COMMENTARY

Environmental Management and Public Health: Challenges and Opportunities in China's Mobile Phone and Telecommunication Industries

By Jacob Park

Since commercial mobile phone services were first launched in Japan thirty years ago in 1978, the number of mobile phone subscribers has exploded to 3.3 billion and nowhere has this surge in mobile phone use been more prominent than in China. In the same way the automobile became a symbol of U.S. industrial might, mobile phones have become a symbol of technological modernization in China with few parallels. If one had to use one symbol to mark China's economic and industrial development over the past 30 years, it might be a close competition between a mobile phone and a building crane.

When any technology reaches the global market penetration of a mobile phone, and when it is growing as rapidly as the mobile phone market in China, it is important to examine the public policy implications of this rapidly evolving consumer product. The introduction of new technologies has always had a profound impact on environment and public health concerns and mobile phones are likely to be no different. Technologies often generate far-reaching environmental and social impacts and as the author Edward Tenner observed in his 1996 book, *Why Things Bite Back: Technology and the Revenge of Unintended Consequences*, these impacts are often unanticipated and go unrecognized many years after the fact.

Some of these environmental and social impacts are becoming better recognized. On 9 November 2008, a 60 Minutes news segment entitled "The Wasteland" reported that 100 million cell phones and 130,000 computers are added to the waste stream in the United States every year. While some are properly recycled, a large percentage (2002 report by Basel Action Network and Silicon Valley Toxics Coalition estimate 50 to 80 percent) of the wastes are not recycled domestically, but placed on container ships bound for destinations like China. What makes this problem of influx of foreign electronic waste so acute in the case of China is the problem of domestically-generated electronic waste. The 60 Minutes segment did not 'break' the story of problem of electronic waste mismanagement in China; in fact, we have known about the problem for more than a decade. However, what the 60 Minutes segment did was bring the problem of electronic waste to the livingroom of millions of American homes and connect the e-waste dot between China and the United States.

ENVIRONMENTAL STEWARDSHIP AND THE MOBILE PHONE INDUSTRY IN CHINA

A quick glance at the list of the world's largest mobile phone companies shows how rapidly China has outdistanced itself from other countries. China Mobile is not only the largest mobile phone company in the world in terms of subscribers, this Hong Kong-based mobile phone company is larger than the number 2 (U.K.'s Vodafone) and number 3 (Spain's Telefonica) largest mobile phone companies combined and it has nearly 7 times the subscriber base of AT&T, the largest U.S. wireless company. In fact, China's second largest mobile phone company, China Unicom, is the fourth largest company in the world or bigger than any company in this industry except for Vodafone and Telefonica. The United States might have received

more total Olympic medals than China, but the United States would be more like South Korea or France if the wireless phone market reach was an Olympic sport.

As of July 2008, the number of mobile phone users in China had reached 600 million people, with over 86 million new subscribers added to the network and 150 million units of new phones being sold in 2007. The United States, by comparison, has a total of 260 mobile phone subscribers. A typical urban mobile phone user in Shanghai, Beijing, or elsewhere replaces his or her phone every two to three years (compared to 18 months in the United States), although it is not unheard of for young fashion-conscious Chinese to replace phones every year. As a result, China ends up discarding 30 million phones every year. These 30 million discarded phones are only part of the nearly 3,000 tons of television sets, computers, and other forms of electronic waste (e-waste) China generates every day. This is on top of the large volume of illegal and legal e-waste China imports every year, although the precise number has never been established.

> **"Years of international pressure…on the United States and other developed countries to manage their e-waste streams without using China as a dumping ground appear to have failed."**

If there is anything that is clear about China's e-waste stream, it is that 90 percent of China's electronic waste ends up in small and medium-sized family-owned e-waste dismantling enterprises in such places as Guiyu, Guangdong Province, where the November 2008 60 Minutes segment did the bulk of its news reporting. As noted by Jamie Choi (2008) in *China Environment Series* issue 9 and Sam Jones (2007) in the China Environmental Health Project Research Brief, Guiyu has rapidly metamorphosed from a small rice-growing village in Southern China to one of the most famous electronic waste dismantling hubs in the world, with over 5,500 households (over 50,000 people) working with e-waste and over 75 percent of the town's 300 odd private enterprises involved in the e-waste business.

FUTURE OUTLOOK FOR GREENING CHINA'S MOBILE PHONES AND THE CONSUMER ELECTRONICS & TELECOMMUNICATION INDUSTRIES

It might be worth asking if the illegal e-waste related environmental problems in Guiyu have been known for so many years, why has the situation improved? Years of international pressure by Greenpeace and other international NGOs on the United States and other developed countries to manage their e-waste streams without using China as a dumping ground appear to have failed. Ironically, this problem persists despite the fact there are eight high-tech, legal e-waste handling facilities under construction and/or in operation along the eastern coast of China. Unfortunately, the problem of mobile phones and other e-waste streams in China continues to pose environmental dilemmas, particularly in disposal because the cost of properly disposing electronic waste in the United States is significantly more than "exporting" the problem to a developing country like China. It should be stressed that the proper disposal of e-waste that meets domestic and international regulatory norms is possible in China.

With environmental pressures increasing due to deteriorating ecological systems, resource scarcity, and industrial pollution, the Chinese government has been forced to recognize the need for a new development strategy to navigate the tricky balance between economic growth, social stability, and environmental stewardship. This new regulatory policy, which some observers refer to as the "circular economy" (CE) approach, can be seen as a way to mediate the conflict between rapid economic growth and resource scarcity within China. Originating within the industrial ecology paradigm and building on the notion of industrial closed-loop supply chains emphasized in German and Swedish environmental policy, the CE concept has been actively promoted by Chinese government policymakers as a way to improve resource productivity, boost eco-efficiency, and strengthen environmental sustainability. Although there is no one single defini-

> **China's Ministry of Environmental Protection is currently researching the environmental and supply-chain management of China's information technology industry and working to establish a mechanism to monitor illegal e-waste imports."**

tion of CE, the circular (closed) flow of materials and energy remains a core feature of this concept, with similarities in practice with the "3R" principles—reduction, reuse, and recycling of materials and energy (Honchun, 2006).

Given the scope and degree of environmental stewardship concerns arising from the information technology sectors, there is an urgent need within China and globally to better understand what CE might imply in terms of business operations, public policy, and corporate strategy in the context of China's mobile phone, telecommunication, and consumer electronic industries. Underscoring the importance of this issue, China's Ministry of Environmental Protection is currently researching the environmental and supply-chain management of China's information technology industry and working to establish a mechanism to monitor illegal e-waste imports (Sarkis & Park, 2008). At the ruling party's National Congress in fall 2007, Chinese President Hu Jintao reiterated the need to protect the environment and conserve resources, which he said was vital to the "survival and development of the Chinese nation" (Subler & Xin, 2007).

Global business supply chains are increasingly being affected by rapid policy shifts in both industrialized and developing countries (e.g., the EU's RoHS and WEEE directives, China's new CE policy). But what happens in China, particular in terms of any new regulations governing the mobile phone industry, is likely to have a disproportionate global impact. Because of the central role China plays in the global supply chain and manufacturing process, any environmental regulations imposed by the Chinese government are bound to have an important global impact, whether or not a company is a major exporter to or importer from China. Companies, large and small, will be able to greatly improve the competitive stance of their organizations by anticipating international environmental policy shifts and adopting a proactive, "beyond compliance" perspective (Sarkis & Park, 2008).

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FEATURE BOX

Strategies for Decreasing the Carbon Footprint of Chinese Companies and Meeting Global Sustainability Challenges

By David Hathaway

As China becomes a dominant force on the world stage, Chinese corporations have the opportunity to adopt proactive environmental sustainability plans and lead the evolution to a more environmentally responsible business climate.

GLOBAL TRENDS

Environmental sustainability is becoming increasingly important in the global marketplace. Due to heightened consumer awareness and media attention, companies are paying more attention to environmental and sustainability performance, realizing that adopting a proactive stance makes good business sense.

Leadership in environmental sustainability is beginning to emerge within Chinese companies. For example, in the summer of 2008 in Shenzhen, one of the world's largest contract electronics manufacturers organized a social and environmental responsibility awareness conference with leading global electronics product companies to discuss options and strategies for improving social responsibility and environmental performance in its manufacturing facilities and supply chain. One of China's largest residential property developers also has taken steps towards developing a sustainable business strategy. Under growing international and domestic pressure, more Chinese companies will be exploring ways to reduce energy consumption, and low- to no-cost building operational changes are the most economical way to proceed.

GROWING PRESSURE

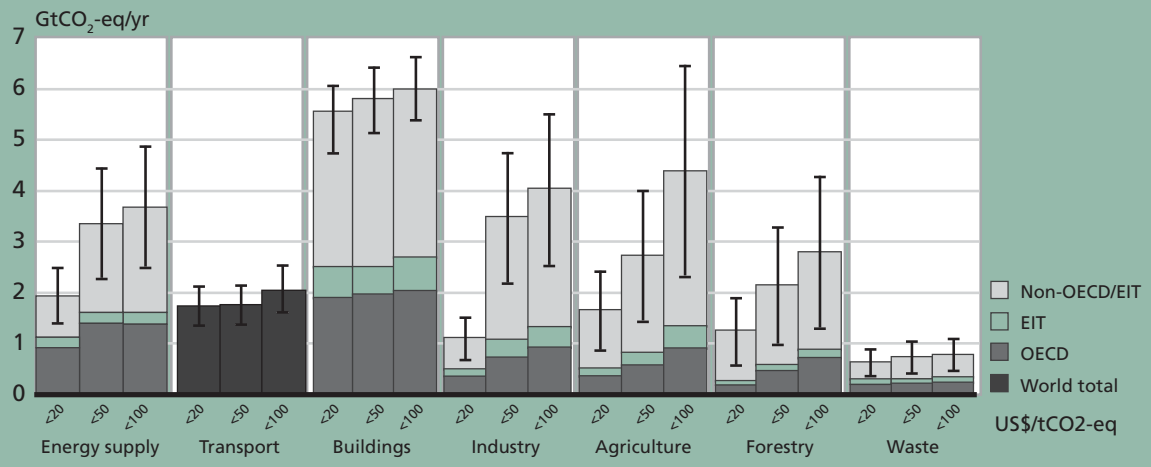
As the supply chain for most Western companies, Chinese companies will face increasing pressure to meet more stringent Western environmental sustainability standards and regulations. For example, many global electronics and IT product firms are rolling out increasingly comprehensive sustainability programs among their supply chain manufacturers. Chinese firms will also need to respond to standards that affect all global companies equally. For example, by 2012, all airlines with flights into and out of the European Union will be required to monitor and report their emissions of carbon dioxide to meet limits established by the EU Emissions Trading Scheme.[1] This new legislation will affect companies like China Southern Airlines, China Eastern Airlines, and Air China, to name a few.

In addition to increasing global pressure, Chinese companies face domestic pressure to improve environmental sustainability performance. For example, state-owned or partially state-owned companies are expected to meet China's Eleventh Five-Year Plan's target of 20 percent energy reduction by 2010.[2] The top 1,000 energy-consuming enterprises in China are also expected to reduce energy consumption from 10 percent to 25 percent by 2010 as part of the Energy-Consuming Enterprises Program launched in April 2006. The program has achieved a reported 28 percent of target energy savings within its first year.[3]

OPPORTUNITIES FOR CHINESE COMPANIES

In response to an increasing global focus on corporate social responsibility, and against a backdrop

Table 1: Economic Mitigation Potentials by Sector in 2030 Estimated from Bottom-up Studies



Source: International Panel on Climate Change (IPCC) AR4 (2007)
http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

of serious policy pressure for energy conservation on large Chinese energy users, there are strategies available that can do the following:

- Bring substantial bottom line business benefits;
- Provide robust inputs for successful environmental sustainability reporting;
- Demonstrate successful responsiveness to government energy policy; and,
- Support a growing movement towards broad-based carbon management by corporations.

STRATEGIES CHINESE COMPANIES CAN TAKE

Currently, there is little guidance available in the marketplace concerning how to initiate a corporate sustainability strategy, and companies in China (and globally) are struggling to develop the best approaches to improving performance. The best and most universally available strategy is to focus on corporate building energy use, along with close attention to tracking energy use data over time. Buildings are the largest controllable component of energy use and carbon emissions for most companies, and China's building stock is the fastest growing in the world. The World Bank estimates that, in the decade leading up to 2015, roughly half of the world's new building construction will take place in China. China's Ministry of Housing and Urban-Rural Construction estimates that the building stock in China will double by 2020.[4] Globally, building energy use has been identified as the single largest opportunity for reducing greenhouse gas emissions.

Improving energy performance across a corporate building portfolio is one option companies can take to cost-effectively improve overall environmental and sustainability performance. Reducing energy use benefits operational efficiency and bottom line business, in addition to being a key part of a carbon emissions reduction strategy.

Focus on No-Cost and Low-Cost Operational Excellence

U.S. Environmental Protection Agency's (EPA) studies show building operations as a critical driver of top building energy performance. In 1999, 2000, and 2001, EPA conducted studies to determine the key construction, equipment, and management characteristics of buildings in the United States that earned the ENERGY STAR® for top building energy performance. These buildings are approximately 40 percent more energy-efficient than average. The surprising finding of these studies was

Figure 1. Leading Chinese Companies Improving Environmental and Sustainability Performance

Globally: Distributes computers and software tools.

In China: Commands about one-third of the Personal Computer (PC) market. Number-one PC vendor in China for eight consecutive years.

Sustainability Efforts: Lenovo has taken steps towards CSR by disclosing greenhouse gas (GHG) emisions from its eight facilities in China, U.S., and Japan for 2007 and has set a voluntary target of improving operational carbon efficiency by 10% by 2012, against the 2007 baseline.

中国移动通信
CHINA MOBILE

Globally: The world's largest mobile network and the world's largest mobile subscriber base.

In China: 5th largest Chinese corporation.

Sustainability Efforts: China Mobile Communications Corporation recently signed a green action plan with mobile communication equipment suppliers and some mainstream support equipment suppliers to increase energy savings and reduce emissions.

that, "While the majority of ENERGY STAR® buildings understandably use highly efficient equipment, they are most similar to the poorest performing buildings from a technology perspective."[5] From this EPA concluded, "This observation does reinforce the need to look beyond technologies and design when defining building performance, and consider building operations and management practices as critical to the realization of a building that performs as well in the ground as it does on paper."[5]

Operational strategies not only drive top energy performance, but top financial performance as well. Most strategies are no- or low-cost to implement, do not require the purchase of new equipment or technology, and can be implemented by existing staff. Case studies in China, such as the iconic Jin Mao Tower in Shanghai (the world's fifth tallest building) demonstrate that the implementation of simple no- or low-cost operational strategies can save up to 20 percent annually in energy use and cost—a surprising finding for a building only several years old, designed by leading architects, and outfitted with the best available technologies.[6]

The energy and cost savings achieved through single-building operational strategies can be increased significantly when these strategies are applied across a building portfolio. Savills, a United Kingdom-based property management firm and a leader in the Chinese market, managing over 30 million square meters of building space in Greater China, is an example of a company successfully applying no- or low-cost operational strategies across its portfolios of managed buildings in Shanghai and Beijing. Savills has implemented innovative techniques to train management and engineering staff, identify opportunities, implement best-practices, and track performance improvement across multiple buildings simultaneously. Case studies of pilot buildings from Savills' Shanghai and Beijing portfolios show savings of up to 15 percent annually.

The Critical Role of Data Management

Collecting, organizing, and tracking energy performance data is essential to a successful, long-term environmental sustainability strategy. Two companies may take the same actions, but the company that tracks performance data will have more success, as it will be able to achieve the following:

- Establish goals and strategies;
- Set baseline performance and calculate savings;
- Identify problems early, before wasting money;

- Communicate data-rich success to investors, employees, customers, and other key stakeholders; and,
- Avoid accusations of 'greenwashing,' by ensuring that energy savings are real. (Most instances of corporate 'greenwashing' are a result of claims that are not clearly backed up by sound data.)

Furthermore, data is a critical component of a carbon offset or neutrality strategy. Companies that want to establish their carbon footprint, "go carbon neutral," or participate in an emerging carbon marketplace must have access to a reliable stream of energy data to quantify and manage their carbon.

A GOOD TIME TO TAKE ACTION

It is a good time for Chinese corporations to begin adopting proactive environmental sustainability strategies. These strategies can deliver significant financial benefits and respond to growing pressure from government, customers, employees, and other stakeholders. Simple, low-cost, and market-tested approaches, such as focusing on building portfolio operational excellence, are readily available. Chinese companies that pursue such strategies, track performance, and communicate success will be well positioned to lead in tomorrow's competitive and carbon-constrained marketplace.

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Figure 2. CSR Statistics for Chinese Firms

- Of the 28 Chinese firms in the Global Fortun 500, **43% have published CSR reports and 21% are members of the China Business Council for Sustainable Development (BCSD)**
- Of the top 100 Chinese companies, **13.6% have published CSR reports and 7% are members of BCSD.**
- **In 2007, 27 Chinese companies were asked to participate in the Carbon Disclosure Project**—an organization that works with shareholders and corporations to gather greenhouse gas emissions data for major global corporations.

COMMENTARY

Yours, Mine, Whose Water? Evolving Water and Property Rights in China

By Sonja Schiller

The fact that a legal or economic model does not exist for an activity or a behavior is no reason to oppose it, because the laws can develop out of experience and practice.

—Wu Guoping, Yangtze River Basin Commission[1]

In February 2009, the Chinese government announced that severe water shortages in northern China would lead to a 5.4 percent drop the country's grain harvest, affecting 43 percent of the winter crop.[2][3] Water shortages not only threaten food security in China, but also exacerbate health problems, particularly in the country's water-stressed rural areas, where illnesses and deaths from poor sanitation and dirty water are a growing concern. Nationwide, some 60,000 Chinese, half of whom are rural children, die each year due to diarrhea from drinking dirty water.[4] Moreover, nearly 4.37 million people and 2.1 million heads of livestock are having difficulty accessing any water in rural communities in northern and western China and such shortages catalyze a growing number of eco-refugees fleeing areas being taken over by desertification.[5] The UN estimates that by 2010 there could be as many as 50 million such people fleeing the oceans of sand in northern China.[6]

While population pressures and thirty years of ostensibly unchecked economic growth clearly have put major pressures on China's water resources, a major driver of water over-consumption and pollution is a lack of clear water property rights exacerbated by disparities in temporal and spatial distribution. For example, 60 to 80 percent of China's rainfall and runoff occur during the flood season.[7] China's annual per capita water supply of 2,200 cubic meters is only 25 percent the global average. Even more sobering is the estimate that by 2030 the per capita water supply could fall to 1,700 cubic meters.[8] China's northern regions have 65.4 percent of the cultivated land and 46.1 percent of the population but only 19 percent of the country's freshwater resources.[9] The Chinese government's solutions to water shortages in the north usually emphasize increasing water supply through engineering, such as the ambitious South Waters Northward Project, which aims to construct three canals to transfer water from the Yangtze River to the dry north. But this and other water transfer projects have become more difficult to implement as they are increasingly costly and contentious as some provinces losing water demand compensation.

Beset by the free rider problem inherent in unconstrained access to a (seemingly) limitless resource, water quantity and quality have been strained in China by the over-consumption of municipalities, farmers, and industry, all of whom have incomplete water property rights that discourage investment in improving water conservation and water quality.[10] Inefficient water resource management and poor enforcement of water pollution laws by local governments have further aggravated water scarcity in China. Local governments that have undertaken "blind pursuit of quick and short-term economic gain without regard to environmental consequences" have encouraged both domestic and foreign investment into large-scale polluting and resource-intensive industries in China.[11]

While there is no silver bullet to cure all of China's water challenges, many water experts within and outside China believe that to significantly

improve water quality and quantity the government must completely recognize and enforce water rights and move towards a system of economically efficient market-based water trading. Recent changes in China's water laws and the creation of a new property rights law have laid the framework for clarifying water rights and facilitating water trade, but challenges remain.

THE END OF SOCIAL CONTRACT

Since 1949, China's water resources have been regulated under a system of communal ownership, with ultimate ownership vested in the state.[12] Before the 1979 liberalization of the economy, Confucianism and Communism arguably provided the "moral and ethical…cement of social stability which ma[de] [the] economic system viable" and reduced the need for a strong rule of law.[13] Under China's Confucian and Communist ideological roots, ownership of a public good by the state[14] posed few problems, for natural resources were entrusted to the "fatherly" state, and a value for the community over individualism discouraged over-consumption for personal gain. These ideological norms helped curb water use—sometimes by simply permitting traditional water right regimes to operate quietly.[15] While the Communist regime reinforced these communal values to keep water users in check, sometimes its own campaigns led to considerable mismanagement of water, such the massive 1950s "Let Deserts Bloom" campaign when millions of citizens were relocated to promote agricultural development in China's dry northern and western regions, a development that greatly exacerbated water shortages and desertification. In the 1950s there were also campaigns to accelerate glacier melt by dumping coal dust in the Himalayas.[16] The rush to promote irrigation often led to water diversions and short-lived dams that quickly silted up and sparked conflicts among communities that previously shared water amicably.[17]

While considerable damage was done to water and other natural resources under Mao, the liberalization of the Chinese economy has resulted in increasing over-consumption of water resources. Because it is difficult to exclude use of such common-pool resources and because individual resource use detracts from other's consumption, free rider problems and water wastage are rampant in China.[18] Water use in the agricultural sector accounts for 65 percent of the country's total while the industrial sector consumes only 24 percent; yet only 45 percent is actually applied to crops due to wasteful irrigation practices.[19] The water-recycling rate in China is only 40 percent, compared to 75-85 percent in developed countries.[20]

The continued absence of a specified property rights regime also eliminated the incentive to invest in conserving water resources and improving water quality. In China, the lack of clear water rights combined with the difficulties in monitoring water use and the unequal bargaining power among users has impeded efficient allocation of water through private negotiations or trade. Instead, water users with greater financial means or higher bargaining power vis-à-vis the government have more water rights allocated to them.

Examples of water trade and transfers that leave some users literally "high and dry" are plentiful in northern China.[21] As Beijing exploded in size, its need for water trumped those of neighboring cities and provinces. For example, over the past decade Beijing has acquired the rights to reservoirs previously supplying other cities and emergency water transfers have often come at a cost to neighboring water-short Shaanxi Province. The need to provide Beijing and the rest of the dry north with water in time for the Olympics was notably the catalyst for constructing the long-debated South to North Water Transfer Project (SNWTP)—three canals intended to bring water from the Yangtze River to northern China. All of these water transfers have generated conflict, for example at the 2008 National People's Congress, delegates from Shanxi made demands for compensation for these excessive water withdrawals.[22] In Hebei, protests and petitions over exacerbated water shortages, land grabs and low or unpaid wages for project workers sometimes delayed work on the SNWTP.[23] Moreover, the second and third canals for the SNWTP have been postponed due to excessive costs and opposition from local governments.

CHINA DEVELOPS WATER RIGHTS

In recent years, the Chinese government has worked to transform water rights to address growing unequal access to water and the growing conflicts. In 2002, the amended Water Law[24] contained three crucial changes to address the challenges of water rights: (1) recognition of the right to transfer water resources; (2) increased autonomy for local governments to regulate water resources on a regional level; and (3) strengthened ability for river basin commissions to

> **"In recent years, the Chinese government has worked to transform water rights to address growing unequal access to water and the growing conflicts."**

manage water resources throughout the basin.[25] However, water policy in China is fragmented and uncoordinated, for in addition to the Ministry of Water Resources and the river commissions it oversees, the ministries of environmental protection, agriculture, construction, mines and minerals all have overlapping authority to manage water.[26]

Building on the 1988 Water Law, the 2002 amendments established a system of water use permits, in which water price was determined according to "compensation for cost, reasonable profits, quality, and equitable burden of price by all water users."[27] Again, in 2004, China's Water Law was further amended to reinforce allocation of water through a system of permits;[28] however, the 2004 Water Law failed to give legal recognition to compensation earned from trading water permits,[29] resulting in incompletely enforced water rights. A 2006 regulation further laid the framework for a system of water use permits by requiring water users to apply for water use permits and pay usage fees for water taken directly from rivers, lakes, or underground sources.[30]

Effective February 1, 2008, the Interim Measures for Water Quantity Allocation provide the principles and processes by which water resources may be efficiently and equitably allocated,[31] feasibly promoting the role of water trading and other market tools in the distribution of water resources.[32] According to China's Deputy Minister for Water Resources, Zhou Ying, "in combination with the existing regulations on management of water abstraction licenses," the Interim Measures "form the start of China's water rights trading system."[33] Specifically, under the Interim Measures, county officials allocate water resources to businesses, villages, and towns, and what the water users conserve, they may sell.[34] Significantly, *Shanghai Securities News* proffered that the Interim Measures could stimulate a water trading market, which indicates that Chinese finance analysts also see promise in what could be a significant new market.[35] While the state still maintains ownership of water resources under the Chinese Constitution,[36] the amendments of the Water Law and Interim Measures, as well as several recent, highly visible water transfers, indicate that the Chinese government has begun to acknowledge lesser property interests in water resources. (See Box 1).

PROPERTY RIGHTS DEFINED AND REDEFINED

China's changing economy has exposed the inefficiencies and shortcomings of the rigid definition of property rights in China's civil law framework. While common law systems describe ownership as a "bundle of sticks," with lesser ownership interests associated with various arrangements of the "sticks," China's civil law jurisprudence[37] considered ownership an indivisible and absolute whole. However, since 1979, China's ambitious market reforms have simultaneously decentralized the economy and started to "transfer" incidents of ownership to various economic agents.

To give legal protection to the various property interests emerging from China's new market economy, notable Chinese legal scholars have promoted recognition of decentralized, lesser "usufruct" rights (*yongyi wuquan*).[38] Proponents of changing China's property rights regime argue that under the new phase of economic development and consumerism, imprecise specification of property rights were insufficient to regulate ownership, which ultimately could hinder economic development.[39]

To respond to the changing dynamics in China's economy, the National People's Congress adapted previous rules regulating property rights and enacted the *Law on Real Property Rights* (Property Rights Law) on 16 March 2007. This law was clearly contentious, as it was enacted after thirteen years and eight rounds of formal deliberation.[40] The Property Rights Law gives unprecedented legal protection to private property ownership, in addition to lesser, usufruct interests ensuing from the decentralization of the economy: under Article 39, "the owner of a realty or chattel is entitled to possess, utilize, seek profits from and dispose of the realty or chattel."[41] Water rights are among those usufruct rights which can be considered property rights in relation to na-

BOX 1. **Under the Table Water Trades**

Although the 1988 and 2002 versions of China's National Water Law indicated legislative support for water trading to promote water conservation, the final laws did not include water trading provisions, implying a reluctance to accept trading as a tool of water resource management. In deliberations for drafts of the 2002 amendment, paid water rights transfers were contemplated, but ultimately rejected as too controversial. Nonetheless, water trading has played a significant—if informal role in recent water disputes.

For example, although they were not officially legal, several notable water transfers and sales have occurred and in effect they have advanced the development of a water rights regime. In 2000, Dongyang City and Yiwu City agreed to exchange $24 million for the annual transfer of 50 million cubic meters of water from Dongyang City's Hengjin Reservoir to Yiwu City. Yiwu City negotiated for a stipulated annual quantity of water at a specified water quality (Class I). Although the water use rights are transferred through the agreement, the ownership of the water does not change.[1]

Although the Dongyang-Yiwu agreement may be considered among China's first transfers of water use rights, the absence of a legal framework to support the agreement risks undermining the future stability of water use rights transfers. Since the Dongyang-Yiwu agreement there have been additional transfers of water for compensation. In 2002 and 2003, the local governments in the lower and upper regions of the Zhanghe River negotiated the transfer of 30 million cubic meters of water from five reservoirs. The documents supporting the sale clearly delineated the legal rights within the water distribution scheme, elucidating the status of related water rights.[2]

Wu Guoping from China's Yangtze River Basin Commission, whose quote opened this commentary, has argued that the recent illicit sale and trade of water permits has encouraged a market-based system of water exchange and has lead to an implicit recognition of property rights in water.[3]

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2. *Ibid.* at 265.
3. *See* Kinne. (December, 2005).

tional ownership of water resources.[42] The Property Rights Law's legal recognition of these usufruct interests also theoretically protects the profits earned from state-owned natural resources,[43] which arguably includes compensation earned through sale and trade of water permits.

THE NEED FOR STRUCTURAL AND LEGAL SUPPORT

Uncertain legal recognition and enforcement of water property rights in China has led to inefficient resource use and pervasive social unrest. Under the current system of water resource management, water permits have been allocated experimentally to Water Users Associations under a rapidly developing system of allocating water usufruct rights.[44] Many of these Water User Associations have notably been created as part of World Bank investments into irrigation projects. However, the usufruct rights in the water resources—or the compensation from the usufruct rights—have not been precisely specified.

Failure to legally define "water rights" has further obfuscated the ownership interests in water resources. In order to encourage the many individuals, corporations, and organizations to invest in efficient and sustainable water rights as China's economy keeps rising, water rights need to be unbundled, which includes right to access; right to withdraw; right to manage; right to exclude; and right to transfer.[45] Clearly delineated and regularly enforced water use rights will also encourage investments in improving water quality, which is crucial in such a water-short country.[46]

Waste water pipes emerge in the banks of a tributary to the Gansu River. A major driver of water over-consumption and pollution is a lack of clear water property rights. Photo Credit: Christina Larson

So as not to compromise human health or humanitarian need, water should be first allocated according to the public good. Even subsequent to enabling water markets, the government should maintain the ultimate right to intervene in water trading.[47] Pursuant to proper allocation of water, expanding the role of market-based water trading in China could improve water conservation and encourage the most economically viable use of the water. However, just as with any property rights regime, "the expansion of water markets and prices presupposes progress on establishing the institutional framework on property rights [water rights/entitlements],"[48] as well as sufficient public participation mechanisms to encourage public enforcement of environmental pollution and water use laws.

For water rights to be an effective means of conserving water resources and improving water quality, courts must protect the property interests of water rights holders. In recognition of this need, there has been innovation at the local level. Namely, five new "green courts" have been created in provinces in southern China with the primary aim to address water conflicts that cut across political jurisdictions.[49] China's new system of water rights will be more successful where there is procedural fairness and significant public participation in the development and enforcement of the water rights regime.[50]

Attributing rights to water permit holders has been offered by Chinese lawmakers not only as a means of improving the efficiency of water distribution, but also of ensuring the quality of water resources.[51] Prior to the development of statutory standing, the basic legal protections inherent in property, contract, and other privately held rights form the foundation of "environmental law." Absent statutory standing, property rights holders may assert claims under tort and nuisance law[52] and seek judicial intervention in cases of interference with their property.[53] Particularly in a developing legal system, enforcement of private property rights is fundamental to environmental regulation.[54] By giving legal protection to the usufruct interests in water resources, the 2007 Property Rights Law offers a notable step towards reducing water consumption and achieving environmentally sustainable use of water.

The grant of property rights to water (through water permits) will likely improve the private rights approach to environmental law enforcement. In the absence of a flexible property rights regime that recognizes usufructuary interests, environmental plaintiffs whose asserted injury concerns an interference with the property interest in the water itself have up to the present been denied standing.[55] China's recent legal recognition and protection of usufruct rights in water heralds the potential to achieve both economically efficient and environmentally sustainable water use. Uniform implementation of a market-based system[56] of water licenses and legal protection of water rights will increase efficient allocation and use of water resources, thereby avoiding social unrest and ensuring continued economic development.

In parallel with the progression of China's decentralized market economy, the development of a market-based, transparent system of water rights, concurrent with the improvement of mechanisms for public participation, will dramatically improve the quantity and quality of water resource management.[57] However, without structural and legal support, true market efficiency will develop slowly, at best.

The strength of property rights results not only from the precise specification of property rights, but also from the effectiveness of the institutions that enforce the rights. Imprecise delineation and irregular enforcement of property rights not only fail to give individual owners an incentive to improve the efficiency of resource consumption, but also encourage property owners to ignore social and other external costs, which results in the over-utilization of the resource.[58] Clear legal rights over water reduce future transaction costs by creating a precedent of acceptable behavior and improves the likelihood of achieving distributive justice.[59]

For her insight and guidance on this paper, special thanks to Jennifer Turner.

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NOTES

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10. For a discussion of the public good problem, *see* Douglass C. North (1981). *Structure and Change in Economic History*. W. W. Norton & Co.

11. Yuhong Zhao. (2007). "Trade and environment: Challenges after China's WTO accession." *Columbia Journal of Environmental Law*, 41, 49.

12. In further support of the theory that ideological norms structure property rights, before the establishment of Communism in China in 1949, water rights were regulated by a system of privately owned permits. According to Kinne, "the long and complex history of property rights in pre-1949 China, and the socioeconomic specificity of those rights, translates into social and legal norms that are not likely to be erased in a half-century of the 'New China'…. Those norms provide yet more theoretical and practical grounding for the extension of property rights to include water rights in contemporary China." Beth Kinne, unpublished LL.M. Thesis. (December, 2005). *Developing Property Rights in Water in Modern China*, University of Washington, p. 4.

13. *See* North (1981) and also John W. Head. (2003). "Codes, cultures, chaos, and champions: Common features of legal codification experiences in China, Europe, and North America." 13 *Duke Journal of Comparative & International Law*, 1, 37-38, which discussed how the informal, unwritten, and widely adhered to Confucian concept of *li* governed social relationships and reduced esteem for a written, formal legal code.

14. One could view water resource management "through a Confucian lens—the strong 'fatherly' central government doling out resources… under the centralized system [in which] the provincial 'sons' strained to get more resources." Subsequent to the 1978 market reforms, economic and administrative authority over water became more decentralized, which exacerbated local government bargaining with central officials for water rights. Wang Yahua. (2003). "Water dispute in the Yellow River Basin: Challenges to a centralized system." *China Environment Series 6*, p. 95.

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24. The 2002 Law amended the 1988 Water Law, which defined a system of water management wherein "the state shall exercise a system of unified administrations on water resources in association with administration at various levels and by various departments." Zhongguo Shuifa [Water Law] (promulgated by the Standing Committee of China's National People's Congress Jan. 21, 1988, effective July 1, 1988), translated in *LawInfoChina*. While river basin management has a lengthy history in China, not until the 2002 Water Law was river basin management intricately detailed with a system for efficient water allocation for economic development, sustainable water utilization for social use, and prevention and control of water disasters. River basin management of water resources originated as early as the Xia Dynasty (2200 BC), where the Great Emperor Yu harnessed rivers and united the state. In the 1930s, the central government in China instituted modern river basin management organizations, and in 1949, the Chinese state instituted the Yellow Water Resources Commission under the auspices of the Ministry of Water Resources. Dajun Shen. (2004). "The 2002 Water Law: Its Impacts on River Basin Management in China." 6 *Water Policy*, 350. The 2002 Water Law declares "the state shall exercise a water resource management system of river basin management in conjunction with jurisdictional management." Zhongguo Shuifa yu [Water Law] (promulgated by the Standing Comm. Nat'l People's Cong. Aug. 29, 2002, effective Oct. 1, 2002), *translated in* LawInfoChina. [hereinafter 2002 Water Law].

25. An impetus for amending the system of water resource management, between 1972 and 1998, the Yellow River dried up during 21 years. Shen, *supra* note 23, at 350.

26. MEP regulates water quality; the Ministry of Construction monitors municipal water supply; the Ministry of Agriculture manages irrigation; and the Ministry of Mines and Minerals is responsible for groundwater supplies. U.S. Embassy Beijing. (2002). *Clearing Muddy Waters: China Centralizing Water Management Authority*. [Online]. Available: http://beijing.usembassy-china.org.cn/report0702water.html.

27. *See* 2002 Water Law, art. 7 & art. 55. Patricia Wouters et al. (2004). "The New Development of Water Law in China." 7 *University of Denver Water Law Review* 243, 282.

28. Kinne. (December 2005).

29. Wang Yahua. (2003).

30. *See* Regulation on the Administration of the License for Water Drawing and the Levy of Water Resource Fees (promulgated by the State Council Feb. 21, 2006, effective Apr. 15, 2006), art. 2, translated in LawInfoChina. *See also* Zijun Li. (2006). "China issues new regulation on water management, sets fees for usage." Worldwatch Institute. [Online]. Available: http://www.worldwatch.org/node/3892.

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34. *Ibid.*

35. *Ibid.*

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41. Real Right Law of the People's Republic of China, art. 39, (promulgated by the Standing Comm. Nat'l People's Cong., Mar. 16, 2007, effective October 1, 2007).

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43. Frank Xianfeng Huang. (2004). "The Path to Clarity: Development of Property Rights in China." 17 *Columbia Journal of Asian Law*, 191, 208.

44. Liu, *supra* note 41, at 272.

45. Edella Schlager & Elinor Ostrom. (1992). "Common Property and Natural Resources: A Conceptual Analysis." 68 *Land Economics*, 249, 249-52.

46. Development of "exclusive property rights which reward the owners provide[s] a direct incentive

to improve efficiency and productivity." Douglass C. North. (1981).

47. Zmarak Shalizi. (2006). "Addressing China's Growing Water Shortages and Associated Social and Environmental Consequences." *Development Research Group*, World Bank Policy Research Working Paper 3895.

48. *Ibid* at p. 17 (emphasis in original).

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51. *Ibid* at 33-34.

52. Eric W. Orts. (2003). "Environmental Law with Chinese Characteristics." 11 *William & Mary Bill of Rights Journal*, 545, 559 n.97. *See Boomer v. Atlantic Cement, Co., Inc.*, 257 N.E.2d 87 (N.Y. 1970) (granting relief where landowners alleged a nuisance claim where the polluting operations of a neighboring cement plant created substantial injury to their property).

53. Orts, *supra* note 51, at 558.

54. The 2001 desertification law, for example, grants property rights to citizens who contribute to land improvement and conservation. Other recent laws have similarly begun to acknowledge the benefits of a private rights-based system of environmental protection. U.S. Embassy Beijing. (2001). *China Adopts Law to Control Desertification*. [Online]. Available: http://www.usembassy-china.org.cn/sandt/desertification_law.htm.

55. Patti Goldman. (2007). "Public Interest Environmental Litigation in China: Lessons Learned from the U.S. Experience." 8 *Vermont Journal of Environmental Law*, 251, 257 n.28.

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58. Douglass C. North. (1981).

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SPOTLIGHT

Redefining the GMO Debate in China: Greenpeace China

By Lorena Luo

As the most populated country in the world, with over 1.3 billion people and only 8 percent of the world's arable land, China has always put food security as its top priority. Genetically modified organisms (GMOs)—with their multifold promises of pesticide reduction, disease resistance, and drought tolerance—have garnered strong interest from Chinese policymakers as a potential solution to the country's agricultural challenges. Nevertheless, the environmental and food safety uncertainties associated with this technology also call for a cautious approach to the application and regulation of GMOs. Civil society should play a key role in the ongoing debate in China over agricultural GMOs, as consumers and farmers need to have a say in the future of their food and crops. Since 2000, Greenpeace China has carried out a campaign on GMOs that exposes gaps in regulation, informs consumers, and promotes the precautionary principle in the application of this controversial technology. Through investigations, outreach, publications, and other campaign work, Greenpeace China has done the following:

- Assisted the Chinese government in discovering and addressing major loopholes in its regulation of GM rice field trials;
- Worked with major domestic and international food companies to establish a non-GM food policy for the Chinese market;
- Tested popular food products and published testing results to ensure Chinese consumers' right to access information on the GMO issue; and,
- Conducted independent assessments on the ecological and food safety risks of GM crops and their intellectual property issues in China.

INVESTIGATING ILLEGAL GM RICE

In late 2004, A *Newsweek* report indicated that a GM rice variety not yet approved for commercialization by the Chinese government was already being grown in central China's Hubei Province. Following the news, a Greenpeace investigation team immediately went to Hubei to assess the situation. From February to August of 2005, the team visited Hubei Province numerous times conducting undercover investigations of the illegal sale of the GM rice seed and tracing the spread of the rice in the food market. The team talked to seed companies, agricultural extension stations, farmers, rice millers, and rice sellers. They collected samples of seeds, seedlings, and rice products. The Greenpeace team also documented the investigation process in collaboration with investigative journalists from leading Chinese news organizations.[1] The investigation uncovered a widespread leakage of illegal GM rice (a pest-resistant variety called Bt63) to the market, which posed serious environmental and food safety risks, as it had not yet been labeled safe by China's Ministry of Agriculture.

A follow-up Greenpeace investigation of the food market in China also found that illegal GM rice from Hubei had contaminated rice products sold by leading supermarkets and baby food brands as far away as Guangdong Province and Hong Kong. In 2006, Greenpeace offices in several European countries including the United Kingdom, France, and Germany discovered that the illegal GM rice was present in rice products imported from China.

Upon the initial discovery of the illegal GM rice in Hubei Province, Greenpeace immediately informed the Chinese government and released the information to the public. Subsequent government investigations into the illegal sale and growth

Early in the GMO Campaign, Greenpeace organized a sit in on 28 May 2001 outside the Nestlé factory in Hong Kong Yuen Long. Photo Credit: Greenpeace China

of GM rice in Hubei resulted in the destruction of illegal GM rice fields, punishment of three seed companies, and stricter oversight of companies producing and exporting rice products.

In 2008, Greenpeace also exposed another illegal GM seed case in Hunan Province, in which a scientist presented a GM seed as a conventional seed for the national seed registration test. After Greenpeace's investigative report, this GM seed did not pass the seed registration.

WORKING WITHIN CHINA'S FOOD INDUSTRY

Urban Chinese consumers are increasingly concerned with food safety issues, including GM food. Since 2004, Greenpeace China has been monitoring Chinese consumer awareness of GM food in collaboration with polling organizations. The latest Greenpeace/Ipsos survey of 600 Chinese consumers in three cities in 2007 revealed that 65 percent of consumers in Beijing, Shanghai, and Guangzhou prefer non-GM food and 97 percent feel China should have a mandatory labeling system for GM ingredients.

Currently, China has a GM labeling regulation covering only non-processed and half-processed products such as seeds and oil. To better support the consumers' right to access information in mainland China and Hong Kong, Greenpeace China has been using different campaign tools such as direct action and negotiations to push food companies to open their ingredient policy to the public. Greenpeace staff has also been working with Chinese officials to advocate the establishment of a non-GM food policy in China to reduce the release of GMOs into the environment.

Since 2001, Greenpeace China has been publishing a consumer guide that categorizes both domestic and international food companies according to their GM ingredient policy in forms that are clear and accessible to Chinese consumers.[2] This guide has been updated regularly, with more food companies publicly announcing their non-GM food policy for the Chinese market. The latest version of the consumer guide (2007) covers almost all of the big food brands in China. Leading global food companies such as Coca-Cola, Pepsi Food, Dannon (Groupe Danone), and Kraft Foods

are among those that have committed to use only non-GM ingredients in their products in China. Greenpeace also tests popular food products produced by our listed companies in the market and releases testing reports as a monitoring mechanism for food company policies.

INDEPENDENT VOICE

Greenpeace has been closely monitoring the development of GM crops in China to provide an independent third-party perspective. In 2002, Greenpeace worked with scientists from the Nanjing Environmental Science Institute to publish a study on some of the key ecological risks associated with GM cotton in China, including its potential for pest resistance and risk of secondary pests.

In 2004, Greenpeace scientists in the U.K. also conducted independent assessments on the environmental and food safety aspects of several Chinese GM rice varieties awaiting approval for commercialization in China. The assessment report was submitted to members of the Biosafety Committee—an advisory group organized by China's Ministry of Agriculture to do GMO safety assessments; it was also released to the public through the news media.

A 2008 Greenpeace study of global food patents notably found that foreign patents are heavily involved in key GM rice varieties in China, despite the Chinese government's considerable emphasis on self-owned property rights in this field. The finding raises serious questions about the implications of foreign patents on the country's food security and the farmers' livelihood. If China approves the commercialization of GM rice, it could risk the staple food grain on which 1.3 billion people rely for survival. There are cases in other countries that show the prices of seeds of GM crops are much higher than those of conventional non-GM seeds, which could eventually result in price increases of seeds at large in the country. Foreign patent holders may also file damaging lawsuits against farmers and seed companies.

PROMOTING SUSTAINABLE AGRICULTURE IN CHINA

Greenpeace believes that genetic modification and heavy industrial agriculture are not the answers to China's agricultural problems. From the very beginning of its work in China, Greenpeace has been promoting ecological agriculture solutions as an alternative future of China's "rice bowl." Greenpeace researchers have been documenting local sustainable agricultural practices such as multicropping—particularly the rice-duck model—and working with Chinese scientists to demonstrate the potential of other eco-friendly practices.[3] These practices also have helped farmers express their feelings towards land use and cultivation using their own creative ways.[4] One of the Greenpeace activities in 2006 was to give local farmers cameras so they could document their lives. The results—three photo exhibitions around China—were excellent; the farmers' viewpoints left a remarkable impression on their viewers and the media.

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NOTES

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2. See Greenpeace China Website: http://www.greenpeace.org/china/zh/campaigns/food-and-agriculture/ge-food/food-safety/foodguide.

3. See Greenpeace China Website: http://www.greenpeace.org/china/zh/news/rice-and-its-partners.

4. See Greenpeace China Website: http://www.greenpeace.org/china/zh/press/releases/20060607-rice-farmers-photo-exhibition.

COMMENTARY

Turning a Double Exposure into a Double Dividend: Black Carbon From Indoor Air Pollution in Rural Yunnan

By Jill Baumgartner and Nina Trautmann Chaopricha

In a village near Lashi Lake in northwest Yunnan Province, Mu Xuequan guides us through her household courtyard and into a small kitchen. "Nothing special," shrugs Mu. "It's the same as most kitchens in this area." Smoke billows up from an open hearth where Mu has balanced a large pot on top of smouldering pine logs. The blackened kitchen walls indicate years of using firewood for cooking. "We built that many years ago," says Mu, motioning to an enclosed and vented cook stove at the opposite end of the kitchen, "but we only use it during family gatherings." She acknowledges that the smoke sometimes bothers her eyes, but still continues to burn wood in the open hearth for cooking and boiling water—the same method her family has used for generations.

Despite having access to existing clean energy fuels and technologies such as liquefied propane gas or biogas, the use of traditional open fire cooking with biomass, mainly wood and crop residues, is persistent among households in this region of Yunnan. Indoor biomass combustion has considerable consequences for environmental and human health due to the emission of pollutants into household kitchens, neighborhoods, and the atmosphere. A particle pollutant from biomass burning that is increasingly blamed for a significant proportion of the negative impacts on both human health and the environment is black carbon (BC). Thus immediate public health and climate-related benefits could be achieved through reducing BC emissions from biomass combustion by substituting biomass with other fuels and combustion methods, many of which are commercially available throughout China. Yet even the most well-intentioned clean energy projects in areas like northwest Yunnan have met with only limited success.

THE HUMAN HEALTH AND CLIMATE EFFECTS OF BLACK CARBON

Rural households in northwest Yunnan are particularly vulnerable to environmental exposures such as indoor air pollution; that is, due to various household constraints, they are not able to avoid or manage their levels of exposure. In fact, many of the households in this region can be considered as "doubly exposed" to potential consequences of domestic biomass combustion: the first being direct exposure to pollutants from indoor cooking and heating and the second being the environmental consequences of regional climate effects. Women and children are particularly vulnerable to the direct impacts as they tend to spend the most time near the domestic hearth.

Households in rural Yunnan—as in much of rural China—typically burn biomass in unvented, inefficient stoves. Smoke from biomass combustion contains a large number of known health hazards and pollutants including particulate matter, carbon monoxide, polynuclear aromatic hydrocarbons (PAHs), and black carbon (BC). There is strong evidence that chronic exposure to particle pollution increases respiratory illnesses in both children and adults. In particular, several recent studies suggest that exposure to BC particles is associated with decreased cognitive function in infants (Suglia, 2008) and both cardiovascular and respiratory illness in adults (Zanobetti, 2006). A 2000 study by the World Health Organization estimated that household solid fuel use was the single largest environmental human health risk factor in China (Zhang, 2005). Moreover, the economic costs of seeking medical care and lost days of work or school due to illness or caregiving further reinforce the poverty traps that many poor households find difficult to escape.

In addition to health impacts, BC particles impact regional climate primarily by absorbing incoming solar radiation and thus warming the atmosphere, and secondarily, by influencing precipitation and temperature patterns with significant regional climate effects (IPCC, 2001). Considering that an estimated 60 percent of China's residential energy derives from biofuels, indoor cooking fires play a major role in regional BC emissions (Fernandes, 2007), which may be contributing to the recent tendency in increased precipitation events and flooding in southwest China (Menon, 2002). Rural households—which are typically those most exposed to indoor pollutants—also tend to be disproportionately affected by the agricultural, water resources, and human health consequences of floods given their dependence on natural resources and limited coping mechanisms.

TURNING A DOUBLE-EXPOSURE INTO A DOUBLE-DIVIDEND

In light of the double-exposure in regions like northwest Yunnan where biomass combustion—especially fuelwood—is the largest source of BC emissions, transition to cleaner-burning fuels and improved energy technologies translates into a double-dividend. First, it would reduce the illness associated with particle pollution exposure for the millions relying on biomass for household energy needs while, second, help to mitigate climate effects (Venkataraman, 2005; IGSD/INECE, 2008).

Despite improvements across most health indicators in China, a closer look reveals considerable differences in regional and urban/rural health outcomes. For instance, life expectancy in rural areas of Yunnan is estimated at almost ten years less than China's average (Congdon, 2007), and maternal mortality in the northwest region of Yunnan is twice that of urban areas of the province and five times China's average (Tien, 2007). Yunnan's rugged and mountainous terrain inhibits access to healthcare centers for many rural dwellers. Further, as each province is largely responsible for its own healthcare provision, prosperous regions in the east of China are comparatively better able to provide healthcare for their population while poorer regions like Yunnan must settle for less (Blumenthal, 2005). In this context, preventative measures resulting in substantial health improvements and less need for healthcare utilization—such as decreasing exposure to indoor air pollution—are important steps in reducing health disparities on both a regional and national scale in China.

In addition, some estimates suggest that BC could have as much as 55 percent of the current global warming effect of carbon dioxide (Ramanathan, 2008). Fortunately, however, reductions in BC aerosols may offer a nearly instant return on investment. While greenhouse gases like methane and carbon dioxide remain in the atmosphere for years and about a century, respectively, BC particles remain airborne for mere days or weeks. Thus, the impact of reducing BC emissions would create almost immediate and regionalized benefits in China, particularly for populations considered most vulnerable to the effects of regional environmental change.

MOVING FORWARD: REDUCING BLACK CARBON EMISSIONS IN RURAL HOUSEHOLDS

The solutions for reducing black carbon emissions from household biomass combustion may initially appear to be very straightforward: transition to cleaner-burning fuels like biogas and liquefied propane gas and implement more efficient biomass-burning stoves in households where financial constraints prohibit sustained use of more expensive fuels. Yet the case of Lashi Lake highlights how technology-based intervention programs must also carefully consider cultural and social complexities in conjunction with both the health and environmental implications for a program to be sustained.

The continued reliance of many northwest Yunnan households on highly polluting open fires are at least in part attributable to a lack of consciousness about the health effects of indoor air pollution. Local knowledge of pollution-health links appears to be minimal in some villages and, mirroring the sentiments of Weller and colleagues working in other rural areas of China (Weller, 1998), coping with indoor air pollution and its associated ills and discomforts are often viewed as an accepted characteristic of rural life. Social marketing campaigns that alert people to the health risks of indoor pollution exposure may encourage a willingness to alter culturally embedded living practices and thereby reduce health hazards and, subsequently, environmental impacts.

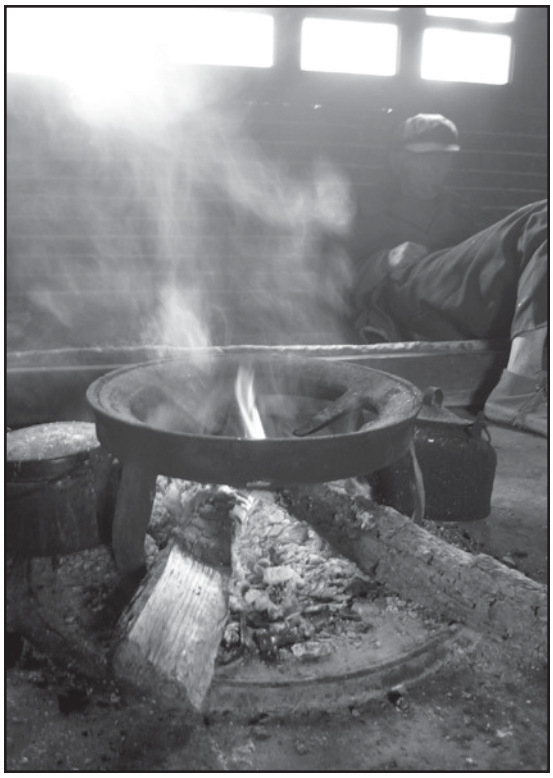
Recent rural energy projects in the Lashi Lake region emphasized technology-based solutions such as biogas or improved stoves with the chief objective of reducing fuelwood consumption in

the name of environmental sustainability. These efforts are certainly an important step; however, even in households around Lashi Lake that already own biogas and improved stove technologies, improved stoves are often only used in conjunction with open fires or as a secondary source to their traditional methods during large family gatherings. Reluctance to make a complete transition appears to stem from a complex interaction of social and cultural factors. Our fieldwork revealed that members of several Lashi Lake households, for instance, pointed to the dual capacity of cooking *and* space heating that open fires provide relative to single-purpose cookstoves. Others expressed their desire to socialize around the open hearth. Assessing the social and cultural barriers to technology adoption in the planning stages of a program will facilitate a better understanding of barriers to improved adoption and sustained use of improved stoves.

Lessons from other intervention programs in different regions of China indicate awareness of health risks alone cannot lead to changes in fuel and stove choices if there is insufficient physical and financial access to alternative fuels and stoves. Results from a recent multi-provincial clean stove intervention study in China indicate that, in the short term, health education and behavioral interventions conducted in isolation have no benefits for indoor air pollution reduction (Baris, 2007).

Successful interventions are likely to need both in-depth input from the targeted communities and clever strategies to address cultural barriers to implementation. For households, there is a trade-off between difficulties in changing habits and daily routines in the short-term and receiving the health and environmental benefits with payoffs in the medium- to long-term. These concerns must be appropriately addressed by both public health and environmental organizations for clean energy project success.

"A 2000 study by the WHO estimated that household solid fuel use was the single largest environmental human health risk factor in China."



A typical open cook stove in rural China.
Photo Credit: Jill Baumgartner and Nina Trautmann Chaopicha

We thank Xia Zuzhang (The Nature Conservancy), Mu Liqin (The Lijiang Government Research and Policy Institute) and Chen Yongsong (Yunnan Eco-Network) for their insights into energy use in northwest Yunnan and their strong commitment to serving rural populations. We also greatly appreciate funding from the University of Wisconsin-Madison National Science Foundation IGERT China Program.

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FEATURE BOX

Digging Behind the Scenes: China Environmental Health Project Research Brief Series

By Linden J. Ellis and Jennifer L. Turner

Since February 2007, the China Environment Forum (CEF) has been publishing research briefs online under the auspices of Western Kentucky University's Hoffman Environmental Institute's China Environmental Health Project, an initiative supported by the U.S. Agency for International Development. Despite a rather academic title, these briefs are a hybrid between anthropocentric journalism and academic research that target practitioners by highlighting opportunities for international cooperation with China on environmental health issues. Through the briefs, CEF seeks the underscore not only the economic and environmental impacts, but also the human health threats linked to pollution and natural resource degradation in China. Rather than only focusing on major issues in the news, CEF often chooses little-known topics where research is challenging, or topics that are rife with misinformation. Through interviews with experts in the field or expert writers (who have authored over a quarter of the briefs), most briefs outline the complexity of the environmental health issue, inventory who is already working on it, and emphasize untapped opportunities for further collaboration or research. Some newer briefs are short case studies of Chinese environmental nongovernmental organizations and overviews of provincial or regional environmental health challenges.

Of the 40+ briefs posted online at this time, some of our most popular include:

- "China as E-Waste Dumping Ground: A Growing Challenge to Ecological and Human Health."
- "Transboundary Air Pollution—Will China Choke On Its Success?"
- "Pesticides and Environmental Health Trends in China."
- "Desertification and Environmental Health Trends in China."

A brief by CEF's Catherine Tai and Linden Ellis tackled Lake Tai, one of China's three most polluted lakes. By combining Chinese language research and interviews with experts in the field, CEF uncovered the complex causes and implications of the major algae blooms on the lake. Although industry is often blamed for the outbreaks, agriculture—particularly aquaculture—and municipal waste are far greater contributors to the toxic slime. Algae expert Hans Paerl, working in partnership with the Institute for Marine Sciences of the University of North Carolina at Chapel Hill and the Chinese Academy of Social Sciences, noted that a full 50 percent of the nitrogen and phosphorus in Lake Tai likely comes from municipal wastewater, which incidentally is the easiest form of water pollution to mitigate.

CEF has produced a number of CEHP research briefs focused on medical, hazardous, electric, and municipal waste, as well as rural "trash villages" in China. In the above photo, a volunteer trash collector in Gansu Province is standing next to mound of rubbish he collected from local roadways and rivers. Photo Credit: Christine Larson.

Far from the slimy green Lake Tai, cotton is growing in the desert. CEF's Erika Scull dug through politics and scarce sources to investigate environmental health in China's Xinjiang Autonomous Region. In Xinjiang's dry and salty Tarim Basin, 70 percent of cultivated land is devoted to labor- and water-intensive cotton. To reclaim salinized and desertified land, farmers flush glacier-dependent river water through the soil before planting—sending salt, pesticides, and fertilizers downstream.

CEF's Elisa Lai targets glacier melt in her brief on the biophysical impacts of climate change. In China's Himalayan glaciers the average temperature has risen 1 degree Celsius over the past decade, triggering glacier retreat at a rate of 7 percent annually, which means permanent water scarcity is a looming reality in the highly populated and water-intensive basins like the Tarim, as well as the Yangtze and Yellow river basins. This brief also presents details on glacier lake floods, sea level rise, biodiversity loss, and coral reef destruction, and increases in natural disasters linked to climate change.

Not all the briefs are doom and gloom at CEF. The Chinese government is aware of its environmental crisis and is approaching the issues with innovation and openness to international collaboration. CEF's Zhimin Mao examines the prospects of one such international initiative—carbon trading as part of the Clean Development Mechanism (CDM). According to the World Bank, China leads the world in CDM projects that comprise 73 percent of the global market share and account for more than 50 percent of the world's average annual Certified Emissions Reductions (CERs). Climate experts have questioned whether China's boon in CDM projects has met the additionality criteria or if they are even significantly lowering carbon emissions. Such doubts combined with uncertainty about the post-2012 carbon market situation have led to a recent slowdown in approvals in China.

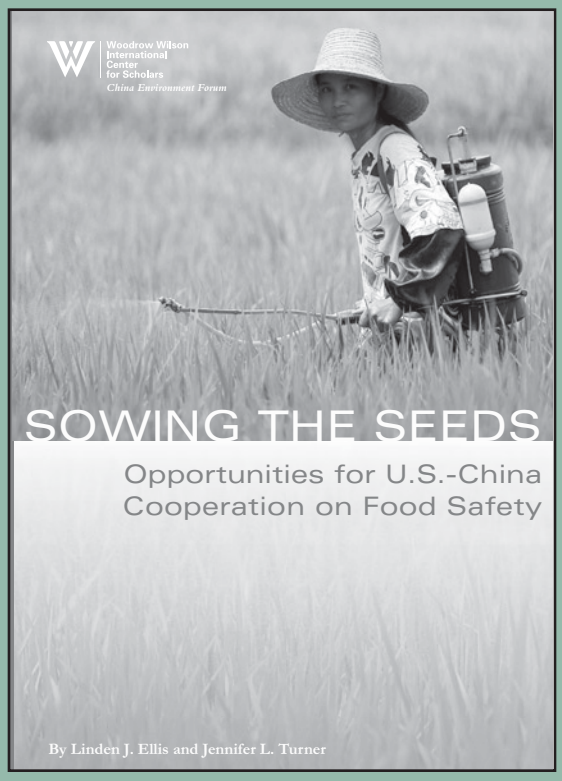
CEFs research briefs can be found online at www.wilsoncenter.org/cef: click on "Briefs" on the right-hand sidebar. For more information on the CEHP see: http://www.wku.edu/cehp/

FEATURE BOX

China Environment Forum Report: *Sowing the Seeds: Opportunities for U.S.-China Cooperation on Food Safety*

By Linden J. Ellis and Jennifer L. Turner

At the crest of a recent wave of import concern, China's food regulatory system and food processing industries have come under intense criticism both domestically and internationally. However, despite the international hype about food contaminated with veterinary drugs and industrial components, the number one domestic food-borne threat to human health in China is microbial contamination from poor handling. China's capacity to effectively protect food quality is hampered by a weak legal, political, and regulatory infrastructure that has not forced food producers and processors to be accountable. Key weaknesses in China's food safety governance system include strong local government protectionism of industries; a lack of a product liability law; and weak monitoring capacity of food products, due both to the vast numbers of small-scale food producers and processors and competition among regulating agencies. China also lacks an independent court system, which could better protect consumers and company whistle blowers. Consumer education is also lagging, in part due to few consumer watchdog organizations. Now, with the development of the Chinese middle class truly underway, China's urbanites are demanding safer food. But answering the demands of urbanites without addressing the rest of the population may create a dual system of food safety, potentially sparking social unrest.



Consumer demands plus an explosion of negative news media attention on food exports have greatly accelerated food safety reforms in China. These same forces also have already begun to catalyze repairs to the U.S. food safety monitoring system, which has long been underfunded and understaffed—with the U.S. Food and Drug Administration inspecting a mere 1 percent of food imports and only analyzing 0.2 percent of the total in laboratories.

Food safety demands the active collaboration of the government, food safety technology leaders, the food industry, and consumers both within countries and across borders. International collaboration on food safety generally prioritizes food security and international trade, but often overlooks the equally

important pursuits of (1) promoting food production systems that protect the environment, and (2) empowering citizens and civil society groups to be involved in monitoring the regulation of food. Food safety offers an important opportunity for the United States and China to collaborate for the benefit of both countries. While the main responsibility for solving China's food safety problems rests with the Chinese government and people, food safety is a global concern, one that all countries must diligently address domestically, and an area in which cooperation among nations is vital.

In 2008, the China Environment Forum, with generous support from Waters Corporation, examined these issues in *Sowing the Seeds: Opportunity for U.S.-China Cooperation on Food Safety*.

Sowing the Seeds is available online at www.wilsoncenter.org/cef or email CEF@wilsoncenter.org to receive a print copy.

COMMENTARY

Risk Management: Lessons Learned From the Snow Crisis in China

By Guizhen He, Yonglong Lu, and Lei Zhang

In January 2008, just before the Chinese Lunar New Year, 21 of China's 31 provinces were hit by an unexpected snowstorm. This large-scale snow was most intense in the usually warm southern China and the storm caused unprecedented havoc for millions of holiday travelers. While the direct economic damage was estimated to be $21 billion, the subsequent bill for infrastructure repairs, living allowances, and agricultural production restoration totaled nearly $35 billion. More than 100 million people throughout the country were directly impacted and more than 129 people died. This snow disaster tested the newly established Chinese emergency response system and exposed the weaknesses of the current risk management system.

China has long been a country plagued by natural disasters, but in today's more interconnected world, Chinese and international journalists, as well as Chinese bloggers are quick to disseminate information on earthquakes, floods, and landslides, as well as the growing number of serious pollution accidents, major disease outbreaks, and food safety incidents. Thus, the Chinese government has come under increasing pressure to show adequate responses to all types of major emergencies. The snow disaster offered Chinese officials many important lessons that were useful in responding to the subsequent earthquake in Sichuan Province in May of 2008.

CHINA RECEIVES A "VICIOUS SLAP FROM MOTHER NATURE"

As the Chinese New Year approached in January of 2008, many in China viewed the upcoming year as an exciting one with the summer Olympic Games opening in Beijing. Ironically, on January 10, just as many were speculating about excessively hot weather for the Games and with no warning from China's Meteorological Administration, the country was hit by a massive snowstorm. This snow marked China's coldest winter in 50 years and even in the past 100 years in some regions (Zheng, 2008). In total, 21 provinces in China were hit by snow and icy rain. (See Map 1). The icy rain and snow lingered for more than 30 days and even provinces that rarely receive excessive snow—such as Hunan and Hubei—were blanketed in heavy snow. The total number of consecutive days of icy rain broke the record in 56 counties of Guizhou Province ("Consecutive days," 2008). With more than half of a meter (18 inches), this storm shattered snow accumulation records from 1951 in parts of six provinces.

This snow disaster overwhelmed the Chinese transport and energy systems, wreaked havoc on food and agriculture, and tested China's fledgling risk management system. The snow halted all New Year's travel in the southern provinces, leaving five million travelers—from what is the world's largest annual migration—stranded. More than 2,850 trains were postponed, and over 3,000 flights cancelled and 5,550 delayed in the 15 days following the snowstorm. The travel woes hit hardest in Guangzhou, where more than one million migrant workers waited in the cold for nearly two weeks for trains to resume service—for most, trains did not start soon enough to return home ("Dynamic news," 2008).

Many more people in China experienced a cold and dark New Year's festival without electricity.

Some 8,000 freight trains were delayed, triggering the country's most serious power crisis as coal deliveries languished on stranded trains. A large number of power lines and towers collapsed

Map 1: Provinces and regions affected by the snowstorms and icy rains in China in January 2008

Source: Authors

under the heavy snow and ice. Parts of central and eastern China saw the worst power failures in the country's history. Nineteen provinces and regions suffered blackouts with some areas losing electricity for nearly two weeks, as was the case in Chenzhou, a city of 4.5 million people in Hunan Province ("Notice of the State Council," 2008). In Guangdong, emergency supplies of coal arrived on a fleet of 125 cargo ships.

Although most Chinese citizens blamed severe winter weather for the power crisis, policymakers are now being forced to admit their own role in the crisis by imposing low, state-set electricity fees that cause power generators to run in the red as coal prices leap. Recent crackdowns on small, unsafe coal mines also led to rising coal prices and shortages. With enormous efforts and investments, on February 6, 2008—almost a month after the storm began—power was restored at least partly to 164 of the 169 counties, including the most affected city of Chenzhou ("Electricity back," 2008). The energy problems following the snow crisis catalyzed more aggressive laws and standards to push for energy efficiency. A stronger amended *Energy Conservation Law* went into effect on April 1, 2008, and 46 national energy-saving standards were promulgated and implemented in the months following the snow disaster.

IMPROVING THE CHINESE RISK MANAGEMENT SYSTEM

Of course, it is easy to criticize China's energy and transportation sectors for poor infrastructure and design flaws that could not withstand the snowstorm. The political institutions also exacerbated the problems—most notable were the failures of the weather forecasting system to provide early warning of the snow and the subsequent slow responses of the central and local governments. However, it is more important to understand the fundamental institutional and management causes behind these problems. Learning from globally established models, a national risk management system should be based on the principles of prevention, preparedness, response, and recovery. The recent snowstorm tested the effectiveness of the country's nascent risk management system and indicated that many improvements are needed. Before reflecting on future changes, it is helpful to examine recent natural and pollution disasters that have shaped the Chinese government's actions in creating better emergency response and risk assessment systems.

Major Pollution Incidents and SARS Catalyze New Planning and Laws

China has been jolted by a series of pollution accidents and major disease outbreaks in recent years—such as the heavily reported Severe Acute

Respiratory Syndrome (SARS) outbreak in 2003, followed by the serious emergence of avian flu, the chemical spill into the Songhua River in 2005, and the toxic algae blooms on Lake Tai in 2007. The central government paid closer attention to emergency response capacity building after the SARS outbreak, which led to 685 deaths within China (including Mainland, Hong Kong, Macao and Taiwan) and 89 abroad. The Chinese government's initial cover-up and later mishandling of the outbreak led to considerable unwanted scrutiny, which prompted the formulation in 2003 of more than 100 emergency response plans at various levels in China. However, most of these were sector or subject-based (e.g., *Emergency Response Plan for Public Incidents of Beijing Municipality*, *National Emergency Response Plan for Environmental Incidents*) rather than integrated plans. Most problematic is the fact that these were quickly prepared campaign-style plans rather than true institution-building mechanisms. Furthermore, the current emergency management system focuses only on the responses to past disasters rather than anticipated or unseen crises.

On the heels of the November 2005 Songhua River chemical spill, China's State Council passed initial measures to establish a formal emergency management system, mainly dealing with natural disasters, catastrophic incidents, public health, and social security issues. On January 8, 2006, when the State Council officially issued the *National Emergency Response Plan*, all the provinces and municipalities had completed their plans, which provided guidelines for officials dealing with different emergencies. These guidelines boosted China's crisis management capacity. *The Emergency Response Law*, which came into effect on November 1, 2007, put into effect the principals of "protecting the security of public lives and property and rescuing humans after sudden incidents." About two months later, the new law was challenged by the snowstorm. Effective responses to this snow disaster demanded coordinated and integrated measures between transportation, power, and communication sectors and public health authorities. However, as the emergency response plans remained simply principles on paper, it is not surprising that miscommunication and inaction by some government authorities were observed during the snow disaster.

Struggles in Top-Down Coordination

Arguably, a formal institutional network for comprehensive emergency management was nonexistent in China before SARS, which was a major shortcoming that the central government tried to address by creating the National Emergency Response Office (NERO) to act as a liaison between the State Council and other governmental authorities in 2006 right after the Songhua spill. Although NERO is responsible for coordination among different organizations and mobilizing resources needed in cases of emergency, given its limited capacity and authority, it performed poorly during the snowstorm. For example, NERO did not issue the "Notice of Low Temperatures and Heavy Snow" until January 21.

The poor coordination during the snowstorm led the State Council to set up an ad hoc national Command Center on January 28 (nearly three weeks after the snow started) to coordinate relief work and direct operations in the coal, oil, and power sectors ("The State Council," 2008). Six offices were established under the Command Center during the first three days and dealt with the following areas: (1) transportation of coal, power, and oil; (2) road repairs; (3) power line repairs; (4) rescue and market safeguards; (5) post-disaster restoration; and (6) news media and public outreach. These offices marked an important model for better disaster preparedness, as was demonstrated during the earthquake in Sichuan in May 2008.

During the Sichuan earthquake (Wenchuan earthquake) the government coordinated a national first-class response to the disaster. The State Council's Earthquake Relief Headquarters, headed by Premier Wen Jiabao, was established several *hours* after the earthquake. Eight working groups dealing with rescue, forecast and monitoring, medicine and sanitation, infrastructure, production recovery, living resettlement, security, and publicity were organized rapidly. Although NERO played an active part in collecting and releasing information (e.g., number of deaths), it did not act as a leading organ or coordinating backbone in the disaster relief. Although the ad hoc response center did function well, ideally the Chinese government should have empowered NERO—potentially drawing on the experiences of American and European systems—to become a more effective management system covering prevention, preparedness, response, and recovery, and the formulation of strategic guidelines for risk management. NERO and its provincial counterparts also need specific training to enhance the management skills and understanding of risk management.

Using the principles of prevention, preparedness, response, and recovery, Table 1 outlines some of the weaknesses of China's emergency management system in response to two pollution incidents (the Songhua River chemical spill and the Lake Taialgae bloom) and two major natural disasters (the snowstorm in southern China and the Wenchuan earthquake). All four cases took place within the past four years and each demonstrated insufficient prevention and inadequate preparation.

Uneven News Reporting

Apart from the important role of the government, a quick response from the news media is crucial for decision-making and communication with the public when a disaster occurs. A review of the news records by Chinese Central Television (CCTV) shows that 68 'snow' news items were released from January 11 to 31, of which only 8 articles were published during the first 10 days. Strikingly, no news was reported between January 14 and 16. These gaps in reporting may be linked to the restrictions placed on journalists after the Songhua River incident, during which the Chinese news media responded quickly and carried out fairly critical investigative reporting into failings by local governments in preventing and reporting the accident. Following the Songhua incident journalists were required to get permission from editors before reporting on environmental accidents and natural disasters. China's news outlets are often ordered not to report on such crises. In contrast to the news media during the Songhua River spill, none of the news content during the snow disaster was critical about the performances of the local governments in the crisis. Moreover, some news stories were even misleading. For instance, the news reports on January 23 declared that the train system was back in order, causing thousands of passengers to push back into the Guangzhou railway station even though the trains were not yet running normally. During the snowstorm the public's right-to-know was not fully protected. The passage of the 2008 Open Information Measures did lift some of the restrictions on journalists. If the news media in China can play its proper role in disaster communication, the Chinese people would benefit from better decision-making.

However, the situation is changing, as can be seen in the Wenchuan earthquake just 12 days after the *Decree of Government Information Openness* was put into effect on May 1, 2008. Notably the new open environmental information measures passed on the same day made misleading and restricted reporting illegal, allowing for much freer reporting during the earthquake. As Table 1 noted, the response time and access to information linked to the Wenchuan earthquake was significantly better than what occurred in previous disasters. Ultimately, timely and sufficient information played a crucial role in decision-making for rescuing people and mitigating losses following the earthquake ("Three breakthroughs," 2008).

CONSIDERING THE ENVIRONMENTAL AND HEALTH IMPACTS OF THE SNOW CRISIS

This crisis also raised questions about environmental and ecological protection in China. Scientists say the snowstorms in China were not directly linked to climate change, but simply an extreme event caused by very cold winter temperatures and a La Niña weather pattern. However, the devastating snowstorms show that China and rest of the world must prepare for possibly increasing and new types of disasters. The storm underlined the need for greater global cooperation on global weather forecasting. Following the lead of many countries that set up key bodies on climate change, China should identify and support science to provide reliable forecasting.

The snowstorms also indicated a need for energy efficiency, which could have helped maintain power to affected areas, and green technology to help in disaster relief. Regarding the latter point, during the snowstorm an average of 60,000-100,000 tons of chemical snow-thawing agents were used in each of the affected provinces. Some researchers have pointed out that the use of these chemical snow-thawing agents has polluted drinking water, damaged or even destroyed plants and animals, and increased saline in soils in Guangdong, Anhui, Jiangsu and Hubei provinces (Peng & Lai, 2008; Wang, 2008).

The direct and indirect ecological impacts of the snowstorm also should not be ignored, especially on forest ecosystems. One-tenth of China's total forested area was destroyed in the snowstorm, which resulted in habitat loss and starvation of many kinds of wildlife (Pan, 2008). The potential, cumulative, and long-term effects of the storm on natural ecosystems will need further research to understand the full extent of the damage.

Table 1: Weaknesses of the Risk Management System in Major Accidents in China

INCIDENT	TIMELINE	WEAKNESSES
Songhua River Chemical Spill (2005)	13 November Explosion at a petrochemical plant in Jilin City, Jilin Province; officials do not notify downstream Harbin city in Heilongjiang Province until eight days later. 21 November Harbin officials cut off water to the city, initially explaining it was for routine maintenance, but public outcry leads to admission about the spill, catalyzes massive news media coverage. 22 November State media says water could have been contaminated after the blast; PLA sent in to bring water to Harbin. 23 November Authorities admit very high levels of benzene have been found in the water. 25 December The polluted water flows into Russia.	Insufficient prevention: Poor governance of chemical enterprises; unsound industrial arrangements; no alternative drinking water sources. Lack of preparation: Petrochemical plant, provinces, and cities lack emergency plans, skills, and technologies to deal with pollution emergencies; no plans for industrial accidents or public information systems. Bad response: Tight control of information in Jilin and Harbin; slow handling of the case; insufficient communication with the public; uncoordinated government agencies at all levels; inappropriate mitigation measures; insufficient emergency response equipment; uncooperative actions by some officials. Difficult recovery: Studies of short-, medium-, and long-term impacts on human health should be conducted; survey of risk assessment at a random sample of Chinese chemical factories needed; aquatic toxicity research should be promoted; cooperation and coordination between China and Russia over the incident should be improved; lessons learned from the incident should be incorporated into legislation and policy enforcement.
Algae Bloom of Lake Tai Lake (2007)	7 April Blue-green algae fans out across Lake Tai. 25 April The algae bloom reaches Meiliang Bay in Lake Tai. 28 May A severe algae outbreak causes water quality to deteriorate, tap water becomes undrinkable for 2.3 million residents in Wuxi City, Jiangsu Province. 29 May Algae bloom threatens water for millions; local residents flock to buy bottled water and bread; local governments take emergency response measures. 1 June The water quality improves; crisis is relieved for the short term. 4 June Water supplies are fixed.	Insufficient prevention: Too much industrial waste discharge; poor governance of industry and agriculture; no alternative drinking water sources. Inadequate preparation: Shortage of pure water; undeveloped emergency response plans and technologies. Imperfect response: Timely yet ineffective (or short-term) solutions; completely inaccurate labeling of the algae bloom as a "natural disaster;" lack of collaboration at all levels of government. Long-term recovery: Uncoordinated government agencies for Lake Tai pollution control; aggressive long-term recovery strategy.

Table 1 (continued)

INCIDENT	TIMELINE	WEAKNESSES
Snowstorm in Southern China (2008)	10 January Epic snowstorms start to slam central and southern China. 22 January The National Emergency Response Office (NERO) releases an urgent notice for preparation and relief of the snow disaster. 25 January Snow disasters exacerbate; trains and aircraft in southern China are almost completely paralyzed. 26 January Coal shortage; 19 provinces and regions suffer blackouts. 27 January More than 100,000 passengers stranded at Guangzhou Railway Station; the China Meteorological Administration issues a red alert warning of more snowstorms and blizzards in central and eastern China. 28 January The snowstorm spreads to 14 provinces and cities in China, affecting nearly 100 million people. 29 January The China Meteorological Administration issues its second red alert warning. 1 February The disaster relief and emergency command center under the State Council is established. 5 February The snow stops. 6 February Snow-plagued residents in central Chinese cities bid farewell to darkness. 9 February China's snowstorm-hit areas begin to recover gradually.	Insufficient prevention: Incomplete road systems; unsuitable power transmission lines; antiquated and inefficient power grid; vulnerable infrastructure; inadequate energy supply; inadequate emergency consciousness and knowledge among officials and citizens. Lack of preparation: Overburdened railways; uncoordinated government response from the top down; separate and narrow emergency response plans; uneven news reporting; unsatisfactory weather forecast system. Slow response: Ineffective response measures; uncoordinated actions; poor communication with the public; ineffective alarm system; uncoordinated mechanism for sudden incidents; nontransparent information. Difficult recovery: Slow recovery of power lines and grids on a large-scale; damage to agricultural and industrial production.
Wenchuan Earthquake (2008)	14:28 Beijing time, 12 May A massive earthquake measuring 8.0 on the Richter scale strikes Wenchuan County, Sichuan Province. 15:40 Beijing time, 12 May National Emergency Response Plan started up. 21:00 Beijing time, 12 May The Command Center for Disaster-Relief of the State Council is established; Premier Wen Jiabao is the commander; eight working groups are organized. 12-15 May A 72-hour period of relief; troops arrive in the affected areas. 4-8 June "Regulations on Post-Wenchuan Earthquake Rehabilitation and Reconstruction" adopted at the 11th executive meeting of the State Council on June 4 and come into effect on June 8.	Insufficient prevention: Poorly constructed buildings; inadequate relief materials; unsuitable urban planning. Inadequate preparation: Unsatisfactory earthquake prediction system; impractical emergency response plans. Timely response and open information: Effective anti-crisis strategy: Command, Control and Communication; uncoordinated and highly helpful spontaneous citizen assistance and donations. Hard recovery: Integrated post-earthquake evaluation needed; extensive reconstruction of infrastructure; human health and psychological therapy required; catastrophe models research needed.

Stranded passengers in Guangzhou railway station.
Photo Credit: Authors

In the background of natural and anthropocentric environmental changes, sufficient public awareness and general knowledge about risks can help reduce damage during disasters. The public should learn about different weather events, their causes and effects, and the regions most likely to experience them. Surveying and researching public health is necessary for building disaster response and prevention capacity within public medicine and sanitation organizations ("The retrospective survey,"2008).

FUTURE CONCERNS

In order to ensure people's health and safety in snow affected areas, the governments had to take precautious measures to prevent the outbreak of infectious diseases. Geological disasters resulting from melting snow should be closely monitored because there are many mountains in southern China where landslide accidents often take place. Between January and March 2008 more than 2,000 instances of snow-melt-induced landslides occurred across Hunan, Hubei, Anhui, Guangxi, Guizhou, and Jiangxi provinces. One major landslide took place in Sichuan two months after the snowstorm (March 22), which caused seven deaths (CIGEM, 2008).

The snow also called into question whether the Chinese government can successfully control inflation. The low temperatures and snow destroyed many vegetable, tea, grain, and fruit crops in China's usually temperate south, leading to food scarcity and higher prices. Clearly China's risk management system needs to include solutions on how to recover agricultural production following a severe weather disaster.

The disaster took a short-term toll on China's economy. However, the snow has also exposed deeper structural problems in the economy. Massive transportation bottlenecks and power shortages are a reminder that, despite years of intense growth, China still has a tremendous need for investment in roads and other infrastructure. Those issues will not melt away with the snow and dealing with these weaknesses is a crucial part of a truly comprehensive risk management system.

Like the SARS outbreak, the snowstorm and earthquake incidents temporarily slowed the economy and caused short-term pain. In the past, the Chinese government has used ad hoc measures to adequately respond to the immediate impacts of disasters, but more needs to be done to coordinate agencies, improve follow through after initial crises, and take measures to better anticipate disasters.

ACKNOWLEDGMENTS

We are grateful to Hongchang Ren for his assistance in making the GIS map. Financial support was provided by the National Basic Research Program of China (2007CB407307), the cooperative project between the Netherlands Royal Academy of Arts and Sciences and Chinese Academy of Sciences (No. 04CDP014), and the Pilot Project of Knowledge Innovation Program of Chinese Academy of Sciences (KZCX2-YW-420-5).

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