable production. This has proved challenging, due to a question of the meaning of "high-efficiency." Large farms tend to use species that cope well with being confined and grow fast, which are usually the same disease prone species cultivated in CAFOs globally. With regards to aquaculture, local governments have encouraged high-value species that can claim a higher price per pound, such as turbot and eel (although African tilapia continues to be the most cultivated fish in China). Emphasizing herbivorous fish species, shellfish, and seaweed cultivation is a way to reduce the need for feed inputs in aquaculture.

It would be prudent for researchers to explore some native chicken and pig species that tolerate local conditions and require less water, as water is so scarce in many parts of the country. In addition, the local species are not as susceptible to many of the common contagious diseases that affect stock all around the world. Currently, MOA highly values the China's native species of domestic animals and has taken measures to document and protect their genes. In 2003, native species of livestock and poultry comprised 74 percent of China's agricultural output, but 41.9 percent were threatened by extinction ("Report on domestic animal," 2003, p.12). Native species can contribute to better animal products in a variety of ways including high fertility, as in the case of the Hu Sheep and the Taihu Pig; leaner or tastier meat, as in the case of the Weijin Pig and the Beijing You Chicken; and low input requirements, such as the Tibetan Pig ("Report on domestic animal," 2003, p.19). Much research is being conducted on crossing native species with those adapted to confined living with positive results, but the real value of these species is their ability to live free-range in a sustainable way due to their adaptation to the local conditions.

Food Monitoring a New Priority

In 2007, the government pledged $1.2 billion to address food and drug safety. By the end of 2007, county and township governments are required to have food emergency response systems in place. In June of 2007, 180 food factories were shut down by the General Administration of Quality Supervision, Inspection, and Quarantine for producing contaminated and unsafe products (Ang, 2007). China's numerous small farms, vast and fast-paced distribution system, and cash-and-carry economy pose hefty challenges to regulators. Although China faces many difficulties in ensuring the safety of its food supply, the government has set up a coordinating committee under Vice-Premier Wu Yi to examine strategies for improving food safety. In recent months, the government also has issued a five-year food and drug safety plan and a food safety white paper, as well as carried out campaigns to close unsafe food processors. Chinese food safety regulators are reaching out to international partners—particularly the United States, as its largest food export market—to discuss issues of mutual interest. The needs of both the United States and China to strengthen their food inspection and regulatory systems underscore the ample opportunity for collaboration between the governments and private sector companies (Ellis, 2007).

One example of increasing government prioritization occurred in Shanghai 2006, when 100 percent of turbot fish tested in the city were found to contain carcinogens. The 3 farms discovered to be responsible were highlighted by name in the Chinese news media and were subsequently fined and ordered to suspend sale ("Fish farms," 2006). Now, in an effort to revive the market, the government is experimenting with a promising branding scheme. The new agreement involves a product identification code on each fish package, doubling prices, but enabling the consumer to request information from the supplier on the particular fish purchased (Deng, 2007). If this project works for turbot, it could be a solution to many of the problems of unaccountability in China's fragmented meat and aquaculture industries.

The Nexus of Food, Farmer, and Environmental Safety

The current CAFO system, based primarily on the U.S. model, is devastatingly polluting to China, and increasingly dangerous to ecological and human health as demand for meat increases. The long-term trend shows that demand for meat will continue to increase; factory farms will spread, particularly in grain-producing areas; and the market share of pork will shrink and be replaced increasingly with beef. The incentives for local governments to encourage economic growth at the cost of the environment have meant regulation of CAFOs and aquaculture is generally weak. Significantly, the recent highly-publicized food safety problems in China's exports have helped shine a light on some of the regulatory

shortcomings of domestic meat and fish production, as well as food processing. The concern for protecting food exports appears to be catalyzing some crucial political reforms and creating opportunities for international aid and assistance.

Currently, the Chinese government is targeting end products through certification and monitoring to ensure food safety. Notably, China could benefit from more "upstream" improvements to promote better agricultural practices. This is the way the United States ensures food safety, by holding farmers themselves accountable for the safety of their products. Although there are many challenges to such a system in China, the creation and enhancement of existing farmer and producer associations is one way to initiate change at this level. Such organizations would help educate farmers to safe handling practices and enable them to market goods as safe.

As Box 2 highlighted, domestic food security problems emerging from outbreaks of diseases in pig and chicken CAFOs have caused prices to rise and led farmers to cut production and off load potentially diseased animals on the market. This situation underscores another crucial area needed to promote safer and more ecologically friendly meat and fish production—farmer security.

The Chinese government has stepped up efforts to protect farmers and encourage them to increase production, such as subsidizing vaccines and insuring sows in the event of epidemic disease. This is an area where more effort could produce exponential benefits. Stronger and reliable insurance for farmers would reduce the incentive for unsafe practices, such as butchering and selling sick animals.

China is already a water- and land-scarce country, so the soil and water contamination stemming from CAFOs and aquaculture could actually limit the growth of this sector. Domestic and international NGOs have a role to play as not simply watchdogs and whistleblowers of the animal husbandry industries, but also as trainers for safer and more humane farming practices. The international and increasingly middle-class Chinese consumers also must play a role in pushing sustainable alternatives to these polluting enterprises.

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NOTES

1. "CAFOs" sometimes refers to *confined* animal feeding operations; however, we use concentrated to indicate the density of the animals in confinement.

2. The five banned fish are catfish, basa, dace, shrimp and eel. Before this ban, China was the United States' fourth greatest source of shrimp ("Beijing will inspect," 2007).

3. Based on an interview with David Brubaker, October 29, 2007.

4. These data are from an interview with Bingsheng Ke, director of the Research Centre for Rural Economy on September 14, 2007.

5. In 2005, China had an average of 437 animals (sheep equivalence) per km^2 of agricultural land, while the United States had only 191 animals per km^2 according to OECD statistics. Sheep equivalence was calculated based on manure produced: 1 horse = 4.8 sheep; 1 pig = 1 sheep; 1 goat = 1 sheep; 1 hen = 0.1 sheep; 1 cow = 6 sheep.

6. Based on information provided by Fred Gale at the USDA Economic Research Service, November 2, 2007.

7. In one example, provided by Fred Gale at the USDA ERS based on research from Dr. Hu Dinghuan of the Chinese Academy of Agricultural Sciences, a farmer received 150 Yuan from the government as compensation for a hog that had to be slaughtered. This amount did not cover the cost it took to raise the 120 kg hog and normally, he would have made a 100 to 200 Yuan profit.

8. Based on interviews with Carl Pray, Rutgers University on April 5, 2007.

9. Based on interview with Bingsheng Ke, director of the Research Centre for Rural Economy on September 14, 2007.

10. Estimates for the number of pet deaths in 2007 due to melamine range from 16 to 300 animals. In order to determine with certainty whether the animal died from the pet food, tissue tests have to be conducted, thus the low number is the number who tested positive, and the high number is reported probable cases.

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FEATURE BOX

Greening China's Banks

By Christina Larson

As every developer and local mandarin knows, it is all too possible to build new factories without living up to the letter of China's environmental laws. But it is not possible to build without money. With pollution statutes poorly enforced, China's environmental officials are now turning to unexpected allies, the country's banking regulators, to devise new ways to force environmental compliance on the front end. Their aim is to have banks review companies' environmental records before writing checks. In July 2007, a front-page headline in *China Daily* announced: "To Fight Pollution, China Takes Capitalist Route." At present, "green banking," a relatively new idea in the west, is more aspiration than reality in China. Yet such efforts may in the future help curb pollution emissions in China, and around the globe.

Because China needs an increasing supply of mineral, timber, and energy resources to maintain economic growth, its banks have been more active since 2001 in promoting extractive industries in Asia, Africa, and Latin America. Between 2001 and 2005, Chinese funding for new large-scale foreign infrastructure projects jumped twenty-fold to $18.4 billion. That total exceeds comparable 2005 spending by the United States ($8.7 billion), Japan ($5.9 billion), and every country in Europe. According to estimates prepared by the U.S. Export Import Bank, China's portfolio is expected to grow to more than $40 billion by 2010, surpassing even World Bank financing (about $25 billion). China is already the largest lender in Africa, and will soon be the world's top financer, bar none. Already China's influence is being felt. European Investment Bank president Philippe Maystadt last year told the *Financial Times*, "Chinese banks have snatched projects from under the EIB's nose in Asia and Africa, after offering to undercut the conditions it imposed on labor standards and environmental protections."

MAKING BANKS ACCOUNTABLE

The idea of holding banks responsible for the impacts of projects they finance has evolved in the west over the last two decades. Calls for "socially responsible investment" first emerged in the late 1980s, when shareholders forced many western banks to divest from projects in apartheid-era South Africa. Following the 1992 U.N. Earth Summit in Rio, banks increasingly faced pressure to become more environmentally responsible. In 2002, a group of leading financial institutions, including Barclays and Citigroup, met in London to develop social and environmental guidelines. The result was the Equator Principles, standards modeled after World Bank benchmarks for projects in developing countries. Requirements include environmental impact assessments, "free, prior, and informed" consultation with affected communities, grievance mechanisms, and independent reviews. Over forty banks—mainly in North America and Europe—have since adopted the framework. Implementation lags behind principle, but the ideal of sustainable banking continues to gain ground.

In China, during those same years, the banking sector embarked on a series of momentous reforms, beginning the transition from a socialist system into a modern competitive industry. To prepare for the country's 2001 entry into the World Trade Organization, China's major financial institutions overhauled procedures for corporate governance, public disclosure, financial supervision, and risk management. The central government infused massive capital and offloaded many bad loans. A series of recent public offerings enabled foreign investors to purchase minority shares in several leading Chinese banks. For instance, the Royal Bank of Scotland is now a strategic investor in the Bank of China, as Goldman Sachs is in the Industrial and Commercial Bank of China. International banks, seeking access to China's lucrative market, have in

several instances agreed to provide domestic banks with expertise in management, technology, and risk assessment techniques.

INKLINGS OF GREEN BANKING IN CHINA

These trends, together with piqued grassroots interest in the environment, came together in 2004 to produce the first inklings of green banking in China. In the same year that China's State Environmental Protection Administration (SEPA) wielded a new environmental impact assessment law to suspend 30 major construction projects and banking regulators began to remind financial institutions that projects approved for loans should comply with regulations, including pollution controls. More recently, the China Regulatory Banking Commission (CRBC) encouraged banks to consult lists of approved and blacklisted projects prepared by SEPA.

In January 2007, SEPA and the People's Bank of China unveiled plans to make these environmental records more accessible. China's central bank was already at work compiling the first nationwide credit database, a key risk-management tool, when it announced that it would also include records of legal actions against companies for environmental infractions since 2003. The CRBC has reportedly begun formulating a "green credit" policy to link this environmental performance data with loan eligibility.

SEPA Deputy Minister Pan Yue is advocating new financial strategies to fight pollution, for years of fines, bans and orders to closer polluters have failed. Pan Yue argues that SEPA sees the need to use economic leverage to "make companies feel it would be costlier to break the law than to abide by it."

Pan Yue's support of such strategies was greeted with special enthusiasm by a number of green nongovernmental organizations (NGOs) that had recently begun to advocate for Chinese banks to adopt standards similar to the Equator Principles. In December 2006, several of China's most established environmental NGOs, including Green Watershed and Friends of Nature, helped organize a "Workshop on Finance, Environment, and Harmonious Society in China" at Beijing's Red Wall Hotel. Attended by dozens of nonprofit leaders and a handful of government officials, the three-day conference introduced the concept and history of green banking. As Green Watershed's Dr. Yu told me, "China's NGOs are beginning to learn an advocacy role." In addition to prompting scrutiny of domestic banks, the conference gave environmentalists ammunition to hold western banks operating joint ventures in China accountable to higher social and environmental standards.

The extent to which China's financial sector will, in practice, prioritize environmental compliance remains a question. "It's a bit early to tell about what ultimate impacts will be," said Michelle Chan-Fishel, Green Investments Program coordinator for Friends of the Earth-U.S. She is also the lead author of a 2007 report, *Time to Go Green: Environmental Responsibility in the Chinese Banking Sector*. She was somewhat more optimistic about the prospects for China implementing "green credit" than the recently suspended "green GDP," an initiative that would have linked cadres' political promotions with environmental indicators. Unlike green GDP, a wholly new innovation, there are established green-banking models to follow. Further, Chan-Fishel believes that international banks providing technical expertise to Chinese banks have a unique "role and responsibility to download good environmental loaning practices."

In at least one instance, a major Chinese bank will be forced to meet international standards. In May 2007, the China Export-Import Bank (China Exim) signed a memorandum of understanding with the World Bank to cooperate on select energy and road construction projects in Africa. For those projects, China's state-controlled export credit agency must adhere to World Bank procedures. For sensitive proposals, environmental impact assessments must be made public and developers must consult affected communities before construction begins. "These are not procedures that China Exim would normally follow," says Peter Bosshard, who has been monitoring the bank's activities for the International Rivers Network. Although China Exim is not expected to adapt its own standards in the near term, staff will gain experience in environmental compliance that may be meaningful in the future. Unlike western banks, China Exim has no environmental-compliance division. Continued multilateral and private bank collaboration with Chinese banks will be crucial, for Chinese banks will finance an increasing number of pipelines, rigs, roads, dams, and mines across the globe.

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FEATURE ARTICLE

Is Guangdong the Dark Horse in Addressing Ecological and Human Health Threats?

By Kaleb Brownlow and Stephanie Renzi

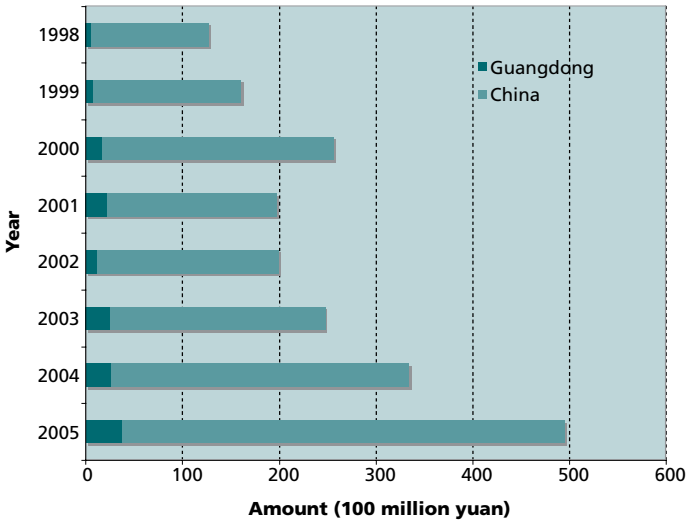
In 2006, Guangdong Province recorded its worst air pollution in decades despite continued government promises to address the problem. That same year, the average number of smoggy days (e.g., visibility below 10 kilometers) reached 120 in major cities such as Guangzhou. Not surprisingly the number of people suffering from respiratory illnesses spiked in 2006 as well. Guangdong also confronts serious water pollution problems from poorly regulated industries and an abysmally low rate of municipal wastewater treatment. The provincial environmental protection bureau received about 80,000 pollution complaints in 2005, most of which were related to water pollution. In 2006, slightly more than 40 percent (22 million) of Guangdong's rural population did not have access to safe drinking water. These poor air and water quality trends represent serious threats to economic growth and human health in Guangdong. In 2006, Guangdong invested more than 60 billion Yuan into environmental protection, which equals approximately 2.5 percent of the province's gross domestic product (GDP)—a ratio significantly higher than that of most other provinces. Besides investment, there are signs of progressive environmental policies within Guangdong, such as growing partnerships with the research communities and government of Hong Kong to work on air quality monitoring, pollution policy development, and even a pilot SO_2 emissions trading program. Guangdong was entrepreneurial in pushing China's free-market reforms, so it is possible (indeed crucial) that the province's growing ecological crises will spark it to become the vanguard for protecting the environment and human health. This paper explores Guangdong, highlighting both signs of emerging leadership in the environmental health realm and the province's failures to be green.

THE SIHUI CITY INDUSTRIAL PARK CASE

China's environmental degradation is often lamented as the byproduct of a dysfunctional environmental governance system mired in conflicts of interest and fragmented lines of authority. There can be little disagreement that China falls far short when it comes to the implementation and enforcement of environmental regulations. Evidence of this abounds at both the national and the local level. Guangdong's experience with the Sihui industrial park pollution case provides yet another testament to weak enforcement; yet the case also hints at a new kind of stricter oversight by the provincial people's congresses. As such, understanding the events surrounding the Sihui case is critical to begin pondering whether Guangdong might prove to be a vanguard for China's environmental health.

In mid-1999, two ecologically interdependent cities located in Guangdong Province found themselves in a heated dispute over the construction of 19 electroplating projects to be built in the city of Sihui within Zhaoqing municipality. Foshan municipality, situated downstream from Zhaoqing, contested the construction of the factories on the grounds it would contaminate their communal water system, violating two water pollution regulations. Foshan's deputies in the Guangdong Provincial People's Congress (PPC) spearheaded this charge, further arguing that construction of the factories should not have been approved in the first place because the local environmental protection bureau (EPB) had not conducted an environmental impact assessment (EIA) (Wang & Wang, 2006). Months of congressional inquiries and infighting between the Foshan and Zhaoqing PPC deputies and the municipal EPBs and executive governments ensued, with each group jockeying for legal jurisdiction to determine the outcome of the case.

FIGURE 1: Investment in Industrial Pollution Control



Source: Drawn from 1999 to 2006 issues of the China Statistical Yearbook.

Although the PPC deputies on each side were asserting their constitutional right to inspect the enforcement of the law, such congressional inquires had never before occurred around a pollution case in China (Wang & Wang, 2006). As such, these actions represented a decisive break from the traditional "rubber-stamp" role of the PPC. In the end, the provincial government had the final say and chose to allow the construction of nine out of the original 19 projects, signaling that concessions were made on both sides of the dispute. Given this outcome, it is clear Guangdong's local environmental governance is still far from perfect. Nevertheless, the case succeeded in elevating public awareness of environmental issues and pioneering new congressional practices (Wang & Wang, 2006). It is also likely that these nine new plants will be carefully monitored for their emissions.

Despite debate over exact numbers, many Chinese and international environmental specialists agree that two decades of a booming economy have drastically worsened air and water quality. Some of the pollutants contaminating air and water have contributed to declining health and increased non-communicable disease (NCD) (e.g., cancer, cardiovascular disease, and diabetes); morbidity; and mortality in China. As Chinese government officials, researchers, and the public struggle to mitigate the harmful effects of environmental degradation, they have become increasingly aware of the negative impact air pollution has on health and social stability (Cheng, 2006). Over the past few years, China's central government has begun to promulgate more aggressive pollution control laws—some even giving more power to the public to monitor dirty industries—and recently developing an, albeit general, National Environmental Health Action Plan. Key to the success of such laws and environmental health initiatives will be the support of local governments, which are often the greatest obstacles to environmental law enforcement. Ultimately, for China to make a breakthrough in halting the skyrocketing pollution levels threatening human health within—and even beyond—China there must be a major shift in the attitude and performance of local governments to fully implement environmental protection laws and regulations. This paper explores Guangdong, highlighting both signs of emerging leadership in the environmental health realm and the province's failures to be green.

EXAMINING THE POLLUTION AND HEALTH NEXUS IN CHINA

Throughout the reform era, many health indices have improved considerably: life expectancy rose from 60 in 1970 to 72 years in 2007; between 1991 and 2003 infant mortality rates decreased from 50.2 to 25.5 per 1,000; and during the same time period the maternal mortality rate decreased from 94.7 to 51.3 per 100,000 (Mao, 2005a). These marked health improvements have shifted the disease burden from primarily infectious diseases to chronic, non-communicable diseases (NCD), which include cardiovascular disease, respiratory disease, and cancer. An aging population, changing lifestyles and behaviors, and environmental pollution represent key factors contributing to increased NCD and mortality rate. One study found 131.39 million disability-adjusted life years (DALYs) were lost due to the disease burden of NCDs in 2002, which is equivalent to 64.36 percent of the total disease burden in China (Mao, 2005b). This figure has grave implications for the health of China's society and its ability to sustain an efficient labor force. In rural areas, respiratory illnesses, many caused by indoor air pollution, are the leading cause of death. (See Table 1).

Large regions across China experience varying degrees of air pollution. A 2003 survey of 341 major cities, undertaken by the Chinese Academy on Environmental Planning (CAEP), reported that

"27 percent suffered from serious pollution, 32 percent had light pollution, and 41 percent enjoyed good air quality." Moreover, CAEP claimed air pollution caused 411,000 premature deaths, mostly due to lung and heart-related diseases, while the World Bank claimed this number could be as high as 750,000 (McGregor, 2007). The study highlighted other pollution-linked illnesses such as increases in childhood and adult asthma, chronic obstructive pulmonary disease (COPD), and a host of respiratory diseases afflict millions of Chinese. There are approximately 38 million Chinese suffering from COPD, with nearly 100,000 deaths each year ("China sets up an alliance," 2006).

Today in China there is an increasing prevalence of lung cancer, which now captures the greatest share of cancer-related deaths. Between 2000 and 2005, the incidence of lung cancer in men and women increased 26.9 and 38.4 percent, respectively (Yang, Parkin, Ferlay, Li, & Chen, 2005). Future projections of lung cancer cases remain equally grim, with approximately one million Chinese expected to suffer from lung cancer by 2025. According to Zhu Xiuyi, a director of a lung cancer treatment center, "Smoking and pollution are two major causes of the high rate of lung cancer [in China]" ("Lung cancer cases," 2007). Air pollution, if controlled and reduced, could ameliorate the situation and reduce the disease burden from lung cancer and a host of other respiratory diseases.

ENVIRONMENTAL HEALTH AS A GROWING PRIORITY

Over the past few years, the Chinese government has increased its prioritization of environmental projects, policies, and investment (see Figure 1) with certain cities or regions making some strides in reducing and controlling pollution. In preparation for the 2008 Olympic Games, Beijing has invested $12 billion over ten years to clean the city's notoriously dirty air and water, shutting down or retrofitting 200 dirty industries in the city, and making plans to keep 1.3 million cars off the roads for the entire two weeks of the Games. While Beijing is experiencing many more days of blue skies, it is unclear whether all the efforts have been enough to guarantee clean air for the Games, as regional pollution from coal and cars could nullify much of the progress (Turner & Ellis, 2007). Beijing's struggles are mirrored nationwide, for despite increasingly progressive energy laws, stringent energy efficiency requirements, and experiments in SO_2 emissions trading, many airborne pollutants were not reduced to levels required in the Tenth Five-Year Plan (2000-2005). Even the first-year energy efficiency and SO_2 emissions goals under the Eleventh Five-Year Program, which the party leadership had prioritized, were not met.

TABLE 1. Leading Causes of Death in China, 2005

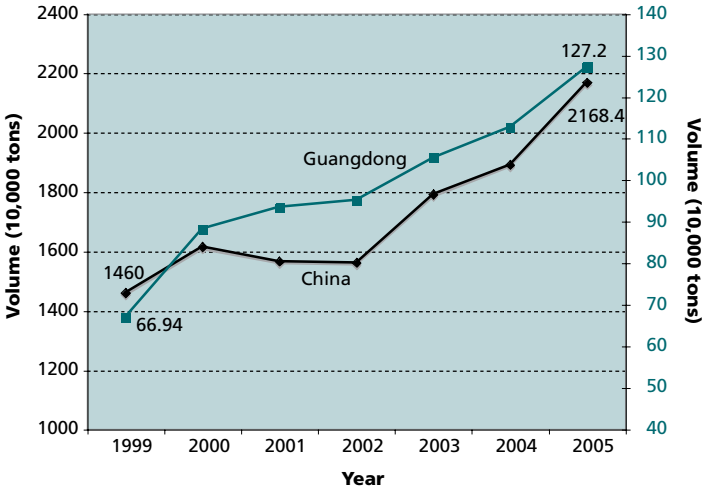
Urban		Rural	
Disease	**%**	**Disease**	**%**
Malignant Tumor	22.94	Respiratory Diseases	23.45
Cerebrovascular Diseases	21.23	Cerebrovascular Disease	21.17
Heart Diseases	17.89	Malignant Tumor	20.29

Source: China Statistical Yearbook (2006).

China's State Environmental Protection Administration (SEPA) has been flexing its muscles of late, publicizing its studies on highly polluting industries and becoming more forthcoming in announcing the economic and health costs associated with pollution. In 2004, SEPA estimated the economic losses from pollution amounted to a staggering $61.8 billion or 3.05 percent of total GDP, of which air pollution accounted for 42.9 percent or $26.54 billion ("Green GDP," 2006).[1] Other unofficial reports indicate the cost could be as much as 8 to 12 percent, which is roughly equivalent to the country's annual economic growth (Landwehr, 2006). After decades of unfettered economic growth, the Chinese central government leadership is faced with significant challenges regarding environmental degradation and health issues, which has galvanized them to more aggressive pronouncements and policies, and permit SEPA to take more stringent steps to address environmental problems.

While there are rumors SEPA will be elevated to ministry level in 2008, the agency is still small and under-funded. Nevertheless, SEPA has become resourceful in wielding increased power under the new environmental impact assessment law, as well as pushing public participation, information disclosure,

FIGURE 2. Total Industrial SO_2 Emissions in China & Guangdong (1999-2005)



Source: *China Statistical Yearbook*, 1999-2006
Note: In 2006, The Guangdong provincial EPD reported that the emissions of sulfur dioxide dropped to 1.26 million tons from 1.29 tons in 2005 (Xinhua, 2007).

and green GDP accounting—all strategies that put more pressure on local governments. The ambitious green GDP effort failed, but it did raise the issue of local government accountability to a higher level and the National Development and Reform Commission (NDRC) now has set energy efficiency performance standards for local governments, with its Deputy Director Zhu Hongren asserting that "we are left with no other alternatives but to meet the targets" ("Energy saving," 2007). As part of SEPA's new and more aggressive stance, SEPA Minister Zhou Shengxian promised that "the implementation of environmental policies will be as forceful as steel, not as weak as tofu" (Yuankai, 2006). However, without concrete action to prove otherwise, Zhou's words will prove as superficial as the countless government statements on environmental protection made before.

The lead feature article in this issue of the *China Environment Series* introduces many of the main central government and international initiatives that are beginning to address the growing environmental health challenges in China. Most of these efforts are uncoordinated, but we wish to highlight one, which offers promise of improving collaboration among central government agencies to environmental health problems. Namely, the WHO/UNEP Regional Initiative on Environment and Health in Southeast and East Asian Countries,[2] which since 2005 has catalyzed a number of forums in China. These forums have enabled China's Ministry of Health (MOH) and SEPA to create an environmental health action plan for the country and have prompted the two agencies to develop information-sharing platforms and mechanisms to integrate inter-ministerial efforts on quantifying environmental health indicators. The two agencies also are designing joint responses to environmental health emergencies (Duan, 2007; "China's environmental," 2007). In 2006, these two agencies sought to establish standards on the most prevalent and harmful pollutants (cadmium, fluoride, arsenic, and mercury). Additionally, SEPA is currently trying to establish specific standards for evaluating the impact of lead pollution on human health, particularly on children ("China to set," 2006; Information Office of State Council, 2006). Better coordination on environmental health could help provide a catalyst for entrepreneurial local governments to begin to address this issue more constructively.

GUANGDONG'S DOWNWARD TREND

Similar to China's national situation, environmental degradation and declining public health are byproducts of Guangdong's impressive economic success and weak environmental enforcement. Particularly evident are the effects air pollution (e.g., coal smoke, suspended particulates, sulfur dioxide, and vehicular emissions) has on the respiratory system (e.g., mortality and morbidity, hospital admissions, and lung function changes) (Chen, Hong, & Kan, 2004). Since 1997, sulfur dioxide (SO_2) emissions in Guangdong have risen by 87 percent and are higher than the national average ("Sulphur dioxide," 2006). (See Figure 2.) Likewise, incidences of respiratory-related ailments have also increased over time.

In 2006, Guangdong recorded its worst air pollution in decades despite continued government promises to address the problem. In 2006, the average number of smoggy days (e.g., visibility below 10 kilometers) reached 75 in Guangdong, a 20 percent increase over 2005 (Zhai, 2007). Major cities such as Guangzhou experienced even higher levels of smoggy days—120. Cars, power generation, and a new surge in heavy industry development by the provincial government in Pearl River Delta (PRD) have exacerbated smog and acid rain problems. The fact the provincial government continues to focus on heavy industry development within the PRD

basin rather than spreading it throughout the province has greatly intensified air pollution problems (Zhai, 2007).

Beyond air pollution, Guangdong must confront serious water pollution problems in its rivers and coastal areas. A recent water quality study by the Guangdong People's Political Consultative Conference (GPPCC) found higher pollution levels in 42 of 111 rivers than a year previously, with 28 percent of all rivers experiencing severe pollution. The severity of the pollution stems in great part from the fact that wastewater treatment occurs in less than 2 percent of Guangdong's cities and townships ("Guangdong pledges," 2006). Further, local news media reported a rapid deterioration in the Pearl River's water quality to a Grade V, the lowest grade, indicating water not even suitable for industrial use ("Guangdong pledges," 2006). In 2006, the *China Daily* revealed that slightly more than 40 percent (22 million) of Guangdong's rural population do not have access to safe drinking water. The provincial environmental protection bureau received about 80,000 pollution complaints in 2005, most of which were related to water pollution. To begin addressing the dire rural water problems the province has allocated 7.2 billion Yuan ($900 million) in the Eleventh Five-Year Program period (*China Daily*, 2006).

POLLUTION AND HEALTH LINKAGES IN GUANGDONG

Located within the Pearl River Delta (PRD) region, the twin economic engines—Guangdong and Hong Kong—face increasingly polluted soil, air, and water, with their cross-boundary exchange of pollution negatively impacting the region. Guangdong's massive industrial/manufacturing complex and the rapid increase in vehicles are degrading the air quality for Guangdong and Hong Kong. In 2004, exhaust emissions totaled over 1.7 million tons, which represents a significant share of total air pollution in the region (Jun, 2004).

Historical trends for lung cancer mortality rates in Guangdong show a significant increase from 28.54 to 39.58 per 100,000 in the 1976-1979 and 1990-1992 periods, respectively (Zhao, Wang, Aunan, Seip, & Hao, 2006). While these figures are slightly dated, they indicate the escalating trajectory of lung cancer cases in Guangdong Province.

Health-threatening pollution from water can be categorized as biological (e.g., microorganisms) or chemical (e.g., heavy metals, fertilizers, and oil). Infectious disease linked with water pollution remains a concern in Guangdong, particularly with regards to chronic diarrhea in children. Other water pollution-related chronic health problems, in particular digestive system cancers, represent a significant health burden in the province. A study conducted by the Population, Resource, and Environment Commission of the GPPCC determined more than 2.5 million people around Guangzhou face increased health risks from contaminated drinking water due to heavy pollution at five water treatment plants in the municipality ("Polluted water," 2007).

Processing of domestic and illegally imported electronic waste is also a major contaminant of Guangdong's water and soil. (*Editor's Note: See Commentary by Choi in this issue on the topic*). Continual exposure to various chemical pollutants in Guangdong's drinking and agricultural water has lead to "cancer villages" such as around Shangba in northern Guangdong, where one unconfirmed account indicates that nearly 250 out of 3,000 villagers have died of cancer since 1987 (Griffiths, 2007). Mines near the village, one owned by the Guangdong provincial government, have been releasing polluted water into local rivers, elevating the lead to 44 times the permitted level ("A great wall," 2004; Griffiths, 2007). Like the rest of China, violent rural protests over pollution are increasing in Guangdong.

Current Environment and Health Research

Environmental health research within Guangdong and the Pearl River Delta region has attempted to assess the exposure-response for varying air and water pollutants, as well as investigate soil, water, and air pollution. In-depth analytical research will, as expressed by a recent World Bank report on premature deaths related to environmental pollution in Guangdong, reduce the information gap and produce a more comprehensive understanding of the health and non-health consequences of pollution. The study focuses on the exposure-response relationship between drinking water contamination and health effects in Guangdong (World Bank & SEPA, 2007). Even though additional research must be conducted, organizations across Guangdong Province have investigated pollution sources, health outcomes, and the movement of air and water pollution. (See Table 2).

TABLE 2. Select Research on Environmental and Health Issues in Guangdong & Pearl River Delta

Research Institutions	Issue(s)	Area	Year
World Bank & SEPA	Economic costs of pollution	China, Guangdong	2007
Guangdong Institute of Ecology	Heavy metal contamination of agricultural product	Pearl River Delta region	2007
Guangzhou Institute of Respiratory Disease	Indoor air pollution and COPD	Guangdong	2007
University of Hong Kong & Civic-Exchange	Air pollution costs and potential solutions	Pearl River Delta region	2006
UCLA, Jiangsu Provincial CDC & Fudan University	Air pollution and case fatality of SARS	China, Guangdong	2003
Guangzhou Institute of Geochemistry & University of Macao	Persistent organic pollutants (POPs)	Pearl River Delta region	2003
Hong Kong Polytechnic University	Modeling cross-boundary water pollution transport	Pearl River Delta region	2003
Hong Kong Polytechnic University & Guangzhou Institute of Geochemistry	Heavy metal contamination of agricultural land	Pearl River Delta region	2001

Source: Compiled by authors.

THE VANGUARD FOR ENVIRONMENTAL HEALTH?

The Guangdong Phenomenon…

Guangdong is the richest province in China producing about 12 percent of the national GDP, higher than any other single province (Ruwitch, 2006) and its progressive economic policies and successes have made it the focus of much international scholarship and media attention. The province gained national economic prominence in 1980 when China's first Special Economic Zones were established (Guangdong PPC, 2004). Guangdong's economic significance was further elevated in 1992, when Deng Xiaoping visited it during his famous Southern Tour and called for renewed economic liberalization ("Deng's southern tour," 2007). Such doting on Guangdong from the central government contributed to its continual economic growth and has helped the province maintain an annual average GDP of over 10 percent since 1978 (Wing-Hung Lo & Tang, 2006; "FDI inflows," 2006). Measurements of Guangdong's economic development in 2005 and 2006 further illustrate its status as an economic powerhouse. As a percentage of the country's total, its foreign trade accounted for one-third; its foreign direct investment represented over one-fourth (DFTEC, 2006); and its GDP equaled nearly one-eighth (Yeung, 2007). These figures indicate how Guangdong has national, as well as international, economic stakeholders. Moreover, such economic achievements readily translate into enviable political status and prestige.

In what has become known as the "Guangdong Phenomenon" (*Guangdong Xianxiang*), the provincial government has established a reputation for being politically assertive, even in the environmental

sphere (Yang, 2004). For example, in response to international bans in the late 1990s on agricultural products from Guangdong for excessive pesticide residues, provincial leaders, in partnership with its agricultural universities began to reorient the province's food production system to promote development and certification of organic food. Guangdong became the leader of this small, but growing, organic food market in China (Riggs, 2005).

Moreover, some experts view Guangdong Province as separate from the country, maintaining an "awkward relationship with Beijing."[3] Somewhat politically insulated, Guangdong operates with a unique degree of autonomy, which can potentially lead to progressive as well as regressive polices. The Guangdong Provincial Peoples Congress (Guangdong PPC) involvement in the Sihui case that opened this paper represents an important example of the province's environmental progressiveness. This congressional move substantially altered the Guangdong PPC's de facto role as a "rubber-stamp" organization and pushed the envelope for further local government reform (Yang, 2004; Wang, 2005; Wang & Wang, 2006). A few months into the Sihui investigation, the Guangdong PPC adopted a new regulation, which now requires all major development programs within the province be submitted to the PPC for approval. While the regulation was adopted in conjunction with the Sihui case, it was actually in the making for five years and was previously rejected three times by the Guangdong PPC's Standing Committee ("Local People's Congress," 2000). Clearly, the political implications of this case extend beyond the realm of environmental protection; thus, it has attracted the attention of a diverse range of China watchers. Guangdong also has been a leader in promoting greater government openness and public participation through e-government and other such forums, which are now common across China's central and local levels (Yang, 2004).

…Or Just Phenomenal Pollution?

Guangdong's environmental health degradation provides both a challenge and an opportunity for its provincial leaders. A January 2007 update from the Consulate-General of Canada in Hong Kong assesses of the current dismal environmental situation in Guangdong:

According to statistics from Guangdong Provincial EPB, Guangdong's occurrence of environmental polluting incidents has intensified in the recent years, causing considerable instability to the society. In 2005, 32 polluting incidents broke out in Guangdong, of which the North River's cadmium contamination is the most serious environment incident ever recorded since the 50s. As the situation worsened, Guangdong plans to invest RMB 2.2 billion during the 11th five-year plan period to set up an environmental monitoring centre.

A counterbalance to the environmental deterioration is Guangdong's increasing commitment to invest in environmental pollution control and monitoring and to release environmental data from provincial and regional monitoring networks. In the Tenth Five-Year Program, Guangdong's investment in environmental monitoring capacity reached 700 million Yuan yielding a threefold increase in data collected on various environmental indices. With 22 environmental monitoring stations certified by SEPA's national laboratory, Guangdong ranks second after Jiangsu Province in the number of certified stations (Consulate-General of Canada, 2007). In terms of overall investment in environmental protection, in 2006 Guangdong invested more than 60 billion Yuan, which equals approximately 2.5 percent of the province's GDP—a ratio significantly higher than that of most other provinces (Zhan, 2007).

While pollution control and monitoring are crucial, the central challenge is whether Guangdong officials are willing to undertake aggressive measures to address some of the political factors and business investments that are driving the pollution. Most of Guangdong's growth has been fueled by low-tech, highly polluting industries that require cheap, unskilled labor. Today there are signs the province is in a transition to shift to high-tech and less-polluting industries and develop a bigger service sector (Ruwitch, 2006). One catalyst for this is the 2007 central government campaign to crack down on the top 1,000 energy intensive industries—particularly those in Guangdong—requiring them to make significant cuts in energy use and emissions (Greising, 2007).

Air pollution in many of Guangdong's cities has become so severe that some municipal governments are closing down or moving particularly dirty industries out of their city to clear the skies. For example, while previously welcoming of any and all industries, today the leadership in Foshan (located on the west bank of the Pearl River next to Guangzhou) claims they are rejecting highly polluting businesses, for the city's smog is the highest in the province, making it one of the most unlivable

places in Guangdong (Ruwitch, 2006). This trend could ultimately mean some of the dirtiest industries move further inland to Hunan or Sichuan, where the hunger for investment is great and willingness to impose environmental standards low. In 2007, the mayor of Shenzhen took a unique, albeit superficial, stance to curb air pollution by asking citizens in the bustling city bordering Hong Kong to stop buying cars (Greising, 2007). A more significant move to improve environmental quality in the city was when in the late 1990s the Shenzhen government created a water resources bureau, which brought key local agencies together to manage water quality and quantity problems better (Eng & Ma, 2006).

Despite these progressive efforts, continued environmental degradation threatens to undermine Guangdong's high-level economic growth and development. Two recent cases reveal the economic consequences of water pollution. First, the cadmium contamination of Beijing River from the Shaoguan Smelting Plant on 15 December 2005 resulted in direct and indirect economic losses amounting to 150 million Yuan ($18.75 million) (Liang, 2005). Second, the U.S. FDA restrictions in 2007 on certain seafood products are seriously impacting China's $35 billion aquaculture industry. Within Guangdong, companies such as the Xulong Eel Factory in Taishan city face restrictions due to shipments containing residues of banned antibiotics, which farmers must give their fish to keep them alive in the extremely dirty river and coastal waters. In May 2007, the Guangdong Provincial Oceanic and Fishery Administration reported that nearly 8.3 billion tons of sewage—most untreated—were emitted into Guangdong's coastal waters in 2006, which is 60 percent more than five years ago (Xinhua, 2007). Fish stocks in the province's coastal areas are highly damaged by the heavy metal emissions, which include lead, copper, and cadmium. Recent studies by the Chinese Academy of Sciences and Guangdong scientists have detected seafood products contaminated with pesticides, including DDT, from eleven coastal cities in the Pearl River Delta region (Barboza, 2007). Thus, bans on Guangdong's seafood will most likely continue. If contamination of its lucrative aquaculture inspires Guangdong to significantly reverse water degradation trends, akin to its actions on pesticide residues, it could become a major provincial leader.

Recent pledges by cities within the province to meet pollution reduction targets highlight emerging local government initiatives to address these concerns ("Local governments vow," 2007). As an indication of the province's progressiveness in pollution control, Guangdong is setting up an environmental monitoring and control station, serving five additional provinces in the region. ("Guangdong reaches," 2007).

Environmental Health Efforts in Guangdong Province

Local government officials have made implicit and explicit public statements on environmental health and its implications for economic growth. In a public address at the Third Session of the Tenth Guangdong PPC, provincial governor Huang Huahua, for example, reported that the government would pay more attention to ecological protection ("GD expects," 2005). In multiple public appearances, Huang reiterated air pollution is high on the government's agenda, although he did not explicitly link air pollution to health concerns ("HK, Guangdong aim," 2006).

The Guangdong EPB website, on the other hand, dedicates multiple pages to informing the public on environmental health issues in general and air pollution/respiratory health issues in particular (Guangdong EPB, 2005).[4] Another key area of information disclosure is the abundance of news media reports on environmental health in Guangdong. Admittedly, these reports vocalize mixed views on the efforts being made by local government actors. Some have favorably compared Guangdong's pollution reduction achievements to those at the national level, arguing that the province is poised to be a national leader in this area ("Guangdong reaches," 2007). Other articles, particularly those quoting local residents, present a more negative assessment of the provincial-level government's environmental performance. As a demonstration of the distrust some Guangdong residents have of the local EPB's air pollution index, one resident said, "the pollution should be quite serious because I had problems breathing as I walked home… how dare the TV news tell us the air quality was good" (Huang, 2006). Similarly, another Guangdong resident attacked a highly polluting state-owned tire factory saying, "we don't need GDP for blood." He further stated that the factory's profits are "nothing compared with the health of the citizens" (Wang, 2007). Similar concerns are fairly common throughout Guangdong and widely reported in the news. As such, they demonstrate residents are leveraging health issues in their criticism of major pollution offenders.

Mirroring some of the national trends, there is a growing collection of laws, regulations, and standards in Guangdong focusing on environmental protection and also considering the health implications of pollution. For example, the Guangdong Provincial Environmental Protection Ordinance, which came into effect on 1 January 2005, clearly states its intention "to protect and improve the living environment and the ecological environment, prevent pollution and other hazards, and *protect human health* [italics added]." While the Guangdong PPC is considering environmental health, it is not an implementing agency and the lack of interagency coordination, especially between the central and local offices of the Ministry of Health and SEPA represent a significant barrier to truly effective environmental health policies.[5]

SO_2 as a Catalyst for Interagency and Regional Cooperation

The Environmental Framework Plan for Guangdong (2006-2020) represents another legislative attempt to address environmental health as a sub-issue within a broader environmental context. By 2010, the plan aims to reduce SO_2 emissions by 7.5 percent from 2005 levels ("Sulphur dioxide," 2006). Although the prospect of achieving this ambitious reduction target is in question, the plan nevertheless demonstrates a strong concern with the adverse effects of SO_2. Among other things, the plan cites declining public health and potential economic loss as the main risks associated with SO_2 and other air pollutants (Guangdong PPC, 2006).

While the formal interaction between government officials, agencies, bureaus, ministries, congresses, and councils on environmental health issues seems limited in Guangdong, the informal interaction of these institutional actors appears to be growing. One prominent example is the ongoing cooperation between the Guangdong PPC and the Hong Kong PPC to address various types of pollution, including air pollution. In 2002, Guangdong and Hong Kong launched the Action Blue Skies Campaign to study air pollution and adopt measures to improve air quality in the Pearl River Delta Region (Huang, 2006). Cooperation on environmental protection is one of the main aspects that both Guangdong and Hong Kong will emphasize during the next five years. Significantly, their shared objective is to reduce SO_2 emissions by up to 40 percent of their 1997 levels by 2010 (Huang, 2006). This timeline obviously corresponds to the Environmental Framework Plan for Guangdong.

Within Guangdong, institutional cooperation is also occurring between 21 municipal governments, which signed SO_2 emission cap agreements with the provincial government.[6] According to Guangdong's vice-governor Xie Qinghua, the province intends to lower SO_2 emissions to 1.10 millions tons by 2010, which is 15 percent less than 2005. To this end, the municipal government officials will enforce stricter desulphurization standards of existing and developing coal and oil dependent industries ("Reducing pollution," 2006).

GUANGDONG-HONG KONG AND THE PEARL RIVER DELTA REGION COOPERATION

Neighboring economic powerhouses, Guangdong and Hong Kong, share environmental resources and negative pollution impacts on air and water. Both governments have acknowledged the shared responsibility for the Pearl River Delta region and strive to collaborate. A notable example is the establishment of the Joint Working Group on Sustainable Development and Environmental Protection (JWG), co-chaired by Hong Kong's Secretary for the Environment, Transport, and Works and Guangdong's Director of Environmental Protection. Formed in June 2000, the JWG provides structured cooperation on a wide range of environmental issues. In December 2005, the JWG held its sixth meeting to review progress on current initiatives and discuss future goals, with an emphasis on air and water pollution (HKEPD, 2006).

Air Quality Monitoring Network

Unique to China, the governments of Guangdong Province and Hong Kong SAR established a regional network to monitor air quality throughout the Pearl River Delta Region. (See Figure 3). Joint efforts by the Guangdong Environmental Protection Centre and the Hong Kong Environmental Protection Department from 2003 to 2005 yielded the Pearl River Delta Air Quality Monitoring Network (the Network). The Network has been reporting data from 16 automatic air quality monitoring stations throughout the PRD in the publicly accessible Regional Air Quality Index since 30 November 2005 (GPEMC & HKEPD, 2006).

Previously, incomplete or poor information on air quality characterized the region leading to an inability to assess the true extent of its air quality

FIGURE 3. Air Quality Monitoring Network

Source: Figure adopted from GPEMC & HKEPD (2006).

and formulate appropriate control policies. Thus, the three primary objectives of the Network are to: (1) provide accurate air quality data, (2) evaluate long-term effectiveness of pollution control policies, and (3) inform the public on regional air quality (GPEMC & HKEPD, 2006). Monitoring stations collect and measure four air pollutants, SO_2, NO_2, respirable suspended particulates, and O_3, and permit site-specific monthly and annual averages as well as daily and hourly maximum and minimum averages. In early 2007, Civic Exchange, a Hong Kong-based NGO, described the Network as a "major advance," which systematically accumulates data year after year. Assessments by Civic Exchange observed how on an annual basis, everyone within the area covered by the monitoring network is breathing air that is a danger to their health (Civic Exchange & Institute for Environment, 2006). Such research analysis may pave the way for bold strides in environmental health.

The first year of data collection in 2006 has helped inform trends and depict spatial distributions of the four pollutants and reveal seasonal variations. Daily reporting of the Regional Air Quality Index provides continuous information to the public on daily air quality at the 16 monitoring stations.[7]

As seen in Table 3, air quality grades show significant variation across the Pearl River Delta as well as within districts in two of the most polluting municipalities in Guangdong (Guangzhou and Foshan) and in Hong Kong.

Particular concern should center on districts reporting air quality Grades IV or V, which indicates that China's Class 2 National Ambient Air Quality Standards (NAAQS) have been significantly exceeded for the pollutants. Disaggregated air quality data reveals environmental pollution hotspots and underscores the need to combine Guangdong Province or the PRD region into a single data point hides major trouble spots. Foshan municipality represents one area of concern for provincial and regional officials, since during approximately a third of 2006, its air quality declined to Grades IV or V.

Thus, the Guangdong and Hong Kong governments must prioritize must prioritize extensive data collection across the region, continued investment and expansion of the Network down to the county level and increasing the number of monitored pollutants in order to develop appropriate pollution control policies.[8]

The central government and Guangdong Province investment into the PRD air monitoring projects totals 300 million Yuan ($38.4 million). Li Qing, Director of the Guangdong Environmental Protection Department (EPD), claims that "[the network] has so far been the nation's largest investment in an environmental project." Furthermore, Li believes "this endeavor, which is the nation's largest scientific and research project in terms of regional air pollution control, will…help improve air quality in the Pearl River Delta" ("China to create," 2007). Expansion of monitoring stations and improving the detection of multiple sources of air pollutants and continued release of collected data should help inform policymakers and provide the public with accurate air quality information for the region. In addition to these efforts, the JWG also is making plans to increase its efforts to combat air pollution through the introduction of an emissions trading scheme for thermal power plants in the Pearl River Delta region (HKEPD, 2006).

Water Quality Monitoring

Initial regional efforts to monitor and assess air quality proved to be highly successful in informing governments and the public on regional air pollution. Yet, equivalent efforts to monitor and assess water quality, another serious cross-boundary problem, have not accomplished a similar regional water quality monitoring network. Guangdong supplies nearly 80 percent of Hong Kong's water needs, with the primary source being the Dong River. Since 1989, a cross-border agreement stipulated

TABLE 3. Regional Air Quality Index Grade for Selected Districts in Guangzhou, Foshan, & Hong Kong, 2006

District	Grade I	Grade II	Grade III	Grade IV	Grade V
Guangzhou	16.33	42.86	34.4	4.96	1.46
Guangzhou	17.28	31.44	33.71	13.6	3.97
Guangzhou	35.5	47.34	14.2	2.96	0
Foshan	5.62	34.32	31.95	18.34	9.76
Foshan	0.92	32.62	32.31	18.77	15.38
Hong Kong	29.19	55.2	14.16	1.16	0.29
Hong Kong	39.48	55.33	4.61	0.58	0
Hong Kong	31.18	46.76	19.71	2.06	0.29

Note: Grade I represents high quality air and Grades IV and V signify extremely unhealthy air.
Source: GPEMC & HKEPD (2006).

that Guangdong Province must ensure water quality standards for raw water supplied to Hong Kong. In an event of poor water quality, the Hong Kong Water Safety Department will liaise with authorities in Guangdong to rectify poor water quality (Hong Kong WSD, 2000).

Water quality in the PRD region remains a concern with the Joint Working Group, which has placed several water quality control measures on the agenda. In 2006, several ongoing activities address various water pollution issues include development of a water quality model for the Pearl River Estuary. Similar to the Network monitoring air quality, the water quality model will be used as an analytical tool to inform and support appropriate measures to control water pollution, such as conducting a needs assessment of water pollution in Shenzhen Bay and analyzing strategies for protecting the quality of Dong River's water (HKETO, 2006; HKEPD, 2006). Both Guangdong and Hong Kong officials must confront lax enforcement of environmental standards and government officials' complicity in the release of untreated industrial and public waste water throughout Guangdong.

CAUTIOUS OPTIMISM

Discussions of China's environmental health situation must not portray it as a homogeneous picture, for significant regional disparities exist in China. For example, the coal-producing regions of northern China (centered on Shaanxi) are poor and even more polluted than the PRD. In stark contrast Guangdong, while highly polluted, is a wealthy, politically powerful province, which has a unique partnership with Hong Kong to help accelerate its research and policy development in the pollution prevention and environmental health spheres. While Beijing remains weak in enforcing environmental laws, continued prioritization at the central level of environmental problems threatening human health will play an important role in helping progressive forces in Guangdong and other regions clean up their air and water.

While it is perhaps too soon to claim that Guangdong is China's vanguard for environmental health, there is reason to continue following developments in the area with optimism. The success of the Regional Air Quality Monitoring Network and other similar initiatives will require continued provincial government support and a commitment for transparency—two issues which are by no means certain in China. Nonetheless, these initiatives represent a decisive step forward for Guangdong, the PRD, and China in general. Additional research on local progress in light of national developments will be needed to continue filling gaps in existing scholarship on this topic.

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NOTES

1. The figures are approximately 511.8 billion Yuan for total cost and 219.8 billion Yuan for air pollution-related costs.

2. For more information on this forum see: http://www.rrcap.unep.org/envhealth/index.cfm.

3. Authors interview with Drew Thompson, June 28, 2007.

4. This information ranges from explaining air pollution terminology such as total suspended particulates to identifying its negative health impact on the respiratory system. The website also provides information on the health risks associated with sulfur dioxide, which is the largest component of Guangdong's industrial emissions ("Sulphur dioxide," 2006).

5. Authors interview with Drew Thompson, June 28, 2007.

6. The agreement also considered chemical oxygen demand (COD), but given the focus of this paper, we have omitted it from our discussion of institutional coordination.

7. For additional information on the Regional Air Quality Index public website, please see http://61.144.36.8/equality2/raqi/eng.aspx.

8. Authors interview with Drew Thompson, June 28, 2007.

COMMENTARY

Choking on Sand: Regional Cooperation to Mitigate Desertification in China

By W. Chad Futrell

A 1994 *Discover Magazine* article about the arboreal "shelterbelt" being planted along China's "Three Norths" lauded the Chinese government's efforts to combat desertification and the resulting dust and sandstorms (*shachenbao*, literally "sand explosion") ("Great green wall," 1994). Strikingly, the article cautioned how the decline in dust and sandstorms could adversely affect plankton that feed on minerals deposited by such storms. Given the frequency and intensity of China's dust and sand storms over the past few years, it is safe to say that the article's praise and concern were both misplaced. Though there have been improvements in some areas, desertification has accelerated in the 18 provinces prone to this form of land degradation, affecting over 2.6 million km^2 (27 percent of China's total territory) by the end of 2004. These wide swaths of land face a variety of challenges, but all suffer from a lack of water and sound management.

The dust storms originate in the arid and semi-arid regions of China and Mongolia before moving towards China's heavily populated east coast. Powerful storms carry sand over the Korean Peninsula and Japan, where they are referred to as "yellow sand" (*hwangsa* and *kosa,* respectively). Particularly strong dust storms from China can hit North America within a week, sometimes even obscuring visibility in the Grand Canyon. Though the sand storms have always had economic impacts, the fine sand is now picking up pollutants as it travels through China's industrial areas, expanding the list of health concerns from eye and throat irritation to asthma, increased risk of stroke, heart attack, and cancer. Regional governments, scientists, and nongovernmental organizations (NGOs) are now working together to understand and mitigate desertification and the damaging dust storms.

HISTORY OF DESERTIFICATION AND DUST STORMS

Desertification and dust storms in China are not new phenomena. Indeed, Chinese scholars reported the first major dust storm in 1150 B.C. during the Shang Dynasty (Chon, 1994), while Korean scholars first recorded "dust falling like rain" in 174 A.D. (Chun, 2003). Within China, strong storms were sometimes seen as a bad omen; a sign that rulers had lost the "mandate of heaven." The number of reported dust and sand storms in China, Korea, and Japan increased from the 15th century onwards as climate changes and continual population growth along the Silk Road increased desertification. Desertification markedly accelerated after the 1940s as Han Chinese farmers moved into areas previously dominated by ethnic minority herders, often tripling the population within a few decades.

The degradation of fragile grasslands in northern China has been significant. From the 1950s to 1975, desertified areas expanded by 1,560 km^2 a year, accelerating to 2,100 km^2 a year from 1975 to 1987, and finally 3,600 km^2 a year from 1987 to 2000 (Wang, et al., 2003). Wind erosion is the most widespread cause of desertification, affecting 70 percent of the desertified land in all 13 provinces in China's northeast, north, and northwest. Water erosion is another major cause, especially along stretches of the Yellow River on the Loess Plateau, while the freezing and thawing process in the alpine zones of the Qinghai-Tibet Plateau also intensifies desertification. All of these natural causes are exacerbated by human activities. The chief anthropogenic causes of desertification, which strip the land of its vegetative cover and/or use already scarce water resources, include over-cutting for firewood (32 percent of

total anthropogenic desertification); overgrazing (28 percent); over-cultivation (25 percent); and the construction of industrial projects such as mines and oil fields (9 percent) (Wang, et al., 2003).[1]

China experienced, on average, 5 strong dust and sand storms per year in the 1950s, 8 per year in the 1960s, 13 per year in the 1970s, 14 per year in the 1980s, and 23 per year in the 1990s (Wang, et al., 2003). South Korea, on the other hand, recorded a large number of dust and sand storms from 1935 to 1945, after which there were relatively few occurrences until the 1980s. Since then, the number of days of dust and sand storms in South Korea has increased rapidly, from less than 4 days a year in the 1980s, to over 6 days a year in the 1990s, and more than 12 days a year since 2000 (Kang, 2004). Japan averaged around 20 days of dust and sand storms a year from the 1970s to the 1990s, with a sharp increase to 40 days a year from 2000 onwards (Yamamota, 2007). Although the exact rate of change varies among these three countries, all have seen a dramatic increase in the number of dust and sand storms per year over the past several decades.

The vast difference in the number of observed dust and sand storm events among these three countries is due in part to the different ways each measures such storms, with China focusing on wind speed and visibility, while South Korea and Japan emphasize sand particle size. However, the discrepancy in frequency is attributed mainly to the different paths China's dust storms travel. Dust and sand storms originating in the grasslands and cultivated fields of Inner Mongolia usually travel eastwards, but sometimes move southwards first and then eastwards, therefore spending an extended period of time in China. Likewise, dust that originates in China's northwest travels southwards first and then eastwards, passing over Taipei rather than Beijing and Okinawa rather than Seoul. Finally, dust storms originating in the northeast may not hit Beijing but cause serious problems for the Koreas and Japan. Thus, Chinese scientists correctly predicted fewer spring dust storms in 2007 while Korean scientists correctly predicted a very bad spring.

Signs of change on the grasslands for Mongolian herders: motorcycles and brick houses with solar panels and satellite dishes. Photo Credit: W. Chad Futrell

The origins of these storms are important to understand because the makeup of dust and sand varies by location. Sand storms tend to pick up salty, fine soil found in dry lake and riverbeds, thus highly sandy deserts such as the Taklimakan are a source of bigger storms than the stony Gobi. Furthermore, dust and sand storms born on the Loess Plateau carry the same fine soil that gives the Yellow River its name. These differences are important in determining sand storm "hotspots," as well as where the dust is eventually deposited. On average, 30 percent of the dust and sand lifted airborne is deposited close to its origins, while 50 percent travels as far as China's coast, and 20 percent travels beyond China's borders, with finer, lighter particles traveling the farthest.

ECONOMIC AND HEALTH IMPACTS

In the 1980s and early 1990s, desertification cost China at least $6.5 billion a year in direct economic losses (Zhu, 1994), a number that has since risen to $7 billion a year (Wang, 2007). The economic and health costs of dust and sand storms vary greatly depending on wind speed and particulate density. For example, a particularly strong sandstorm in 1993 killed 85 people and 120,000 animals while destroying almost 4,500 houses and 400,000 hectares of crops in Xinjiang, Gansu, Inner Mongolia, and Ningxia provinces (Asia Development Bank, 2005). The direct economic costs of that one storm were more than 550 million Yuan ($72 million) in China alone. As dust and sand storms became more prevalent in the late 1990s, electronics firms in Korea and Japan began to worry about the fine particles infiltrating semiconductor factories. Powerful storms such as those in 1993, 2002, and 2006 can also shutdown airports and schools. South Korean scientists estimated their country suffered $4.6 billion in sandstorm-related losses in 2002, equivalent to 0.8 percent of the country's GDP (Kang, 2004).

The economic costs of dust and sand storms, however, pale in comparison to the confirmed and

The power lines that came in 2006 signal imminent changes for this Mongolian herder. Photo Credit: W. Chad Futrell

potential health risks. The most common health impact associated with these storms is increased incidence of eye, nose, and throat irritation, along with asthma. Scientists are becoming increasingly concerned, however, by the long-term damage caused by inhaling the fine quartz dust. While breathing in silica-rich quartz particles smaller than 10 micrometers (μm) is dangerous, those smaller than 2 μm have the greatest impact on human health because they penetrate deep within the tiniest passages of the lungs. A study in 1993 found that over 21 percent of the residents over 40 years old in a desert area of Gansu Province had pneumoconiosis, a non-industrial version of silicosis, putting them at greater risk of tuberculosis, heart disease, and lung cancer (Xu et al., 1993).

Scientists are even more concerned about the cocktail of pollutants that are increasingly attached to the dust particles. First, the fungi, viruses, bacteria, pesticides, and fertilizers already present in the soil are picked up and carried along with the dust and sand. Then the dust particles pick up pollution as they pass over industrialized areas, including sulfur, lead, cadmium, arsenic, iron, and manganese. Korean and Japanese scientists have studied the concentration levels of these and other metals before, during, and after dust and sand storms from China, finding concentration levels dozens of times higher than normal. Korean scientists now maintain that dust and sand storms raise mortality rates from cardiovascular and respiratory causes, and may even damage human DNA through oxidative damage (Kwon, 2004), while Taiwanese scientists have linked dust and sand storms with increased incidences of stroke (Yang, Chen, Chiu, & Goggins, 2005).

NATIONAL AND INTERNATIONAL GOVERNMENT EFFORTS

Given the substantial economic losses and health risks caused by dust and sand storms, it is not surprising that the Chinese government has been working to reverse desertification for almost thirty years. Starting in 1978 with the "Three Norths" Shelterbelt Program mentioned in the *Discover* article, Chinese national, provincial, and local governments have spent billions of dollars on tree-planting and other soil stabilization campaigns.[2] These efforts have met with mixed success, however, suffering from inadequate funding and poor implementation. Some of the overarching problems include planting tree species not suitable for local ecosystems, poor site selection, and insufficient care of trees. This has led not simply to very low tree survival rates, but in some cases planting efforts have actually made the surrounding area drier, lowering water tables even further. The central government also passed a number of laws, including the Law on Combating Desertification Prevention and Control in 2001. However, like other environmental legislation, a lack of specificity about implementation limits its effectiveness.

The World Bank has supported rural poverty programs that have included extensive grassland and soil stabilization initiatives. Most notable is the Loess Plateau Watershed Rehabilitation Project where, since 1994, the World Bank has been working with communities and local governments in the upper and middle parts of the drainage basin of the Yellow River, one of the most eroded places on earth.

The increasing severity of sand storms has sparked unprecedented levels of environmental cooperation within the region. Not only have dust storms been one of the central topics of the annual Tripartite Environment Ministers Meeting (China, Japan, and South Korea) since 1999, these countries are working with Mongolia and the Asia Development Bank to establish a regional network of observation stations to share data on the origins and paths of dust and sand storms (ADB, 2005). Japan has focused an enormous amount of money on desertification in China, spending around $375 million in 2003 and 2004 alone, while South Korea has provided over $10 million since 2001 to fund efforts to plant trees and shrubs in desertified areas.

EFFORTS BY JAPANESE AND KOREAN NGOS

Though environmental ministries and their related research centers are increasingly working together to study desertification and sand storms, NGOs from Japan and Korea also have been working with local groups in China since the 1990s to both alleviate poverty and prevent desertification. Through this work, many of these NGOs are exploring the ecological, political, economic, and cultural drivers of desertification in order to devise area-appropriate solutions. This attention to the specific conditions of various locations is markedly different from the traditional large-scale government campaigns, such as the "great green wall," which planted the same species of trees in regions with markedly different ecological and socio-economic conditions. Some of the most noteworthy NGOs include:

- *Japan's Green Earth Network* (GEN) has been working around Datong, Shanxi Province since 1992 when its founder, Kunio Takami, began spending over three months a year on the Loess Plateau. Recognizing the need for an environmentally motivated project to work with the local government and address the needs of the local residents, GEN focused on methods that would both generate income and protect the fragile soils around Datong. After experimentation, Takami discovered promise in apricot trees, which are resistant to drought and farmers could sell the fruit and earn 10,000 Yuan ($1,300) annually, compared to 2,000 Yuan ($260) for other crops (Shi, 2007). Over the last 15 years, GEN raised almost $3 million and recruited almost 2,500 Japanese volunteers to help tens of thousands of local people plant over 17 million apricot and pine trees.

- *Organization for Industrial, Spiritual and Cultural Advancement International* (OISCA)—another Japanese NGO—has been conducting afforestation programs along the Yangtze River and in Inner Mongolia since 2000. OISCA established a center for technical cooperation with Shanghai's Jiaotong University in 2002 and founded the Alashan Desert Ecological Research and Training Center in Inner Mongolia in 2006 (Efird, 2007).

- South Korea's *Northeast Asian Forest Forum* (NEAFF) was established in 1998 by former forestry officials and scientists, and held its first international seminar on desertification in 1999. NEAFF has worked with forestry bureau officials to carry out reforestation projects in Shandong Province and Inner Mongolia. NEAFF also has worked with Korea's Forestry Service and China's Forestry Bureau to hold 2 to 3 conferences a year for scientists and government officials since 1999.

- *The Yuhan-Kimberly Corporation of Korea*, a company focusing on paper hygiene projects, initiated the "Keep Korea Green" program over 20 years ago. Its path-setting environmental CSR programs have long-funded a number of NGOs and "forestry and friendship" projects, including those of NEAFF and the Future Forests, Forests for Peace, and School Yard Forest movements.

- *The Korean Federation for Environmental Movement* (KFEM), the largest and most prominent environmental NGO in South Korea, has been working with the Chinese NGOs *Friends of Nature* and *Echoing Steppe* since 2003. They have organized a number of educational exchange programs and fieldtrips for Korean and Chinese high school and university students. KFEM also has hosted annual meetings in China and Korea to help NGOs network domestically and internationally on desertification and other regional environmental issues. Feeling that the emphasis on trees has been misplaced, KFEM and their Chinese partners have been co-managing hybrid grass test sites with local herders and farmers in 4 locations in Jilin Province and Inner Mongolia. Finally, KFEM has helped Korean reporters and documentary filmmakers come to China in order to raise awareness of the economic and cultural issues that lead to desertification.

BUILDING A COMMUNITY

Scientists have made great strides in understanding the causes of desertification, along with the biogeochemistry and health effects of the dust and sand storms plaguing China and the region. The economic and health impacts of these storms have sparked governments in the region to prioritize investments and projects aimed to mitigate desertification. While smaller in scale, NGO projects in the region are coming to understand the political, economic, and cultural roots of desertification. Greater government

attention and support of these grassroots initiatives could help mitigate desertification and dust and sand storms, as well as build a stronger environmental community in Northeast Asia.

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NOTES

1. See the China Environment Health Project Research Brief by Linden Ellis for further information on causes of desertification: http://www.wilsoncenter.org/index.cfm?topic_id=1421&fuseaction=topics.item&news_id=231756.

2. See Yin, Xu, Li, & Liu (2005) for an extensive review of these efforts.

FEATURE BOX

Driving into the Desert of Sand—Circle of Blue

By Jennifer L. Turner

The grasslands of northern China are dying, turning into mini-deserts that grow and connect, forming oceans of sand. And just as oceans produce hurricanes, the deserts of China and Mongolia are increasingly producing dust and sandstorms. These sandstorms have long plagued China's northeast, north, and north, but now they are gaining international attention as sandstorms blanket the Korean Peninsula and Japan every spring. The number of sandstorms has increased in frequency and intensity over the past decade. Within and beyond China these sandstorms force the closure of schools, airports, and factories and have caused billions of dollars in economic losses and pose serious health hazards.

The above paragraph captures the problem addressed in a new multi-media web-based collection of stories that the China Environment Forum (CEF) designed and produced in partnership with Circle of Blue—a network of media professionals, nongovernmental organizations (NGOs), and researchers seeking to focus attention on global freshwater problems. In August 2007, CEF partnered with Circle of Blue to assemble a group of desertification experts and photographers to take a five-day car ride from Beijing into eastern Inner Mongolia. On their drive into the ocean of sand, they gathered stories, photos, and video to put a human face on the impact of China's growing desertification crisis.

Central to the success of the trip was activist Chen Jiqun from the NGO Echoing Steppe, who for years has been advocating better awareness of the plight of Mongolians suffering from relentless desertification in Inner Mongolia. Chad Futrell brought his knowledge and years of experience researching China's policies and programs on desertification to explore the drivers of increasingly harsh sand storms. Getty photographer Palani Mohan and Circle of Blue videographer Eric Daigh captured images—both the stunning and heartbreaking—of how the dry environment is challenging many citizens in Inner Mongolia. CEF and Circle of Blue have melded Chad's story with images from Palani and Eric onto the website: www.circleofblue.org.

circle of blue

The story posted on Circle of Blue's website explores many of the political inequities and environmental complexities behind water scarcity, but also highlights some relatively unknown challenges stemming from mining and the trend of dirty industries moving to the grasslands under China's "Go West Campaign." An excerpt of one of Chad's poignant vignettes is below.

TAKING A STAND TO PROTECT THE GRASSLANDS

"I want my sons and other herders to know that they can stand up to people destroying the grasslands," reflects Damulinzabu as he looks out over the inky black pond that abuts his grasslands. Although Damulinzabu and his two co-plaintiffs won their legal case against Dianhua Paper Mill in 2004, the noxious odors from the cesspool still give him and his wife headaches and nausea. The paper mill has already left Jirigalanggazha village, and Damulinzabu will soon follow. "We can't drink the water, and our sheep still can't put on weight, so how could we stay?" He has used the money from the legal settlement to lease some land outside his village, though it cannot compare with the land he has been forced to leave. "These grasslands were some of

A Mongolian herder sifts through sand where the three-meter deep Arxiaot Lake stood a mere five years ago. Photo Credit: Palani Mohan (Getty Images) for Circle of Blue.

the best in the region. We have a lot of water, which is why that paper mill wanted to come here. Now the water is ruined."

The Dianhua Paper Mill, originally located in Hebei Province just outside of Beijing, was forced to close in 1999 because it was producing too much water pollution. Rather than pay for an expensive water filtering and treatment system, the owner decided to relocate the factory to an area more "amenable" to polluting industries. The Dianhua Mill thus moved about 500 miles north of Beijing to Jirigalanggazha Village, on the relatively water-rich Wuzhumuqin Grasslands. The county government, for its part, was looking for a company to occupy the building originally used by the Dongwu Horse Meat Processing Factory, which had gone bankrupt. The county attracted the mill by providing the empty building and land that had originally belonged to 18 Mongol herders. The county government also promised to return any income taxes to the mill for the first seven years of its operation, and charge very low water and wastewater fees.

As is often the case in China, the paper mill started production in March 2000 without having undergone any kind of environmental evaluation. The mill dug out a 640-acre area to serve as its wastewater pond, and began discharging 2.5 million tons of untreated wastewater into the pool every year. No measures were made to treat the water or to prevent the wastewater from seeping into the ground and aquifer below. Herders living around the mill and its wastewater pond began complaining of headaches, dizziness, and nausea from the noxious odors almost immediately. Not long after the mill began operating grass around the pond began dying, a sign that the wastewater was already seeping into the groundwater. Damulinzabu and other herders filed their first petition to local village Communist Party members and cadres within a few months of the mill's opening, requesting a return of the land, compensation for their losses, and that measures are taken to protect the water supply and grasslands.

After three years of fruitless appeals to the government, Damulinzabu led a group of seven herders in August 2002 in filing a lawsuit against the Dianhua Paper Mill with the help of a Beijing-based law firm. Four of the herders dropped out after considerable pressure from the local government and the loss of legal rights to their land. The Intermediate People's Court of Xilingele Prefecture accepted the case and ruled in favor of the plaintiffs—the first time Mongolian herders had successfully pressed such a case.

To read more on water and desertification in Inner Mongolia along other water stories from around the world please visit: www.circleofblue.org.

COMMENTARY

Tackling Cross-border Air Quality in Southern China

By Christine Loh

It is time to clean the air that the 60 million inhabitants of the Pearl River Delta (PRD) region breathe every day. Guangdong's industrialization and urbanization—driven largely by Hong Kong capital—has had a significant impact on the environment of the whole PRD region. In view of the close economic relationship between Hong Kong and the PRD, the question is whether these two governments can collaborate to meet these challenges to insure their future competitiveness in a world in which energy-efficient, low-emissions, and low-carbon economies will be rewarded.

SMOGGY DEVELOPMENT IN THE PRD

As a hyper-growth region, Hong Kong and the PRD present enormous ecological and environmental challenges, for it is now one of the world's largest export-manufacturing bases. The region started as a center for the production of light industrial products in the 1980s, then expanded to highly polluting heavy industries, particularly automobile and petrochemical production. Over the past two decades, several cities in the PRD have recorded rapid population growth as rural migrants flocked to them to find better-paying jobs in manufacturing. The population size of the PRD area has increased dramatically from 20 million in 1982 to 45.5 million in 2005 (National Bureau of Statistics, 1995 & 2005). While the concentration of light industries in such a small area has created significant pollution, the later arrival of heavy industries is leading to even greater energy consumption and polluting emissions, including climate changing greenhouse gases. Moreover, to support the expansion of the export sector, port and logistic facilities in Guangdong and elsewhere in southern China have been greatly expanded, often with Hong Kong capital and management.

Air quality in Hong Kong and the PRD has deteriorated steadily since the early 1980s. In 1998, the Hong Kong government acknowledged the seriousness of the problem, emphasizing a duel strategy of cleaning up locally and cooperating with Guangdong to improve air quality. In October 1998, the Chief Executive Tung Chee Hwa announced that Hong Kong and Guangdong would initiate a study of the air quality in the region, with the aim of developing joint improvement measures from 2000 onward (Tung, 1998).

In 2002, the jointly sponsored *Study of Air Quality in the Pearl River Delta Region* between the Hong Kong and Guangdong authorities was published, and produced the first emissions inventory for the region (CH2MHill, 2002). The study revealed that 80 percent of air pollution emissions in the region originated in Guangdong, while 20 percent were from Hong Kong. As a result of the study's recommendations, both governments agreed to reduce on a best-effort basis by 2010 the regional emissions of SO_2, NO_x, respirable suspended particulates (RSP) and volatile organic compounds (VOCs) by 40%, 20%, 55% and 55%, respectively (using 1997 as a base year) (HKSAR Government, 2002). While Hong Kong environmental nongovernmental organizations (ENGOs) were critical because the targets were only voluntary, it was the first time that Hong Kong and Guangdong agreed on specific targets, which were announced at the highest level on both sides making them well-intentioned and important political statements.

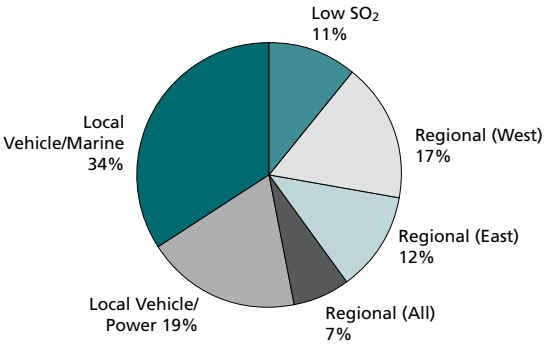
MOVING FROM STUDIES TO ACTION

In December 2003, the two sides drew up the PRD Regional Air Quality Management Plan, with the details of pollution control measures to be implemented in Hong Kong and Guangdong in order to meet the set targets (ETWB, 2004). The PRD Air Quality Management and Monitoring Special Panel formed under the Joint Working Group for Sustainable Development and Environment Protection (hereafter JWG) and is responsible for monitoring the PRD Regional Air Quality Management Plan (HKEPD, 2005a and b). It was expected that if these targets were achieved, then Guangdong's air quality would improve, and Hong Kong would be able to meet its Air Quality Objectives. It took the two governments an additional three years to implement a Joint Regional Air Quality Monitoring Network, which commenced operations in November 2005 (HKEPD, 2005). In 2005, the Hong Kong and Guangdong Energy Efficiency and Cleaner Production Special Panel was established under the JWG to promote energy efficiency and cleaner production initiatives in the PRD to improve regional air quality.

ACTIVISTS, SCIENTISTS, AND BUSINESSES STEP IN

Since the late 1990s, public concern in Hong Kong about air quality has grown substantially[1] and continues to present a problem to employers trying to attract global-knowledge workers to stay in or relocate to Hong Kong (Merrill Lynch, 2006). While Hong Kong ENGOs have complained about air quality for many years, there has been an upsurge of their activity since 2000. Today, ENGOs in partnership with local scientists not only highlight air problems, but also provide new data and policy solutions that counter or go beyond those of the Hong Kong government. The research and policy capacity of this active ENGO and scientific community focusing on air issues has grown dramatically, and the severity of the problem has attracted new private sector funding to assist them in upgrading the quality of their work.[2] The ENGO sector in Hong Kong has also increased their cross-boundary collaboration on air quality issues, notably helping to connect Hong Kong and PRD scientists. This ENGO work, coupled with government-funded studies, has markedly increased air quality management knowledge in the PRD.

FIGURE 1. Sources of Air Pollution Impacting Hong Kong in 2006 (Average Percentage of Days Each Month)



The percentages labeled Regional East, West, or All signify the source of pollution from the Pearl River Delta that was impacting Hong Kong (on average each month) in 2006. When conditions are Regional All, pollution from the PRD is the primary type of pollution over all of the HKSAR. Low pollution denotes the percentage of days (on average) each month that $S0_2$ (sulphur dioxide) concentration was below 20 ug/m^3. Local pollution is divided into emissions from vehicles and power generation and vehicles and marine sources.

The biggest contribution by the Hong Kong scientific and ENGO communities is the discovery that the emissions picture for the PRD is far more complex than what the government-led emission inventory showed. For example, in the winter months, pollution from the region affects Hong Kong more severely, but in the summer months, the dominant polluting emissions are from Hong Kong's own sources. Thus, in terms of time affected, there were 192 days in 2006 (53 percent) when the dominant emissions affecting Hong Kong were locally generated. (See Figure 1).

ENGOs researcher verified that Hong Kong needs to work harder still to lower the emissions from its own transportation, power generation and marine sectors, as well as intensifying cooperation with the Guangdong authorities to fight regionally generated pollution (Lau et al., 2007).

To date, the Hong Kong government has focused primarily on power generation and some aspects of vehicle emissions, which ENGOs in Hong Kong argue is insufficient. While the government looked at total tonnage emitted and deemed power plants as the biggest emitter by far, local ENGOs argue that in public health terms, the emissions from vehicles

and marine sources are equally important, as those emissions affect high population areas in many parts of the city (Trumbull, 2007).

TRANSPARENT AND RELIABLE DATA

The Pearl River Delta Regional Air Quality Monitoring Network has been providing data for the reporting of the Regional Air Quality Index on SO_2, NO_x, RSP, and ozone (O_3) that is posted daily on the Internet.[3] The network has monitoring stations in both the PRD and Hong Kong with the Guangdong Provincial Environmental Protection Monitoring Center and the Hong Kong Environment Protection Department (HKEPD) responsible for the coordination, management and operation of the monitoring stations of their respective side of the border. The governments believe the monitoring results will help both sides carry out scientific analysis of the air quality trends in the PRD. Moreover, the governments expect they will be able to assess the impact and effectiveness of pollution control measures after the monitoring network records more data.

The importance of the monitoring network, the Regional Air Quality Index (RAQI) and Guangdong's release of data cannot be overemphasized. It is the first of its kind in China, providing reasonably reliable scientific data not only to Guangdong and Hong Kong, but also to the national authorities so that all concerned stakeholders can gain deeper understanding into emission profiles and trends in a rapidly industrializing and urbanizing part of the nation. The learning from this cooperation could be scaled up in other regions and eventually nationwide.

> **"The biggest contribution by Hong Kong scientific and ENGO communities is the discovery that the emissions picture for the PRD is far more complex than what the government-led emission inventory showed.**

Moreover, the organization of the network and index to ensure data integrity and reliability represents an important aspect to capacity building in air quality management for Guangdong and Hong Kong. The Hong Kong partnership serves as quality assurance of the data. In the long term, the two sides must devise a new way to manage air quality together with a new joint regulatory framework backed by law.

With China's state secrecy culture, including the non-release of much environmental[4] and public health data, Guangdong's data is already enabling air quality scientists all around the country and internationally to learn more about China's pollution problems, which can only help the diffusion of ideas for solutions in the future.

CATALYZING CHANGES IN GUANGDONG AND HONG KONG

The joint Guangdong and Hong Kong targets, while voluntary, have had a positive impact on catalyzing improvements. The Guangdong provincial government has been strengthening its hardware and software to reduce air pollution, including installing flue gas desulphurization equipment in the large coal-fired power plants, using more natural gas for power generation, and striving to speed up the introduction of National III motor vehicle emission standards (on a par with Euro III standards) in PRD cities. In Hong Kong, the government has imposed emission caps on power plants and is adopting new fuels and technology to reduce polluting vehicle emissions; promoting building energy codes; reviewing new Air Quality Objectives (which have not been changed since they were established in 1987) and the long-term strategy on air quality management by 2009 (Tsang, 2007).

New areas of cross-boundary collaboration have also emerged. For example, the Ministry of Science and Technology granted Guangdong 150 million Yuan in 2007 under China's National High Technology and Development Program (a.k.a. Project 863) to carry out a five-year pilot air pollution and control technology investigation research project focusing on key PRD cities.[5] Guangdong has matched this amount with its own funds, which means there is a total of 300 million Yuan put towards this project. Significantly, Guangdong has invited Hong Kong's participation, although at the time of writing, the Hong Kong government has yet to respond.

With an active civil society in Hong Kong, a free news media, and a legislature that demands officials to account for progress on policy implementation in the open, Hong Kong has a "pull effect" on Guangdong, applying pressure to be accountable even though the agreed target reductions are on a best-effort basis. While much more can and should be done, events over the past ten years represent a series of innovations in regional air quality management that have created the foundation to build upon.

Christine Loh, one of Time Magazine's *2007 Environmental Heroes, is the Founder and CEO of the nonprofit public policy think tank, Civic Exchange, based in Hong Kong. She is a lawyer by training and a commodities trader by profession (with energy trading experience) who also has been a member of the Hong Kong Legislative Council (1992–1997 and 1998–2000). She is also adviser to the GLOBE G8+5 Climate Change Dialogue and a director of the Hong Kong Exchanges and Clearing Limited (stock exchange). She can be reached at: cloh@civic-exchange.org.*

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NOTES

1. Concerns have been shown on both sides of the border. Over 50 percent of 1,528 respondents in the PRD expressed high or comparatively high concern on the air pollution. In addition to those working in the education and government sectors showed the highest concern, 70% to 80% of the remaining respondents ranked air pollution and its impact on health a serious concern. See Civic Exchange and China Development Institute. (2002). *Attitudes on the Environment: A Survey*

on Pearl River Delta Residents, http://www.civic-exchange.org/publications/2002/PRD%20report%20-%20E%20-%20web.doc.

2. In the case of the nonprofit think tank Civic Exchange, funding in recent years has come from new donors in the financial services sector who are finding it hardest to retain and attract global talent as a result of air quality deterioration. Since 2005, a string of international reports about Hong Kong's air pollution has highlighted the impact pollution has had on personnel retention and hiring for major international financial firms.

3. For daily readings on the RAQI visit: http://serve.gdepb.gov.cn/raqi/QEng.aspx.

4. In the spring of 2007, China's State Environmental Protection Administration did pass draft regulations on environmental information dissemination, which highlights a new step towards openness on pollution data.

5. The National High Technology Research and Development Program (Project 862) was launched in 1986 with the aim to enhance China's international competitiveness and improve its overall capability in high-tech research and development. There have been many projects done as a part of this program. The program is supervised by the Ministry of Science and Technology, see http://www.863.org.cn/english/annual_report/annual_report_1999.htm. Since 2004, Hong Kong and the Mainland has set-up the Mainland-Hong Kong Science and Technology Cooperation Committee, which is co-chaired by a minister in Hong Kong and the national vice-minister of Science and Technology. During the Committee's 2nd working meeting on 20 April 2006, the Ministry of Science and Technology invited Hong Kong technology experts to participate on expert committees and panels under the program. The pilot air pollution-control technology project includes many sub-projects.

COMMENTARY

Institutionalizing Public Participation in AIDS Governance in China:

Notes from a Unique Meeting for Activists and Grassroots NGOs

By Fengshi Wu

In early December 2006, I had the unique opportunity to attend a meeting of HIV/AIDS grassroots activists in Wuhan. Attendees were primarily representatives from Chinese HIV/AIDS nongovernmental organizations (NGO) and community-based organizations (CBO). They were tasked with designing the rules for electing NGO/CBO representatives for the China Country Coordinating Mechanism (China CCM), which coordinates the funding and projects supported by the Global Fund to Fight AIDS, Tuberculosis (TB), and Malaria (the Global Fund). (See Box 1). In short, the activists came together to decide how to choose their own representatives, who would be part of the governing body overseeing million-dollar HIV/AIDS projects throughout China.

Even on the surface this meeting was unlike the typical government-dominated procedural sessions in Chinese public health politics, for it involved many nongovernmental players. More significant than the diversity of the participants was the goal of the meeting to be a trial in institutionalizing public participation in health policymaking structures. If this trial succeeds, China observers may look back at this little-publicized meeting as a symbolic event in the history of China's AIDS prevention and governance.

BACKGROUND OF AIDS PREVENTION IN CHINA

Over the past five years, the Chinese government has become much more open to international organizations and domestic grassroots groups addressing the problems emerging from AIDS-related policy implementation.

Partially due to the 2003 SARS crisis and the change of public health leadership, AIDS control and prevention in China has entered a dramatically new phase. The Chinese government has not only publicly acknowledged the dreadful situation of AIDS infection in the country, but has also strengthened the institutional capacity of AIDS governance at the central level. The central administrative arm leading AIDS prevention affairs in China has been upgraded to the State Council Committee of AIDS Control and Prevention.[1] Today this committee coordinates 29 state ministries to determine national-level policies, and all provincial governors are on board. Moreover, between 1995 and 2005, China's total national budget for AIDS prevention has increased from 500,000 to 2 billion Yuan.[2]

Meanwhile, international assistance for AIDS prevention in China has increased rapidly since 2000. With support from China-UK HIV/AIDS Prevention and Care Project, the Global Fund, the U.S. President's Emergency Plan for AIDS Relief, and many other agencies, total bilateral and multilateral funding available for China is estimated to have reached $8.1 billion in 2005.[3] International foundations, NGOs, and businesses also have provided significant amounts of financial and human resources to China, including Merck, Ford Foundation, Clinton Foundation, and most recently, the Bill and Melinda Gates Foundation. Internationally funded HIV/AIDS initiatives and projects include nationwide

surveillance and monitoring, cross-departmental policy coordination, medical and clinical research, public education, community-based care programs, treatment delivery, self-help and poverty relief.

THE GLOBAL FUND IN CHINA

The reform of the China CCM for the Global Fund to include representatives from outside the state apparatus is one concrete example of this political opening to grassroots HIV/AIDS activists. In order to obtain financial support from the Global Fund, the Chinese government established its own CCM in 2002. At that time, it was composed mostly of representatives from the central government and UN agencies located in China and focused on supporting TB-related projects. In September 2003, the Global Fund approved the application from China to support work in the area of AIDS for the first time. The following year, China CCM formed a Special Working Group, led by UNAIDS in China, to improve the efficiency of its work and the composition of its members.

As a result, CCM redefined its composition and decreased its members from 54 to 22. It also clarified duties and mechanisms of the CCM Plenary, CCM Secretariat, Principal Recipient and AIDS/TB/Malaria Working Groups. CCM passed its constitution in June 2006, and started electing new members—five are standing members (including the chair); five from the Chinese government; six from the nongovernmental sector; one from the corporate sector; four from multilateral agencies (e.g., World Bank); and one from people living with HIV/AIDS (PLWHA).

Among all the seats for the CCM, the ones allocated to the nongovernmental sector caught the most attention. If fully realized these seats, together with the one seat of PLWHA, would open the door for direct public participation in AIDS governance. However, of the six seats, the CCM constitution designates one for the China Center for Disease Control (China CDC)—a subordinate branch of the State Ministry of Health; one for an international NGO; and three for the traditional mass-based, so called "social mobilization organization" in China (e.g., All-China Women's Federation). Only one seat is reserved for grassroots voluntary- or community-based groups. Under the current political and regulatory context, such groups are often either not formally registered, or registered in a status other than nonprofit. Thus, even if the selection process of the NGO/CBO sector representative went smoothly, the degree and scope of public participation facilitated by the CCM mechanism would remain limited. However, NGO/CBO representatives from throughout China are involved in the nomination process for all six of the non-governmental seats. Thus, the CCM represents an unprecedented attempt to formally include grassroots groups in decision-making and monitoring structures in China's public health structure.

It is also worth mentioning that the Global Fund has continuously accepted AIDS-related project applications from China since 2004. Projects supported by the Global Fund have become an integral part of the overall AIDS prevention effort led by the Chinese government. All the funding is channeled through the CDC at different administrative levels and most project sites are decided in parallel with China's own state-run projects. Moreover, most staff and professionals in charge of Global Fund projects are formerly affiliated with China CDC. Therefore, it is not unreasonable to anticipate that the experience of China CCM integrating NBO/CBO representatives might provide lessons for AIDS governance in China more broadly. In other words, if bringing grassroots participation into the China CCM is successful, CDC-led HIV/AIDS projects might be more willing to open the door to NBO/CBO involvement.

THE WUHAN MEETING: MOVING TOWARDS INSTITUTIONALIZED PUBLIC PARTICIPATION

To implement the decision to include NGO/CBO and PLWHA representatives, China CCM Special Working Groups engaged with NGO/CBO leaders and called for an election in Beijing in April 2006. Some 20 NGO/CBO representatives attended and voted. The election result immediately caused strong reaction from the rest of the NGO/CBO community. Many felt the meeting was rushed and were distrustful of the elected person. Subsequently, an ad hoc working group was formed, and two independent consultants were invited to review the disputed election. In July, a final review was released that acknowledged the result of the April election and provided detailed advice for improving future elections.[4] A new election was soon put on CCM's agenda. Pre-election meetings were organized to involve as many NGOs, CBOs, and PLWHA as

possible at an early stage and to produce a set of procedures and guidelines for the new election. The meeting for NGOs and CBOs was held in Wuhan in December 2006.

A total of 106 grassroots social groups, over 20 HIV/AIDS patients, around 50 observing agencies, and a group of farmers from rural Henan attended the Wuhan meeting.[5] I attended as a member of the Aixin Foundation that was established in Maryland (U.S.) and recently moved its main operations to Beijing.[6] The meeting lasted three days and two nights, during which time I did not take one step out of the hotel where it was held. I spent all possible tea, meal, and nap breaks conversing with various participants; yet, I left the meeting regretting that it was too short to get to know all the participants well.

Grassroots Voices

My roommate was Ms. Guo, an AIDS patient and PLHA group leader from Guizhou Province. She tested HIV positive four years ago after the death of her husband, who doctors suspected had infected her. As is common in rural China, relatives did not take pity on her. On the contrary, they distanced themselves from her and took away her only son. She was deeply depressed when she encountered the staff of China-UK AIDS Prevention and Care Project in Guiyang city. Through the project activities, she learned more about the disease, and more importantly, she learned that she can live with the disease and even help others fight it. Her PLWHA group has created various programs to obtain skills to support their families. At the meeting, Ms. Guo met many other PLWHA groups, and was not shy in discussing with them the meaning of the upcoming China CCM member election.

Loving Source, a Beijing-based NGO devoted to AIDS care programs in rural Henan and AIDS policy advocacy, also participated in the meeting.[7] The organization recently completed a leadership and board member transition—a significant achievement in China where civil society organizations are often created by charismatic leaders and fall apart once that person departs.[8] Its new director, Mr. Cheng Xiangyang, is originally from rural Henan, the heart of the blood contamination scandal and HIV/AIDS spread in north-central China. By working together with activists, researchers, and medical staff from Beijing, San Francisco, and many other places around the world over the past seven years, Cheng has quickly grown into a mature professional activist. He found the Wuhan meeting a timely opportunity to introduce Loving Source's newly modified mission and working plans to peer organizations and international agencies.

During one lunch session, I sat beside the representative from the Beifang Jinde Catholic Social Service Center based in Hebei Province, and we had an animated, enlightening chat.[9] Jinde is a nonprofit Catholic group devoted to providing basic social services to rural communities in north-central China. In the area of AIDS prevention, it has successfully helped a group of HIV/AIDS patients infected by blood transfusion win reasonable compensation in a class action suit against local hospitals. They recently launched their new projects in the Shahe region of Hebei, and hope to replicate some of the effective service and legal strategies used in previous work. Even though the presence of religious groups in social welfare is expanding in China, I was still very impressed by the successful stories from Jinde. I believe their experience can encourage other religious organizations to undertake similar work.

> **"Mistrust and envy abound when… millions of dollars of international assistance suddenly become available to Chinese AIDS NGOs, turning them into competitors before they even know each other.**

There was a group of special participants at the Wuhan meeting not on the official list. They all came from one village in rural Henan, led by Professor Liu of the Henan Social Science Academy. Professor Liu has been conducting research in the village on the impact of HIV/AIDS since 2004. She gradually found her passion searching for resources to help the villagers rebuild their livelihoods and regain hope. She encouraged some of the villagers to come to Wuhan with her, believing this experience would open their eyes and expose them to the current discussion of related policies. Moreover, she

BOX 1. China Country Coordinating Mechanism for the Global Fund Projects (China CCM)

One of the major achievements under the former UN Secretary, Kofi Annan, was the establishment of the Global Fund (www.theglobalfund.org) in 2002 to enhance the global fight against AIDS, tuberculosis and malaria. To date, the Global Fund has committed $7.1 billion in 135 countries to support aggressive interventions against all the three diseases. What distinguishes the Global Fund from other UN affiliated programs is it operates as a financial instrument, not an implementing entity. It prefers applications that reflect national ownership, and emphasizes the need for simplified and rapid grant making.

The Global Fund requires each applicant country to form a coordinating mechanism (CCM) to review applications, and to monitor and guide the implementation of funds and projects approved by the Global Fund. China established its own CCM in 2002. In September 2004, the Global Fund (3rd Round) approved the first grant of $32 million (for 2 years) to China for HIV/AIDS-related projects, and has since continuously provided funds to China each round. For more information see: www.chinaglobalfund.org.

strongly believed that these farmers, direct bearers of the epidemic, need to have their voices heard, and need every opportunity to learn how to express their opinions and raise their concerns in multi-stakeholder forums. Although these villagers were not "officially" invited, I did not notice discomfort or resentment by any of the participants or meeting organizers. They sat around the same table as others, and took part in the discussions.

Bonding

In contrast to the freezing-cold rainy day outside, the meeting rooms were full of heated discussions. After every day's formal sessions, which ended at 9 pm, participants spread into smaller groups on their own and continued their conversations, exchanging information and brainstorming project ideas late into the night.

The Wuhan meeting, first and foremost, provided a long-awaited opportunity for Chinese AIDS prevention activists, grassroots NGOs, and community groups to meet in person and get to know each other. The community is not that large. According to China AIDS Work Directory (http://www.china-aids.org), in 2006 there were only 150 AIDS related quasi-NGOs, grassroots NGOs/CBOs and PLWHA groups in China (compared to the estimated 2,000 registered green groups). These numbers are growing and my research indicates there are over 120 PLWHA groups alone operating across the country in 2007. The HIV/AIDS civil society community surely needed this opportunity, for it has suffered from loss of trust caused by the April 2006 CBO/NGO sector representative election. Meanwhile, new patient mutual-help groups, youth volunteer teams, and NGOs are emerging every day, yet few know where to find peers and leaders for advice. In a sense, the Wuhan gathering was timely for old friends to reconnect, and new activists to learn that they are not fighting alone.

This meeting reminded me, and probably many of my environmentalist friends, of the annual New Year parties that the Friends of Nature (a Beijing-based green NGO) used to host for all environmental NGOs and green groups (when they were not as numerous) in the late 1990s. Many veteran environmentalists in China feel nostalgic for such large gatherings, for they created a sense of belonging for all the involved groups.

DEBATING THE ELECTION GUIDELINES

The Wuhan meeting was not merely a "family reunion." Besides exchanging name cards and chatting, the CBO/NGO representatives were divided into six groups that mixed geographical regions and activism types to design a candidate nomination and election guideline. Over four three-hour sessions, participants engaged in intensive group discussion and debates, went through the drafted election procedures word by word, and put forward many new principles for the election. Such group meetings sometimes were accompa-

nied with shouting that was eventually followed by apologies.

One of the controversies that emerged in my group was a clause concerning candidate eligibility. The question was whether a criminal record should impede one entering the China CCM election ballet. Those who were against this clause argued that leaders of groups for drug users and sex workers might be denied candidacy because they may have previously been drug users or sex workers, and therefore could have been arrested by pubic security agencies. Sometimes HIV/AIDS activists trying to help these marginalized communities are arrested for they are seen as supporting "criminal" activities. Those who supported the clause firmly believed that a CCM member should not only represent the NGO/CBO sector, but also be a good citizen. The discussion was stalemated until one participant stood up and reminded the whole group to be extremely careful with the exact articulation of the clause. The Chinese public's general opinion towards AIDS, PLWHA and the work related to AIDS prevention is still vague. The election guideline ought not to promote social discrimination by indicating that HIV/AIDS patients and activists are somehow related to criminal acts. At last, my group agreed to strike the phrase "criminal record," but to add a statement holding the election committee responsible for reviewing the background and eligibility of the candidates.

In our group, there was a quiet Kazak college student from the Xinjiang Autonomous Region. He and his college friends in Xinjiang University of Medical Science formed their group for AIDS prevention in 2006. When the discussion came down to the issue of dividing the country into several election zones based on geographic location, he finally spoke up in spite of his shyness. His argument was that because NGOs and activism were underdeveloped in minority regions compared with other parts and cities of the country, by only considering geographic-based fairness, minority groups would miss out in the early stage of the election. My peer group members were bewildered upon hearing his point, for this problem had never occurred to them before. Though their daily job is to fight for marginalized people, for example, farmers, women, children and gays, they were not sensitive to the fact that minorities are on the margin of the marginalized. Even though, our group did not come up with a smarter strategy on how to allocate the limited number of candidates to the large number of NGOs/CBOs across the country, except by dividing the vast country into six regions, we did agree to add a line into the election guidance that "special attention needs to be paid to minority representation." However, it is not merely what was put in the guidelines that mattered, but also that the activists tried to listen and acknowledge different opinions.

Beyond networking, the Wuhan meeting created a setting conducive to collective learning that facilitated mutual respect and skills in compromise and collaboration among grassroots activists. The Wuhan meeting gave diverse AIDS-related citizen groups an opportunity to listen to each other, and work together for a common goal through detailed discussions of how to organize the NGO/CBO community, generate candidates, publicize the ballot, set up voting channels, and conduct vote counting. In a sense, they became better acquainted with each other via disagreeing, debating, and eventually reaching an agreement, than had they simply met for a conference describing each of their group's work.

FOLLOW-UPS AND LESSONS TO BE LEARNED: BUILDING TRUST WITHIN A COMPLEX PUBLIC POLICY COMMUNITY

By the end of the Wuhan meeting, participants completed their tasks—drafting a set of binding laws for the election of their own representatives. Most groups found the meeting a worthwhile and meaningful experience. Elections of NGO/CBO and PLWHA were held in March 2007. On 30 March 2007, the 20th Plenary of China CCM officially acknowledged the membership of Wang Xiaoguang (and two non-voting members) representing the CBO/NGO sector and Meng Lin (and two non-voting members) representing people living with AIDS/TB/malaria.

Criticisms of the election still arose. For example, many of the issues raised and statements passed at the Wuhan meeting were not applied in the actual execution of the March election.[10] Observers were also critical about UNAIDS China's arbitrary decision of having the election during the Chinese New Year break, when the whole nation basically shuts down and even some of the election-related websites were not functioning. Many felt that grassroots participation would be more full-fledged, if more pre-election workshops had been held and the

election could have been delayed slightly.[11] Despite these disappointments, the consensus within the AIDS prevention community is that the reform of China CCM has institutionalized public participation in AIDS governance in China.

What further can be drawn from the Wuhan meeting and the NGO/CBO election is that collective learning and trust are crucial for the overall development of the AIDS prevention community. Compared with the environmental, women's rights, and other activist communities mobilized by more or less focused issues or communities, the area of AIDS prevention is distinctive in terms of internal diversity. AIDS-related grassroots groups consist of individuals and groups with extremely different social, economic, and ideological backgrounds. Because of this high level of internal diversity, it is difficult to form a sense of belonging among all AIDS-related groups. Many groups, especially those composed of only PLWHA, see themselves as victims of policy failure, and value compensation and access to treatment over other issues. An urban gay group probably has a dramatically different notion of discrimination and fairness related to AIDS prevention than a rural farmer group who are mostly infected through blood contamination. Good will is not enough for policy-oriented NGOs, often based in Beijing, to form empathy with migrant workers, drug users and sex workers. Mistrust and envy abound when, for example, millions of dollars of international assistance suddenly become available to Chinese AIDS NGOs, turning them into competitors before they even know each other.

The Wuhan meeting gave activists and NGOs a collective experience of getting to know each other, establishing mutual respect, and going through disagreements. Such an intense meeting produced fruitful results, not only paving the way for the first nation-wide election for grassroots activists in the field of AIDS prevention, but also teaching participants the way to form a common voice and to better influence the overall policymaking process in China.

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NOTES

1. In Chinese, National Committee is *Quanguo Weiyuanhui*, and State Council Committee is *Guowuyuan Weiyuanhui*. Usually, in practice, the latter is ranked higher, and endowed with more resources. The establishment of the latter is an indicator of stronger political will from the top leaders in the related issue area.

2. Bates Gill & Xiaoqing Lu. (2007). "Demography of HIV/AIDS in China." Center for Strategic International Studies.

3. UNAIDS. (2006). *Report on the Global AIDS Epidemic*.

4. See both "Review of China CCM Elections" (by Bernard Rivers and Qiu Renzong, 26 July 2006), and "Statement by Joel Rehnstrom, UNAIDS China, Chair of the ad hoc working group on the disputed CCM sector group elections" (in August 2006). [Online]. Available: http://www.chinaglobalfund.org.

5. The HIV/AIDS patients' identities were kept unknown throughout the meeting, and therefore the number 20 is estimated based on the author's observation. The farmers from Henan were from different villages. They were not all infected by HIV, but their lives are certainly affected by the diseases. They neither established their own organizations yet nor understood the purpose of the Wuhan meeting, but they still arrived at the meeting hoping to voice their opinions and learn what to do to better the situation back home from this occasion.

6. For more information, please see: http://www.aixinfund.org

7. For more information, please see: http://www.chain.net.cn/qshcy/fzfzz/bjayxxzxzx/

8. Loving Source's founding person, Hu Jia, and its first executive director, Zeng Jinyan, have both become too politically sensitive to remain affiliated with the organization.

9. For more information, please see: http://www.jinde.org.

10. Interview with Prof. Li Dun, Tsinghua University, in Beijing, August 2007. Prof. Li was invited by the election committee to run three regional pre-election workshops to prepare NGOs/CBOs to run their election campaigns and voting, in Kunming, Xi'an and Beijing. He is also the author of the executive review of the whole election commissioned by the UNAIDS China office.

11. Multiple interviews with researchers and experts in Beijing, August 2007.

FEATURE BOX

Environmental Health Perspectives: A Portal to Environmental Health Information in China

By Tanya Tillett

For more than a decade, *Environmental Health Perspectives* (*EHP*) has published news and research chronicling ongoing and emerging environmental health issues affecting China and its people.

Arsenic exposure poses a major health issue in China that *EHP* documented through a series of research articles over the last year. The July 2007 issue of EHP included a study of metallothionein as a biomarker for individual sensitivity to metal toxicity in arsenicosis patients in Guizhou Province (Liu et al., 115:1101–1106); the May 2007 issue includes an assessment of the cardiac effects of arsenic (Mumford et al., 115:690–694); and, in the April 2007 issue, a collection of five papers examines arsenic occurrence and health effects throughout China (115:636–662). In June 2006, EHP published research indicating a link between oxidative stress and arsenic exposure in the Ba Men region of western Inner Mongolia (Mo et al., 114:835–841).

EHP has also recently examined the health effects of other elements and environmental pollutants in China. In the February 2006 issue, Chen et al. examined the interaction between selenium and mercury, and noted that selenoproteins may help protect against mercury toxicity, a key issue in the industrial regions of China (114:297–301). In the August 2006 issue, Zhang et al. presented results from a study of the acute effect of ozone on mortality outcomes in Shanghai (114:1227–1232). That same issue examined the relationship between prenatal exposure to polycyclic aromatic hydrocarbons (PAHs) and reduced fetal and child growth in Tongliang (Chongqing), the location of a seasonally operated coal-fired power plant (Tang et al., 114:1297–1300). In another article relating to children's environmental health research, published in

the July 2007 issue, Huo et al. observed that unsafe electronic waste recycling methods may contribute to the elevated blood lead levels in children living in Guiyu (Guangzhou Province) (115:1113–1117).

Over the past year, EHP published research documenting various occupational health effects among Chinese workers. These include altered adduct levels among benzene-exposed workers (Lin et al., 115:28–34); reduced testosterone among phthalate-exposed flooring manufacturers (Pan et al., 114:1643–1648); hearing loss among workers exposed to toluene (a clear organic solvent widely used in various manufacturing industries) (Chang et al., 114:1283–1286); and decreased PON1 gene activity among lead-exposed battery makers and recyclers (Li et al., 114:1233–1236). A June 2007 review by Zhang and Smith (115:848–855) surveyed approximately 200 Chinese- and English-language reports documenting the health effects and exposure characteristics of indoor solid fuel use, a practice used by workers across the industrial spectrum.

"Disseminating the latest environmental health science information to the widest audience possible is one of the primary goals of EHP.

In addition, EHP reported and discussed timely news topics regarding environmental health in China over the past year. News items have addressed lung disease (115:A131), soil contaminants (115:A23), lead in medicinal herbs (114:A344), environmental policy (114:A345), and green buildings (114:A347).

Disseminating the latest environmental health science information to the widest audience possible is one of the primary goals of *EHP*, and, with a population of more than 1 billion, China accounts for a significant portion of this worldwide audience. For the past six years, the journal has published the *EHP Chinese-Language Edition* on a quarterly basis. The *EHP Chinese-Language Edition* consists of news articles and research summaries from the English version that are reprinted in Chinese both in hard copy and online at www.ehponline.org/cehp. Ken Korach, *EHP*'s interim editor-in-chief, says this effort has "allowed Chinese environmental science research to reach a broader portion of the scientific community." Hui Hu, *EHP*'s international editor, adds that the Chinese-language edition "has become a useful resource for the entire environmental health community, which includes scientists, policymakers, public health practitioners, and the general public." The Shanghai CDC has made publication of the Chinese-language edition possible for 2007, and EHP is currently seeking continued funding for this endeavor.

Tanya Tillett is an associate news editor with EHP. EHP is available online at http://www.ehponline.org.

COMMENTARY

High Tech's Toxic Legacy in China

By Jamie Choi

The modern world is full of electronic products, many of which are quickly outdated and replaced by newer, supposedly improved, models. Thus, it is not surprising that electronic waste (e-waste) has become the fastest growing component of the municipal solid waste stream. The United Nations Environment Programme (2004) estimates that between 20 and 50 million tons of e-waste are discarded annually worldwide. While developed countries generate the overwhelming majority of e-waste, it is developing countries that must bear its environmental and social burden.

China has a unique position in the e-waste dilemma, for it both manufactures and dismantles the majority of electronic products. While e-waste scrap yards can be found in many countries throughout Asia, Africa, and Latin America, it is believed China receives over 70 percent of the world's e-waste (Basel Action Network, 2002). In recent years, domestic consumption of electronic products has dramatically increased in China and since 2003, the country has generated roughly 1.1 million tons of e-waste annually (Li Yanbo, 2005). While China has begun to play the role of e-waste producer, it remains far behind the United States, which generates approximately 5 to 7 million tons of e-waste annually (Basel Action Network, 2002).

E-waste is a problem not simply due to its sheer quantity, but also its toxicity. Modern electronics contain many hazardous materials, which makes dismantling e-waste a difficult and dangerous task. The environmental and health problems arising from e-waste dismantling are enormous and are mainly borne by developing countries, particularly Chinese scrap yard workers and surrounding communities.

TRANSBOUNDARY MOVEMENT OF E-WASTE

Why do developed countries not process their own e-waste? The answer is simple: the process is both expensive and labor-intensive. Waste companies can instead earn a profit by selling e-waste to brokers in developing countries.

Recycling companies in developed countries strip e-waste of its most valuable parts before shipping it to brokers in developing countries. In China, containers packed with e-waste are smuggled predominantly into ports located in the south, where they are stored in warehouses before being shipped to scrap yards throughout the country.

The transboundary movement of e-waste is often justified in the name of "recycling," a misleading phrase, for it is impossible to safely or effectively recycle many hazardous e-waste materials. E-waste "recycling" is done primarily in small towns where environmental and workplace regulations are lax and expertise on safe dismantling is sometimes nonexistent. Improperly-handled e-waste toxins harm workers and pollute the environment.

SO HOW TOXIC ARE ELECTRONIC PRODUCTS?

Electronic devices are a complex mixture of several hundred materials and components, which often contain a variety of toxic substances such as lead, mercury, cadmium, beryllium, brominated flame retardants, and polyvinyl chloride (PVC) plastic. These toxins can have a wide range of negative health effects, including suppression of the nervous system, endocrine disruption, respiratory and developmental problems, liver damage, cancer, and

Guiyu's mountains of electronic components grow higher, highlighting the failure of the government's ban to stem the flow of e-waste into China. Photo Credit: Greenpeace China

damage to reproductive systems. Scientists found large quantities of these toxins in both the water and soil of e-waste dumpsites (Greenpeace Research Laboratories, 2005).

GUIYU: THE HAZARDS OF E-WASTE DISMANTLING

In recent years, the town of Guiyu in Guangdong Province has gained international notoriety as one of the largest e-waste dismantling centers in the world. Until the 1980s, Guiyu was a small rice-growing community. Over the past two decades, Guiyu has rapidly metamorphosed into a booming e-waste processing center. While some rice farms still exist, virtually all the available land in Guiyu is occupied by thousands of e-waste dismantling yards. It is estimated that Guiyu now has some 2,500 computer-dismantling businesses. The labor-intensive nature of e-waste dismantling has drawn hundreds of thousands of migrant workers from all across China to work in Guiyu.

In Guiyu, the word 'recycling' quickly loses its meaning. Workers burn the plastic coating from copper wires over open flames, brush carbon black toner from printer cartridges into a bucket, melt lead solders[1] over hotplates in workshops ventilated only by a small fan, and dip circuit boards into open vats of concentrated acids. Protective clothing usually only involves cotton gloves. In my visits to Guiyu, it was not uncommon to spot children, some as young as four years of age, stripping copper from cables and wires, smashing computer chips with hammers, or plucking valuable metals from shattered components.

The e-waste dismantling industry's impact on the environment is palpable. As one enters Guiyu, the smell of burning plastic fills the air—even people from nearby towns complain of the smell. The streams running through and around Guiyu are black. A water sample taken in 2002 revealed levels of lead 190 times higher than the drinking water standard set by the World Health Organization (Basel Action Network, 2002). In the mid-1990s, Guiyu residents began to notice that the water had an abnormal taste, so water began to be imported from Ninjing, a town 30 miles away. However, workers can still be seen using the black-colored water to wash vegetables, dishes, and clothes.

In a 2005 report of industrial wastes, dusts, soils, river sediments and groundwater contamination in Guiyu, Greenpeace discovered high levels of lead,

tin, copper and cadmium, as well as pollution from organic chemicals used in the electronics industry. For example, dust collected from a solder recovery shop contained levels of lead hundreds of times higher than those typical of indoor dust. Persistent organic pollutants (POPs) were also commonplace, including the highly toxic and bioaccumulative polychronated biphenyls (PCBs) and polybrominated diphenylethers (PBDEs) (Greenpeace Research Laboratories, 2005).

Impacts on people's health are as conspicuous as environmental degradation in the area. In 2005, the Medical School of Shantou University conducted blood tests and health checkups of Guiyu's e-waste workers and children. The results were shocking—of the 165 children between ages 1 and 6 who were examined, 81.6 percent showed symptoms of lead poisoning. Moreover, 88 percent of the workers suffered from skin diseases or had developed neurological, respiratory or digestive ailments (Peng Lin, et al., 2005).

In private interviews with Greenpeace China, many dismantlers complained of respiratory difficulties, stomachaches, headaches, and skin problems. When asked whether they knew if dismantling e-waste was bad for their health, one laborer responded: "Of course we know. But what can we do? We have to make a living."

These workers earn between $1.5 and $4 a day—meager salaries by Western standards, but much more than many can earn from farming. Ultimately, e-waste trade forces Guiyu's workers to choose between their health and making a living

REGULATIONS TO STEM E-WASTE TRADE

Governments around the world have slowly begun to rise to the challenge of the harmful impact of e-waste. In an effort to curb the unjust trade of hazardous wastes, the Basel Ban Amendment to the Basel Convention, which prohibits the export of hazardous waste from OECD to non-OECD countries, was ratified in 1994, but has not yet entered into force. Most developed countries as well as some developing countries, including China, have ratified the ban. The United States remains the only major e-waste exporter that has not ratified the Basel Convention (or the Basel Ban Amendment), thereby making it legal for U.S. recyclers to continue exporting hazardous e-waste to the developing world. It is estimated that somewhere between

> **"Of the 165 children between 1 and 6 who were examined [in Guiyu], 81.6 percent showed symptoms of lead poisoning.**

50 to 80 percent of the e-waste collected in the United States is exported for disposal (Basel Action Network, 2002).

The Basel Ban is not the only recent regulation addressing the issue of e-waste exports. In 2006, the European Union adopted another law, the Restriction on Hazardous Substances Directive (RoHS), which prohibits the use of six hazardous substances—including mercury, lead, cadmium, hexavalent chromium, and the toxic flame retardants PBB and PBDE—in all electronics sold in the EU. The EU, Korea, Japan, Taiwan, and several states in the United States have also introduced take-back legislation making electronic manufacturers responsible for the ultimate disposal of their products.

Countries at the receiving end of e-waste exports, such as China, also have enacted their own sets of legislation to tackle this problem. In 2000, the Chinese government banned the import of e-waste. In 2003, the State Environment Protection Administration issued a notice banning outdoor burning of e-waste components and the practice of acid bathing PCB boards. Finally, in March 2007, the Ministry of Information Industry put into effect its own China RoHS directive, similar in content to the EU RoHS. To date, the creation of safe e-waste treatment facilities has been limited:

- Beijing municipal government established China's first registered e-waste facility, the Beijing Jin Huan Industry Waste Treatment Service Station, in 1996.

- Beijing's Haidian District, home to many of China's top technology companies and universities, initiated the Electronic Environmental Protection and Recycling Economy project and licensed the first activities in four test sites in April 2006. The four sites are located at Zhongguancun Repair City, BUAA Business Incubator, Yuga International Resources Cyclic Utilization Company, and Red Tree Company.

Each site manages different tasks in the processing and recycling of goods. Zhongguancun Repair City is the site for electronic waste drop-offs. BUAA is responsible for dismantling and processing the waste, particularly electrical panels. Yuga is in charge of processing the plastic packaging and Red Tree handles other waste like used batteries.

- Jiangsu Province's first e-waste dismantling facility, built by Singapore's Citiraya Industries, opened in Wuxi at the end of 2004.

- Tianjin has one e-waste facility, built in 2005 by Taiding (Tianjin) Sci-tech Environment Protection Company.

- Shanghai opened its first e-waste facility in April 2007. The facility is called the Xin Jin Hua Old and Waste Electronic and Electrical Appliance Recall Center and it covers Changning District only. Sometime in 2008 the Shanghai Municipal Development and Reform Commission may form an e-waste recall network covering all the nine key districts of Shanghai, which will include a hotline for the citizens to book a collection service to come to their homes to pick up used goods.

While the government has taken these important first steps, in practice little has changed. Firstly, RoHS regulations cover only a fraction of the hazardous chemicals in use. Moreover, the regulations prohibiting the import of e-waste are easily circumvented through payments to corrupt border officials or simply smuggling into the country. The regulations to make e-waste dismantling safer are oftentimes ignored, and the e-waste dismantling industry throughout the developing world continues to be largely unregulated. Without strong and consistent regulatory pressure, progress throughout the sector will remain slow.

PROMOTING BROADER STAKEHOLDERS IN THE SOLUTION

It is clear that government regulations are not sufficient to fully halt the import of illegal waste so long as it remains a highly profitable business. Thus the need to find safer ways to disassemble, recycle and store old electronic products has become all the more critical. Organizations such as Greenpeace,

A migrant worker strips wires from e-waste in Guiyu, Guangdong Province. Photo Credit: Greenpeace China

the Basel Action Network and Silicon Valley Toxics Coalition have been working aggressively to address the problem "upstream" by demanding that manufacturers of electronic products reduce the amount of hazardous substances that go into their products and take active responsibility for recycling their products once they have reached the end of their useful lives.

It is crucial that manufacturers stop using toxic substances in their products so as to limit toxic exposure for workers and the environment during the dismantling process. Resting the financial burden of taking back end-of-life products on the manufacturers will give them the incentive necessary to design electronic products that are safer and easier to recycle.

Since 2004, Greenpeace has used direct negotiations with companies, non-violent direct actions, research, and other campaign tactics to reach its aim of cleaning up the electronics industry. In China, Greenpeace also launched a consumer campaign directed at creating a demand for greener electronic products and business "take back" within the country. For instance, in 2006, the organization released a purchasing guide designed to help individual consumers seeking to buy greener electronic products. It also helped SACOM, a student-based organization in Hong Kong, to successfully lobby the Chinese University of Hong Kong to adopt a procurement policy where it only purchases from computer companies that offer a free take-back policy.

Greenpeace's efforts combined with public pressure have encouraged companies such as Acer, Dell, Lenovo, LG, Nokia, Samsung, and Sony Ericsson to commit to phase-out a series of toxic substances (e.g., brominated flame retardants and poly-vinyl-

chloride) in their products. Moreover, in 2006, Dell and Lenovo became the first companies to offer a free take-back policy to all their consumers in China—a service that is usually reserved for consumers in developed countries. While these changes cannot eradicate the many problems associated with e-waste, they can at least lead to safer dismantling and recycling in scrap yards such as Guiyu.

FINAL THOUGHTS

The story of Guiyu provides a compelling case for an electronics revolution that promotes the abatement of toxic material use and producer responsibility for product disposal. Such changes must also be combined with strong regulatory pressure that encourages innovation in the industry sector and holds accountable those who violate e-waste trade regulations. Until such changes are made, workers in scrap yards such as in Guiyu will continue to face the risks of e-waste dismantling.

Jamie Choi has been working as a toxics campaigner for Greenpeace China since November 2005. In her capacity, she engages in company talks, carries out public awareness-building campaigns, and contributes to the development and implementation of campaign strategy. She is based in Beijing and can be reached at: Jamie.Choi@cn.greenpeace.org.

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NOTES

1. A solder is a fusible metal alloy that is melted to join metallic surfaces.

Promoting Pesticide Eco-Alternatives

By Sun Jing

China's large-scale pesticide production and consumption brings with it an inevitable amount of pesticide abuse and misuse. Although the causes of these problems are complicated, many can be attributed to lack of knowledge about the health and environmental risks of pesticides. Raising awareness about these risks is therefore a challenging, but critical step to promote the safe use of pesticides.

Founded in 2002, Pesticide Eco-Alternatives Center (PEAC) based in Kunming (Yunnan Province), is China's first—and still only—environmental NGO focusing exclusively on pesticide problems. The mission of PEAC is to protect human and ecological health threats from farm chemicals by lowering the use of harmful pesticides and promoting alternative forms of pest control. PEAC carries out research and outreach projects that use consumer and farmer participatory approaches. PEAC projects follow a five-pronged strategy:

1) Advancing Pesticide Alternatives and Organic Agriculture

- Promoting classic bio-control practices, such as controlling the green peach aphid in Yuxi, a tobacco growing area in the central part of Yunnan Province, by deploying some of its natural predators.
- Extending or reintroducing indigenous knowledge to control vegetable crop pests through organic farming, such as the traditional practices of intercropping and crop rotation. PEAC has helped to implement some of these alternatives in Yuxi and in Haobaoqing Organic Plantation of Tuanjie town in Yunnan Province.

2) Training and Empowerment of Farmers

PEAC pesticide reduction projects prioritize the active involvement of farming communities. Over the past few years, PEAC has worked with several communities to promote local awareness of pesticide risks. For example, in Chengguan village in Eryuan county (within Dali municipality in Yunnan Province), PEAC has carried out numerous participation-based trainings that have produced some positive changes in pesticide use:

- Whereas farmers in Chengguan village previously used bare hands to mix pesticides, they now wear rubber gloves.
- The percentage of the local people who are using highly toxic pesticides such as methamidophos has been reduced 80 percent. As of 1 January 2007, the Chinese government banned the use of methamidophos in addition to the use of four other highly toxic pesticides—parathion, methyl parathion, monocrotophos and dimecron.
- Groups of village women now regularly and safely clean pesticide containers and packaging materials that were once abandoned to contaminate farmland soil.

Today, farmers in Chenguan village are anxious to reform their farming practices. In order to encourage farmer-led training programs, in October 2006, PEAC helped farming leaders and local officials set up a Community Farmer Training School (CFTS). The school aims to promote sustainable farming, protect human health (especially of women, who do most of the farming) and the environment, and to empower farmers with new working skills and knowledge of relevant laws.

In April 2007, CFTS held a seminar in Chengguan village to discuss the importance of protecting traditional species of rice with local farmers. This seminar also introduced basic knowledge about the potential risks of genetically modified organisms. This was an ambitious initiative for the school, but the seminar effectively organized the participation of numerous journalists, local officials, farmers, agricultural technicians and foreign experts.

Because rural women are primarily responsible for farming and handling pesticides, nearly all PEAC projects include outreach to women as a key component. Photo Credit: PEAC

3) Promoting Consumer Awareness of Pesticide Dangers

To a certain degree, the wide use and abuse of agrochemicals is linked to the demands of the market because consumers prefer large, blemish-free fruits and vegetables. Thus, consumers play an important role in pesticide reduction work. Since 2002, PEAC has held several consumer awareness-raising training programs, which are a mainstay of its activities in Kunming. In order to extend PEAC's training on pesticides, a new website (www.panchina.org) was created in March 2007.

4) Protecting Women's Health

Rural women are particularly vulnerable to the harmful affects of agrochemicals like pesticides, for as men have moved to cities to seek work, the burden of farming increasingly falls to women. Thus, in nearly all PEAC projects, outreach to women is a key component.

5) Developing Appropriate Policy Responses and Advocating Policy Reform

Promoting understanding and good communication between organizations are two key skills for successful policy advocacy. PEAC therefore has become a platform for multi-stakeholder forums that bring government, NGO, researcher, and farmer communities together to discuss pesticide and environment-related issues. Such dialogues are important for expanding thinking on pesticides and pushing policy reform. In June 2006, PEAC held a seminar in Kunming on genetically engineered crops, which included the participation of officials from local and central governments, NGO delegates, stockholders from organic food plantations, scholars and students from local universities, as well as agro-technicians from Xinjiang. Participants sat together with experts from the United States, Malaysia and India to discuss the risks and legislative status of regulating genetically modified organisms.

For more information on PEAC please see: http://www.panchina.org. Sun Jing is deputy director at PEAC and she can be reached at: peac.sj@gmail.com.

COMMENTARY

Complex Tradeoffs: Urban Transport, Land Use, Air Quality, and Health in Chengdu

By Chris P. Nielsen

No resident or visitor encountering China's major cities today fails to experience first-hand the dramatic impacts on urban life and the environment of the recent explosion of Chinese vehicle ownership. These effects can be positive: for many, the convenience of expanded mobility, or for some, the private traveling comfort of a plush seat and air conditioning. Other effects are negative: the clock-watching frustration of traffic gridlock, streets less amenable to pedestrians and bicyclists, or the irritated lungs from inhaled fine particles.

Development of cities and the demand for urban mobility on the scale and pace that China is experiencing pose no mean management challenge to municipal authorities. There are many tradeoffs to judge, some far more complex than they first appear. For example, expanding a road system does not always alleviate congestion, because it also encourages demand. Moreover, planning a city around use of private vehicles marginalizes the needs of the many who cannot afford them; controlling millions of individual emission sources requires policy strategies quite apart from those that target stationary smokestacks; and transport-driven photochemical smog is chemically more complex than primary air pollutants against which China has made progress. Scholarly research on these and related topics, leveraging diverse expertise through collaboration, can build knowledge and capacities to inform urban planning for the future.

THE RESEARCH INITIATIVE

The China Project, an interdisciplinary research program of Harvard University, collaborates with Chinese universities and research institutes to build fundamental scholarship and research capacities relating to atmospheric environment. An ongoing initiative of the China Project, coordinated with Tsinghua University, focuses on the city of Chengdu to explore confluences of urban transportation, land use planning, vehicle emissions, and effects of mobile-source air pollution on human health and the economy.

The Chengdu initiative seeks not to answer policy questions posed by government, rather to explore innovations in independent, basic research—ideally applicable to cities in general—that in turn may strengthen capacities to inform policy deliberation. A number of separate but linked subsidiary studies are underway covering original data collection, development and application of models, and analyses. Individual studies have timelines, but the initiative as a whole is open-ended and is evolving as research interests of participants dictate. Findings are submitted to peer-reviewed academic journals, with a collection in an edited volume planned. Results are also presented in seminars, workshops, and conferences. (*Editor's Note: Notices of past and future seminars at Harvard on Chengdu work are listed at chinaproject.harvard.edu*).

The Chengdu initiative was motivated in part by research on the transport sector in the China Project's recently published national assessment: *Clearing the Air: The Health and Economic Damages of Air Pollution in China* (Ho & Nielsen, 2007). This study identified mobile-source air pollutants, and associated population health risks, as an essential area for new research. The Chengdu initiative builds on the book's exposure assessment methods. It also adopts its modular structure, in which teams of scholars pursue independent research interests, but under an umbrella of cross-disciplinary review that fosters confluence and sparks new research ideas.

Organized chaos: Segregation of transport modes at a Chengdu intersection. Photo Credit: Chris Nielsen

All researchers tackling topics on China's environment swiftly run up against a hard constraint: limits in the quantity, accuracy, and availability of primary data. Official data are sometimes accessible, but rarely with detail on how they were collected and thus how research might control for their inherent biases. This is not a criticism, as official data are gathered to meet the needs of management objectives, not scholarly ones; however, their utility to basic research depends on such information. The Chengdu initiative has therefore invested heavily in fieldwork, led by Chinese participants, to collect original data.

BUILDING RESEARCH TOOLS: DATA COLLECTION AND ANALYTICAL METHODS

Household Survey

Chief among data collection efforts was a comprehensive survey of 1,001 households in the summer and fall of 2005, administered by the Research Center for Contemporary China of Peking University led by Shen Mingming. Conducted in two waves of interviews, the survey was designed to serve the needs of the program's researchers across many fields. It included sections on travel behavior, mode choice, daily trip diaries, land use and proximity to amenities, socioeconomic conditions, popular perceptions of transport, environment, the value of health, and more.

For a survey to represent a target population, its sample must be unbiased. Almost all probability-sampled household surveys in China draw from official lists such as the oft-violated household registration (*hukou*) system. A central distinction of the Chengdu survey was a painstaking sampling approach to include the large population of migrants who remain off urban *hukou* rolls. China's 2000 census estimated this pool of migrants nationally at 144 million, including a large "floating population" that moves between urban and rural areas following economic opportunities. Migrants are typically poorer, less educated, and more dependent on non-motorized and public forms of transportation. Omitting them from surveys systematically biases findings against their interests, perpetuating a view that migrants do not "officially" exist, or at least do not merit equal consideration, for the purposes of urban, transport, and environmental planning. Aside from obvious implications for social inequity, this may lead to policies mismatched to actual pressures on the ground.

A sampling protocol designed to address undercounting of urban migrants in China—and applicable to any context with problematic population counts—is described in Landry & Shen (2005), and was employed in the Chengdu household survey. In this spatially based sampling method, a jurisdiction is precisely gridded and surveyed by teams using satellite-based Global Positioning System (GPS) receivers. As long as *all* households and residents in spatial sampling units are identified and enumerated, the likelihood of selection can be deduced. The result is a truer equal-probability sample. (Space does not allow making the statistical case for this protocol, for more information see Landry & Shen, 2005).

Travel Demand

Urban governments like Chengdu's need integrated planning that considers land use, transportation, and environment in concert, but generally lack the detailed and costly land use and travel behavior data required to forecast travel demand. A technical team led by Joan L. Walker of the Center for Transportation Studies at Boston University (BU), Sumeeta Srinivasan of Harvard, and Li Jieping of BU and Harvard is seeking to improve travel demand modeling under such constraints. The team has used commuting data from the Chengdu survey to test the development of mode-choice travel demand models where level-of-service data—i.e., times and costs—are poor (Walker et al., 2007).[1] The results spotlight that models failing to control for measurement error will underestimate travelers'

values of time, which in turn will lead to incorrect travel demand forecasts.

Vehicle Activities and Emissions

To estimate emissions from the transport system for modeling air quality and human exposure, a field study of vehicle activities is led by He Kebin of Tsinghua. It combines existing datasets for Chengdu with new data collected according to the International Vehicle Emission Model (IVE) that his team previously applied in Tianjin and Beijing (Liu et al., 2005). IVE is a protocol of intensive field efforts that include estimating the on-road vehicle distribution by: (1) counting vehicles videotaped at carefully sampled streets, (2) surveying vehicle and emission technologies in sampled parking areas, and (3) characterizing driving cycles and start patterns using GPS receivers and voltage sensors mounted onboard sampled vehicles.

> **"Planning a city around private vehicles marginalizes the needs of the many who cannot afford them.**

Air Quality and Human Exposures

If one wants to understand total population risk from mobile-source air pollution, a central question is how health effects of concentrated exposures to primary pollutants on and near streets compare to those of less concentrated primary and secondary pollutants dispersed over a region. This is a function of many determinants, including emissions, air transport and chemistry, population distribution, and time-activities, notably where and when people are outdoors versus indoors.

Wang Shuxiao of Tsinghua has been modeling the fate of vehicle emissions in Chengdu, including air dispersion and human exposures, building on the "intake fraction" method applied to transport sources in *Clearing the Air* (Wang et al., 2007).[2] Wang led field efforts to observe traffic and measure nitrogen oxides and particulates at three road segments in Chengdu, and to test them against street canyon simulations. She also has used a preliminary emission inventory and simple dispersion model to simulate urban-scale concentrations. With time-activities derived in part from the household survey's trip diaries, Wang is calculating intake fractions of mobile-source pollutants in Chengdu, a key input to analyses of the health benefits of transportation options.

Health Valuation

Estimates of the Willingness-to-Pay (WTP) to reduce health risk—on which there are very few published, peer-reviewed studies for China—are essential inputs to analyses of the costs and benefits of pollution control, a form of policy analysis preferred by many decision-makers. The Chengdu household survey was initially designed for a "contingent valuation" study of the economic values of air-pollution-related health risks by a team including James K. Hammitt of the Harvard School of Public Health and Guo Xiaoqi of the China Project and Ohio State University (Guo, 2006; Guo et al., 2007). In contingent valuation, a survey asks respondents to directly value a good or service in a hypothetical market. The health risks evaluated here were cases of asthma and premature mortality. This study also explores respondents' motivations by testing whether WTP depends on how the health risk is reduced: through the private market (paying directly for a treatment) or through a public health policy, paid by a tax.

APPLYING RESEARCH TOOLS: ISSUES, OPTIONS, AND COMPARISONS

Costs and Benefits of Transit Options

Most of the outputs of research described above—especially emission estimates, intake fractions, and health valuations—can be brought together as inputs to evaluation of costs and benefits of possible interventions in Chengdu's transportation system. The goal of the Chengdu initiative remains research innovation more than direct policy applications. In the next phase of cost-benefit analysis, all the researchers discussed above, along with Peter Rogers from Harvard and the author, have begun to assess potential new policies and programs that influence travel behavior in ways that lessen harmful air pollution. Analyzing such policies to see if they are applicable to China is complex and demands more collaboration across research fields.

For example, the research team is starting with cost-benefit analyses of two comparatively simple

transit system interventions. The first focuses on bus technology retrofits such as diesel particle filters, following similar analyses applying intake fractions in Mexico City (Stevens et al., 2005) and Boston (Greco, 2006). The main benefit is reduction of health risk by reducing vehicle emissions, also translated to economic values. This is relatively easy to estimate, because the intervention engenders no change in travel behavior. A second cost-benefit analysis explores Bus Rapid Transit (BRT) on specific routes in Chengdu. BRT will displace traditional transit buses, if not other modes, and may influence travel demand of commuters and vehicle activities on target roads. These changes may bring benefits from saved travel time and cost, along with reduced emissions and health risks.

Transportation, Land Use, Income, and Gender

Sumeeta Srinivasan of Harvard is investigating the relationships of land use to travel behavior, including differentiation by income and gender, through measures of accessibility (Srinivasan, 2007a,b). Accessibility is a central but elusive quality capturing the ability of an individual to conduct activities in a given environment. It recognizes that the final objective of planning a land use-transportation system is not *transportation* or even *mobility* per se—with supply-side bias—but *accessibility* of amenities needed for daily life. Planners must consider, moreover, that place-based accessibility varies widely for different segments of the population. For example, the Chengdu survey confirms that women and low- and middle-income households are more dependent on public transit and walking. This emphasizes that public transit routes and pedestrian facilities can and should be planned accordingly, to target the needs of those who depend on them most in their daily lives.

International Comparisons

Srinivasan (2007b) explores the roles of income and gender in part through comparison of Chengdu and Chennai, India. She and P. Christopher Zegras of M.I.T. also have used the household survey to contrast mobility and accessibility across income groups in Chengdu and Santiago, Chile, two cities with roughly equivalent purchasing-power-adjusted GDP per capita (Zegras & Srinivasan, 2007). Among other lines of inquiry, they spotlight how cultures, histories, and economic systems are powerful determinants of travel behavior and accessibility. Notably, for all the attention to China's swift motorization, this study illustrates how comparatively dependent Chengdu citizens remain on walking and bicycling, and how little mode share is served by cars, taxis, and even buses. Along with the many comparisons, the authors explore how accessibility might be measured in the two cities.

VALUE OF THE STUDY BEYOND CHENGDU

City leaders in China, as around the world, are realizing the inescapable interdependency of urban transport, land use, and air quality. The challenge of integrated urban planning is in part political, with entrenched, even rival, bureaucracies organized as if these are separable concerns. No one should overlook, however, that the challenge is, perhaps more fundamentally, a complex intellectual one. The tradeoffs among urban transport, land use, and air quality, not to mention other public needs, are not easily understood or even described, let alone resolved. Wholesale solutions are very unlikely. For any city, progress will be piecemeal, but accelerated if informed by objective data, analytical capacities, and a body of relevant knowledge developed over time. Independent, collaborative scholarship can play a valuable role, leveraging perspectives across disciplines, and past experience across national boundaries, in ways more politicized, government-based processes cannot.

The Chengdu program grew from seed funding of the V. Kann Rasmussen Foundation. Much current research is supported by the Volvo Research and Educational Foundations. Elements of the household survey were funded by the Harvard Real Estate Academic Initiative and the Harvard Asia Center, the latter also supporting a research and policy workshop held in Chengdu with local scholars and municipal leaders. The many research participants in the United States and China thank all funders for their generous and flexible support.

Chris P. Nielsen is executive director of the Harvard China Project. He is co-editor and a lead author of Clearing the Air: The Health and Economic Damages of Air Pollution in China *(2007, MIT Press). He developed and now manages the Chengdu research initiative in coordination with He Kebin of Tsinghua University. He can be reached at: nielsen2@fas.harvard.edu.*

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NOTES

1. For the technically interested, the team's approach is to treat level of service as a latent, unobserved variable, and use measurement equations to represent it in a hybrid choice model.

2. Intake fraction is a research tool for approximating the proportion of total emissions from a given source that ultimately reaches human lungs.

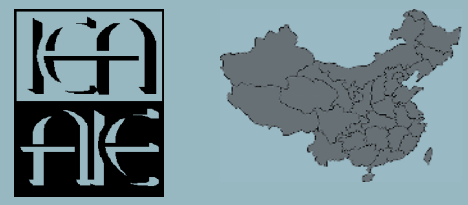
FEATURE BOX

Highlights of International Energy Agency-China Activities

By Jonathan Sinton

The oil crisis of 1973-74 shocked the nations of the industrial world into taking action to ensure that they would never again be so vulnerable to a major disruption in oil supplies. The result was the creation in 1974 of the International Energy Agency (IEA), a cooperative group of industrialized member countries (now numbering 26), committed to responding swiftly and effectively to future oil emergencies and to reducing their dependence on oil. To attain these objectives, member countries agreed to establish emergency oil stocks, reduce consumption, and—if necessary—share supplies. They also committed to increase the efficiency of their use of energy, conserve this valuable resource, and diversify their energy supplies through development of alternatives to oil.

Energy markets have changed significantly since 1974 and with them, the scope of IEA work, which now focuses on broader energy issues beyond oil crisis management, including climate change policies, market reform, and energy technology collaboration. As energy demand and supply become increasingly driven by non-OECD countries, close collaboration with key consuming countries like China and India becomes a priority. The IEA has been studying energy-related developments and drawing policy lessons from over 30 years of global experience. One of the IEA's key departments, the Office of Global Energy Dialogue, was established in 1993 to better understand the energy situation of key transition and emerging economies outside IEA membership, and to develop policy dialogue and collaborative programs with them. The IEA is strengthening ties with these countries, and this outreach forms an important part of the IEA focus on promoting global energy security, environmental protection, and economic development.



IEA-CHINA ACTIVITIES

Since the early 1990s, China and the IEA have had frequent high-level meetings, regular exchanges of visitors and statistical information, joint workshops and training sessions, and collaboration on in-depth analysis projects. In every major IEA study, special attention is paid to China; the IEA's yearly *World Energy Outlook* has had a chapter on China since 1996, and the 2007 issue focused on China and India. Moreover, the IEA seeks to deepen China's participation in the work of the IEA by extending invitations to Chinese officials to observe selected IEA governing board and committee meetings. Following are some highlights:

Formal Agreements

- In October 1996, the IEA and the National Development and Reform Commission (NDRC) signed a *Memorandum of Policy Understanding in the Field of Energy*.
- In August 2001, the IEA and the Ministry of Science and Technology signed a *Framework for Energy Technology Co-operation*.

Energy Statistics

- Since receiving statisticians from China's National Bureau of Statistics (NBS) in 1996 and

"As energy demand and supply become increasingly driven by non-OECD countries, close collaboration with key consuming countries like China and India becomes a priority.

2000 for training, IEA now has a regular channel of communication and exchange with NBS.
- China has joined as a participant in the multinational Joint Oil Data Initiative (www.jodidata.org).
- The IEA trained Chinese oil statisticians in Paris in October 2006 to assist in establishing China's emergency oil data system and to improve oil statistics.
- The IEA is currently providing training on best-practice energy statistical methods to national, provincial, and municipal energy statisticians in 2007, with support from the United Kingdom.

Coal

- China's largest coal producer, Shenhua, joined the IEA's Coal Industry Advisory Board (CIAB) in 2007. CIAB is composed of CEOs from 40 of the world's largest coal companies, and provides the industry's perspective on key issues to the IEA and its member countries (www.iea.org/ciab).
- In cooperation with NDRC, the IEA, supported by the UK, has commenced projects to analyze China's strategy for cleaner coal and the place of international cooperation in it, and options for refurbishing or closing older coal-fired power plants.
- The IEA and CIAB will hold a conference on clean coal technology and policy in Beijing in May 2008.

Oil Markets and Emergency Preparedness

- Chinese experts participated in 2004's Emergency Response Exercise (ERE) 3 in Paris, and have been invited to join ERE 4 in 2007-2008.
- In February 2006, colleagues in China completed translation into Chinese of IEA's publication *Oil Supply Security*, as well as supplied information for the 2007 update of the publication.
- A joint workshop on oil security in was held with NDRC in Beijing in October 2006.

Natural Gas

- In 1999, IEA and Chinese partners began researching natural gas issues in China, which led to the December 2002 publication of *Developing China's Natural Gas Markets.*
- IEA technical assistance and outreach projects are underway on both landfill methane and coalmine methane.

Electricity

- The IEA worked with experts in China to prepare *China's Power Sector Reforms: Where to Next,* a study released July 2006.
- China's power company State Grid has asked IEA for technical assistance in planning for regulatory evolution in the power sector.

Renewables

- Chinese delegates have attended meetings of the IEA Renewable Energy Working Party.
- A detailed assessment of China's renewable energy markets and policies will be a major input to the global assessment of renewables that the IEA is currently preparing.

Energy Efficiency

- In 2006 and 2007, Chinese delegates have participated in workshops at the IEA on energy indicators and industrial energy efficiency, as part of the IEA's support for China's ambitious plans to improve energy efficiency, and to carry out the G8 Gleneagles Plan of Action.[1]
- The IEA co-organized with the World Business Council for Sustainable Development a major conference on building energy efficiency in Beijing in March 2007.
- IEA-China cooperation on transport energy efficiency now includes fuel economy standards for heavy-duty vehicles and efficient tires.

Energy Technologies

- China is a contracting party in three energy-technology R&D cooperation programs—hydropower, fusion materials, and multiphase flow. China is also a sponsor in the IEA Clean Coal Centre.
- Under the G8 Gleneagles Plan of Action, IEA carried out an energy technologies workshop in November 2007 in Beijing.
- With support from the UK and in collaboration with the World Bank on G8 activities, the IEA is supporting work on energy technology indicators and scenarios in China.

Climate Change

- In accordance with the G8 Gleneagles Plan of Action, the IEA and China are discussing new collaborative activities to track greenhouse gas emissions and develop strategies to cope with the challenge of climate change.
- The 2008 edition of the *World Energy Outlook* will focus on climate change, including analysis of the potential role of China and other developing countries in ameliorating energy-related greenhouse gas emissions.

Publications mentioned above are available at www.iea.org. For other questions please contact Jonathan E. Sinton, at +33 (0)1 40 57 65 05 or Jonathan.Sinton@iea.org.

NOTES

1. Under the G8 Gleneagles Plan of Action, the IEA is working with partners around the globe to focus on climate change, clean energy and sustainable development. The IEA's G8 Gleneagles Programme is promoting energy-sector innovation, better practice and use of enhanced technology.

COMMENTARY

A Case Study in Indoor Air Pollution and Lung Cancer in Xuan Wei, China

By H. Dean Hosgood, III

Globally, lung cancer is estimated to account for 1.4 million cancer cases and 1.2 million cancer deaths per year.[1] While smoking is the primary risk factor of lung cancer, domestic fuel combustion from cooking and heating is also associated with the disease.[2] About half of the world's population, approximately 3 billion people, almost all living in developing countries such as China, are exposed daily to high levels of domestic fuel combustion.[3]

XUAN WEI COUNTY: HIGHEST LUNG CANCER RATES IN CHINA

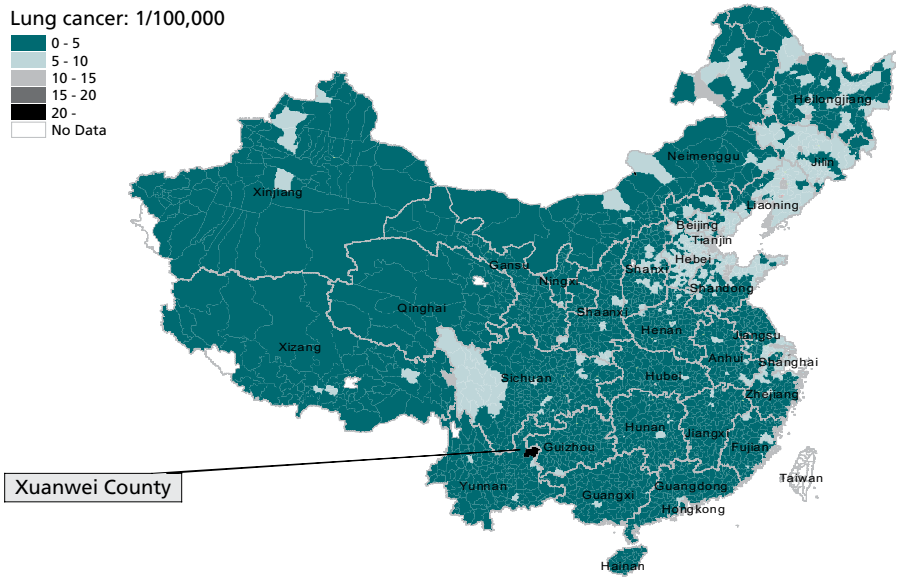
Xuan Wei is a coal-rich semi-mountainous county in eastern Yunnan Province. The population of Xuan Wei has especially high in-home coal smoke exposure due to the widespread use of smoky (bituminous) coal for heating and cooking. Xuan Wei has the highest prevalence of lung cancer in China and greater than 90 percent of these cases are due to coal smoke exposure.[4] (See Figure 1). In Xuan Wei, nearly all women and few men cook, while most men and nearly no women smoke tobacco.[5] These characteristics make the location ideal to study the impacts of coal smoke in women because it eliminates the overlapping influence of tobacco smoking that confuses analyses in other populations. Further, 90 percent of Xuan Wei's residents are farmers and have minimal industrial and automotive air pollution exposure.[6]

Early studies in Xuan Wei provided evidence suggesting that risk of lung cancer attributed to coal exposure might be driven by exposures to polycyclic aromatic hydrocarbons (PAHs). Exposure assessments of the indoor air pollution generated from the burning of smoky coal in fire pits found elevated levels of airborne benzo(a)pyrene, a strong indicator of the presence of PAHs.[6,7] Further studies on biological samples supported this hypothesis. For example, mutations in the p53 gene in tumor samples from nonsmoking women in Xuan Wei were consistent with those of PAHs and different from those of lung cancer tumors from smokers.[8] Also, exposure to smoky coal has been associated with increased levels of PAHs bound directly to human DNA, or PAH–DNA adducts, in placentas and cord white blood cells in this population.[9]

IMPACT OF STOVE IMPROVEMENTS IN XUAN WEI

Beyond exploring the carcinogenic agents in the smoke, Xuan Wei has offered an exceptional opportunity to study the impact stove improvements have on human health. The Xuan Wei Cohort Study, which was initiated by the U.S. Environmental Protection Agency and the Chinese Academy of Preventative Medicine in 1992, is comprised of 42,422 consenting farmers who were born between 1917 and 1951. The study area consisted of Xuan Wei's three central communes, covering 175 square miles, selected because these communes have had the highest lung cancer mortality rates in Xuan Wei. Subjects were retrospectively followed from 1976 to 1992. To date, this is the only study in the world to have evaluated the long-term health benefits of combustion exposure reduction in subjects who underwent stove improvement. The stove improvements were part of the China National Improved Stove Program, which installed 129 million new stoves in rural homes between 1982 and 1992. Study subjects underwent stove improvements from fire pits to stoves with chimneys, stoves without chimneys,

FIGURE 1. County Specific Female Lung Cancer Mortality Rates (per 100,000) in China, 1973 – 1975



Source: Mumford JL, He XZ, Chapman RS, Cao SR, Harris DB, Li XM et al. (1987).

or portable stoves. Significant reductions in lung cancer incidence and chronic obstructive pulmonary disease (COPD) in both men and women using smoky coal were associated with improvement from fire pits to stoves with chimneys.[5,10] The stove intervention also significantly decreased the indoor airborne concentrations of particulate matter (PM10) and benzo(a)pyrene.[5]

GENETIC SUSCEPTIBILITY STUDIES

Recently, findings from a pilot molecular epidemiology case-control study in Xuan Wei have provided evidence of genetic susceptibility to lung cancer in populations with smoky coal exposure. This study was primarily undertaken by the U.S. National Cancer Institute, in collaboration with the Chinese Center for Disease Control and State Environmental Protection Administration. This population-based case-control study was carried out between 1995 and 1996 and included 122 lung cancer cases and 122 controls individually matched based on age and gender. Subjects with exposure to smoky coal combustion and genetic variation in the DNA repair pathway genes,[11] the immunoregulatory genes,[12] the base excision repair genes,[13] and the one-carbon metabolism pathway genes[14] have been found to be genetically susceptible to lung cancer in this population. Furthermore, subjects with variations in key genes involved in the metabolism (activation and detoxification) of PAHs were also at an elevated risk for lung cancer.[15,16] While this pilot study was one of the first to evaluate these genotypes and lung cancer susceptibility in such a population, new studies in other populations with similar exposures have replicated some of the findings.[17]

POLICY IMPLICATIONS

Currently, ongoing studies by the U.S. National Cancer Institute, in collaboration with the Chinese Center for Disease Control and State Environmental Protection Administration, are underway to expand on the findings from the cohort study and the molecular epidemiology case-control study. An extended follow-up of the Xuan Wei Cohort Study will potentially allow researchers to evaluate stove improvement effects on other diseases and in subjects utilizing other fuel types and stove types. This research will hopefully assist Chinese policymakers

Photo showing exposure of Xuan Wei farmers to indoor air pollution. Photo Credit: Dr. Qing Lan

in determining the most cost-effective manner to reduce indoor air pollution and increase both short- and long-term health benefits.

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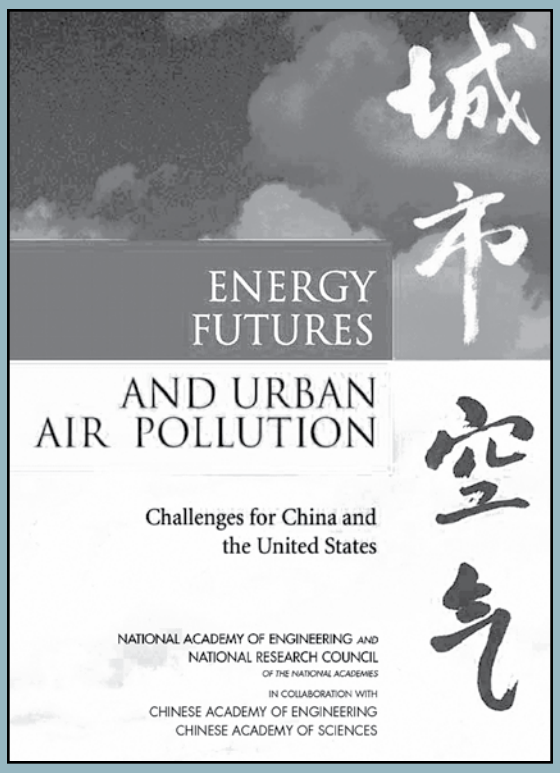
FEATURE BOX

Energy Futures and Urban Air Pollution:

Challenges for China and the United States (2007)

The United States and China are the number one and two energy consumers in the world, with China being the largest emitter of sulfur dioxide (SO_2) and both countries leading the world in carbon dioxide emissions (CO_2) due to their extensive use of fossil fuels. To examine the energy use and urban air pollution challenges faced by these two countries, the U.S. National Academies, in cooperation with the Chinese Academy of Engineering (CAE) and the Chinese Academy of Sciences (CAS), jointly researched and coauthored the book *Energy Futures and Urban Air Pollution: Challenges for China and the United States.*

This comparative study identifies lessons learned from case studies of four cities (Pittsburgh and Los Angeles in the United States and Huainan and Dalian in China); addresses key technological and institutional challenges and opportunities; and highlights areas for continued cooperation between the United States and China on energy and air quality issues. The report is geared towards policymakers at all levels of government as they seek to balance urban energy consumption with air quality management. It is the hope that the report is of value to policy communities not only in China and the United States, but also other countries worldwide.



FEATURE BOX

Partnership for Clean Indoor Air in Guizhou Province: Promoting Environmental Health in Rural China

By Jennifer L. Turner

Among the 57 percent of China's population living in rural areas, indoor air pollution affects the lives of over 700 million people, many of whom are women and children living in the poor province of Guizhou, where people cook and warm their homes with biomass and coal they mine themselves. The China Environment Forum hosted two speakers, Dr. Jin Yinglong and Mr. Tang Ning, from the Chinese Center for Disease Control's (CDC's) Institute for Environmental Health and Related Product Safety (IEHS) on 13 June 2006 to discuss the status of their environmental health projects in Guizhou Province. Throughout the world, indoor air pollution (IAP) has been difficult to address due to its multi-disciplinary nature, which requires nongovernmental organizations and policymakers to consider energy, deforestation, gender issues, health, and economic development as they seek solutions.

Indoor Air Pollution and Environmental Health

Most of China's rural population cooks indoors with highly inefficient stoves. This creates a situation in which the combustion of coal and biomass release hundreds of pollutants at levels several times higher than general health guidelines. Notably, in Guizhou Province, rural residents burn coal briquettes that contain a high level of naturally occurring arsenic and fluoride.

Some of the health impacts linked with indoor air pollution include dental and skeletal fluorosis, respiratory diseases, and acute respiratory infections. It is therefore not surprising that one of the leading causes of death among rural children in China is pneumonia. In Guizhou alone, over the past few years there were 10 million dental fluorosis patients and 640,000 people suffer from skeletal fluorosis. Besides inhalation of the smoke, one of the main causes behind these grim statistics is the link between smoke and food preparation methods. In rural Guizhou residents dry corn, chili peppers, and meat above their coal-burning stoves; thus, people end up digesting high amounts of fluoride and arsenic. In their assessment of counties in Guizhou, the IHES researchers found that along with food preparation methods, the use of inefficient stoves and chimneys (or lack of chimneys) were all contributing to the severe indoor air pollution.

The Institute for Environmental Health & Related Product Safety

IEHS of the Chinese CDC is promoting efficient coal and biomass usage throughout rural Guizhou and Gansu provinces and Inner Mongolia with the goal of creating multi-stakeholder programs promoting clean cooking stoves that can be replicated around China. Established in May 2002, the IEHS is an incorporation of the former Institute of Environmental Health and Engineering, Institute of Environmental Health Monitoring, and Chinese Academy of Preventive Medicine. As China's national professional institution for environmental health and product safety, it provides scientific research and technical support to guide policy, regulations, and strategies within the Ministry of Health and provincial CDCs. IEHS also holds numerous national and international seminars and training workshops on environmental health matters.

The Partnership for Clean Indoor Air Pilot Project in Guizhou

To address severe indoor air health problems in China, IEHS has been working with the U.S. Environmental Protection Agency on a pilot project

that has: (1) distributed energy efficient stoves, (2) incorporated health and environmental awareness into the local school curriculums, (3) promoted local clean cook stove production/distribution businesses, (4) trained locals in stove maintenance methods, and (5) tested and marketed a number of other clean household energy technologies such as biogas digester systems and solar cookers.

The project began by targeting 50,000 households in seven counties in Guizhou for dissemination of improved stoves and chimneys. The IEHS researchers first established a local team to help in the design, distribution, and follow-up education of the clean cook stove program. The team included village, township, and country government officials, as well as local representatives of the community, the Chinese Women's Federation, and the energy, finance, and agriculture sectors.

In an attempt to guarantee community commitment and to encourage a sense of personal investment, rural residents were encouraged to purchase the biomass stoves through a soft-subsidy strategy. Currently, residents in the targeted rural communities put forward 30 percent of the cost of the stoves, with the rest being subsidized by IEHS; however, this will rise to 50 percent in the future.

Along with the dissemination of cook stoves, IEHS and the local team set up health education activities at township and village levels. One of the more interesting methods for environmental health information dissemination was to target young children, in hopes they would then pass on their newfound knowledge to their parents. Other methods included passing out leaflets, community meetings, and even artistic performances to underscore the linkage between poor cook stoves and health problems. Education efforts led many villagers to write and sign a pact laying out rules on how the stoves would be used correctly in the community. The education curriculum also targeted behavioral changes by suggesting different food preparation methods, such as sun-drying rather than smoke-drying foodstuffs, storing items in bags instead of around coal stoves, and washing food more carefully before eating.

Although the IEHS staff recognizes there are still numerous environmental health threats in rural China—such as excessive usage of pesticides and fertilizers that are contaminating ground water systems—the Guizhou IAP project represents a promising model for the national government to engage local governments and citizens to become environmentally conscious and to become proactive about seeking solutions to local environmental health problems. Such collaboration among government agencies and communities is still rare in China, but necessary to help promote stronger implementation of environmental protection policies and programs.

For more information on IEHS contact Ning Tang at ningtanglcp@126.com. Queries on the Partnership for Clean Indoor Air should be directed to John Mitchell at Michell.John@epa.gov and Brenda Doroski at Doroski.Brenda@epa.gov.

COMMENTARY

Exploring a Forgotten River

By Baohua Yan

Decades ago, a river nourished Xindian village, a small peri-urban community in Daxing District in southern Beijing. The river water has dried up and today no one in Xindian can even recall the river's name. Since then, local villagers have deposited garbage and wastewater into the dry riverbed. Today the dump attracts swarms of mosquitoes, flies and other insects with a filthy summertime stench that the surrounding community tries to ignore.

The movement to restore Xindian's nameless riverbed dump began in 2004 when one of China's first officially sanctioned private schools for the children of migrant workers opened on adjacent land. The first step towards restoration was to give the river a name, so teachers and students dubbed it Xinzhi River in honor of Tao Xinzhi, often considered the most influential and renowned educator in modern China, after whom the nonprofit migrant children's school was also named.[1]

Tao returned to China in 1917 after studying at Columbia University's Teachers College with John Dewey, and spent years evaluating the Chinese education system. He crafted an education philosophy based on the principle that education needs to integrate real-life experiences (Su, 1996; Yao, 2002). Xinzhi School uses Tao's educational theory to reform traditional Chinese approaches to schooling—which tend to stress rout memorization over student innovation— so as to focus on real-life issues and enable students to become active in their communities (Daniels, 2005). With the school's front door opening up to the stagnant wastewater riverbed, the teachers at Xinzhi Migrant School were inspired to design an environmental learning curriculum that integrates the improvement of Xinzhi River into students' learning, based on Tao's philosophy.

Our Xinzhi River: Designing of an Environmental Learning Curriculum

The environmental learning curriculum, initiated in the spring of 2006, is based on three principles; (1) improve the local environment; (2) promote school-community relationship by having students participate in a community improvement project; and (3) engage students in solving real-life problems instead of merely learning from textbooks.

Since this curriculum is still at the early design stage, it is currently only being piloted in a fifth grade class. Three teachers of biology, computer science, and mathematics, respectively are leading the design and implementation of the curriculum. Every Monday afternoon, the class meets to learn basic environmental information, make research plans, and conduct related laboratory experiments. In addition, time has been allotted to conduct fieldwork, such as on-the-ground investigations of the river bed.

Students first collected information on the history of Xinzhi River from online resources and local libraries. Next, students conducted field investigations to determine the current situation of the river. With oversight from teachers, the students collected water samples to test for PH levels and major pollutants. They identified household wastewater and garbage as the two major sources of pollution. Within the village, the students found one wastewater disposal pipe almost every 10 meters along the river. In addition, the riverbank and riverbed were treated like a garbage station where local villagers dumped garbage without any treatment.

Xinzhi School students found one wastewater disposal pipe almost every ten meters along the river.
Photo Credit: Baohua Yan

Using their initial research, the students and teachers designed a survey to evaluate local villagers' knowledge and perceptions of water pollution in the Xinzhi River. Questions included:

- Where do you usually dispose of wastewater and garbage?
- What do you think about designating a special garbage disposal station for our village?
- If having a garbage station requires a certain amount of funding to cover staff salaries, who do you think should pay for it?

For the local village interviews, volunteers from China University of Geosciences were invited to pair with fifth graders in order to ensure the safety of students and improve the survey quality. Finally, based on the information gathered from the survey, students, teachers, and college volunteers designed an action plan. They carried out publicity activities to spread information about water pollution and related health problems, and wrote and performed an environmental play with the theme of water pollution. They also researched ways to involve villagers and government agencies in the treatment of the polluted water and in reduction of pollution sources.

The Xinzhi river restoration project continues, but the project has already positively impacted students. First of all, students learned how to work as a team with peers, teachers, and college students. Secondly, students developed inter-personal skills by interviewing local villagers. Thirdly, students learned research project skills, including problem identification, field studies, and report writing. Most importantly, students have gained a sense of ownership of the project. One teacher commented that although the Xinzhi River pollution is a very complicated issue and an immediate solution is difficult to find, the students still showed considerable enthusiasm for the project. The students came to see caring for this forgotten river as their responsibility.

CHALLENGES FACING MIGRANT CHILDREN IN EDUCATION

According to 2006 population statistics, there are about 120 million migrant workers in China, 2.8 million migrant workers in Beijing, and 370,000 migrant worker children in Beijing (*Xinhua News Agency*, 2006). According to China's education policy, nine years of compulsory education is free

to all children. However, educational funding is allocated on a geographical basis, and children are expected to receive this education in the place where their families legally reside. The social services registration (*hukou*) of migrant workers remains in their hometown and thus their children cannot enter Beijing public schools without paying extra fees to the municipal government. Many migrant families cannot afford such fees, so they send their children to one of the many for-profit private schools that quickly sprang up in the 1990s.

In 2006, the local educational authorities in Beijing approved 49 private schools for migrant children, but nearly 300 such schools operated without official approval (*Xinhua News Agency*, 2006; Zhou 2007). While both the official and unofficial migrant schools generally charge a much lower fee to migrant workers than that required by the local public schools, the quality of the education they offer is often far inferior. Many private school teachers possess neither teaching certificates nor educational training of any sort and some are only junior high school graduates. The inferior facilities of these schools—which are often located in areas of poor environmental quality—often present safety problems to students. In 2006, the Beijing municipal government passed legislation to increase funding to accommodate migrant children in local public schools, requiring private schools to undergo evaluation for official approval, and shutting down those private schools that did not meet basic safety and education standards. However, the issues surrounding schools for migrant worker children are still being resolved.

Migrant students face many specific social and academic challenges. One of the biggest hurdles for migrant children is social integration and self-identity because they are often marginalized by their rural background, different dialects, and poor economic status. Another major challenge for migrant children is adjusting to the class content, teaching styles, and learning patterns of new schools after frequent moves due to searches for new work or school closings. The Chinese education system's heavy emphasis on examination preparation for university also poses a major obstacle for migrant children, whose opportunities to attend college are limited by poor education and high costs.

IMPLICATIONS FOR EDUCATION OF MIGRANT CHILDREN IN CHINA

Xinzhi School is a unique migrant school in Beijing. Not only has the school maintained its registration to operate because of its high-quality education, but the faculty also created the Xinzhi River Environmental Learning Curriculum, which enabled the school to address many of the above-mentioned challenges.

Community Connection

Taking community environment and health issues as the context for students' learning and active engagement improves the school-community relationship. As schools for migrant children are often located in places of inferior environmental quality, issues of pollution and health are generally highly important for both the community and the school. River restoration is only one practical topic that migrant students can address to better connect with their community.

Student Empowerment

The focus on community environment and health issues embodies the core educational philosophy of life education advocated by Tao Xinzhi. Students are learning by dealing with real-life problems, and they can see the impact of using their new knowledge. Schools that engage and empower students can increase their interest in learning, and improve their academic performance. Such schools could also become powerful grassroots agents to initiate solutions to pollution issues threatening the health of local people and the environment.

Xinzhi school's river restoration project underscores a valuable model for China to better address the challenges of providing quality education to marginalized children while also imbuing them with a valuable environmental education.

Future research and pilot projects are needed in China to improve curriculum design to connect real-world experiences with academic studies and student development. Moreover, appropriate evaluation approaches should be employed to document the effects of this kind of curriculum on students' academic performance and personality development, as well as school-community relationship. Ultimately such programs could be employed in all schools in China to strengthen environmental education among all Chinese children.

Xinzhi school students investigating the pollution sources along the Xinzhi River. Photo Credit: Baohua Yan

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NOTES

1. The school's full name is Beijing Daxing District Xinzhi School.

FEATURE BOX

Chang Lin Migrants' School Program

By Steve Kloos and Qing Zhao

2006 was a year of evolution for GE Volunteers in Greater China, with a total of 74 projects carried out, benefiting 18 GE communities, compared to only 7 in 2005. The number of volunteers engaged nearly doubled to 2,988 people, contributing a total of 20,859 volunteer hours, a 140 percent year-on-year increase. Speaking as GE volunteers in China, we must confess that these numbers do not begin to reveal the joy and satisfaction that these activities bring to all those involved.

Although China has experienced astounding economic growth in recent decades, more than 100 million Chinese continue to live below the international standard of absolute poverty ($1/person/day), many of whom are among the floating population of migrants in cities. In Shanghai, where we are based, there are more than 400,000 migrant students; they come from families with an average household income of $100-200 per month. Because they lack a proper resident permit, their children are not eligible to attend local public schools and must then enroll in the generally under-equipped migrant schools.

Recognizing a need to do more to reach low-income migrant workers and their children, GE Water & Process Technologies (GEWPT) team based at the China Technology Center (CTC) in the Pudong district of Shanghai, launched the Chang Lin Migrants' School Volunteering Program in 2006. The aim is to provide needy children with a variety of age-appropriate, fun and practical education programs to widen their horizon, cultivate their interest in science, and train their teamwork spirit.

The first event with Chang Lin Migrants' School started with a charity sale by the GEWPT team at the CTC that collected more than 4,000 Yuan ($571) to be used at the school. After the fundraiser, our volunteering at the school started appropriately on the 1 June 2006, International Children's Day. On that day, 37 volunteers were divided into seven teams to host different eye-opening activities in separate classrooms, which children could participate in freely. There was an activity where volunteers gave a fundamental yet engaging introduction into water and water scarcity. In another room, students were grouped and had a drawing competition. We were exhilarated that more than 1,000 students and their teachers participated in this initial activity!

> **"In Shanghai there are more than 400,000 migrant students…from families with an average income of $100-200 per month.**

On 20 April 2007, 80 GEWPT volunteers from China and members of our Asia/Pacific team held another event with 192 fifth and sixth grade students and nine teachers from Chang Lin Migrants' School in Shanghai's Century Park to celebrate the 38th "World Earth Day." In this event, the students and volunteers were divided into eight groups with each group holding an environmental protection knowledge contest. Besides learning about environmental preservation through contests, the students also learned English songs, played games, and did crafts with the GE volunteers.

As a regular program, GE volunteers go to the school once a month on a weekend afternoon to

Steve Kloos and kids from the Chang Lin migrant school.

hold experiment-oriented science projects, as well as team-building and personal development activities with a different theme each time. The participants are students from the first to sixth grade, and topics include film clubs, a national geography class, and courses on wind energy. In addition, at the school GE volunteers hold regular weekend workshops for the parents and teachers focusing on a variety of topics and share practical information on early education, with about 50 participants each time. There are many interesting discussions about how to communicate with children, how to get children interested in learning, and how to help children understand parents. Notably, while the volunteer work at Chang Lin School started as a small weekend activity for the GEWPT team, volunteers from other GE now have joined to help with the expanded program with the migrant children.

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Qing Zhao is a research scientist on the GEWPT team and she can be reached at: Qing.Zhao@ge.com.

A Child's Right: Bringing Water Purification Systems to China's Orphanages

By Eric Stowe

SWEET WATER

In every orphanage we have worked around the world, children regard us with great hesitation or skittishness when we first arrive. In June 2007 at the orphanage Chongqing Children's Welfare Institute, our team from A Child's Right was amused at how the children warmed to us. Once we had worked for several hours and enough of the older children cleared us through their own personal vetting processes, the room became rather lively as the once shy toddlers and big kids started congregating en masse to watch us work—sometimes heckling us lightheartedly—but mostly to see how we planned to clean their drinking water.

Since they were able to walk and talk these children have been told "never drink from the tap." By the time we are done working and the staff and children gather to watch how our water purification system functions, it becomes quite a celebratory atmosphere. Nothing lights the spark better than our team's ritual of being the first people to drink the water directly from the newly installed taps. Every time we take huge sips of the newly cleaned water, the children's response is one of outright incredulity and shock. By the time we have sufficiently proven the water is clean, the children quickly queue up to sample the water firsthand and offer their critique to any listening ear.

At the Chongqing Children's Welfare Institute the children and staff lined up for thirty minutes to sample the water. Water that was previously latte colored and visibly filthy was now crystal clear, odorless and relatively tasteless. Several of the children commented that the water was "sweet" compared to traditional boiled water, which retains the "flavor" of the grime and grit from the tap. Our team laughed when several children expressed frustration that the water tasted like nothing at all! The end result, unrestricted access to clean and safe drinking water will assuredly change the lives of these children who have so little.

NGOS DIP THEIR TOES IN

The vocabulary of the global water crisis, once so rarified and isolated to academics, a handful of non-governmental organizations (NGOs), and water specialists, has disseminated rapidly in the last few years and the majority of those living in more developed countries do comprehend the basic plight currently affecting more than a billion people on a daily basis. Many understand the global statistics of childhood illness and mortality rates due to, or in direct correlation with, the lack of clean and safe drinking water. This understanding has provided the basis for some amazing work done by many international organizations to help people living without access to water.

Today there are more than 20 fairly large and well-established NGOs within Europe and North America devoted solely to providing clean and safe drinking water to communities in need around the world, in addition to some of the larger global development organizations (UNICEF, CARE, Save the Children, World Vision, and PATH) that have distinct clean water departments and staff devoted to water problems in the developing world. Although critiques are aplenty about how some of the organizations operate or how they select their targets and implement their projects, their collective work has unquestionably been a force for positive change for millions of people, primarily in the rural environs, in desperate need of clean water. However, these organizations work across a vast number of countries and cannot focus their work exclusively on China, despite the great need.

WATER NEEDS OF CHINA'S ORPHANAGES

Our Tacoma, Washington-based agency was established to provide charitable relief for children living in orphanages and street shelters as well as those attending schools and visiting children's

hospitals in the impoverished urban and peri-urban areas of underdeveloped countries. This target population remains severely underserved by international charities and clean water organizations and as such our mission revolves solely around these children and improving their lives through relatively simple provisions and education. Since 2004, China has become an annual project for us and with every trip we are able to directly impact the lives of 2,000 to 3,000 children by providing immediate, unfettered, and sustained access to clean and safe drinking water.

It is hard to select a demographic more at risk than the thousands of children abandoned and orphaned every year and living in China's social welfare institutions. Although the majority of Chinese orphans are abandoned in rural areas, like virtually every other country in which we work, orphaned children will invariably make their way to the urban and peri-urban sphere as the basic social welfare and orphan care infrastructure remains fractured or nonexistent in the countryside. The primary facilities that provide for orphaned children lie tucked away in the heart of hundreds of Chinese cities across the country. With more than 500,000 documented orphans in China, of which a significant portion reside in the country's 300+ orphanages, there is considerable work needed to ensure their basic needs are met for healthy development. A Child's Right therefore focuses on providing these children with clean and safe drinking water to alleviate many of the severe health and developmental issues they would likely otherwise face.

HEALTH IMPROVEMENTS

In the orphanages we have worked, all the water for cooking, drinking, and infant bottles now comes from our water systems. We have seen in the last three years of working in China's orphanages, as well as orphanages around the world, that a dramatic reduction in stomach maladies and diarrhea has occurred after the orphanages switched over to our water systems. At all of the orphanages in China where we have worked, staff members tell us they see a rapid decrease in "the number of times children go to the potty." For example, in one orphanage in Guangdong Province, the staff noted that they typically had to deal with 10 to 12 outbreaks of diarrheal illness every year; however, in the year following our equipment installation, the outbreaks were reduced to 1 or 2.

The children are always excited at having their first cup of truly clean tap water. Photo Credit: Eric Stowe

In June 2007, we brought several engineers with us to work in 8 orphanages in Chongqing municipality and Jiangxi Province. Most of the water we tested came up positive on our total coliform tests. Although two of the orphanages we tested were in close proximity to newly constructed, state-of-the-art water treatment plants, the water quality was still quite unsafe for human consumption. Urban water quality remains questionable because of the antiquated plumbing and the often poor distribution methods. These infrastructure problems mean that water can even be contaminated in facilities with new plumbing and high-end water treatment facilities nearby due to backflow and back-siphonage.

We cannot change or cure every environmental and human contaminant found in China's waters. But we can ensure a dramatic reduction in the life threatening illnesses that are directly caused by the bacteria, viruses and pathogens overloading the water systems where we work. We can assure that high-quality water is reaching some of the most vulnerable children in China.

For more information on A Child's Right's work in China and other countries see: http://www.a-childs-right.org.

Eric Stowe is the director of A Childs' Right and he can be reached at: eric@a-childs-right.org.

COMMENTARY

A Call for Transparency: China's Emerging Anti-Nuclear Movement

By Wen Bo

On 18 August 2007, China kicked off a new round of nuclear power plant construction by breaking ground on the Hongheyan Nuclear Power Plant, which is located on a coastal flatland 110 kilometers north of Dalian city in Liaoning Province. Using China's own nuclear technology, the Hongheyan Nuclear Power Plant will have six generators, each with a capacity of 1 million kilowatts.

Though Chinese news media reported assurances from government officials on the safety of Hongheyan's nuclear reactors, the *China Daily* took a rare stance and publicized the concerns of residents in nearby Changxing Island. The third largest island in China, Changxing Island was designated a national spotted seal nature reserve in 1997. Each spring, spotted seals and their pups stop along the western shore of Changxing Island before continuing their migration into the open seas of the Pacific.

The coastal area surrounding the Hongheyan Nuclear Power Plant had been a breeding ground for spotted seals and a stopover of migratory birds traveling between the Russian Far East and Australia. Being a coastal flat with sparsely populated villages, this area was chosen as a potential site of nuclear power plant as early as 1978. However, the Chernobyl nuclear power plant accident in 1985 put the plans on hold. Even in 1995 when the construction plan was revisited, a senior official in the government opposed building a nuclear power plant so close to the tourist city of Dalian. The construction was subsequently postponed for another ten years.

Wang Zhifeng, a retired Dalian factory worker who has long been an individual advocate for protecting Liaoning's coastal areas, expressed outrage during his conversation with Pacific Environment on the proposed nuclear plant, saying it would mark the end of China's spotted seal and endanger the entire Bohai Sea ecosystem. Wang Zhifeng is a veteran activist trying to rescue wild birds and publicize the plight of endangered spotted seal.

In spring of 2006, Wang learned about the nuclear power plan and impending construction activity from the Dalian Environment Protection Bureau. According to Wang, the government of Dalian was not even invited into the decision-making process for Hongheyang Nuclear Power Plant and no adequate environmental impact assessment (EIA) had been conducted, much less disclosed, as is required by law. It appears while some local environmental officials leaked information on the tensions between the Dalian government and the advocates for the Hongheyan nuclear power plant, no city officials seem to possess enough political clout to stop the construction project.

Concerns about China's rapidly approaching new nuclear era have triggered concerns beyond Dalian, among citizens and environmentalists across China who are not involved in the decision-making process.

GOING NUCLEAR

China's energy shortages and rising demand for electricity have pushed the government to consider nuclear as another source for future power supply. The Nuclear Power Institute of China submitted a letter to the Chinese leadership in 2003 urging them to prioritize nuclear power production. In March 2005, Premier Wen Jiabao publicly announced his support for rapid development of the nuclear power sector. China plans to build 40 new nuclear reactors by 2020 with a capacity of 40 million kilowatts as part of a major effort to diversify the country's energy development.

Popularity of spotted seal has led to increased catching from the wild to supply zoo and aquariums. A spotted seal pup at Dalian SunAsia Ocean World. Photo Credit: Wen Bo

Nuclear power currently supplies only 2 percent of total electricity output. Notably, while the planned nuclear plant construction is faster than any other country in the world, China's energy demand is growing so rapidly that in 2020 coal will still supply nearly 70 percent of the energy and nuclear power would make up only 5 percent of the total.

Eighteen Chinese provinces are actively designing blueprints and bidding to host nuclear power plants. Besides the real shortage of power, economic incentives in the form of government subsidies and tax breaks, have prompted local officials to actively lobby to have nuclear power in their province. International business interest also is helping to promote the growth of this industry, with U.S., European and Russian nuclear power companies cultivating good relationships with the Chinese government to highlight their equipment.

While the enthusiasm of the government and investors is great, China is ill prepared on several fronts for the impending nuclear power boom. Besides the astronomical financial investment required, lack of nuclear technical personnel could pose long-term challenges. Currently only three Chinese universities supply nuclear-related scientists. A lack of training and experience, as well as lax quality management and insufficiently transparent EIA processes, could make China's nuclear power facilities vulnerable to various structural and environmental problems already widely occurring in other infrastructure projects (e.g., collapsing bridges and polluting chemical plants near drinking water sources).

A CONCERNED CITIZENRY

Like many in the world, most Chinese citizens became aware of the dangers of nuclear power from news of the Chernobyl accident, which the Chinese news media covered extensively without any censorship. Similarly, news about nuclear accidents in Japan's nuclear power plants has been reported openly in China. The Chinese news media also has been open in publicizing anti-nuclear rallies in Taiwan, as well as the international criticism of Taiwan's planned nuclear waste shipment to North Korea. Even the yearly Stop Castor campaign, in which German citizens protest the transport of nuclear waste from France into Germany, is broadcast on Chinese TV news.

The openness in international reporting of nuclear issues stands in stark contrast to the lack of news on environmental impacts of nuclear power and nuclear wastes within China. While there has been considerable coverage of the transformation of a previous nuclear testing site in Qinghai into a radiation-free tourist site, the Chinese news media has only moderately covered uranium mining radiation accidents. Therefore, Chinese people in general are less aware of nuclear threats that exist domestically or their rights to voice concern over such issues.

Over the past few years the Chinese government has pushed for more citizens' rights to participate in environmental policy decision-making, most strikingly in the EIA processes. Channels for complaints are growing, such as government hotlines and websites. Pollution victims—often with assistance from Chinese legal NGOs or pro bono lawyers—are turning to the courts to demand compensation for damages. Despite a somewhat arduous registration process, Chinese civil society has grown phenomenally over the past 15 years, with green groups being the largest. The expansion of political space for bottom-up involvement in policy has catalyzed Chinese citizens and NGOs to become more active in expressing concerns about planned infrastructure projects, even nuclear power plants.

For example in 2006, a well organized anti-nuclear petition campaign against three proposed nuclear plants on the Shandong Peninsula—two near the famous Silver Beach resort and another a mere 6 kilometers away—was started by Dahai ("Ocean") Commune. The founder of the Dahai Commune, who goes by the nickname Yi Wuchen (literally "Wearing-No-Dust"), walked along China's coastlines in the year 2000 and witnessed first hand how China's coastal seas were under serious ecological threat. Yi Wuchen subsequently established the Dahai Commune to bring together volunteers and unite an online community of ocean lovers who wanted to learn about China's coastal ecosystems and the threats they face. Through this online community, in 2006, the Dahai Commune sent a petition letter opposing the three planned nuclear power plants with hundreds of signatures to Premier Wen Jiabao. The petition letter also was delivered to the State Environment Protection Administration to voice their environmental concerns over the nuclear power plants.

Concerned local citizens in Weihai also formed a network called the "Silver Beach Environmental Initiators," which has been actively appealing to various government agencies in Beijing to reconsider the need to protect Silver Beach. The group maintained that a public hearing to review the EIA should have been organized before the nuclear project plan was approved. The group also demanded the government first promote more renewable energy and conservation efforts to meet the province's energy need.

Another predominantly online anti-nuclear campaign also emerged in Hainan Province, where on 25 July 2007 the China National Nuclear Corporation signed an agreement with the Hainan provincial government to build the Taohuajiang Nuclear Power Station. This would be the first nuclear power plant on this island province. Similar online anti-nuclear debates have emerged over nuclear power plans in Fujian and Jiangsu provinces.

NORTHWEST CHINA—A LEGACY OF NUCLEAR WASTELAND

Northwestern China, particularly Xinjiang and Qinghai, has for decades been the site of nuclear weapon testing and uranium mining, which even government documents have identified as the source of higher cancer rates and other illnesses among people living close to the sites.[1] Such testing also has taken an ecological toll; for example, in Xinjiang, Lake Lop Nor was wiped off the map due to nuclear testing and related human activities.

Yoon Sanghoon, coordinator of the Eco-system Conservation team of Green Korea, looking for spotted seal along Dalian's coast. Photo Credit: Wen Bo

In Gansu Province, uranium mining and corruption within military mining companies have produced grave human and ecological tragedies. According to Sun, a former miner at Gansu's most important uranium mine Project 792, improper handling of radioactive material from the mine has led to contamination of water and soil and a sharp rise in incidences of cancerous tumors, leukemia, birth defects, and miscarriages in the surrounding communities (HRIC, 2005). The surrounding area has become devoid of wildlife, and livestock suffer from high death rates, most likely linked to contaminated water. Since 1988, Sun has repeatedly traveled to Beijing to report on corrupt officials stealing government funding meant to clean up the mines and relocate uranium miners and their families away from the mines. He also brought evidence of frequent discharges of radioactive waste into Gansu waterways. Sun lost his job in 1994, but kept advocating on behalf of sick miners and an endangered environment, which led him to be subjected to numerous arrests, including being detained by security forces for 8 months in 2005. In 2006, the German group Nuclear-Free Future Resistance Award recognized Sun for his extensive advocacy work.[2]

FUTURE TRENDS

Although environmental groups make up the largest sector of China's civil society, no Chinese (or international) NGOs focus work on nuclear power

plants or hazardous waste issues. Strikingly few Chinese NGOs work on clean energy initiatives. Political sensitivity and lack of capacity explain this gap in NGO activism. Current anti-nuclear efforts in China have been predominantly online "not-in-my-backyard" (NIMBY) campaigns. However, the spontaneous emergence of such grassroots campaigns highlights that the foundation for such NGOs is emerging. The small NIMBY campaigns are not yet capable of forming an inter-regional alliance for joint advocacy; however, possibilities could develop in the future.

In Asia, the most well connected anti-nuclear network is The No Nuke Asia Forum, which has organized forums in various East Asian countries. Though the member groups in South Korea, Japan and Taiwan have been active nuclear watchdogs, the decentralized network does not have much capacity to function as a facilitator of anti-nuclear movement in mainland China. However, it does offer a model for Chinese anti-nuclear advocates.

By comparison in Australia, the primary concern over exporting uranium to China revolves around whether it will be used to expand Chinese nuclear weaponry. Environmental organizations, such as Friends of the Earth-Australia, also have expressed concerns about the environmental impact of uranium mining domestically. Notably, the Anti Nuclear Alliance of West Australia has been working with Chinese groups and citizens to raise awareness on uranium mining and its negative impacts.

As was the case with the recent hydropower development boom, Chinese companies are rapidly investing in nuclear power projects to address China's very serious energy shortage. However, as many petitioners opposing some of these infrastructure projects have highlighted, the huge financial investment in these projects can become a hotbed for government corruption. Moreover, the social and environmental impacts of poorly run nuclear power plants could be enormous. It is unlikely the current building boom of nuclear power plants can be stopped; however, pressure from citizens and anti-nuclear campaigners could help increase transparency and safety of such projects. With today's Internet-savvy grassroots watchdogs, international investment in new nuclear power plants, and citizens increasingly aware of their rights to participate in infrastructure decision-making, it is less likely any radiation accidents or illegal dumping could be as easily covered up as what occurred at the Gansu Uranium Mine 792. Moreover, with increased knowledge and capacity Chinese environmental groups, as well as growth of sophisticated anti-nuclear campaign organizers, a full-fledged anti-nuclear movement could soon be in the making.

Wen Bo is Pacific Environment's Beijing-based consultant, where he is working to develop the organization's China project. He is a founder of the China Green Student Forum, which is now a network of more than 100 student environmental groups. Wen Bo also is currently on the China Advisory Board of Global Greengrants Fund to facilitate the growth of environmental communities in China. He can be reached at: wenbo2@yahoo.com.

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NOTES

1. Five Chinese ministries, including Ministry of Health and Ministry of Civil Affairs, issued a notice on 6 July 6 2007 to handle health compensation and pension increase for retired troop members who participated in China's nuclear testing. Other information health impact of Chinese nuclear testing can be found *Zhou Wenliang & Zhang Zhijing*, Citizens' health impact around nuclear testing site in Xinjiang, *Research of Environmental Sciences*, 1989 Volume II, Issue 1.

2. For information on the award see: http://www.nuclear-free.com/english/sun.htm.

COMMENTARY

An Olympian Task: Alleviating Health Threats From Beijing's Polluted Groundwater

By Laurel Meng Lelan Miller and Samantha L. Jones

饮水思源
"When you drink the water, think of its source."- Chinese proverb

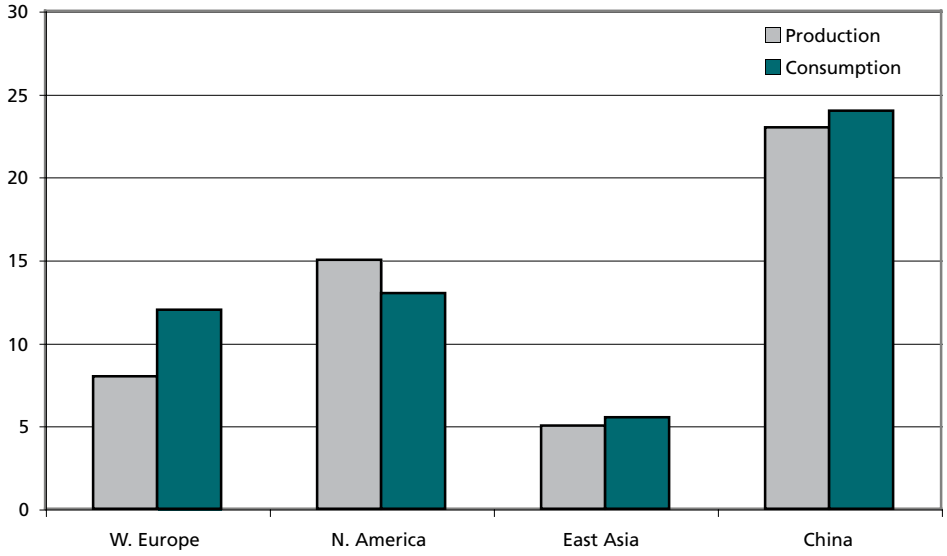
Within a week of winning the Olympic bid in 2001, the Chinese central government approved the long-debated South Waters Northward Transfer Project (*nanshui beidiao*), which will ultimately create three canals (each approximately 1,200 kilometers long) that divert water from the Yangtze River to the parched north where water per capita is one-tenth the world average. The eastern canal that utilizes the ancient Grand Canal will be operational in time for the 2008 Olympics, providing Beijing 400 million cubic meters of water. This amount is, however, 1 billion m^2 less than what the pipeline was supposed to deliver. Moreover, much of the water will be heavily polluted and require clean up—a cost northern provinces are at loathe to take (Liang, 2004). The central canal will come online within two years, but the third canal poses considerably more engineering and political challenges, which underscore the difficulty of over-reliance on supply-side water management in Beijing.

Beijing's thirst has grown increasingly severe over the past half century, leading it to rely on water transfers and more groundwater pumping. For over 2000 years, much of Beijing's water needs have been supplied by groundwater, today making up over 70 percent of the city's total water supply (Beijing Water Authority, 2005). In ancient times, it was forbidden to dig wells at random near the Imperial Palace in Beijing, so as not to disturb the fortunes of the emperor. Thus, the earliest groundwater wells were carefully placed according to *fengshui* principles and mainly served the elite.

Wangfujing, literally "the well of the princes' mansions," is an example of groundwater's historical presence in the capital. Now a major shopping district, Wangfujing was originally a groundwater well that served imperial estates and residences close to city center during the Ming Dynasty. Another royal well was the Jade Spring in the Western Hills (2.5 kilometers west of the Summer Palace) that produced high quality groundwater that was conferred the title "Spring of the First Order Under Heaven" and was a source of drinking water reserved for the imperial family during the Qing Dynasty. The first groundwater plant that served the city residents was a surface water treatment plant at Dongzhimen, which during the Japanese occupation of Beijing was modernized and the first groundwater wells were built in 1940 (*Beijing Zilaishui*, 1986). Today's groundwater is pumped and distributed by the Beijing Waterworks Group, which operates over 250 wells in ten municipal water supply plants throughout the city. In addition, a 70-kilometer pipeline transports groundwater from Pinggu County into Beijing's No. 10 Waterworks.

Since the mid-1980s, Beijing municipality has consumed an average of 3.7 billion m^3 of water each year, nearly two-thirds of which is from is from groundwater (Beijing Water Authority, 2005). Such unsustainable groundwater abstraction is practiced throughout northern China, where over the past ten years groundwater tables have fallen by 10 to 50 meters (at an average of 0.5 meter/year) (OECD, 2007). Groundwater overexploitation in the northern regions of China has been a major contributor to desertification, forest loss, saline intrusion into aquifers, land subsidence, and river drying (OECD, 2007). A striking example of subsidence problems has occurred in the eastern plain in north China's

FIGURE 1. Production and Consumption of Nitrogen Fertilizers in China (1999 and 2000)



Source: Adapted from International Fertilizer Industry Association (2006).

Hebei Province, where groundwater overuse endangers the Beijing-Shanghai railway ("Groundwater overuse," 2004). Another major issue is anthropogenic contamination that in recent decades severely degraded groundwater quality. In 2006, Deputy Director of the State Environmental Protection Administration, Zhang Lijun, stated that groundwater was contaminated in about 90 percent of Chinese cities ("China: ground water," 2005).

Between 1991 and 2001, approximately 740 million m^2 of agricultural land in Beijing was reclaimed for urban development (Beijing Municipal Statistical Bureau, 2002). Whereas farmland once provided pervious surfaces through which precipitation and irrigation water entered the groundwater table, an increasing proportion of groundwater recharge is being "supplied" by urban sewage, septic tanks, surface runoff, and leaking water networks. In 2001, the World Bank reported that nearly half of the groundwater in Beijing municipality alone was severely contaminated. Groundwater contaminants that pose serious environmental health risks in Beijing include polycyclic aromatic hydrocarbons (PAHs), nitrates, and heavy metals, which are present at levels far exceeding World Health Organization (WHO) and U.S. Environmental Protection Agency (EPA) recommendations.

POLYCYCLIC AROMATIC HYDROCARBONS

A study of the Tonghui River in Beijing concluded that total PAH concentrations ranged between 0.1929 to 2.651 micrograms/liter, which is significantly above the EPA limit of 0.0002 micrograms/liter for PAH content in safe drinking water (Zhang et al., 2004). The main concern surrounding PAHs is that some are suspected carcinogens. Zhang et al. (2004) observed that in addition to coal and heavy industry fuel combustion, another major anthropogenic source of the growing PAH groundwater contamination levels in Beijing is rising vehicle ownership. Vehicle exhaust, tire degradation, industrial emissions, asphalt particles, petroleum residues, and tar all release PAHs, which then contaminate groundwater (Nikolaou et al., 1984; Baek et al., 1991; Manoli et al., 2000; Mahler et al., 2005).[1]

PAHs also directly enter groundwater from underground petroleum storage tanks. In 2006, *Xinhua News Agency* ("Beijing to keep," 2006)

reported that improperly constructed gas stations have caused numerous groundwater pollution accidents in the Chinese capital. Lin (2006) reported that Beijing has plans to investigate groundwater contamination associated with gas stations during a Geologic Investigation Development Plan authorized by the Beijing Municipal Bureau of State Land and Resources for the period of 2006-2010.

NITRATES FROM AGRICULTURAL RUNOFF

China is the world's largest producer and consumer of nitrogen-based fertilizers (see Figure 1) and, correspondingly, nitrates are Beijing's major groundwater contaminant (Wolf, 2003). The Chinese Research Academy of Environmental Sciences reported in 2006 that the average application of nitrogen fertilizers is 400 kg/hectare in China, significantly above the 225 kg/hectare limit that most developed countries consider safe ("China's agriculture," 2006).

The rising urban population in Beijing requires increased food supply, resulting in greater production of nitrate-rich runoff from crops grown in the peri-urban areas surrounding the capital. Nearly 50 percent of nitrogen fertilizers leach into the soil and groundwater instead of being utilized by crops. In Beijing, nitrogen fertilizer use has been steadily increasing from 263 kg/hectare in 1991 to 344 kg/hectare in 2001 (Beijing Municipal Statistics Bureau, 2002). In addition, the booming population creates an increasing amount of nitrate-rich sewage effluent, and the rising standards of urban living bring more parks, lawns, sporting complexes, and upscale residential areas that require increased herbicide and pesticide use, leaching more nitrates into groundwater.

In Beijing municipality, the land area with excessive concentration of nitrates increased from 72 km^2 in 1980 to 169 km^2 in 2000. Moreover, in 2005, one study found that nitrates were present at depths up to 80 meters in concentrations of 150 mg/L in the Beijing area, well in excess of World Health Organization drinking water standards of 45 mg/L (Wolf, 2003; Chen et al., 2005).

HEAVY METALS

The Beijing Geological Exploration Bureau reported in 2005 that 95 percent of Beijing municipality's refuse is dumped in landfills that do not comply with groundwater pollution prevention regulations (Nan, 2005). One report examining water quality in Beijing cited landfills, fossil fuel combustion, coal mining effluents, and agricultural wastes and fertilizers as the sources of the arsenic, mercury, cadmium, phenol, and cyanide that were detected in 36 percent of Beijing's groundwater (Wolf et al., 2003). Although the city of Beijing has proposed closing 70 percent of the local mines in order to address water supply contamination issues, to date strong economic interests have prevented further action on this proposal (Zhu, 2006).

> **"In ancient times, it was forbidden to dig wells at random near the Imperial Palace in Beijing, so as not to disturb the fortunes of the emperor.**

Arsenic

Organic arsenic compounds used as feed additives—a practice banned in the European Union, but still common in China—are released through animal manure and convert to an inorganic form in soil, thereby becoming water soluble and seeping into the groundwater table. Elevated levels of arsenic have been found in groundwater sampling surveys from fourteen sites in northern Beijing. Groundwater from all fourteen of these sampling sites exceeded WHO maximum levels (0.01 mg/L) and two of these samples exceeded Chinese national arsenic standards (0.05 mg/L) (Dou et al., 2006). Moreover, Gao et al. (2004) reported that with arsenic levels between 0.20 – 3.00 mg/L, Beijing drinking water contains almost four times WHO limits.

Mercury

Mercury in landfills leaches from fluorescent lights, batteries, thermometers, electrical switches, and circuit boards into the groundwater, where it dissolves in acidic leachate. Levels of mercury in Beijing's drinking water are between 0.10 and 0.74 mg/L, considerably higher than the WHO and Chinese standards of 0.001 mg/L (Gao, 2004). Compared to Tianjin, Lanzhou, Dalian, Xian, and Shenyang,

> **…95 percent of Beijing municipality's refuse is dumped into landfills that do not comply with groundwater pollution protection regulations.**

Beijing has the highest level of mercury in groundwater (Han, 1998).

FUTURE CHALLENGES

Groundwater pollution is an especially vital issue to modern-day China considering the huge time period required for groundwater to be naturally filtered clean. Without significant improvements in regulating groundwater protection, contamination from PAHs, nitrates, and heavy metals will only increase with the booming economy.

In 2001, the Municipal Bureau of Water Conservation set up an official program to promote sustainable application of water resources, which includes the hefty goal of recovering currently polluted water to meet acceptable standards by 2030 (Wolf, 2003). Effective groundwater management in Beijing and other urban—particularly northern—areas in China must focus on advancing hydrogeological research, sound urban planning for aquifer zones, improved groundwater data collection and monitoring, and last but not least, public environmental education. Because groundwater seems an "invisible" source of water owing to its underground location, environmental education in schools and the news media would do well to increase awareness about PAH, nitrate, and heavy metal contamination, as well as how water excessive withdrawals exacerbate the contamination.

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SPOTLIGHT ON NGO ACTIVISM IN CHINA

A Community of Grassroots NGOs Protecting China's Rivers and Lakes

By Daniela Salaverry

It is mid-March in western China's Gansu Province and despite the wet snow covering roads and the dry and dusty landscape, we drive our minivan hundreds of kilometers from the capital Lanzhou into the rural countryside. As we leave Lanzhou on a new super-highway, we found our landscape shifting quickly from modern skyscrapers and department stores to farm fields dotted with mud houses. I felt as if I had gone back in time. Zhao Zhong, the volunteer leader of Green Camel Bell—Gansu's first environmental NGO—has done environmental education work in the province for many years, so he knew the practicality of living in these traditional mud houses, which have sharp angled roofs that help keep the indoors cool in the summer and warm in the winter.

I am traveling with Green Camel Bell to visit Huining county, where tributaries of the Yellow River run murkier than the "mother river" itself. This northwestern province is essentially a desert that supplies much of the silt that gives the Yellow River its name. However, it is more than just silt that causes the tributaries in Huining to turn a dirty shade of brown. Like most of rural China, Gansu's rural areas lack basic waste disposal infrastructure. It is on the banks of the tributaries we visit, as well as all the other local waterways, that people deposit their trash, waiting for the river's meander to bury or wash it away.

Zhao Zhong and Green Camel Bell represent a growing and critical part of China's environmental movement. These young, energetic groups are popping up across China to act as community leaders on environmental issues. Often times, such groups emerge out of student organizations, but then develop into professional NGOs. Groups like Green Camel Bell are seizing the opportunity to take action, from launching public education and outreach programs, to aggressive campaigning to shut down polluting enterprises.

The young leaders of such green groups represent the generation in China that grew up during the country's opening and reform. The fact they have seen their childhood swimming holes turn into polluted wastelands is often the motivation to help improve their communities and country.

Many of China's grassroots groups conduct surveys of river basins, sometimes bringing volunteers to educate them on the overall health of the river on which they depend. Photo Credit: Pacific Environment

This increasing citizen concern for the environment and social wellbeing is welcomed, to some extent, by the central government both in new laws permitting public involvement in environmental decision-making and in official pronouncements. For example, in a recent article, the State Environmental Protection Administration called the public "the biggest party that has interests in the environment…[and] a driving force for the government's self reform in environmental protection.[1]

In Huining County, Green Camel Bell is establishing a relationship with a local primary school to launch an environmental education curriculum that the NGO created to target rural populations. Zhao Zhong and his colleagues will conduct week-long programs educating students and their families on ecology, environmental protection, water conservation, and garbage reduction. Green Camel Bell also has a strong presence in Lanzhou, where it has organized several river walks, not only as outreach tools, but also to collect and map the environmental quality of the Yellow River in Lanzhou.

Green Hanjiang acts as a liaison between local communities, government and businesses. For example, this photo shows the head of Green Hanjiang calling the environmental protection bureau about a new waste pipe the community had discovered flowing into the river. The EPB was also investigating it and she was able to inform the community when the pipe was to be removed. Photo Credit: Pacific Environment

Hundreds of miles away in Anhui, Zhao Zhong's home province, another community-based group, Green Anhui, is working to protect the Huai River. Green Anhui staff and volunteers have hiked huge stretches of the notoriously polluted Huai River, meeting with communities, learning their concerns, and educating them about water conservation practices.

In the sleepy rural town of Bengbu next to the Huai, Green Anhui has even set up a small office. Having Green Anhui in town was fortuitous for Bengbu residents when in the winter of 2006, thousands of batteries were surreptitiously dumped onto the river's banks. Green Anhui was able to quickly mobilize the local media to cover this "midnight dumping" incident, as well as start organizing clean-up efforts. Their action sparked the local government to assist in the proper disposal of tons of batteries.

Groups like Green Anhui and Green Camel Bell also are reaching beyond their communities to increase the impact of their work. Through a larger coalition of environmental groups working on issues like water pollution, they are meeting with and learning from veteran activists and established groups like Green Hanjiang and Tai Lake Defenders.

Since 2001, Green Hanjiang has organized citizen walks of the local waterways and launched a citizen monitoring program, which provides water quality training to empower community members to identify and address water pollution. Green Hanjiang's efforts have been successful, and their work prompted a national-level investigation that shut down polluting enterprises and supported the digging of a new well for their community.

Equally successful, Wu Lihong of Tai Lake Defenders has independently led an effort to close down over 200 factories in his home region. Wu's aggressive and effective strategy involved tarnishing the reputations of local government officials by linking them to polluting enterprises. In April 2007, a few days before Wu planned to travel to Beijing to raise a case against another local polluter, he was arrested.

Ironically, a mere six weeks following his arrest, Tai Lake erupted with a toxic blue-green algae bloom that resulted in water being shut-off to two million people in the city of Wuxi. Following this incident—which not only made international headlines, but also raised concerns from within China's central government—all the officials Wu had targeted were demoted for negligence. Despite his vindicated whistle blowing and regular coverage in the *Wall Street Journal*, *Associated Press*, and other international news media, in August 2007, Wu was sentenced 3 years in prison for extortion.

Thwarted or not, the strong response of China's grassroots activists to address water pollution is proving that citizen-led efforts are having positive impacts within and beyond their local communities. There is a growing national movement within China to address water pollution, and each small victory is fuel for a successful national coalition.

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1. *China Daily*. (2007, July 4) "The public is the biggest environment group." [Online]. Available: http://www.chinadaily.com.cn/china/2007-07/04/content_909242.htm.

COMMENTARY

Breathing Better: Linking Energy and GHG Reduction to Health Benefits in China

By Kong Chiu, Yu Lei, Yanshen Zhang, and Dan Chen

What health benefits can be associated with actions that reduce greenhouse gas (GHG) emissions? How do GHG reduction measures affect ambient air quality? Do the costs of implementing these measures exceed any short-term economic benefits? What are the best multi-pollutant strategies for reducing greenhouse gas emissions while improving air quality? How can greenhouse gas reduction considerations be integrated into existing or planned air pollution programs? These are just some of the questions the U.S. Environmental Protection Agency's (EPA) Integrated Environmental Strategies (IES) program helps developing country policymakers consider.[1]

Through the IES program, EPA builds capacity around the world to cost-effectively manage greenhouse gas and air pollutant emissions concurrently. This is often referred to as "co-control." IES focuses on demonstrating and quantifying the mutual benefits associated with energy and transport policies and measures. This knowledge can then be used by policymakers to understand co-control opportunities in and synergies between climate change, energy and air quality management policies.

While GHG emissions are generally thought to have no direct, short-term impacts on public health, they are often emitted concurrently with other air pollutants that have direct health impacts. The fact that fossil fuel combustion leads to emissions of both carbon dioxide and criteria air pollutants creates a logical connection between policies that manage GHG emissions and policies that manage air quality. Since air quality directly affects public health, it is not difficult to demonstrate the public health benefits of certain GHG reduction measures and policies. In fact, a large body of analytical work has been conducted worldwide on the many co-benefits associated with GHG reduction measures (OECD, 2000; Burtraw et al., 2003).

CHINA'S AIR CHALLENGES

China's rapid economic growth has created a dramatic expansion of energy production and consumption, mostly from fossil fuels. As a result, China's rapid urbanization and growth is behind the nation's increasing emissions of greenhouse gases and other air pollutants. Ambient levels of criteria air pollutants, including particulates, sulfur dioxide and nitrogen oxides significantly exceed World Health Organization (WHO) standards in many Chinese cities. In some instances, particulate and sulfur dioxide concentrations in China's urban centers are among the highest in the world. Similarly, China's GHG emissions are among the highest in the world. In fact, recent estimates suggest China has already overtaken or may very soon overtake the United States as the largest GHG emitter.

A newly released OECD study (2007) on environmental indicators in China estimated that health damage from air pollution in China cost the country anywhere between 1.8 to 4.7 percent of GDP. Drawing from studies by Ho and Nielsen (2006) and the World Bank (1997), the OECD report cited that without major improvements in air quality, by 2020 China could lose up to 13 percent of its GDP to health effects, which include:

- 600,000 premature deaths in urban areas;
- 9 million person-years of work lost due to air pollution-related illness,

BOX 1. Energy Options and Health Benefits Analyses in Shanghai and Beijing

Integrated Assessment of Energy Options and Health Benefits for Shanghai, China: a co-benefits analysis of energy and air quality policies and measures in Shanghai. Local technical team members included the Shanghai Academy of Environmental Science and Fudan University. The Shanghai Assessment was completed in 2001 and demonstrated that certain industry and power sector measures could simultaneously reduce greenhouse gas emissions, and emissions of SO_2, NO_2 and PM_{10}, while yielding substantial, quantified, public health and economic benefits. Results from this analysis influenced the development of Shanghai's Tenth Five-Year Year Plan.

Energy Options and Health Benefits for Beijing Case Study: a co-benefits analysis of energy and air quality measures to support the 2008 Beijing Olympics, was launched in Beijing in 2002. Local technical team members included Tsinghua University and the Peking University Health Science Center. Results from this analysis indicated that SO_2 and NO_X concentrations would reach the city's goals by 2008 if all of the measures included in the scenarios (derived from the Beijing Olympic Action Plan) were implemented. However, additional policies and measures would be needed for the city to reach its targets for fine particles.

- 20 million cases of respiratory illness per year; and,
- 5.5 million cases of chronic bronchitis and health damage.

In many countries, including China, policies that address energy and climate change are often managed separately from air pollution control policies. This makes it difficult for policymakers to adopt an integrated or multi-pollutant approach to managing emissions. For example, China's most recent Five-Year Plan includes a goal to reduce energy intensity by 20 percent by 2010 and a goal to reduce sulfur dioxide (SO_2) emissions by 10 percent. The lead agency for implementing the energy intensity goal is China's National Development and Reform Commission (NDRC) and the lead agency for implementing the Total Emission Control policy to reduce SO_2 emissions is the State Environmental Protection Administration (SEPA). While the government appears to treat these as two unrelated policies, China's heavy reliance on fossil energy creates powerful linkages and potential synergies between energy intensity and SO_2 emissions. Both policies clearly have implications for GHG emissions.

EPA's ongoing IES work in China seeks to shed light on linkages between the energy intensity and SO_2 policies by quantifying the related energy, GHG, air pollution and health benefits of measures that meet their targets. Other co-benefits may also be examined. The IES-China program was launched in 1999 under a statement of intent between EPA's administrator and SEPA's minister in conjunction with the U.S.-China Forum on Environment and Development. Since that time EPA has teamed with local partners to quantify the benefits, including greenhouse gas reductions, of energy and transport programs in China—initially with studies in Shanghai and Beijing that were well received by municipal governments. (See Box 1). The most recently completed phase of U.S.-China collaboration on IES is a national-level assessment of air quality, public health and economic impacts of clean energy and transportation strategies in China. It is part of a broader effort by EPA to support integrated planning and multi-pollutant approaches to environmental management in China.

OVERVIEW OF ENERGY SCENARIOS AND ASSUMPTIONS

The IES China National Assessment examines the air quality and public health impacts of clean energy and transport sector strategies in China

TABLE 1. Summary of Business as Usual and Climate Change Policies Scenarios

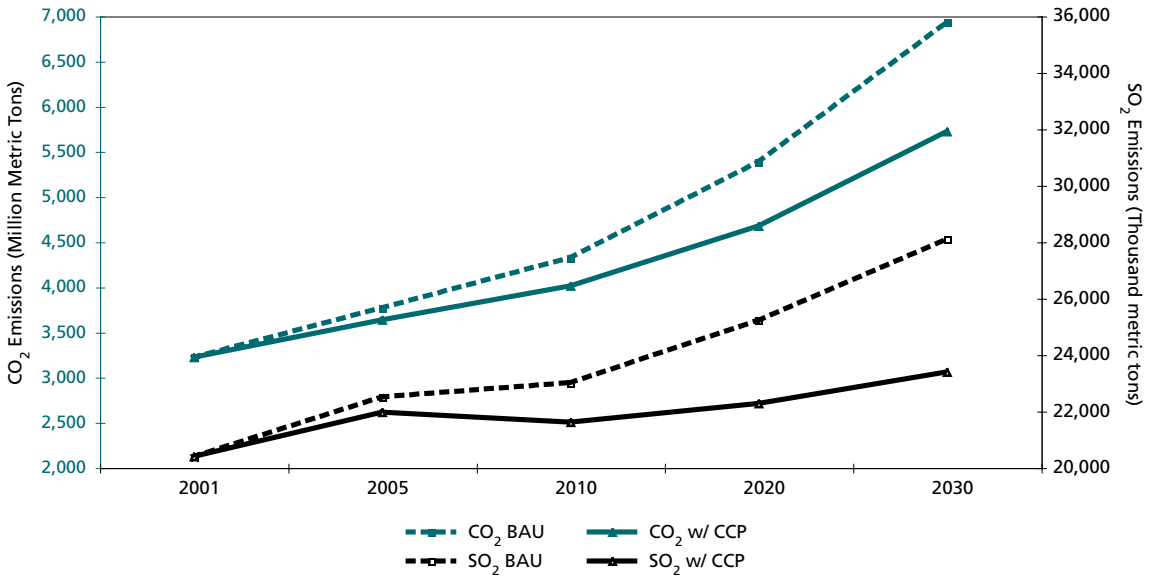
	BAU Assumptions	CCP Assumptions
Household Energy Efficiency		
Urban household energy saving lamp usage by 2010 and 2030	34% by 2010 45% by 2030	45% by 2010 70% by 2030
Rural household energy saving lamp usage by 2010 and 2030	20% by 2010 40% by 2030	24% by 2010 53% by 2030
Industrial Energy Efficiency		
Iron & steel annual energy intensity reduction	1.62% / year	1.72% / year
Nonmetal minerals annual energy intensity reduction	2.9% / year	3.2% / year
Chemical production annual energy intensity reduction	3.25% / year	3.5% / year
Manufacturing annual energy intensity reduction	2.5% / year	3.5% / year
Building Energy Efficiency		
Terminal heat load (Watts/cubic meter, W/m^2) of public buildings as percentage of 2001 value	68.4% in 2010 51.8% in 2030	54.4% in 2010 32.8% in 2030
Terminal heat load (W/m^2) of residential buildings as percentage of 2001 value	70.6% in 2010 54.0% in 2030	55.5% in 2010 36.1% in 2030
Vehicle Energy Efficiency		
Increase in energy efficiency of light buses and cars by 2030	46%	87%

from 2001 through 2030. The IES team compared analytical scenarios incorporating polices and measures against a "business as usual" (BAU) baseline scenario. The BAU scenario adopts long-term economic and energy projections developed by NDRC's Energy Research Institute in 2003. These projections assume:

- Continued GDP growth between 5.5 and 7.2 percent annually through 2030;
- Population will grow from just under 1.3 billion in 2001 to over 1.5 billion by 2030;
- Urbanization will shift from its current levels below 50 percent to approximately 65 percent by 2030;
- Industrial energy intensity will gradually improve through structural adjustments, technological improvements and cost-reduction measures;
- Existing energy conservation laws and policies will be well-implemented; and,
- In the transportation sector, the vehicle population will continue to grow, EURO III standards will be established in 2008, EURO IV in 2012 and EURO V in 2018.

Two policy scenarios were designed for analytical comparison against the BAU scenario.[2] One is a climate change policy (CCP) scenario that assumes the adoption of policies and programs that reduce the emissions of GHGs. The scenario's assumptions include: (1) the dissemination of efficient technologies throughout all industry sectors, (2) improvement in building energy conservation standards, and (3)

FIGURE 1. Projected CO_2 and SO_2 Emissions Reductions with Climate Change Policies



improvement in the efficiency of electric power plants and industrial boilers and vehicles. Overall, the CCP scenario projects a more rapid improvement in energy intensity over BAU assumptions, but was developed before China's recent national goal to reduce energy intensity by 20 percent. A summary of the BAU and CCP scenarios is provided in Table 1.

The second policy scenario adds pollution control policies to the CCP scenario. The pollution control policies scenario assumes: (1) a more aggressive timeline for adoption of EURO IV and V vehicular standards, (2) phase-out of power plants over 30 years of age, (3) faster than BAU installation of Selective Catalytic Reduction technology in power plants; and (4) more aggressive particulate matter (PM) controls for industry.

TOOLS AND METHODOLOGY FOR THE NATIONAL ASSESSMENT

The energy and emissions outcome of each scenario was modeled using two tools, the Long Range Energy Alternatives Planning System (LEAP), a multi-sector bottoms-up energy-environment model developed by the Stockholm Environment Institute and an emissions inventory developed under the Transport and Chemical Evolution over the Pacific (TRACE-P) program. A modeling timeframe of 2001 through 2030 was used to calculate the energy demand, supply and investment under each scenario as well as the emissions of SO_2, nitrogen oxide (NO_x), PM, volatile organic compounds (VOC), carbon monoxide (CO), and carbon dioxide (CO_2).

Total criteria air pollutant emissions were translated into atmospheric air pollutant concentrations using EPA's Community Multi-scale Air Quality (CMAQ) system, a third generation air quality model that uses a "one atmosphere" approach to estimate primary and secondary pollutant concentrations based on emissions and meteorological data. CMAQ can predict concentrations of pollutants that are created in the atmosphere through photochemical reactions, like ground-level ozone and fine particulates ($PM_{2.5}$). Many of these pollutants have strong health impacts, making CMAQ an important tool for air quality and health analysis. While CMAQ has been used often in the United States for air quality modeling, the IES China National Assessment was one of the earliest applications of CMAQ to China.

Information on air pollutant concentrations generated by CMAQ was then used to estimate health impacts with EPA's Benefits Mapping Assistance Program (BenMAP) health benefits model. Historically, avoided health impacts have been one of the key co-benefits examined under IES. Building the capacity to conduct health benefits analysis has been an unintended, but not unwelcome consequence of this

TABLE 2. Baseline Incidence of Health Endpoints

Health Endpoint	Incidence Rate, per 100 persons, per year
Mortality	
Death by All Causes	0.575
Death by Cardio-pulmonary Disease	0.320
Death by Lung Cancer	0.028
Morbidity	
Hospital Admissions, Respiratory	0.597
Hospital Admissions, Cardiovascular	0.881
Outpatient Visits, All Causes	26.18

work. Health effects partners in China included Fudan University (formerly Shanghai Medical University) and the Peking University Health Science Center. Through the course of conducting an IES project, these partners have received practical hands-on experience and training on topics including estimating avoided health impacts, examining local epidemiological studies, developing and/or adapting appropriate concentration-response functions and calculating changes in health impacts for different scenarios. Part of this capacity building has been the introduction of tools and resources including BenMAP.

BenMAP uses changes in pollutant concentrations, exposed population data and baseline incidence rates of health endpoints in conjunction with concentration-response functions to estimate health impacts associated with changes in ambient air pollution. With the inclusion of estimated unit economic values for each health endpoint, BenMAP also calculates the economic impact associated with their incidence. This project was the first application of BenMAP to calculate health effects in China.

The researchers used the 2001 *China Statistical Yearbook* for baseline mortality incidence rates. Baseline morbidity incidence rates were taken from the 2003 Chinese National Health Services Survey. Air pollution has both chronic, long-term impacts on human health and acute, short-term impacts. Numerous studies have been done to determine the concentrations response relationship between air pollution and human health. Looking specifically at particulate matter as a pollutant, the IES team examined both long-term cohort studies and short-term time series for the China National Assessment. These studies include the impacts of exposure to total suspended particulates, PM_{10} and $PM_{2.5}$ on human health. Table 2 lists the health endpoints examined and the baseline incidence rates.

In calculating economic impacts and benefits from air pollution, the team used contingent valuation (a.k.a. willingness to pay values) for the mortality estimates and cost of illness for morbidity estimates. The contingent valuation figures were derived from values published by Wang and Mullahy in 2006. The cost of illness figures (e.g., medical expenditures and lost earnings) were derived from the 1998 National Health Services Survey conducted by China's Ministry of Health.

Sample Results

The results of the IES analysis show that the climate change policies examined can reduce annual CO_2 emissions by approximately 13 percent by 2020 and roughly 17 percent by 2030. Concurrently, annual SO_2 emissions could be reduced by approximately 12 percent by 2020 and 17 percent by 2030. Projected annual emissions of NO_X, black carbon, organic carbon and non-methane volatile organic compounds also experience reductions with implementation of the climate change policies. Figure 1 illustrates the concurrent air pollution and GHG reductions achieved through the climate change policies.

With the reductions in pollutant emissions, modeled pollutant concentrations also fall when compared to the business-as-usual (BAU) base case scenario. For example, the study's preliminary results indicate that the climate change policies decrease national average particulate matter ($PM_{2.5}$) concentrations by 2 percent or 0.2 micrograms per cubic meter by 2020 and 3.5 percent or 0.4 micrograms per cubic meter by 2030. Although the study calculated annual emissions and average $PM_{2.5}$ concentrations of several air pollutants, only estimates of concentrations were used in the health effects analysis.

Preliminary results of the health impact analysis indicate that implementing the climate change policies (CPP) could prevent 20,311 cardiopulmonary related premature deaths nationwide annually due to

by 2020 and 29,239 by 2030. The results from examining morbidity under the CCP scenario suggest that more than 6,000 respiratory hospital admissions could be avoided by 2020 and approximately 9,000 respiratory hospital admissions could be avoided in 2030. Applying the economic valuation figures derived by the team, these results translate (in 2005 U.S. dollars) into economic savings of more than $22 million for avoided respiratory hospital admissions in 2030 and approximately $4 billion for avoided cardiopulmonary deaths. Thus the adoption of certain climate change policies could help address the growing health problems stemming from China's severe air pollution and the co-benefits of these policies could help offset the cost of implementing them.

POLICY IMPLICATIONS

China's rapid expansion is expected to continue in the immediate future, with the National Congress establishing a goal of fourfold economic growth between 2000 and 2020. While the economy remains heavily industrialized and dependent on fossil fuels, China's GHG emissions also will continue to grow. China is clearly paying attention to these trends, as indicated by the release of their National Climate Action Plan in June of 2007. With economic growth as a priority in the nation's development, China must weigh the costs and benefits of implementing measures to support the plan. Analyses like this one, and the capacity to conduct similar studies, will help the Chinese government understand and quantify additional benefits, including air pollution reductions and avoidance of health impacts that climate change mitigation measures may yield. Integrated analytical approaches like IES may also help China identify potential overlaps between climate, energy and air quality goals and synergies between actions to reach those goals.

The opinions and recommendations included in this article are those of the authors and do not represent official policies or positions of the United States Government, the U.S. Environmental Protection Agency or the Government of the Peoples Republic of China.

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NOTES

1. For more information on U.S. EPA's Integrated Environmental Strategies program, including full copies of studies from the China program, please see: www.epa.gov/ies.

2. Specific details of the BAU and other scenarios are available in the IES China National Assessment final report, "Energy Options and Health Benefits: China Case Study" available at www.epa.gov/ies.

COMMENTARY

Back to the Future: Bicycles, Human Health, and Greenhouse Gas Emissions in China

By Peter Koehn

China's greenhouse gas (GHG) emissions either have surpassed or shortly will surpass those of the United States (Bradsher, 2006; Graham-Harrison & Wynn, 2007). However, few individuals in China or elsewhere are motivated to change their emission-producing behavior exclusively out of concern for global warming. In every country, mitigating GHG emissions requires issue-bundling, or establishing links with other compelling human motivations. In urban China, reducing air pollution and protecting personal and family health constitute powerful current public concerns (Koehn, 2006). GHG emissions will be simultaneously mitigated as policymakers are successful in changing behaviors that currently produce air pollution and undermine health.

A majority of the world's most air-polluted cities are in China, and over the past decade vehicle emissions have replaced coal soot as the principal source of urban air pollution. In 1996, 8 out of every 1,000 inhabitants owned a car in China (Sperling & Salon, 2002). By 2006, some 24 million private vehicles (roughly 18 per 1,000 persons) navigated, or idled, on China's roads ("Low-emission cars," 2006; Kim & Turner, 2006). In Beijing and other major cities, the public refer to the prevailing rush-hour transportation gridlock as "one giant parking lot" (Murray and Cook 2004, 8-9**;** Phoenix Satellite Television, 2006).

China's vehicle emissions are associated with "brain damage, respiratory problems and infections, lung cancer, [and] emphysema" among other health concerns (Paterson 2000). A joint UNDP-WHO study found air pollution responsible for an estimated 500,000 unnecessary deaths per year in 28 Chinese urban centers (Porter, Shi, & Zhao, 2003). Asthma attacks in urban areas of China have reached 75 million a year, with the young and elderly the most susceptible (OECD, 2007).

At the turn of the century, pedal-power friendly China boasted one of the world's lowest rates of obesity among men and women aged 35 to 64 (McQueen, McKenna, & Sleet, 2001, 320). Since then, however, China's population has experienced a dramatic rise in obesity, diabetes, and abnormal blood lipid levels ("Health and Weight," 2004; "Obesity Increasing," 2006; Brownell & Yach, 2006).[1] Studies indicate that Chinese households with access to private motorized vehicles possess obesity rates that are 80 percent higher than peer households' records (Saletan, 2006).

City planners are responsible for the transportation decisions that have triggered much of the pollution and health issues. These recent developments not only coincide with rapidly increasing ownership and operation of personal motor vehicles, but also with the elimination of bicycle lanes and pedestrian sidewalks (Liu, 2006; Notar, 2006). Many Chinese cities continue to encourage private car ownership and create obstacles to bicycle use. For example, Guangdong has banned bicycles from the city center and many other cities are building new roads without separate bike lanes.[2]

For China's cultural leaders and local government authorities, reaching back to the bicycle as the "vehicle of the future" would enable them to connect public-health promotion with motor-vehicle-emission mitigation (see Lowe, 1989). Less than a decade ago, Shanghai inhabitants made 60 per cent of their trips by biking or walking (Schipper, 2006). Nationwide rates for non-motorized travel have declined to about 40 per cent at present (Oliver, 2006). Addressing the manifold problems associated with operating even more private motor vehicles

> **A joint UNDP-WHO study found air responsible for an estimated 500,000 unnecessary deaths per year in 28 Chinese urban centers.**

constitutes an urgent sustainable-transportation priority throughout China (Schipper, 2006, 22).[3]

Since curtailing automobile emissions primarily requires addressing "the amount and length of journeys" (Potter, 2001, 141-142) and, on average, people in China only move a total of 12-14 kilometers per day (Schipper, 2006), expansion of cyclist- and pedestrian-friendly routes and encouraging pedaling in place of short car trips—particularly during peak traffic hours—could bring about a substantial reduction in local air pollution, GHG emissions, and help keep respiratory problems, obesity, and type-2 diabetes in check (Helgerson, 2006). More than any other form of urban mobility, with the exception of walking, biking is consonant with the principal economic, social, and environmental "drivers" of sustainable transportation (Schipper, 2006): it is affordable to users, bears full social costs, promotes access for all, builds healthy communities, minimizes accidents and damage to human health, leaves no burdens for future generations, and produces no GHG emissions. In certain situations, biking even reduces overall travel time.[4] Current pedal-power options include the traditional "affordable" bicycle model, upscale versions designed for managers, various load-carrying models with trailers (Benjamin, 2004), and zero-pollution zinc-air-battery-powered bicycles (Tao, 2003).

Of course, not all of China's city and town dwellers can be expected to rely on bicycles as their exclusive form of vehicular transportation. Parallel pollution-reduction efforts, including links with improved bus and subway systems and support for concentrated residential patterns that are integrated with services, schools, and employment opportunities (Zhou et al., 2001), also constitute important components in an overall sustainable urban transportation-sector package. A feasible bicycle-centered goal would concentrate on reversing current personal-car usage and urban air-pollution trends. To encourage increased use, local policymakers in China need to ensure that bicycles are a safe, convenient, and cost-effective option. With the requisite infrastructure in place, a large-scale incentive scheme would further enhance the attractiveness of the bicycle among mobile individuals.

Encouraging sustainable pedal power in China (and elsewhere) calls for a new accounting system that rewards zero-emission, health-promoting mobility. In comparison with calculating clean-development credits by measuring reductions in GHG emissions, a more direct, personally recognizable, and potentially decisive approach would amply reward zero-emission (bicycle and foot power) travel. In the section that follows, I present some initial thoughts on what an emission-avoidance transportation incentive scheme might look like.[5]

Under my proposed emission-avoidance approach, each mobile individual would receive a monthly "GHG-transportation score." For illustrative purposes, a simple "zero-emission reward" system would calculate GHG-transportation scores as follows:

- Each zero-emission trip by bicycle, roller blades, or walking of one kilometer or longer: 1 point
- Each trip by public transportation of any distance: -1 point
- Each motorcycle trip of any distance: -2 points
- Each trip (multiple occupancy) of any distance in a passenger motor vehicle (or taxi): -2 points
- Each trip (single occupancy) of any distance in a passenger motor vehicle: -3 points

A GHG mobility-accounting system could involve a combination of honor-system reporting, observation, and trip-monitoring technology. Scores would be linked to powerful symbolic and monetary incentives for individuals, households, organizations, and communities. Individuals, families, business, government, and not-for-profit organizations, cities, and townships[6] would be recognized and rewarded/docked (in terms of health co-benefits, by financial remuneration, prizes, awards, tax relief, or clean-development credits, and by local, national, and international recognition) based on their net annual scores, applying the principle of *net emitters pay, net non-emitters reap*.

Monitoring and recording trips and managing the allocation of rewards would be challenging. While the prospect of such a system seems unwieldy,

this proposal is meant to stimulate interest among and elaboration by policymakers, community members, local planners, and far-sighted thinkers in China and other countries (such schemes should not simply be attempted in China). Detailed consideration of these issues goes beyond the scope of this commentary. Possibilities include submission by employers of independently verified reports on employee commuting, biking bonuses and commuting tax exemptions (see Daly, 2003), tax breaks for businesses when their employees record a net positive annual GHG-commuting emission score, support for a zero-emission tracking network of NGOs, monitoring and reward allocation by local environmental protection bureaus, and strengthened case for model-green-cities recognition.

Rediscovering and revitalizing China's vehicle of the past as the premier vehicle of its future represents a promising climatic-stabilization and health-promoting alternative, which could offer a model for other countries. At this juncture, the outcome of the emission-mitigation/health-promotion race remains undecided. Reaching back for lessons on how to protect and promote pedal power can thrust China forward into the "yellow-shirt" position of global mobility-leadership.

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NOTES

1. U.S. studies indicate that the health hazards of commuting by automobile include elevated blood pressure, increased neck and spine problems, and "lower thresholds for frustration at work" (Weiss, 2007).

2. In Beijing, however, "attempts to build new roads in the city without the obligatory bike paths were defeated by popular protests …" (Notar, 2006, 96).

3. Even in Europe, passenger-vehicle emissions "are rising rather than falling, unlike overall greenhouse gases …" (Landler, 2007, C1).

4. Zhi Liu (2006) reports that peak-hour speeds on Beijing's arterial roads averaged about 10 km/hour in 2005. Bicyclists can match or better this speed and save additional travel time in the vehicle-parking process. While living in Shanghai in the mid-1990s, the author usually was able to outpace buses on his affordable-model bicycle.

5. One advantage of an emission-avoidance-reward approach is that it incorporates populations that currently produce little in the way of *reducible* greenhouse gases (see Agarwal, 2002, 386).

6. This scheme also should be feasible in villages and small towns. Special consideration might be necessary for remote rural residents who depend upon motorcycles for contact with settlements and services. Aggregate country-wide scores need not be computed so that credit and attention remains focused on grassroots efforts.

Shanghai Green Oasis

By Kang Hongli and Mayu Suzuki

Recipes for *Heibanwa* (black-spotted frog) abound in China—gently-spiced stir fry, stewed, deep fried, or made into a congee. Frog legs are especially popular in these dishes, which are consumed most heavily in Shanghai, Guangdong, and Hubei. Despite prohibitions on eating frogs, they remain on the menu. In 2006, the NGO Shanghai Green Oasis conducted a survey on frog consumption in Shanghai and discovered that among 267 stores, 38 percent stocked frogs (102 stores); and slightly over half of the 259 street markets they investigated sold frogs. Shanghai Green Oasis estimates that annual frog consumption in Shanghai is approximately 3,000 tons. Frogs are imported from provinces near Shanghai (Zhejiang, Anhui, and Jiangsu) and further away (Sichuan and Shandong). This massive capture of frogs is leaving a decisive footprint on local rural ecology in these provinces in that they have lost a major natural insect predator, which translates into a greater need for chemical pesticides. In an effort to raise awareness of the danger of wild frog consumption, Shanghai Green Oasis has distributed this survey to government organizations, food safety management units, private companies, schools and neighborhood associations.

This activity is but one of many environmental education projects undertaken by Shanghai Green Oasis, one of the few green groups in Shanghai. This NGO was established in 2004 by a handful of volunteers who were working at various environmental organizations, such as the Shanghai Wild Animal Protection Association. The group's education activities focus on protecting wild animals, reducing water pollution emissions, and raising awareness of global warming—the last being an issue that could severely impact this coastal metropolis.

ENVIRONMENTAL EDUCATION PROJECT

Shanghai Green Oasis shapes its environmental education projects in ways that not only aim to raise awareness, but also help people feel connected to the issues, which ultimately could lead them to change their behavior. In 2005, Shanghai Green Oasis received 50,000 Yuan from the China Youth Toyota Environmental Protection Award to launch an educational project in ten elementary and middle schools in collaboration with the Shanghai Youth Technology Center. These ten pilot projects aim to develop and test an "ecological moral education" curriculum, which they hope could eventually be carried out nationwide.

FINDING SUSTAINABILITY FOR A SHANGHAI-BASED NGO

Unlike Beijing, Shanghai is not a hotbed of environmental NGO activism in China in terms of domestic or international groups. Thus, Shanghai Green Oasis decided to act as a communication network for the few environmental groups in the region, creating the Shanghai Green Association Forum. This forum has helped give Shanghai area NGOs an opportunity to interact and share ideas and to create joint activities.

Like other NGOs in China, Shanghai Green Oasis finds it difficult to maintain a consistent group of volunteers to carry out their work, for many of their volunteers are students who eventually move on. While funding has been challenging for Shanghai Green Oasis, they have benefited from support from Pacific Environment, Global Greengrants Fund, Bird Life International, and the Shanghai bureau for wild animal protection.

For further information about Shanghai Green Oasis see www.greensocc.org or contact info@greensocc.org.

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FEATURE BOX

China Holds the Key to Saving Wild Tigers

By Grace Ge Gabriel

It was not long ago when wild tigers roamed the dense forests of Lei Gong Mountain in Xi Jiang, Guizhou Province. That's when the forest in Xi Jiang teemed with wild bears, deer and boars, essential prey species for tigers, the ultimate predator. That was also the time when Tang Zhengbao, an ethnic Miao hunter, became known as the Tiger-Killing Hero. Responding to the government call for the elimination of tigers, then considered "pests," Tang bought a rifle and some traps. He proceeded to hunt anything that moved in the mountains and subsequently brought down over 30 tigers during the 1960s alone. For the pelt and bones from a 300-pound tiger, he was paid 500 Yuan ($70), a good price at the time! Today, Lei Gong Mountain stands empty and silent, barren of wildlife. Old man Tang, the hunter-turned-forest guard still goes into the mountain everyday hoping to find signs of tigers. Yet he has not seen anything bigger than a snake for a long time.[1]

This story captures the tragic end of the South China tiger (Panthera tigris amoyensis), the tiger subspecies that existed only in China. Merely 40 years ago, there were reportedly over 4,000 tigers. Yet, no South China tiger has been seen in the wild in nearly 20 years. Scientists believe this subspecies has become extinct in the wild. In fact, in the last fifty years, habitat loss and intensive poaching of tiger prey and tigers for the commercial trade in their parts and derivatives have caused the extinction of three additional subspecies of tigers in Asia. The fate of those remaining in the wild is uncertain.

While fewer than 30 individual South China tigers may still exist in the wild in the border region between China and its neighbors, over 5,000 tigers live on various captive breeding facilities across China. Under pressure from businessmen with commercial interests in these "tiger farms," the wildlife authority in China announced that it is "conducting policy research on the possibility and feasibility of permitting the medical use of tiger bone derived from captive bred tigers."[2]

This announcement brought significant alarm to the international community, particularly in many of the tiger range countries, which are experiencing increased poaching and a resulting dramatic decline of wild tiger populations. The status of tigers in the wild is now so precarious that any additional poaching pressure could quickly push the species to extinction.

Tigers have been listed on Appendix I of the Convention on International Trade in Endangered Species (CITES) since its first Conference of Parties (CoP) in 1975, and the desire to conserve the world's remaining wild tigers has galvanized the political will of the global community ever since. In order to halt the dramatic decline of wild tigers, CITES countries have adopted by consensus numerous resolutions and decisions to control the illegal trade of tiger parts and derivatives. To demonstrate compliance to CITES and effective implementation of its resolutions, China in 1993 banned the domestic trade in tiger bone, an ingredient historically used in Traditional Chinese Medicine (TCM). Since then, the government had removed tiger bone from the official pharmacopeias, conducted public awareness campaigns, and actively sought alternatives to replace tiger bone in medicine. These actions effectively closed down a significant legal tiger parts industry in China, which exported 27 million units of tiger products to 26 countries between 1990 and 1992.[3]

The ramifications for the surviving wild tiger populations of opening a floodgate to tiger parts consumption, even from captive bred tigers, in the world's

Factory farming of tigers in row after row of enclosures at the Guilin Xiongsen Bear & Tiger Farm, Southwest China. Photo Credit: IFAW/Sinopix

fastest growing economy is simply too dangerous an idea to contemplate. To counter this huge threat to the survival of wild tigers, an unprecedented coalition of NGOs from conservation, animal welfare, zoological and TCM communities came together to form the International Tiger Coalition (ITC) in 2006. Coming from around the world and each with its own mandate, ITC members share the common concern for the survival of wild tigers and work to end tiger trade (www.endtigertrade.org).

By the end of 2006, tiger farms across China have about 5,000 tigers in captivity with an annual reproductive potential of 800. Seeking a way out of the financial predicament that has resulted from the bad business decision of investing in the production of a banned commodity, tiger farm owners have been openly and actively lobbying the Chinese government to lift the trade ban.

ITC member investigation found that under the while tiger farms bill their work as "conservation" and "benefiting human health," they are in fact pure commercial operations that speed-breed tigers, stockpile tiger carcasses, and some even sell tiger bone products illegarlly. Farm-bred tigers are genetically compromised and therefore have no conservation value, nor can they be released into the wild, as they lack the skills to survive.

Farming tigers for legal trade in their parts would revive what is now a waning market interest in tiger products. Lifting the ban would stimulate more poaching of wild tigers, for it costs as little as $15 to kill a tiger in the wild, yet as much as $7,000 to farm a tiger to maturity for trade.[4] Since it is impossible to distinguish between farmed and wild tigers from their bones and products, farming tigers for trade provides opportunities to "launder" products made from wild tigers, creating enormous difficulties for law enforcement.

Moreover, farming tigers for trade in their parts tarnishes the reputation of TCM. With increasing recognition that prescribing endangered species hurts the image of TCM and reduces its ability to expand into global markets, the TCM communities within China and abroad have stopped using tiger bone. A recent survey by one ITC member revealed that of 518 TCM shops in China, a mere 2.5 percent of them claimed to stock tiger bone.[5]

"TCM as a cultural heritage of China does not wish to take the responsibility of causing the extinction of tigers," said Lixin Huang, the president of the American College of Traditional Chinese Medicine (ACTCM) who works to promote TCM in the United States. ACTCM, representing the TCM community in the ITC made the clarification at

the CITES CoP that "the request to legalize trade in tiger parts does not come from the TCM community. It represents only the desires of tiger farm-related business interests."

Concerned that farming tigers for trade could be detrimental to the survival of wild tigers, the 171 State members that are Parties to CITES, adopted by consensus the decision Conservation of and Trade in Tigers and Other Asian Big Cat at CoP14. The decision specifically urges all Parties to strengthen implementation of the previous tiger protection resolution (Res. Conf. 12.5), to improve international cooperation to control trade, and to not breed tigers for trade in their parts and derivatives. The decision became effective on September 13, 2007.

In this tiger emergency, the world awaits China's commitment to make the tiger trade ban permanent, close down tiger farms to keep the captive population only at conservation levels, and invest in the protection of tigers in their natural habitat. If the stabilization of the Amur tiger population of the Russian Far East is any indication, there may still be hope for wild tigers to roam the mountain forests of south China.

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COMMENTARY

Where the Wild Things Are…Sold

By Linden J. Ellis and Jennifer L. Turner

As China becomes more affluent, demand for previously unaffordable goods has increased, most strikingly rekindling the age-old tradition of wild animal consumption on a massive scale. Despite wildlife protection laws and fears of wildlife spreading diseases, such as SARS, wild animals continue to be consumed as fur, food, and medicine all over China, particularly in the southern regions. Because of the great consumer demand, China has become the world's fastest growing market for illegal wildlife smuggling, despite the government's efforts to crackdown on such trade ("Endangered wildlife," 2004).

SURVEY OF CONSUMPTION

In 2006, WildAid and the China Wildlife Conservation Association released findings from a one-year study of wildlife consumption in China between December 2005 and January 2006. The survey showed that the percentage of people who did not eat wildlife had increased by 11 percent since 1999. SARS contributed to the drop in consumption over this time period. The top reasons for consuming wildlife were health and nutrition, curiosity and taste. Other interesting findings included: restaurants serving wildlife had decreased by 6.6 percent, but the number of grocery stores selling wild animals had increased by 22.8 percent; around 63 percent of those people surveyed believed that eating wild animals from illegal sources was unsafe; and 74 percent of all the respondents knew that consuming certain wild animals was against Chinese law (Parham, 2007).

A SLITHERING LUNCH

One recent *China Dialogue* article (Parham, 2007) notes that "twenty tons of snakes and as many as 20,000 birds were eaten every day in Guangdong restaurants in 2001." The popularity of snakes on the menu in southern China has led to significant drops in cobra and rat snake populations ("Snake species," 2004). While officially banned, hunting and raising snake and other wild animals is a lucrative endeavor, with a pound of civet cat costing more than 8 times a pound of pork. Many farmers depend heavily on wildlife consumption for their income.

Something Fishy

South China is a major gateway for live fish and shark fin imports into China. While such marine animals are not illegal, the rate and means of catching them pose a growing threat to marine ecosystems globally. For example, many Chinese fishers use cyanide or dynamite to stun fish so they can be sold in the lucrative live-fish markets, inflicting great collateral damage upon habitat and non-target species. Until the late 1980s, shark-fin soup was only a regional delicacy in southern China. Notably, the Chinese government had for decades condemned the soup as a symbol of elitism, but according to a WildAid researcher, the official stance against the soup ended in 1987 (Pellissier, 2003). Shark-fin soup is an increasingly popular dish throughout China at weddings and banquets, eaten more for social status than for nutritional value. Conservation International researchers report that fishing fleets globally are capturing millions of sharks each year to sell fins to what appears to be an insatiable and primarily Asian market (Barret, 2007). Nearly half of the global trade in shark fins goes to China through Hong Kong (Pellisier, 2003).

Fur for Fashion

In 2007, 104 furs, including 27 highly endangered snow leopard pelts, were confiscated from a man's flat in Gansu Province ("Snow Leopards," 2007).

The fur trade in China is geared towards export, where it is consumed primarily in Europe. In many cases, the fur trade is impossible to separate from the food and medicine trade, for while tiger pelts are very lucrative for clothing, their paws and meat also fetch a high price. While the lucrative sale of endangered animals threatens wildlife, it does not match the volume generated by lower tier fur animals, such as raccoon dogs (*Nyctereutes procyonoides*), which is a farmed wild animal, not a domesticated dog. Due to a U.S. law stating that any item sold in the United States priced below $150 does not need to label the type of fur, many garments have fur trims that can only be identified through DNA. In February 2007, the Humane Society released a report showing that 24 out of 25 Chinese-made coats labeled "faux fur" were raccoon dog fur, most of which are raised in concentrated animal feeding operations (CAFOs) (Holland, 2007).

> **Many Chinese fishers use cyanide or dynamite to stun fish so they can be sold in the lucrative live-fish markets, inflicting great collateral damage upon habitat and non-target species.**

Bony and Bilious Medicine

Traditional Chinese Medicine is responsible for endangering 27 species in China, according to the *OECD Environmental Performance Report for China* (2007). Based on a 1998 survey, 74 percent of Hong Kong medicinal animal consumers would give them up if they knew it would save wildlife, and 65 percent who consume rhino and tiger parts for medicinal purposes would give them up if they knew they were illegal to consume (OECD, 2007). The survey underscores a major problem of uninformed consumers.

Additionally, bear bile farms in China market their products aggressively, driving consumers away from better, more environmentally friendly, synthetic products (Lavorie, 2007). Many Chinese believe that wild animal parts are more potent and beneficial than farmed animals. One wild-caught bear gall bladder—used for preventing and repairing liver damage—can sell for $45,000, as compared with around $230 for a farmed gall bladder (Lavorie, 2007; Highley & Highley, 1993).

Wildlife Farming—Good Protection Strategy?

The central controversy around wildlife farming is whether it actually helps protect wild animals or exacerbates their consumption. Some believe that legalizing farm-raised animals represents a promising strategy for protecting wildlife for two reasons: (1) wildlife is a high-value product that could help lift some poor farmers out of poverty, and (2) farming increases the numbers of the animals for sale thereby lessening pressure to poach them. Moreover, because animals can be farmed for much less money and risk than they can be poached, farmed animals in theory out-compete wild animals in the market.

Notably, there are two obstacles that prevent legalized farming from being a sustainable option. Firstly, since the SARS epidemic, many consumers now believe that, at whatever price, wild-caught animals are safer to eat than farmed animals. Secondly, there is no discernable difference between the products of farmed and poached animals, so illegally caught wildlife can easily slip into the market without punishment. The alternative plan for wildlife conservation is to make all forms of wildlife consumption illegal, thus anyone selling the animals or their derivatives can be identified easily and punished.

Legalized sale of farmed wildlife thus can increase demand for consumption and poaching, which depletes ecosystems of important animals. For example, snakes, one of the most widely consumed predators, have experienced high population losses in China over the last decade—as high as 90 percent of cobras and 75 percent of common rat snakes. This has left the mouse population unchecked, adding to crop decimation in southern China ("New lunar year," 2001). Another ecological side effect from increased wildlife farming is pollution, since few wildlife farms in China process animal wastes before dumping them into local waterways (Ellis, 2007).

Besides ecological damage, cruelty is another argument against wild animal farms. Many animal activist organizations, such as Animals Asia and International Fund for Animal Welfare, argue that wildlife farming has led to cruel treatment of many animals For example, bear bile farms keep bears

in small cages so as to continually drain their bile through a permanently inserted tube ("China bear rescue," 2007). Rough transportation to markets and rapid slaughter resulting from an intense preference for fresh products, is another source of cruelty. So as not to damage pelts, animals for fur production are beaten on the head to stun them, but many remain conscious for 5 to 10 minutes after they are skinned (Hieh-Yi et al., 2005).

Illegal Animal Smuggling Into China

A 2006 study found 80 types of wildlife species available for consumption in Chinese markets, up from 53 found in a 1999 survey (Wong, 2007). With such a high domestic demand, China has become the world's fastest growing market for illegal wildlife smuggling. Despite the Chinese government's efforts to crack down on such trade, China's wildlife market is estimated at $10 billion annually (Wong, 2007). Four examples to give a sample of this smuggling include:

- In 2005, a police raid in Hong Kong found 2,000 pangolins destined for restaurants in Guangdong ("Odd chicken wings," 2005).
- Malaysia's marine police thwarted an attempt to smuggle 5,000 endangered monitor lizards to Hong Kong and Thailand in 2006 ("Malaysian police, 2006).
- In 2007, 2,400 live banded rat snakes were intercepted in Penang airport, Malaysia, on their way to Hong Kong ("Outrage as snakes," 2007).
- In Guilin in 2007, police arrested one man smuggling 64 bear paws from a protected species. The net worth of the catch was $42,666 (Chinese police nab," 2007).

Government Action

The Chinese government has been attempting to prevent unsustainable consumption of wildlife, beginning with the 1982 Constitution that directs the state to ensure rational use of endangered animals (OECD, 2007). The foundational 1988 Wildlife Protection Law dictates a list of protected species and allows the death penalty for significant damage to wildlife resources (OECD, 2007). In 2001, the Chinese government began issuing hefty fines for consuming protected wildlife (Parham, 2007). Perhaps one of the most successful efforts has been the Traditional Chinese Medicine labeling system introduced in 2003 by the State Forestry Administration (OECD, 2007). Under this program, only medicines containing legal ingredients can be labeled.

China also has been increasing both land and marine protected areas to cover about 16 percent of the country's area, with 31 percent dedicated to protecting wild fauna (OECD, 2007). According the 1994 Regulations on Nature Reserves, the protected areas are intended to be strict nature reserves, but management of these areas is often insufficient.

To combat trade in endangered species, China became a member of the Convention on International Trade of Endangered Species (CITES) in 1981. In 2006, the Chinese government issued new CITES regulations directly impacting Traditional Chinese Medicine (OECD, 2007). According to the OECD, China has a good reputation for submitting CITES reports, and has a national office dedicated to enforcing the regulations. Nevertheless, on-the-ground enforcement remains weak.

Conclusion

Wildlife consumption in China continues despite government intervention and education campaigns, such as those by WildAid, which is using Chinese Olympiads to help in their aggressive public service advertising campaign against wildlife consumption. Shark-fin soup remains standard fare at Chinese weddings, which indicates environmental education has not yet stymied the age-old appeal of consuming wildlife. Ultimately the best solution to wildlife consumption in China lies primarily with consumer education and in streamlining identification and prosecution of anyone dealing in threatened species.

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SPECIAL REPORT

The Nexus of Health and Environment: Update on Western Kentucky University's China Environmental Health Project

By Jennifer L. Turner and Linden J. Ellis

THE CHALLENGE

Millions of rural and urban citizens in China suffer from health problems and constraints to economic development due to air pollution from coal and contamination or shortages of water. In southwest China, water challenges are particularly acute due to that region's karst geology, where much of the water flows underground through caves rather than at the surface and the soil is extremely porous, which allows pollutants to quickly contaminate water. Health problems stemming from polluted water or lack of access to water are yet another burden on tens of millions of subsistence farmers who live below China's poverty threshold of $85 per year. Urban China is not immune to growing environmental health threats—on the highly urbanized east coast emissions from coal-fired electric power plants have led to growing respiratory illnesses and premature deaths.

THE CHINA ENVIRONMENTAL HEALTH PROJECT

For 15 years, scientists at Western Kentucky University (WKU)—together with Chinese university counterparts—have undertaken applied research and training projects focused on enhancing Chinese infrastructure and technical capacity to solve drinking water challenges in southwest China's limestone karst regions and to monitor emissions from coal burning on the urbanized east coast.

In October 2006, WKU's research efforts coalesced into the China Environmental Health Project (CEHP). With major support from the U.S. Agency for International Development, WKU's Hoffman Environmental Research Institute and Institute for Combustion Science and Environmental Technology began carrying out CEHP in partnership with the China Environment Forum (CEF), the International Institute for Rural Reconstruction (IIRR), as well as Chinese scientists from the School of Geography at Southwest University of China near Chongqing and the Anhui University of Science and Technology in Huainan. The main foctus of this collaborative environmental health project is promoting university partnerships to enhance technical infrastructure in air quality analysis, hydrogeology, and geographic information systems computer mapping technology. Besides the scientific component of the karst water and coal activities, CEHP includes a strong outreach component to communities and relevant policy and research representatives in China.

In this short report, the lead CEHP researchers at WKU—Chris Groves and Wei-Ping Pan—provide updates on their work in the field in China. Amelia Chung, from IIRR presents a short piece about her community outreach work for the CEHP karst project in Yunnan. Below we outline some of CEF's work under CEHP.

CEF Outreach Work

In Yunnan, CEF and IIRR are working with a local research institute to help communities work with the U.S. and Chinese karst scientists. CEF is also setting up workshops and meetings to help WKU researchers do outreach to Chinese government officials, journalists, scientists, and interested citizens on the environmental health issues addressed by CEHP field work. Besides on-the-ground work, CEF has created a new environmental health website for posting CEHP papers and updates, as well

as information, news, and research on broader environmental health challenges in China (see details below). CEF also has been focusing most of its monthly meetings in Washington DC on issues of environmental health and public participation in the environmental sphere in China. The 2007 and 2008 issues of CEF's flagship publication—the *China Environment Series*—will feature special reports on the CEHP's activities, as well as papers and reports on broader environmental health trends, policy, and activism in China.

CEF Website

New in 2007, CEF has vamped up its website with a new section on environmental health, which includes a collection of original research intended to link environmental problems to their human impacts and emphasize gaps in policy and research spheres. The CEF environmental health page is divided into 4 categories: (1) declining air quality; (2) water pollution and scarcity; (3) land use including waste, agriculture and food safety; and (4) environmental health policies, research, and activism. CEF and members of our network have been busily compiling research briefs and fact sheets on different topics within these categories, which are on the CEF website in html and Adobe formats.

Declining air quality is a significant threat both to China and its neighbors. Within China it causes acid rain over two-thirds of the country and leads to as many as 750,000 respiratory deaths domestically each year. In 2007, CEF produced environmental health research briefs on air pollution that cover transboundary air pollution, coal mining, desertification, cement production, and indoor air pollution. While China's air pollution is serious, perhaps the greater environmental health threat is water degradation and scarcity. At least 300 million Chinese lack access to safe water and consume water contaminated with organic and inorganic pollution causing a variety of illnesses from typhoid to cancer. Water scarcity in northern China is among the most severe worldwide, with millions of farmers becoming eco-refugees fleeing a growing ocean of sand. CEF's environmental health research briefs on water cover water-borne illness in China; Chinese water pollution control laws and regulations; child mortality and water pollution in the Chinese countryside; and aquaculture.

Deforestation, overgrazing of grasslands, excessive pesticide use, and uncontrolled disposal of solid, hazardous, and medical wastes not only endanger China's rich biodiversity, but also represent major threats to human health through soil and water contamination and reduced land on which to make a living. In 2004, SEPA Vice Minister Pan Yue estimated that each year China generates, 10 million tons of industrial waste, 650,000 tons of medical waste, and 115,300 tons of radioactive waste. CEF has produced environmental health research briefs that cover hazardous and medical wastes, imported solid wastes, e-wastes, and shipbreaking. Other research briefs have highlighted links between agriculture and environmental health and covered China's concentrated animal feeding operations, pesticides, organic food developments, and food safety.

More information about CEHP can be found at www.wku.edu/cehp and at the China Environment Forum website www.wilsoncenter.org/cef. Jennifer Turner can be contacted at cef@wilsoncenter.org and Linden Ellis at linden.ellis@wilsoncenter.org.

The Jane Goodall Institute Roots & Shoots Program in China

By April Nigh

Every individual matters; every individual has a role to play; every individual can make a difference.

—Dr. Jane Goodall

With one of the fastest growing economies in the world, China faces stresses on its resources and environment that are perhaps unprecedented in human history. Many Chinese citizens know little about their individual or collective impact on the environment, and do not necessarily understand how they could even participate in conservation.

This lack of awareness makes Dr. Jane Goodall's values, message, and example extremely important for China's citizens, animals, and environment. The Jane Goodall Institute (JGI), in all its locations around the world, works to advance the power of individuals to take informed and compassionate action to improve the environment for all living things. It strives to create healthy ecosystems, promote sustainable livelihoods, and nurture new generations of committed, active citizens.

JGI's Roots & Shoots (R&S) is a nonprofit environmental and community education program for youth. Since its inception in Tanzania in 1991, R&S—which now has members in nearly 100 countries—has made a long-term impact on many young people, teaching them they are capable of protecting the environment and wildlife. Members of the R&S network create service learning projects based on their own ideas and concerns, and in the process develop leadership skills and a stronger sense of environmental stewardship.

ROOTS AND SHOOTS SPROUT IN CHINA

Foreign teachers began to facilitate environmental education activities for children in China in 1994, using the name of JGI's Roots & Shoots program. These initial activities helped lay the groundwork for the establishment, in 2000, of the JGI China office in Beijing as a financially independent entity of the global JGI network. JGI China has responded to a growing need for and interest in environmental education outside of the regular school curriculum in Chinese schools and universities by promoting the participatory, child-led, extra-curricular approaches of the international R&S Program.

In addition to the office in Beijing, which works with teachers and students all around China to promote and nurture the R&S program, JGI China opened an office in Chengdu, Sichuan Province in 2006 to enhance the program in southwest China, with a special focus on rural environmental education. China's southwest is one of the most biologically diverse regions in the world, and conservation education—particularly in rural areas surrounding forests and nature reserves—is imperative for its preservation. Prior to establishing the Chengdu office, JGI China staff had been working in villages surrounding Sichuan's Baishuihe Nature Preserve for over two years through the Pride Campaign program, for which it was awarded a Ford Motor Conservation & Environmental Award Honorable Mention in 2006. The Pride Campaign consisted of education and awareness activities centering on the golden pheasant—a local flagship species—as a way to build and nurture the local population's pride in their natural environment. Components included educational activity booklets and teacher trainings for local schools, as well as distribution of calendars and other promotional items to villagers in the area as a way to build awareness of the local environment.

ROOTS AND SHOOTS SPECIAL PROGRAMS

The Roots & Shoots China network also includes offices in Shanghai and in Nanchang, Jiangxi Province. In addition to individual R&S student group projects, the JGI China R&S offices also offer

Jane Goodall's yearly visits to China have been a major catalyst to the creation of new Roots and Shoots groups throughout the country. Photo Credit: Jane Goodall Institute.

special programs and events to boost the activities of the R&S network:

In April 2007, the Beijing Office partnered with Friends of Nature, China's first local environmental NGO, to hold the second annual "New Earth Echoes" Earth Day concert in Beijing, which featured popular local rock bands. Also in April 2007, the Beijing Office launched a city-wide water conservation education curriculum and program in Beijing area middle schools. Other special programs of R&S Beijing include a R&S zoo enrichment volunteer program, an environmental English training activity in local middle schools, summer service learning programs, and teacher and volunteer trainings. The R&S Beijing Office planned the country-wide R&S member summit during Jane Goodall's China visit in November 2007.

The Chengdu Office continues the aforementioned Pride Campaign program with the help of WWF-China to strengthen and expand existing rural environmental education programs, as well as a mentorship program linking university students with R&S student groups in primary and middle schools. The Chengdu office is also cooperating with the UK's Royal Society for the Prevention of Cruelty to Animals to hold animal welfare education workshops for R&S teachers in southwest China.

The Shanghai Office is working with several R&S groups to start an organic garden on their campuses. They also have launched an "eco-office" assessment team, which visits and evaluates the environmental efforts of workplaces around the city. Other R&S Shanghai initiatives include a project to support planting trees in Mongolia, a Yellow Pages Recycling program, and a service learning trip for urban R&S students to rural Anhui Province. R&S Shanghai was also able to participate in the recent "Live Earth" Shanghai activity by setting up a display table at the venue.

The Nanchang R&S Office was established in October 2006, and has begun building R&S student groups and launching an "eco-office" assessment.

IMPACT OF ROOTS AND SHOOTS

Thanks to the spreading popularity of Dr. Goodall through her annual visits to China and the growing reputation of the R&S network, new R&S groups continue to "sprout" all over the country. There are now over 300 R&S groups throughout China and all of them are based on a spirit of volunteerism, demonstrating that individuals can make a difference through active participation. Meanwhile, JGI has established and continues to build relationships and grassroots projects with government agencies, teachers and schools, communities and nonprofit organizations in China. In 2007, JGI China welcomed a team of graduate students from Columbia University's School of International and Public Affairs to conduct an evaluation of the R&S Beijing program's impact on the environmental consciousness of participating Beijing area youth. Their conclusion was extremely encouraging, reporting that R&S is truly turning its members into active and responsible environmental stewards. R&S students have more confidence and leadership skills, and a stronger tendency to increase their knowledge and awareness about issues regarding the environment and animals.

For more information on JGI and Roots and Shoots activities in China see: http://www.jgichina.org.
April Nigh is the program officer in the Beijing Office of JGI. She can be reached at: anigh@jgichina.org.

SPECIAL REPORT

Water Resource Challenges in Karst Regions of Southwest China

By Chris Groves

Besides offering a crash course in karst water problems in southwest China, this section of the report highlights the ways in which the USAID-supported China Environmental Health Project (CEHP) is carrying out field activities in Yunnan and Chongqing to improve local community access to water.

Building on a long-standing university partnership with the School of Geography at Southwest University of China (SWUC) in Chongqing, Western Kentucky University's (WKU) Hoffman Environmental Research Institute is providing training to Chinese scientists in critical technological areas to better understand and develop solutions to karst-related water problems. The SWUC group is one of China's most experienced in karst science, with extensive knowledge of the geography, resources, social and cultural issues in the southwest karst regions. However, there has been relatively limited access to training and information on the most up-to-date technical methods in this relatively esoteric field. Notably, karst hydrogeology has been an area of intense specialization at Western Kentucky University for several decades, which has enabled its scientists and students to develop a solid research infrastructure, with extensive international experience in both the basic and applied areas of karst science and water resources development. CEHP karst activities also include a community outreach component to help increase local village and government involvement in the research and design of solutions increase access to reliable and safe water in the karst areas of rural southwest China.

WATER WATER EVERYWHERE…

Karst regions have been estimated to cover some 15 percent of the earth's land area, and supply drinking water to nearly a quarter of the world's population (White, 1998; Ford & Williams, 1989). Southwest China's more or less contiguous karst area is among the world's largest and has produced some spectacular landscapes—the most well known of which are the gumdrop-shaped mountains along the Li River near Guilin (See Figure 1). Covering some 500,000 km^2 in parts of Guangxi and Hubei to the east, westward through Hunan, Guizhou, and Yunnan, and from there upwards into Sichuan and the municipality of Chongqing, these karst areas are home to an estimated 80 to 100 million mostly rural residents.[1]

While water *quality* challenges are common throughout China, with wet monsoonal rains each summer, this region in the southwest is not often considered to have widespread water *quantity* problems. Serious problems, however, do occur in the widespread limestone karst region in southwest China. In this region, highly soluble and permeable bedrock has over centuries dissolved to form "Swiss cheese"-like landscapes, in which caves and underground rivers are common, but surface water is often scarce in the long dry season.

…BUT NOT WITHIN REACH

This lack of access to surface water for much of the year exacerbates the widespread rural poverty in the southwest—seven of the region's eight provinces are among China's poorest. As many as 10 million of the karst area's mostly rural residents earn below the current national poverty standard of 680 Yuan ($91) per year. Thus, resources in the region to ameliorate karst water-related environmental and public health problems are limited.

China's karst regions are in fact plagued with both water access and quality. The vast underground rivers are can be over a thousand feet below the surface, leaving water largely inaccessible at the surface. In the extensive agricultural areas of this region water infiltrating underground rivers also can carry contaminants, such as pesticides and fertilizers, as well as bacteria associated with human and animal waste. In contrast to many areas where groundwater reaching the surface through springs or wells is of relatively good quality, in the southwest China karst region groundwater is very often polluted to some degree, because the underground rivers move too fast to filter out contaminants.

In the dry season, residents of the region often are forced to carry water from a spring or cave several miles away, and as these supplies are often lower in elevation, the loaded route back can be even more arduous with a steep upward path. This time-consuming task naturally impacts social and economic conditions as time spent carrying water neither generates income nor contributes to any number of other useful pursuits, including for example, family activities or education. There can also be direct health consequences, including injury, particularly to the neck and spine (Curtis, 1986), as well as health impacts from differences in hygiene behavior and diet as travel times to water sources increase (Cairncross & Cliff, 1987; Mathew, 2005).

Outside observers may query why people established villages in such water-scarce areas. The answer lies in a striking environmental change in the landscape caused by deforestation in the 1950s. Southwest China is an area with a subtropical climate that used to possess relatively lush vegetation and thick soils. In subtropical karst areas it is common that very shallow underground water bodies can form in the vicinity of the soil/bedrock interface within what geologists call the *epikarstic* zone, where the upper parts of the bedrock are especially highly dissolved and soil-filled fractures can provide zones for water storage. In southwest China these zones naturally get charged with water during the rainy season and in many cases can leak out through small springs throughout the year, supplying enough water to sustain a community. Prior to the 1950s, this delicate ecological balance existed, with water supply problems limited to drought conditions.

Unfortunately, widespread deforestation of southwest China beginning in the late 1950s wreaked ecological havoc on the vegetation (Shapiro, 1991) and in turn there was massive soil loss in the steep karst mountain areas, leaving bare rock exposed over thousands of square miles. (See Photo 1). With the soil gone so was the water storage capacity of this shallow zone, and the abundant springs (Huntoon, 1992; Yuan, 1997; Huang & Cai, 2006, 2007). Chinese scientists call this process rocky desertification (石漠化), and it is recognized as a major environmental difficulty in the southwest. Studies in 2005 estimated that areas impacted by rocky desertification in the southwest karst area are growing by nearly 600 square miles per year (*People's Daily Online*, 2005). Of course agriculture and the ability to grow crops were also heavily impacted by this soil loss (Yuan, 1997).

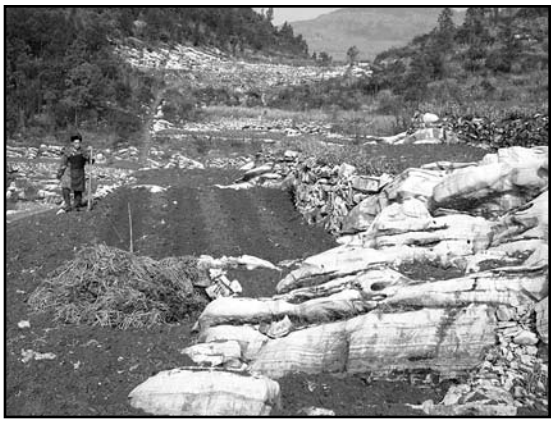
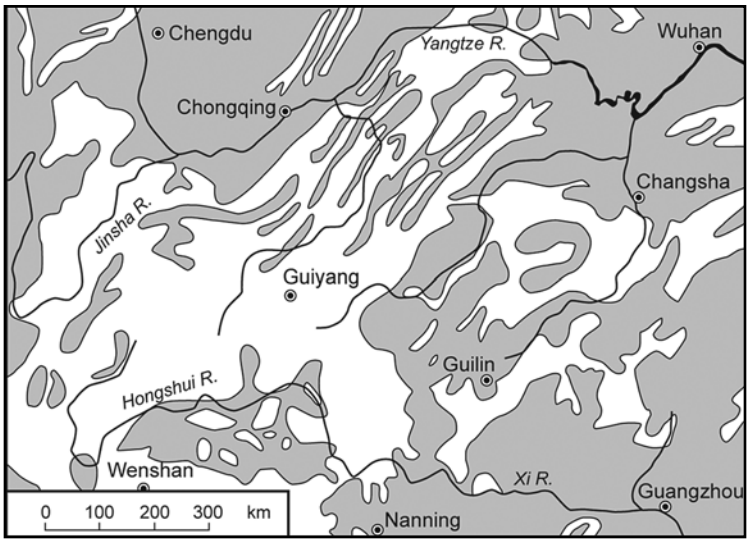


Photo 1. Typical scene of rock outcrops and thin soils associated with rocky desertification in the karst areas of the southwest, following widespread deforestation and soil loss. This photo example was taken in southern Chongqing municipality.
Photo Credit: Chris Groves.

TECHNOLOGICAL CHALLENGES TO SOLVING KARST WATER PROBLEMS

Exploitation and management of groundwater resources in karst settings requires methodologies quite different from those used in other areas. In many non-karst regions, for example, underground water exists in pore spaces between grains of rock or soil (e.g., akin to how water is able to soak down into the soil when one is watering a houseplant) or extensive networks of fine fractures. In such cases if one drills down far enough into a saturated zone of bedrock at some location, or moves a few hundred feet in either direction, it is likely that a productive well can be established. Within the bedrock of karst regions, in contrast, water flows as discrete rivers through a natural underground "plumbing system" of conduits (such as the extensive caves in Guilin



Generalized map of the southwest China karst region (white areas show extent of karst area). Source: Map prepared by Erin Lynch, modified from Yuan (1991).

popular with the tourists), that exist within rock that is otherwise comparatively impermeable. Thus, a well that makes a direct hit into an underground river within such a conduit may be able to supply an enormous quantity of water, while another missing the conduit by as little as a few feet may produce a dry hole. For this reason a major emphasis in the methods used to study and exploit underground karst water resources involves identifying the locations and pathways of these conduits and their associated underground rivers. Such methods also are needed to identify the locations of the source areas for such rivers to understand how upstream land-use practices may be impacting the water's suitability for drinking or other uses downstream. Unfortunately, the most up-to-date technology for undertaking such karst-specific studies is relatively limited among Chinese scientists.

Mapping Invisible Rivers

Major methods for studying underground river pathways include direct exploration and mapping of the underground rivers themselves. In rivers where direct human access is not possible, for example beyond where a cave passage has collapsed, fluorescent dyes can be used to trace underground water pathways. The dye can be added to the water, where a surface stream disappears underground into a cave entrance, and then springs in the area are monitored to see where the dye flows back out. State-of-the-art methods for such work use nontoxic dyes that can be detected in extremely low concentrations, with the advantage that small amounts of tracers can be used.

While such water tracing is a relatively obvious concept to study water in these regions, and has indeed been undertaken in China, up-to-date methods are only now being introduced there, as discussed later in this article. Previously, the most common tracing method used in China was rock salt, which while invisible when dissolved, has a chemical signature that can be easily detected in sufficiently high concentrations with very simple equipment. A problem with this method, however, is that large and environmentally questionable quantities of salt are required for tracing larger streams. In one breathtaking example that the author learned about while studying a cave system in southern Yunnan Province, Chinese scientists had previously traced the route of a large underground river using more than 26,000 pounds of rock salt! An estimated 300 laborers carried the salt some 5 miles from the nearest road to a site where they introduced the salt into the river where it disappeared into a cave entrance. While they were indeed successful in proving the connection of that that river with another cave river miles away and adding to the overall knowledge of the subsurface flow system, with appropriate analytical technology the same water tracing experiment could be completed with probably less than ten pounds of fluorescent dye—an amount easily carried by one person in a small backpack.

Diving Underground

Another important method is to directly explore and map of underground river systems. Such mapping is done by groups of three or four traveling into the underground system and, to the extent possible, following the rivers and making surveying measurements that will later allow the production of three-dimensional maps displaying the geometry of the passages with respect to the surface landscape above. As the passages can be (and often are) wet, muddy, and in some cases tortuously tight, the mapping equipment must be small and compact, and not easily

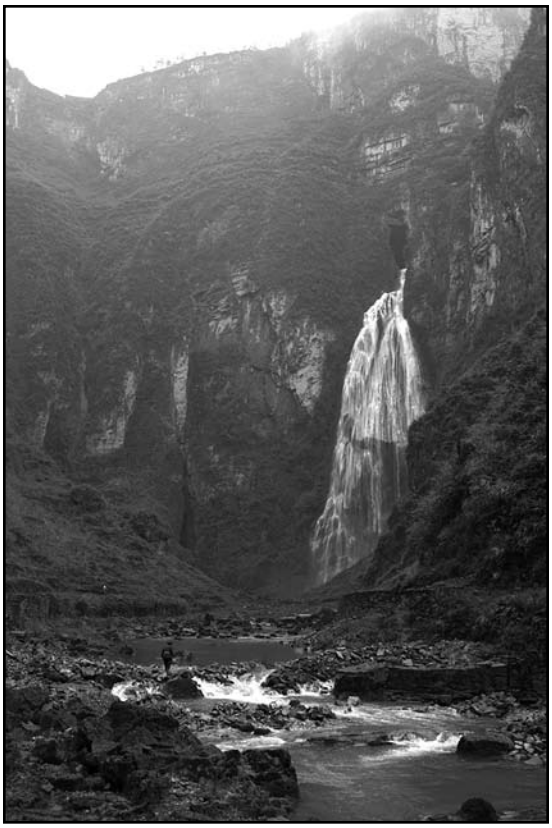


Photo 2. Spring entrance to Dalongdong (Big Dragon Cave) in western Hunan, shown during the summer rainy season. The entrance to the cave is about 100 feet high and the waterfall drops about 850 feet to the valley floor—note person in the foreground to the left of the stream. Photo Credit: Kevin Downey.

damaged. Hand-held compasses and measuring tapes work well, and if carefully used provide excellent data. There are a range of methods for converting these measurements into a final map, ranging from performing the requisite calculations on a hand calculator and then plotting the map on paper, to employing sophisticated Geographic Information Systems (GIS) computer software. While GIS technology in general is rapidly spreading in China, the most current technology for these specific karst-mapping applications is not uniformly available.

An associated challenge—and one for which there exists limited technology among Chinese water resource scientists—is the fact that many of the river caves in southwest China extend with great vertical drops sometimes 1,000 feet below the surface. Thus, ropes with complex rigging and related equipment, and a high level of associated skills are often required to negotiate these systems to collect the mapping data, a prerequisite for the exploitation and protection of karst water resources.

CEHP Work

A major effort of WKU's China Environmental Health Project (CEHP) is to provide training in each these critical technological areas to researchers at SWUC. With major support from the U.S. Agency for International Development, the long-standing partnership between WKU and SWUC is undertaking bigger field studies and training activities that aim ultimately to increase access to reliable and safe water in the karst areas of rural southwest China. Their multi-pronged approach includes:

(1) Increasing the physical and intellectual academic infrastructure for this work at SWUC;

(2) Undertaking watershed-scale demonstration projects with WKU and SWUC participants that strive to improve local water and environmental conditions; and,

(3) Using these projects as a training vehicle to ensure that Chinese partners are better equipped to carry this work forward into the future beyond the immediate scope of CEHP activities in China.

The strong partnership between WKU and SWUC that enables them to carry out these activities is built on collaboration that has evolved over the past 12 years.

EVOLUTION OF THE WKU-SWUC PARTNERSHIP

In Chinese there is a term—*yuanfen*—literally fate or destiny. My *yuanfen* in working on karst issues in China stems from a lucky meeting with Professor Yuan Daoxian, who is widely considered to be the leading Chinese authority on the country's karst regions. In 1995, I was on a lecture tour in China, primarily focused on coal chemistry issues, when I first traveled to Guilin and met Professor Yuan, who was the director of the Karst Dynamics Laboratory at the Institute of Karst Geology in Guilin. I was intensely interested in learning about the spectacular southwest China karst area, so my conversations with Professor Yuan on various chemical impacts that karst landscape development is having on the global carbon cycle led him to invite me to participate in an international research effort to improve understanding of these processes under the auspices

of UNESCO's International Geoscience Program. Thus began a long and fruitful collaboration between our two research groups and more recently with scientists from Southwest University of China (SWUC), where Professor Yuan subsequently founded the Institute of Karst and Rehabilitation of Rock Deserts.

Through much of the 1990s, WKU and our Chinese partners carried out very academic joint research, focusing primarily on geologic questions concerning Chinese landscape evolution and geochemistry. Both groups certainly benefited from the interactions: the U.S. group gradually gaining familiarity with southwest China and experience in how to work there, as well as learning about the beautiful karst landscapes from those most expert in their nature; and the Chinese groups learning GIS, water monitoring instrumentation, and geochemistry through workshops and research interactions.

While results of this work made various scholarly contributions in scientific journals (e.g., Groves & Yuan, 2004; Lui et al., 2004a, 2004b) and research conferences, it did little to improve the conditions of rural, and often very poor, Chinese with whom the teams were interacting during fieldwork, particularly during those years in Guangxi, Guizhou, and Hunan. Time and again the teams would hike from the car through the rural countryside to study or collect samples at some cave or other, passing through villages, often populated by Miao and other minorities, meeting residents and at times sharing meals. As friendly and gregarious as we found virtually all of these interactions, it could not help but inform our thinking that we were, for example, collecting rock samples from a cave to determine whether it had formed one million or ten million years earlier, while in the villages we were passing were facing real challenges in the quality of their lives directly related to poor access to water because of the karst conditions. Our Chinese colleagues had been doing applied karst research to help the communities for many years and it became clearer to us at WKU that the resources and energy we were expending might be turned towards improving the quality of life for rural Chinese, particularly with regard to water supply and public health.

Photo 3. Miao resident of the dry plateau above Big Dragon Cave, Hunan. Photo Credit: Kevin Downey.

The evolution of WKU's discussions with Chinese partners on developing an applied research agenda was timely, for in the early 2000s the Chinese government began increasing attention and investment into environmental, and in particular water, problems in both urban and rural areas. Central policymakers have come to recognize the threats water scarcity poses to the economy, human health, and social stability (Turner, 2007). Central authorities have even recognized the importance of investing resources to improve environmental conditions in the southwest karst areas, with karst resources mentioned explicitly in both the Tenth and Eleventh Five-Year Programs ("Report on the Outline," 2007; "All-China Environmental," 2007). The former addressed the problem of "rocky desertification"[2] and then the latter discussed land use and ecological protection of the southwest karst region, citing as examples those in Guangxi, Guizhou, and Yunnan. Over the past 10 years, WKU's Chinese colleagues have obtained significant grant funding for karst-related work from Chinese government sources, including the Natural Science Foundation of Guangxi, National Natural Science Foundation of China, Ministry of Science and Technology, and Ministry of Land and Resources.

TURNING TO APPLIED KARST RESOURCE MANAGEMENT EFFORTS

After 7 years of smaller joint projects, WKU and Professor Yuan's team began a series of applied projects, instigated by various government groups and carried out in collaboration with the Karst Institute scientists and students from Guilin. Each provided training opportunities for our Chinese colleagues to gain more experience in the technical aspects of karst water and other resource management investigations. These projects have given WKU and Chinese partners the ability to undertake more ambitious efforts under CEHP.

Dalongdong—Big Dragon Cave in Hunan

In 2002, local government officials in western Hunan Province began designing an ambitious underground reservoir and dam in a large cave system called *Dalongdong* (Big Dragon Cave). A significant underground river flows through this cave about 600 feet below the ground surface of a high limestone plateau. The river eventually emerges at a huge spring at the plateau's edge, creating a spectacular 850-foot tall waterfall. (See Photo 2). Some of this water is current diverted by engineering structures within the cave to a hydroelectric station at the base of the plateau for power generation. Atop the plateau about 30,000 residents, primarily of Miao nationality (see Photo 3), live in small villages and face serious challenges due to their remote location with nearly nonexistent transportation infrastructure, poor economic conditions, and lack of access to water. Their average annual income was 500 Yuan ($65). In the dry winter season some residents must walk more than a mile each way to carry water home from the nearest water spring, often involving a trek to the edge of this high plateau, down 600 feet along a switchback trail that is so steep ladders must be negotiated in places.

The proposed engineering plan was to dam the river cave passage, backing the water up behind so that it rose closer to the surface and some areas on the surface could flood up on the plateau making water more readily available. The plan included additional benefits of increased power generation and flood control by controlling the water volume of the resulting underground water reservoir.

While our Guilin colleagues from the Karst Institute had ably provided geologic and hydrologic consulting services with regard to karst-related aspects of the dam planning work, they asked WKU to contribute advanced cave survey techniques to gather key information about the geometry of the conduits that would ultimately form the underground reservoir. The techniques included both the ability to use scuba gear to dive through and map completely flooded portions of the cave passages, as well as advanced levels of rope work to explore caves from the top of the plateau through deep vertical shafts that could connect into and lead to new sections of the main cave system. Experienced cave divers and the requisite equipment and support were simply not available in China. The WKU group agreed to put together a team of experienced expedition cave explorers and surveyors, all with extensive international experience and most with cave expedition experience in southwest China.

The toughest task was arranging for the diving team as the equipment and logistics are complex and even under the best of circumstances cave diving is an extremely hazardous activity. When I visited Hunan in January 2004 to do final arrangements on the cooperative effort, the Chinese engineers were adamant to begin the survey before the onset of the monsoon in April. This news shocked me for I thought the diving logistics would take at least 6 months of preparation and we were struggling to acquire the proper air compressors for filling the diving tanks, which were not available for rent in China. Through friends of friends, at the last minute one was finally located in Hong Kong from a dealer who would sell us a used one for $4,000 and buy it back for $2,000 a few weeks later if it was returned undamaged. Although the trip was arranged as quickly as possible, another challenge occurred when the monsoon rains started within a few days of the divers getting started in the cave, swelling the underground rivers and to some degree causing diving conditions to deteriorate.

Despite the stomach acid-producing logistics, in April 2004 WKU and Guilin colleagues under the competent direction of expedition leader Pat Kambesis, were able assemble a team of two highly trained cave divers and a support crew of seven additional experienced cave surveyors who were able to explore and generate three-dimensional maps of a considerable amount of the cave to aid the Chinese engineering team in their work.

Wanhuayan—Ten Thousand Flowers Cave in Hunan

In 2005, through a bit of serendipity, an opportunity presented itself for WKU and its Guilin colleagues

Photo 4. Chinese students during CEHP training in Geographic Information Systems at Southwest University in Chongqing. Photo Credit: Kevin Cary.

to work together again on another cave, which while not directly focused on water resource development, did provide an excellent training opportunity in underground river surveying, dye tracing, and related methodologies.

The managers of the tourist cave Wanhuayan near Chenzhou in eastern Hunan had seen the news coverage of the *waiguoren* (foreign) cave scientists at the Dalongdong project, which led them to contact our colleagues in Guilin to request the U.S.-Chinese team visit their cave during the following spring dry season. The primary task they needed was to explore, map, and evaluate both water resources and tourism potential of incompletely explored areas off of the existing tour routes. Our group was also asked to make photographs of the cave and provide scientific input to enhanced interpretive materials for cave visitors. Most Chinese cave tours focus primarily on esthetics and highlight the remarkable resemblances of various stalagmites and other cave formations to vegetables, animals, pagodas, and fish. These tours are typically enhanced with multitudes of colored lights and the occasional papier-mâché dinosaur.

The main cave mapping and resource inventory work focused on an effort to continue exploration and detailed mapping of a major side passage in the cave, which contained a large river that had been incompletely explored by another American team from the Cave Research Foundation some ten years earlier. That group had explored about two and half miles moving upstream in this beautiful river passage, stopping at that base of a large waterfall due to lack of time.

The WKU group was able to complete each of the objectives set for the expedition, including extending the exploration and mapping past the waterfall. One karst water investigation method that provided a useful training vehicle for the Chinese partners was the completion of two underground water tracing experiments using fluorescent dyes that showed how two cave rivers formed the headwaters of the main river in Wanhuayan. This information, along with additional geological observations, extensive photography in the cave system, and the newly explored cave passages mapped by the expedition provided a great source of interpretive information to enhance the public tours of the cave system.

> **Lack of access to surface water for much of the year exacerbates the widespread rural poverty in [China's] southwest karst region.**

Like other hosts with whom we have interacted, the Wanhuayan managers were exceedingly gracious, although there was initially a clash when they wanted us to end our cave expeditions by five or six p.m. in order to make a scheduled banquet. While expressing our team's deep gratitude for the arrangements made by our hosts, the need for scheduling to accommodate long cave trips was effectively communicated, and as plans were made for the first major mapping trip to the far reaches of the cave, it was estimated that the team would be out of the cave about four a.m. the following morning. To the surprise of the exhausted cave team, upon reaching the lit portions of the existing cave tour on the way out of the cave at the scheduled time, a large party was waiting for them. An in-cave banquet had been prepared for the group and was waiting for them in those early morning hours, complete with lots of food and beautifully dressed Hunanese serving girls. Of course, continuous camera flashes from

the ubiquitous media folks documented the whole event, and to the relief of the cave team, as they were still more than a mile from the cave entrance, hot tea was served in place of the ubiquitous baijiu!

THE CHINA ENVIRONMENTAL HEALTH PROJECT

In October 2006, following these years of relationship-building and experience in learning about water resource challenges in the southwest's rural karst areas, our efforts expanded with the establishment of the USAID-supported CEHP. With both air and water components, the CEHP strives to strengthen existing U.S.-China university partnerships with a goal of increasing Chinese academic infrastructure in the ability to develop solutions to problems of environmental health.

At Southwest University of China (SWUC), where we focus on karst water resources, we are doing this in several ways. The first is through the direct development of critical laboratory infrastructure, with associated training opportunities. In late 2006 we installed hardware and software to establish a small, yet state-of-the-art laboratory for Geographic Information Systems (GIS) computer mapping and spatial analysis technology. The current lab set up with five computers plus a server for full implementation of current Environmental Systems Research Institute (ESRI) software, which will be expanded in late 2007 to 20 computers. CEHP teams have also conducted four workshops in both fundamental and advanced aspects of this technology (see Photo 4), which serves as a critical tool for spatial record-keeping and analysis in a wide variety of environmental applications. In the current context these have focused on water resources, including tools for hydrologic and land-use analyses.

CEHP scientists have also equipped and provided training for a new laboratory at SWUC for the analysis of fluorescent dyes that are a critical tool for tracing the routes of underground flow paths in karst areas.[3] The CEHP laboratory at SWUC, which was put in place in October 2007, is a state-of-the-art facility for this kind of work, allowing us to conduct several training workshops on the field methods.

The other major method for mapping out the underground river pathways is by direct exploration and survey. This is in fact preferable as the actual locations of the rivers are determined precisely, in contrast to water tracing with dyes where only the input and output locations are established. Underground river mapping takes very specialized training, both with regard to the surveying techniques themselves, as well as the skills necessary to safely negotiate the cave passages in the first place. This can be particularly challenging in some areas of southwest China, where the underground rivers can in some cases be more than a thousand feet below the surface. Thus, training and experience with ropes and other equipment to negotiate these areas is also important, and has been included as part of our training program at SWUC. (See Photo 5).

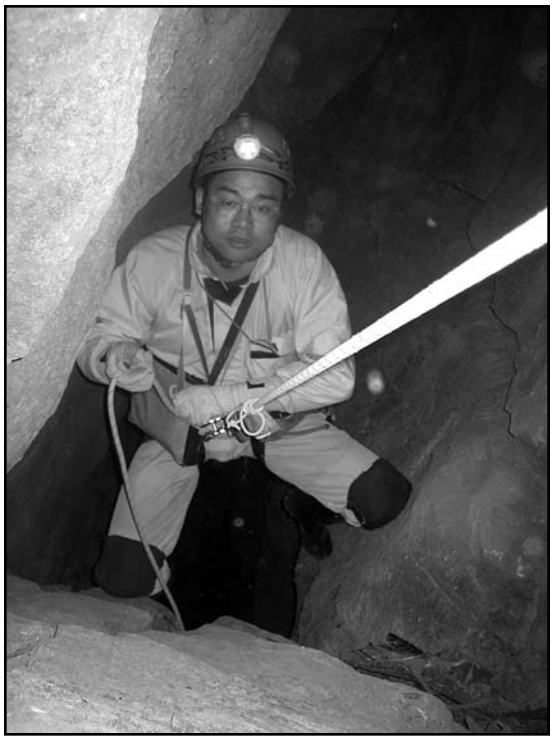


Photo 5. Chinese graduate student rappelling into a cave entrance near Kaiyuan in southern Yunnan during CEHP training in field methods for studying groundwater in southwest China's karst areas. Photo Credit: Pat Kambesis.

These specialized field and laboratory methods of identifying the underground river networks by direct exploration and dye tracing, combined with Geographic Information Systems technology to map and analyze the systems, provide a powerful set of skills for identifying contamination of karst springs by agricultural, residential or other land uses. It is not until the relationships between land use and water quality at a spring are explicitly identified that steps can be taken to remediate those problems.

In addition to the technical aspects of exploring and trying to solve karst water problems in rural

China, there is a great need for extensive communication and relationship building with local government and communities who live and farm within the identified drainage area leading to an impacted spring, as well as with appropriate governments up several levels. Not until this network has been built can education be done to help the residents understand these hydrologic relationships and to create a multi-stakeholder plan on potential methods of changing land use practices. The CEHP recognizes the complex and critical role of this relationship-building as an adjunct to the technical aspects of our training at SWUC, and therefore has developed a partnership with the International Institute of Rural Reconstruction (IIRR) to utilize that organization's expertise in this area of social science. IIRR's work with the CEHP in southern Yunnan is described in the following paper of this special report.

In the CEHP model, training also must move outside of the classroom, and thus we are developing demonstration sites for projects that can improve water resources, while serving as a training vehicle. In addition to local sites in Chongqing near the SWUC campus (Jinfu Mountain and Qingmuguan), in early 2008 the CEHP team will have the second joint U.S.-Chinese expedition to the East Plateau area in Honghe Prefecture in Yunnan Province, about 120 km from the border with Vietnam. The East Plateau, near the counties of Mengzi and Kaiyuan, is a remote rural region on a high limestone plateau, with about 30,000 people living in scattered small villages, and in which there are serious water supply challenges during the dry season. It is also an area with a significant minority population including Miao and Yi groups. The physical, political and cultural complexities there provide a wide range of challenges, which provide great experience for both the U.S. and Chinese members of CEHP.

Looking Forward

In spring 2007, CEHP was awarded a grant by the ENVIRON Foundation to expand CEHP's existing training program by working with our colleagues at SWUC to develop a training program for scientists and environmental officials in Yunnan Province who are responsible for local policies and regulations to protect and exploit karst water resources. The goal is to enhance these leaders' abilities to understand the nature of karst systems and to exploit water resources while developing sensitivity to environmental/ecological considerations, with the bigger goal of improving public health and quality of life in rural Yunnan. This training program is designed to serve as a template that could ultimately be transported to the other karst-rich provinces of the southwest. These activities also would be designed in a way that SWUC scientists and students would ultimately be the primary providers of information.

The CEHP team was also quite excited when, in late 2006, scientists at SWUC received a major, five-year grant (4,000,000 Yuan) from China's Ministry of Science and Technology for poverty reduction efforts throughout areas of Chongqing municipality, a project that includes demonstration sites for karst water resource efforts in the Nanchuan area. We at WKU look forward to collaborating with our partners in this effort under the CEHP umbrella.

Besides the scientific research, the CEHP karst team endeavors to help make people aware, both within and outside of China, of the under-appreciated challenge to public health and quality of life occurring in the limestone karst areas of southwest China, home to millions of China's poorest residents. Because of the peculiar nature of the landscape, these people face real water resource challenges, not just water quality problems as in other parts of the southwest, but basic access to sufficient water supplies during parts of the year.

Chris Groves directs the China Environmental Health Project within the Hoffman Environmental Research Institute at Western Kentucky University. He is past President of the Cave Research Foundation, and currently serves as Project Leader for the UNESCO scientific program "Global Study of Karst Aquifers and Water Resources." He can be reached at: chris.groves@wku.edu.

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NOTES

1. While limestone is also widespread in Tibet, these areas are scattered at high elevations impacting relatively few people.

2. In translation the 10th Year Plan in 2001 contained the text "We need to step up our efforts to prevent the karst from becoming stony desert."

3. Although the process is simple in concept, in practice the procedure is quite involved, typically utilizing automated monitoring techniques, such as collecting water samples at timed intervals at a spring that can later be analyzed in a laboratory, or placing small packets of activated charcoal at springs prior to the introduction of the dye into the flow system. The charcoal adsorbs the dye even if it has been diluted by that point to very low concentrations. Each of the various charcoal dye receptors is later collected and is treated in a solution in the laboratory that removes and measures the dye from the charcoal.

Natural Resources Defense Council China Program

By Alex Wang

In 1997, the Natural Resources Defense Council (NRDC) was the first international nongovernmental organization (NGO) to establish a clean energy project in China to focus on opportunities in energy efficiency, green buildings, sustainable transportation and advanced energy technologies. The China Environment Forum has covered many of NRDC's initiatives over the years (*Editor's Note: See Commentary in CES 5 titled "Brick by Brick"*).

In the early days of NRDC's work in China, the concept of energy efficiency was not seriously considered in Chinese decision-making circles given the short-lived electricity surplus in the early 1990s and the tremendous success in energy efficiency that China achieved in the 1980s. China's construction boom was in its nascent stages in the mid-1990s, and the concept of nonprofit environmental groups working to promote environmental protection was a mystery to many potential Chinese partners. "One of our first potential partners in western China for a green building demonstration project was unusually enthusiastic about a collaboration," says Barbara Finamore, director of NRDC's China Program. "Then we realized that he thought we were real estate developers."

A decade later, much has changed in China and NRDC's work in China has expanded significantly as well. Indeed, NRDC has designated China as one of its six key organizational priorities, and opened a 25-person office in downtown Beijing in 2006. While continuing to build on its core expertise in clean energy, NRDC's China Program also has expanded into a variety of new areas, including:

- Environmental law and public participation;
- Environmental health;
- Sustainable cities and smart growth; and,
- Market transformation (e.g., the greening of business).

These days Chinese partners certainly no longer mistake NRDC for a real estate developer. Indeed, NRDC has become a key advisor on a variety of issues to the Chinese government, businesses, policymakers, lawyers, judges and NGOs. NRDC works in a wide variety of areas to promote clean energy and environmentally friendly policies and laws, and to educate the public on environmental rights and green business practices. The work is done at central, provincial and local levels and with a range of partners from the highest levels of government down to local environmental groups. From humble beginnings without a single staffer on the ground, NRDC's China Program is now well on its way to carrying on in China the full range of work that NRDC has long engaged with in the United States.

Energy Efficiency

China is significantly less energy efficient than the world average, utilizing 15 percent of global energy consumption to achieve about 5.5 percent of worldwide GDP. To produce one unit of GDP, China utilizes 8 times more energy than Japan and 4 times more energy than the United States. In a power sector driven overwhelmingly by coal, all of this wasted energy produces enormous amounts of avoidable pollution and reduces China's energy security.

To remedy this situation, China has launched the most aggressive energy efficiency campaign in the world, with the goal of reducing the nation's energy use per unit of GDP by 20 percent before 2010. NRDC has worked on a variety of initiatives to promote the widespread implementation of energy efficiency in China:

- In 1997, NRDC hosted the first conference in China on the implementation of its newly enacted *Law on Energy Conservation*.
- NRDC conducted the first comprehensive study in two key provinces of the energy efficiency potential in their industrial, commercial and residential sectors.
- For several years, NRDC has advised Jiangsu Province on the development of a financial incentive system for promoting energy

efficiency, which was recently recognized by Premier Wen Jiabao as a model for China.

- In 2007, NRDC's collaboration on energy efficiency reached the central government level, as NRDC and China's State Grid and Southern Grid Companies co-sponsored an international forum on demand side management and energy efficiency, hosted by China's National Development and Reform Commission and the Ministry of Finance.

The potential environmental benefits for China are substantial. A nationwide "California-style" incentive system for energy efficiency in China, coupled with the implementation of existing building and equipment standards, could obviate the need to construct 530 to 730 coal-fired power plants over the next decade.

Sustainable Cities/Green Buildings

In the area of green buildings, NRDC served as the lead project manager of a green buildings demonstration project sponsored by China's Ministry of Science and Technology and the U.S. Department of Energy. The building, completed in 2004, is the first LEED Gold certified building in China and uses only one-quarter of the energy and produces only 40 percent of the wastewater of a typical Beijing office building. NRDC is now working with the Shanghai municipal government to implement a system for enforcement of building codes and is also partnering with the China Human Settlement Council of the Ministry of Construction to promote "smart growth" principles in urban planning and building design. NRDC also helped develop government energy efficiency design standards for residential and commercial buildings in several different climate zones.

> **"A nationwide "California-style" incentive system for energy efficiency in China…could obviate the need to construct 530 to 730 coal-fired power plants over the next decade.**

Advanced Energy Technologies

China's phenomenal growth over the past three decades has been powered, in large part, by coal. In 2005, 76.4 percent of China's primary energy production was provided by coal. While China has targeted alternative forms of energy, including renewables, it is clear that China will continue to utilize large amounts of coal for a long time. Indeed, Chinese experts believe that by 2050, coal will still account for nearly 50 percent of China's energy production. Given this, NRDC is promoting the use of technologies that can help reduce pollution and the carbon impacts of coal, such as coal gasification with carbon capture and storage. NRDC helped to make coal gasification-based polygeneration one of the top priorities in China's 2006-2015 National Research and Development Plan and persuaded the Ministry of Science and Technology and the Chinese Academy of Sciences to draw up a national roadmap for the development of coal gasfication-based technologies and demonstration facilities for power generation, co-production and carbon capture and storage. NRDC has also been working with local partners to promote biofuels and hydrogen fuel cells in China.

Environmental Law and Public Participation

For nearly 40 years in the United States and internationally, the cornerstone of NRDC's work has been improving the enforcement of environmental laws through legal advocacy and public participation. Recognizing the substantial need to improve environmental enforcement, public input and transparency in China, and at the invitation of local partners, NRDC established a new initiative on Environmental Law and Public Participation in 2005 to work with leading Chinese experts and environmental groups to promote the implementation of a wide array of new Chinese laws and regulations concerning open information, public participation, as well as judicial and administrative relief. NRDC has worked extensively with the Center for Legal Assistance to Pollution Victims (CLAPV) and the Zhongnan University of Economics and Law to train judges, lawyers, environmentalists and others in environmental and public participation law. In 2007, NRDC and the China Environmental Culture Promotion Association launched China's first website devoted to open information and public participation law (www.greenlaw.org.cn).

Environmental Health

NRDC recently established a new Environmental Health and Law Initiative to build capacity of China's lawyers, scientists and NGOs to educate the public and prevent exposures to environmental pollutants that cause harm to human health, and to develop policy recommendations for health risk reduction, environmental cleanup and compensation to pollution victims. NRDC has also been working for the past several years with China's State Environmental Protection Administration to identify the major industrial uses of mercury in order to craft policy proposals to reduce mercury use (and the accompanying harms to human health) through supply- and demand-side advocacy.

Market Transformation

China supplies the world (and particularly the United States) with an overwhelming amount of the material goods it utilizes every day and the major multinational corporations that source these goods in China can have a significant influence on the way that these goods are produced. NRDC has been working with local researchers and environmental officials to support the innovative Greenwatch environmental performance ranking system in Jiangsu Province, and is identifying factories and industrial sectors with large potential for environmental improvement in preparation for work with multinational corporations to "green" their supply chains.

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SPECIAL REPORT

Reaching Out to the Community in Rural Yunnan's Karst Region

By Amelia Chung

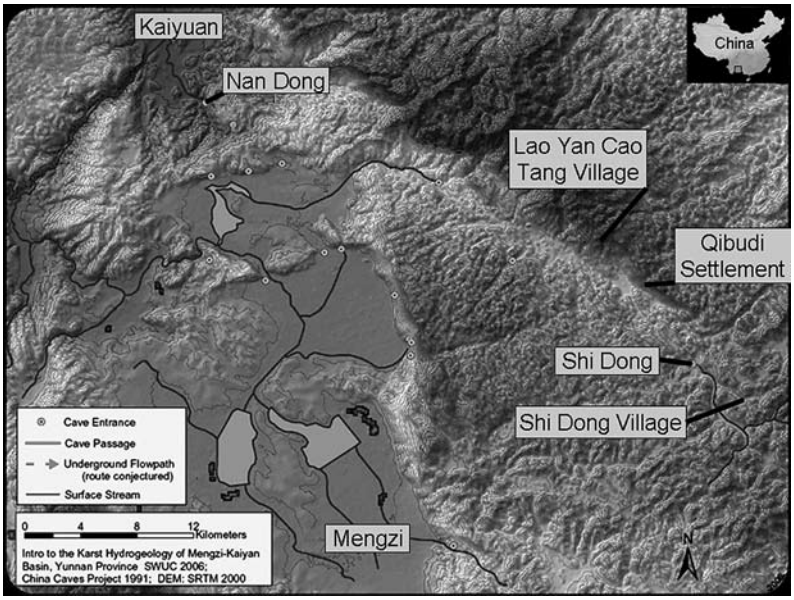
This section of the report discusses the role the International Institute of Rural Reconstruction (IIRR) is playing in CEHP activities. IIRR is an international development and training organization with more than forty years of experience in mobilizing community action to achieve lasting solutions for addressing the causes and consequences of poverty. They have extensive experience in working in China with rural communities, which makes IIRR an ideal partner to help with the community outreach portion of the CEHP karst activities in Yunnan.

The International Institute of Rural Reconstruction (IIRR) is the only non-governmental organization (NGO) involved in the fieldwork of the China Environmental Health Project (CEHP). I head the IIRR office in Yunnan Province and am responsible for the community outreach and knowledge-sharing component of CEHP's karst water activities. The need for such work is clear for many involved in international development work and research—without involving the community in the beginning of a project, the ultimate "solution" designed by external parties may miss the mark. One case in point was another environmental health project in China led by the U.S. Geological Survey and the Armed Forces Institute of Pathology that focused on naturally occurring fluoride and arsenic in Guizhou's coal (Hildebrandt & Turner, 2003). The smoke from this coal not only contaminated the air, but the chilies and corn that were dried above the coal-fueled fires. Many in the remote villages were suffering serious illnesses from eating the poisoned food. The Chinese and U.S. researchers identified the source of the poison and designed an inexpensive test kit for villagers to use in selecting less toxic coal during mining, thereby immediately lessening the toxin levels of the smoke. The researchers gave the kits to village leaders, some of whom quickly taught everyone to test their coal. But other leaders did not, most likely because they had not been willing to be involved in the problem identification, research, and solution processes. Thus, my job in the CEHP project includes finding a local organization to help me connect the communities to the work of the karst hydrologists, so communities are partners in the project from the beginning.

I first had the opportunity to visit and interact with the local communities of the areas of interest to CEHP's karst hydrogeologists in March 2007. During that month the project team of Chinese and U.S. scientists traveled to Honghe Prefecture in Yunnan to learn more about how water impacts people's lives in the surrounding karst region in order to target problems that will ultimately help improve the standard of living of the local communities. CEHP scientists are not simply interested in research for research's sake.

Before going into details on our visits to the local communities, it would be helpful to give an overview of the site of this project, which spans across the Kaiyuan and Mengzi counties in Honghe Prefecture. The project site is located about 400 kilometers (km) southeast of the provincial capital of Kunming. Continuing in the same direction for another 120 km or so, one will arrive at the China-Vietnam border. The two main ethnic minority groups living in the Honghe Prefecture are the Hani and Yi. The Hani mainly inhabit the southwest region of the prefecture. The Yi are the most indigenous and widely dispersed group in Mengzi County, the capital of Honghe Prefecture. Together with another minority,

FIGURE 1. CEHP Karst Activity Site with Location of Major Local Communities



Bai, the Yi make up more than 80 percent of the total population of the prefecture's capital. The distribution of the Yi minority and Han Chinese majority in Mengzi is unlike that of other minority dominated regions in China with Yi people are mostly settled in the relatively political, economical, and cultural developed areas, such as the basins, while the Han Chinese communities can be found primarily up in the mountains of Mengzi.

The Honghe Prefecture encompasses both a basin to the west and a plateau on its east side (called East Mountain Plateau). The basin is considered a "wet" area with surface water coming out from *nan dong*—literally south cave—one of many caves in the area. Ironically, most of the communities on the plateau are considerably more water stressed, especially during the winter dry season. While there are plenty of underground rivers, they are difficult to access because they flow too deep, sometimes 1,500 feet below the surface.

LEARNING THE LAY OF THE LAND

The U.S. and Chinese CEHP scientists and I spent the first night in Kaiyuan county (north on the map) and the project team rose early to set out to see Laoyan Caotang village up on the plateau. After a 30-minutes bumpy ride from town, we stopped at a cluster of brick houses. Besides the conventional village houses there were some intriguing smaller ones without windows and doors except a small square opening close to the ground and smoke burn marks near the top. Initially, no one from our group could fathom the function of these buildings. After meeting some villagers who came out of their houses to chat with us, we learned these were smokehouses for tobacco, one of the main cash crops in the village. Other less lucrative cash crops were corn and sweet potatoes.

When we were introduced to the head of this village, Mr. Chen Yonghua, he invited us to his house for more in-depth discussions about the economic and water challenges in his village. We learned that this administrative village government oversees 10 natural villages with a total population of about 3,000 with an annual per capita income of 1,200 Yuan ($158). Access to underground rivers is difficult in this area, which has meant many villagers struggle to get by.

Two of the ten villages lack tap water. The villagers of these more remote villages up in the hills must walk to fetch water from one of several muddy ponds, which while a short walk from their homes, do not provide good tasting or clean water. Photo 1 shows one of the larger ponds.

Comparatively, people from the other eight villages are better off than the villagers dependent on fetching muddy water to meet their needs. These villages have dealt with water scarcity by building

Communities on the plateau in the CEHP project area are very water stressed, for while there are plenty of underground rivers, they flow as far as 1,500 feet below the surface. Photo Credit: Amelia Chung

cisterns that collect and store rainwater during the rainy season. Each 25-cubic meter household cistern costs 2,500 Yuan ($329), double the annual income of the village households. Villagers were able to purchase them through partial support of the local government. All the villagers we spoke with emphasized how the convenience of the cisterns drastically improved their lives. As both men and women were responsible for fetching water for household needs, there was no significant ease of burden in terms of gender after the cisterns were built.

Although Laoyan Caotang villagers struggled with access to water, overall they told us their lives were acceptable with adequate food and shelter. Nevertheless, they hope access to more water could be found so they would have more opportunities to generate household income, such as growing more tobacco and cash crops, and improve their lives. More income could help fund better transport for getting people and goods to more distant markets.

In the late morning of day one, the team drove further southeast and reached a large area of land called the Qibudi Settlement. Village houses were not in sight but we ran into a dozen village men who were wandering around. This is a relatively dry area with some sinkholes where water is almost exclusively in underground rivers. (See above photo). The older villagers told us that this area used to have water back in 1958 but local people have not had access to surface water for the last forty years. Conversations with younger villagers revealed that many of them are idle most of the time because the lack of water limits their ability to grow crops. Many young people have migrated to surrounding cities and towns, a process that is slowly emptying the settlement. Those left behind still hope that one day this area can be used to grow staples or cash crops and they would make themselves useful for the land they belong to and love. To them, the problem is all because of the lack of water for irrigation in the area. They strongly believe that with better access to water akin to what it was forty years ago they would be busy tending the fields and farming, and their villages would be saved from poverty. Not surprisingly they were interested in the possibility of our team exploring for water access routes underground.

After a quick picnic lunch at the Qibudi Settlement, we left the plateau and continued our journey southeast. We passed by *shi dong* (or stone cave), the last opening where surface water is visible before it submerges underground and travels northwest. We then stopped at nearby Shidong village, which represents clusters of settlements in an area where surface water is accessible for both drinking and irrigation.

When we approached a villager who was breaking rocks for construction purposes outside his home he—perhaps relieved to take a break—took time to speak with us about the village. He related how most villagers grow enough food for their own consumption while allocating and utilizing large areas of land for cash crops, primarily tobacco. The annual per capita income of these villages is 6,000 Yuan ($789)—five times that of the plateau village. The villagers also tend to work outside of the village in the winter months and farm in the summer. They live comfortably with tap water conveniently placed in front of their houses and have access to irrigation water to improve their harvests.

These three villages—all within a half-day's travel—revealed the full spectrum of wealth and poverty in the prefecture. In all cases, people's economic security was determined by their access to water. The researchers, all karst specialists, had seen the problems many times and acknowledged that karst landscapes are very harsh for many. Lacking water or access to clean water is a major source of illness in rural China and every year nearly 30,000 children in such areas die from diarrheal illnesses contracted from drinking dirty water (OECD, 2007). Villagers in this area—even the wealthier ones—all face challenges in accessing basic health care. Thus, the ability to access clean water is a serious health issue. As Chris Groves explains in his section of this report, karst geology is complex and finding solutions sometimes even more so.

FINDING A LOCAL PARTNER

Against this backdrop, it is especially important to incorporate local communities' needs and concerns in mapping out underground water passageways, documenting conduits, and assessing water quality. As such, the means to engage communities and provide opportunities for them to participate in the research must become a major component of the project, not an afterthought. After our initial visit to the communities in the area, we had gotten a better understanding of their different needs and situations concerning the primary necessity of life—water. In order to begin to carry out a more thorough study of community needs and to help involve the communities and local governments in the scientific research, IIRR will partner with a locally based ethnic research institute, the Honghe Prefecture Nationalities Studies Institute (Honghe Institute), with staff culturally and socio-economically familiar with the communities in the region. The Honghe Institute was established in 1984 and has been supervised by the Yunnan Academy of Social Science since 1992. Over the years, its main activities include research, restoring, translating and compilation of classical books and manuscripts; editing and publishing reading and teaching materials in Chinese and minority languages; conducting surveys and studies on traditional cultures, socio-economic and development issues of the prefecture.

For this endeavor, the Honghe Institute is conducting socio-economic studies with the project team to gather information that is significant to be considered and integrated into the karst water research to achieve the project's development objectives. It is also participating in the IIRR-facilitated training in community mobilization to enhance their capacities for them to work in the local context and better support the local communities in meeting their different development needs. The Honghe Institute is an essential liaison between the project team and the local communities of concern.

IIRR will also provide researchers at this institute with training in community engagement and mobilization, which the staff at this institute can use to improve their capacity to further their work in the communities. Moreover, since this institute is involved in long-term work in these communities, they can sustain water work with the communities even after the research project is complete. With such joint implementation, the CEHP team hopes to encourage the communities to participate with and help the karst scientists look for ways to solve the poverty issues linked to water shortage and poor water quality. And eventually, the ultimate objective of hydrogeological research in southwest China can be complemented and successfully achieved by benefiting and improving human's lives there.

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Catalyzing Participatory Governance From the Grassroots to the County Seat

By Amelia Chung

The International Institute of Rural Reconstruction (IIRR) is an international development and training organization with more than forty years of experience in mobilizing community action to address the causes and consequences of poverty. Headquartered in the Philippines, IIRR carries out programs in Asia and Africa that: (1) form partnerships with rural communities to enable them to effect meaningful change in their lives; (2) train development practitioners through practical field experience; and (3) publish information from on-the-ground research to share lessons and to facilitate learning among practitioners and policymakers.

IIRR's activities are rooted in the pioneering work carried out by its founder Dr. Y.C. James Yen in China in the early 1920s. In 1926, Dr. Yen used the rural county Ding Xian (today Dingzhou) in Hebei as a "social laboratory" to experiment with empowering poor villagers to better their lives. Dr. Yen recognized the inner strength of the poorest villagers and designed a people-centered training program that helped them channel their strengths to improve their livelihoods.

The China Program

Dr. Yen left China in the early 1950s, but returned in 1990 to visit with the Chinese National People's Congress to initiate the China Program. Since then, a variety of programs and capacity development activities have been launched in China, mainly in the southwest region where IIRR has been: (1) providing technical support to Chinese research institutions and government units; (2) facilitating local training programs and writeshops for communities and nongovernmental organizations (NGOs); (3) organizing study programs for exchanges between Chinese development professionals and their counterparts in other Asian countries; and (4) joining multi-lateral development agencies like UNDP in poverty alleviation planning and programs. Many projects have had a strong focus on improving local community control over managing natural resources. Some notable activities that have promoted governance at the grassroots level include:

- From 1994 to 2000, IIRR worked closely with the Guangxi Education Commission to design and implement study programs and vocational training in environment and natural resource management, worker safety, occupational health and sanitation, agro-ecology, and bio-gas to over 1,000 township/village leaders, extension workers, adult education teachers, and farmers.
- IIRR's participatory rural assessment training work in 1999 for Oxfam America and the Chinese NGO Green Watershed helped establish a multi-stakeholder watershed management committee in Lashi watershed—the first of its kind in China.
- In 2001, IIRR provided the training-of-trainers for the Participatory Rural Assessment (PRA) Network in Yunnan, China and capacity building for project stakeholders in the Nujiang Watershed Conservation and Development Project. The trainings covered agricultural extension and participatory project management.

In September 2004, a full-time China Program Coordinator commenced working in an office in Kunming (Yunnan Province). While in the 1990s, IIRR worked predominantly with rural communities, at present, the IIRR China Program is mainly focused on promoting better governance and participatory development at the county government levels in Yunnan to provide experience for other parts of

China. Expanding IIRR's participatory approaches from the village level to the county government in China has been a challenging, but ultimately fruitful endeavor, as the following section illustrates.

IIRR Participatory Trainings in Yimen County

Throughout the trainings with the Yimen county officials in Yunnan, IIRR has learned to be flexible and creative in applying participatory approaches. When IIRR, in partnership with the Regional Development and Research Center (RDRC), first launched a participatory approach project to help Yimen county officials improve their five-year planning process, the planners were very skeptical about using a supposed "improved" integrated methodology over their "approved" and familiar methods for gathering information. Thus, the planners were initially very passive in the training sessions. Most discouraging for IIRR was when during a PRA field practicum, most of the county participants withdrew from the exercise to apply the PRA tools that they learned to collect information from the villagers. IIRR later learned from them that work of these county officials does not require direct interaction with villagers and their experience with villagers is minimal, which is why they were uncomfortable with the exercise. Thus, in order to proceed with the project, IIRR staff knew that it could not rely on the "conventional" PRA tools because these county officials had rejected them to interact with villagers. However, after numerous workshops the same planning officials modified what IIRR had taught them about participatory assessments and devised their own tools to gather information from stakeholders within the government (e.g., government officials in other county departments or higher levels). With numerous opportunities for discussions on finding solutions to their own difficulties with current planning procedures, these members gained new insights of participation from their own perspectives. Ultimately, IIRR did not impose the idea of participation; rather, the planners realized the virtue of participation with their first-hand experiences in the project, which had a significant impact in their attitudes. The planners learned that participation would lead to better effectiveness of the outcomes and would not be as time consuming as they had feared.

IIRR's Other Recent Activities

- *China Environmental Health Project (Mengzi, Yunnan)*—IIRR is involved as the key partner in engaging local communities and building local organizations' capacities in participatory approaches for Western Kentucky University's China Environmental Health Project in Yunnan. (*Editor's Note: See Special Report in this volume*).
- *WWF Multi-stakeholders Eco-tourism Workshop (Shangri-la, Yunnan)*—IIRR facilitated a multi-stakeholder meeting in the renowned Shangri-la region to surface interests, concerns and viewpoints on eco-tourism development in the area. Five groups representing government agencies, local communities, the private sector (travel operators), NGOs, and a Tibetan Buddhist monastery participated in the workshop.
- *Gender and Development Case Conference (Kunming, Yunnan)*— IIRR is taking a leading role in providing technical assistance by writing cases and documenting experiences in gender and development for this conference, organized by the Yunnan Academy of Social Science and attended by 60 participants from more than 10 provinces across China in various development fields.
- *Participatory Strategic Workshop for Sustainable Development (Anlong Village, Sichuan Province)*—The workshop was facilitated in the village to build the capacity of the staff and community partners of the Chengdu Urban Rivers Association based in Sichuan. The workshop provided training to engage community leaders in analyzing problems and their root causes and in designing locally appropriate solutions. The most remarkable outcome of this workshop was that the local people were empowered to play an active role in projects that directly affect their communities and livelihoods, such as organizing their village's first general assembly to make plans and take the lead on implementing and sustaining development projects.

For more information on IIRR see: www.iirr.org or contact the China Program Coordinator, Amelia Chung, at: amelia.chung@iirr.org.

SPECIAL REPORT

Clearing the Air: Promoting Clean Coal Technology and Environmental Health Studies in Huainan City

By Wei-Ping Pan

This section of the special report introduces the coal component of the USAID-supported China Environmental Health Project (CEHP), which aims to obtain accurate data on coal-fired pollution emissions in Huainan city in Anhui Province. Key to success of this data collection is the strong collaborative partnership Western Kentucky University (WKU) has formed with the Anhui University of Science and Technology (AUST) and the provincial and municipal government agencies. The collection of this information could not only help promote transparency on pollution emissions in China—supporting new laws on environmental information dissemination—but also could generate awareness among policymakers on the health dangers of coal.

COAL EMISSIONS—CEHP ADDRESSING A CRUCIAL NEED

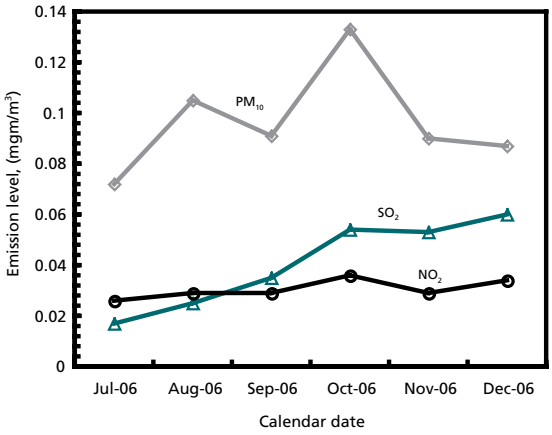
China is the biggest producer and consumer of coal in the world, depending on coal combustion for 70 percent of the country's total energy. Despite investment into renewable and nuclear power, this heavy dependence on coal is expected to continue for the next 50 or more years. Surprising even Chinese planners, over the past 7 years the country has doubled its use of coal, which has helped fuel China's continued rapid growth, but at a cost to the environment and human health both domestically and abroad. A major challenge in dealing with coal emissions is that the available statistics on China's dismal air quality are dated, anecdotal, or limited in scope. For example, China has not publicly disclosed CO_2 or mercury emissions data since 2001.

The CEHP air team is carrying out its coal monitoring and training work in the city of Huainan in Anhui Province, sometimes dubbed the country's "coal-powered Three Gorges." Huainan has a coal reserve of 44.4 billion tons, which is 32 percent of the reserve in eastern China and 19 percent of the national total. Anhui is an important Chinese energy base relying on coal, electric power, and chemical industries for its development. The total quantity of Huainan coal consumption in 2004 was 12 million tons, making up 90 percent of the city's energy consumption. This coal has enabled urbanization and industrial development in Huainan on an unprecedented scale, but at a cost—its ambient air quality has been rapidly deteriorating.

The production of industrial liquid, solid, and gas wastes from coal use makes up about 98 percent of the city's industrial pollution emissions. In 2004, the city's total air emissions were 97 billion m^3, which included 92,300 tons of sulfur dioxide (SO_2) and 36,000 tons of smoke-dust. The annual average concentration value per day of SO_2 was 0.024 mg/m^3; while nitrogen oxide (predominantly NO_2) and PM_{10} were 0.026 mg/m^3 and 0.111 mg/m^3, respectively. These three pollutants have lowered Huainan's air quality to China's Grade II (moderately deteriorated) level. Trends of major pollutant emission levels in Huainan since 1995 are presented in Figure 1.

Huainan's increasingly degraded air quality is causing serious public health problems for the city's residents, such as asthma (impacting up to 2 percent of the total population—most likely a higher percentage among the more vulnerable communities); chronic bronchitis (2 percent of the population); conjunctivitis (20 percent of eye illness); and coryza (2 percent of the population). Large numbers of people also suffer from occupational diseases related exposure to toxic air.

FIGURE 1. Trends of Major Pollutant Emission Levels in Huainan



Source: Cheng et al., 2007.

CEHP AIR QUALITY MONITORING RESEARCH AND TECHNOLOGY TRAINING ACTIVITIES

Central to WKU and AUST training and joint research activities under CEHP is the work to build up the Huainan Environmental Automatic Monitoring Center (HEAMC) to measure SO_x, NO_x, PM_{10}, and other air toxins resulting from coal-fired power and chemical plants. This comprehensive center has automated environmental monitoring, information exchange, and data network transfer, which gives scientists easy access to considerable data covering not only the emissions, but also the technologies used in coal extraction and burning in the city. Currently HEAMC has the capability to automatically monitor air quality of the city every 30 minutes with five stations surrounding the city.

As part of the CEHP project, flue gas monitoring system for each stack at three power plants has been installed, which collects information on the concentrations of CO_2, NO_x, SO_2, PM_{10} and other gases. In additional to monitoring SO_2, NO_x, CO, and CO_2 in air samples, the CEHP team is working with HEAMC staff to use wet chemistry to collect trace metals such as mercury, selenium, and lead. The physical/chemical properties of PM_{10} in air samples also will be analyzed during different seasons to study the chemical transformation of PM, which is one of the most important factors in studying air quality and public health. The CEHP team is collaborating with HEAMC to utilize all of the air emissions data to create an air quality model using BENMAP software (freely available from EPA).

In addition to providing state-of-the-art technologies to teach Chinese researchers and students about sampling and analysis of various pollutants, WKU is assisting AUST in monitoring three power plants in Huainan using U.S. EPA methods to ensure quality of the sampling data. The partners also have begun to test the air and take coal and ash samples in some of Huainan's industrial and mining areas, business districts, and residential communities. In addition, WKU training will enable AUST researchers to:

(1) Investigate the sources, distribution and polluting level of PM_{10} and $PM_{2.5}$ in Huainan's atmosphere, as well as the behavior of the pollutant polycyclic aromatic hydrocarbons (PAH) in PM_{10} and $PM_{2.5}$;
(2) Analyze the effectiveness of various air pollution control devices;
(3) Study the effect of coal pre-washing on dust emissions; and,
(4) Utilize data generated by coal emissions testing to assist AUST Medical School researchers in studies of how air pollution is impacting the health of various communities within Huainan.

CEHP COLLABORATING WITH LOCAL GOVERNMENTS AND INFORMING POLICYMAKERS

Besides helping in the collection of accurate data on coal-fired pollution emissions in Huainan, the CEHP air team wishes to disseminate the information widely to policymakers and communities in the city. Reliable monitoring combined with information dissemination is key to helping to pressure polluters to reduce emissions. For example, better monitoring capacity can permit the adoption of some market and information disclosure type regulations such as: voluntary reporting, emissions trading, and tax-related incentives. CEHP's goal of promoting information transparency is timely, for on 11 April 2007, SEPA signed a new *Decree on Environmental Information*

Disclosure (Trial), which will go into effect on 1 May 2008. This is the first formal regulation on information disclosure by a Chinese government agency following the State Council's release of the *Regulation on Governmental Information Disclosure*. Additionally, the CEHP research findings could help catalyze city policymakers to adopt measures to reduce public health problems caused by coal combustion.

The Huainan municipal government is encouraging and actively collaborating with CEHP activities. Information updates on the CEHP air team's work are notably posted the Huainan city website and introduced periodically in the *Huainan Daily Newspaper*. CEHP plans to promote local news reporting on the project as data collection and analysis continues. WKU and AUST monitoring work has benefited greatly from collaboration with the Huainan Environmental Automatic Monitoring Center (HEAMC), which is supported and funded by the Anhui Provincial Environmental Protection Bureau.

Paralleling this coal study will be an environmental health survey conducted by the AUST Medical School in the communities surrounding the three power plants. The China Environment Forum at the Woodrow Wilson Center is organizing an environmental health workshop at AUST in December 2007 for AUST medical school researchers and some Huainan officials. For this workshop, CEHP will bring some Chinese environmental health researchers to present the results of their own air and health studies in China, as well as discuss how they have conducted effective outreach to local policymakers. Most notable will be Shanghai researchers who worked with the U.S. EPA in the late 1990s to conduct a three-year energy options and health benefits study that led the Shanghai government to greatly increase its investment into energy efficiency and clean energy. (*Editor's Note: See Commentary by Chiu et. al in this issue*). CEHP hopes this workshop will help strengthen the design and outreach in the AUST Medical School's study.

CEHP TRAINING RESEARCHERS AND STUDENTS TO BUILD LONG-TERM CAPACITY

WKU researchers have been collaborating with AUST counterparts since 1988. Although the air emission data gathering under CEHP was initiated in late 2006, the project already has catalyzed some valuable training activities. As a part of the CHEP project, WKU and AUST are carrying out training work that will strengthen the capacity of the AUST research community to improve air quality monitoring and control in Huainan, as well as improve the design of environmental health studies.

Even before CEHP, Western Kentucky University researchers were helping their AUST counterparts establish a stronger curriculum on environmental health and coal monitoring techniques. For example, a new class on preventative medicine was offered to approximately 144 undergraduate students for the first time in the spring of 2007. This course introduces the impact of environmental pollution on human health and the prophylaxis and control of the correlative disease. There are 11 other classes with over 700 students that AUST offered in the spring semester that are related to either air pollution or environmental health.

Conclusion

The coal activities under the USAID-supported China Environmental Health Project are fostering partnerships between scientists and students in the United States and China, as well as involving Chinese provincial and local government officials, students, and citizens in promoting better monitoring of coal emissions. This project notably aims to generate awareness among policymakers on the health dangers of coal and hopefully will catalyze city officials to adopt measure to reduce public health problems caused by coal combustion. In conclusion, this collaborative international research project also showcases that WKU faculty and students do not just do research for the sake of conducting research, rather they carry out work on global environmental issues that address local pollution concerns.

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FEATURE BOX

Coal City—Measures to Control Urumqi's Health-Threatening Air Pollution

By Zhang Chen and Rui Li-hong

Urumqi, the capital of the Xinjiang Uygur Autonomous Region, is the number one coal-consuming city in China. Coal is readily accessible, for Xinjiang produces 40.6 percent of China's supply. Besides burning for fuel, Xinjiang's coal mining and underground coal fires also severely pollute the region.[1] Formerly ranked as one of the top ten most polluted cities in the world, Urumqi has made significant policy changes to reduce its air pollution despite continued reliance on coal-fired power plants to fuel the heavy industries (e.g., machinery, petrochemical, metallurgy, and construction materials) that provide most of the city's GDP. The 1.9 million Urumqi residents face serious health problems—asthma, lung cancer, cardiovascular disease and premature death—from air pollution, particularly in the winter months when coal burning is at its heaviest.

WORSENING AIR QUALITY

The number of coal-fired power plants is increasing in the city to meet the growing energy demand, leading to greater emissions of pollutants such as particulates, sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) (See Table 1). The overall ambient air quality of Urumqi is Grade III, which means excessive exposure is unsafe for sensitive groups. NO_2 levels meet China's national Grade II air emission standards, or relatively safe for all groups. However, NO_2—which originates in combustion engines and paper mills—is toxic in high doses and perhaps linked to Sudden Infant Death Syndrome, so lowering these emissions would lessen a potentially dangerous health risk in Urumqi.[2]

Because there is no effective technology for desulphurization employed in Urumqi, the concentrations of SO_2 in the city exceed the national ambient air quality Grade III standards (unsafe for sensitive groups) every year and continue to rise. Particulate matter measuring less than 10 nanometers (PM_{10}) also regularly exceed Grade III standards. Such small particulates can reach deep into the lungs and are associated with many respiratory diseases. Acid rain from SO_2 can damage the area's sensitive flora when levels are a mere .12 particles per million (ppm) for 8 hours—a level Urumqi regularly exceeds in the winter months.[3] With increasing efforts to control soot and dust pollution in the city, the concentrations of particles have decreased gradually over the past five years to nearly Grade II on average. However, as Table 2 shows, ambient air quality exceeds Grade III significantly in winter months.

CAUSES OF AIR POLLUTION

Geography and Climate

One factor exacerbating Urumqi's air quality problems is the natural geography—with three sides surrounded by mountains, pollutants are trapped over the city. This process is exacerbated by predominantly calm winds in the winter and frequent temperature inversions, which trap air pollution low over the city. Urumqi has a winter heating season greater than 180 days, and air pollution can be dire in cold months.

Air quality is also worsened due to Urumqi's dry climate. With an annual rainfall of only 300 millimeters (mm) and an annual evaporation rate near 3,000 mm the area suffers from severe desertification and sandstorms. Desertification is due not simply to grazing animals, but also to decades of excessive water withdrawals for agriculture and urbanization that have drained the region's lakes and rivers.

TABLE 1. Annual Changes in the Emission of Air Pollutants in Urumqi (2001-2006)

Years	Coal Use (10,000 tons)	Dust Emissions (10,000 tons)	Sulfur Dioxide Emissions (10,000 tons)
2001	770	7.11	9.11
2002	781	6.22	9.13
2003	855	5.68	8.71
2004	957	5.76	9.47
2005	998	6.03	9.92
2006	1138	6.50	11.40

Source: Urumqi Environmental Protection Bureau

Urumqi is windy in spring and autumn leading to a greater risk of sandstorms, which cause respiratory problems in addition to skin and eye irritations. All of these health problems pose an increasing burden on the city's long-term ability to improve its economic activity.

Inefficient Use of Energy

Potential energy sources in Xinjiang are very rich—coal, wind power, natural gas, and solar—but the low price of coal ensures that it comprises 67 percent of the Urumqi's energy consumption. Annually, Urumqi uses nearly 10 million tons, particularly in the winter when coal use is two-thirds higher than the rest of the year. An energy structure dominated by cheap coal discourages efficient use—according to official statistics, power conversion efficiency of the city is only 28 percent, the average energy consumption for power generation is 0.44 tons of standard coal per million kilowatt hours, higher than the national average of 0.37. Moreover, the efficiency of heating coal conversion is only 65 percent—low even by China's standards.

Urumqi is also low in terms of meeting energy-saving insulation standards, a major sector of wasted energy. On average in winter months every square meter of Urumqi's buildings needs 36 kilograms standard coal, more than double the central government's targeted minimum of 17 kilograms. The result is the highest annual per capita coal consumption in the country at 3.96 tons—four times the national average. Considering such wasteful coal use, it is not surprising that the continuous expansion of the city is exacerbating the frequency of heavy pollution days.

Urban Development and Environmental Management Challenges

Since the Develop the West Campaign began in 1998, investment in Urumqi has increased, which has helped stimulate economic growth and urbanization. However, the construction of dense high-rise buildings in the city center of Urumqi has exacerbated air problems by decreasing natural airflow, destroying green spaces, and forming urban heat islands. In addition to the layout of the city, antiquated urban infrastructure and poor environmental management capacity have made enforcing pollution control laws difficult in Urumqi. Nevertheless, under the Eleventh Five-Year Program the city has put forward some goals that will begin to address the health-threatening air pollution in Urumqi. Some planned air pollution control measures in the plan include:

Urban Layout: Urban environmental zoning to expand the city must follow environmental objectives. The need to direct new building and infrastructure development onto the flatland north of the

TABLE 2. Concentrations of Annual Ambient Air Pollutants in Urumqi (2001-2006)

	PM_{10}		SO_2		NO_2	
Years	**Heating**	**Non-heating**	**Heating**	**Non-heating**	**Heating**	**Non-heating**
2001	0.267	0.135	0.367	0.037	0.091	0.064
2002	0.234	0.096	0.240	0.023	0.080	0.049
2003	0.175	0.056	0.081	0.021	0.050	0.045
2004	0.172	0.069	0.180	0.026	0.071	0.044
2005	0.185	0.044	0.207	0.025	0.070	0.044
2006	0.231	0.072	0.198	0.031	0.078	0.050

Source: Urumqi Environmental Protection Bureau

city is great in order to reduce the intense pollution in the city center.

Improved Energy Structure and Emissions Control: In terms of developing a cleaner energy supply, the city has set two major priorities: (1) speed up construction of the city's southern district thermoelectric heating grid and (2) promote natural gas use. Expanding clean energy sources cannot free the city of coal dependence, which is why Urumqi must improve incentives to raise energy efficiency, particularly in promoting energy-saving insulation. In terms of emissions control, two central goals are the installation of desulphurization facilities on existing power plants and measures to decrease industrial energy inefficiency.

Improved Capacity of Supply-Side Environmental Management: Crucial for improving enforcement of air pollution laws is stricter environmental protection bureau (EPB) oversight of the planning (e.g., environmental impact assessments) and operation (monitoring and penalizing violators) of construction projects. A key measure to strengthen enforcement is to improve Urumqi's automatic air quality monitoring system to include an online record of the data by source, which will provide timely information to the EPB.

Improving the Urban Landscape: Under the 11th Five-Year Program, Urumqi aims to improve the urban landscape through large-scale reforestation of barren hills and greening the urban center (e.g., trees along roads and more parks and gardens). Another goal is to target air pollution control in existing coal-fired plants and better control of vehicle pollution by increasing public transportation capacity and strengthening vehicle emissions management.

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