COMMENTARY

Mining in China: A Primary Ecological and Human Health Concern

By Saleem H. Ali

People naturally don't like the dark. Who would want to be a miner digging galleries?
—Chronicler from Han dynasty, Wang Chung Lun Hong, A.D. 82[1]

The pessimists will be proved wrong. Chinese mining multinationals will be a permanent feature of the future and they will, I have no doubt, increasingly strive for excellence in their performance.
—Sir Mark Moody-Stuart, Chairman Anglo-American Mining Group, 2006[2]

Considerable international attention has been accorded to China's environmental record with the publication of popular books such as Elizabeth Economy's The River Runs Black, which often incriminate the mining sector for creating ecological damage. The impact of the mining sector is considerable at both the level of human health as well as environmental pollution. While exports from China are often marked by manufactured goods, the country's rapid economic growth has largely been spurred by its natural resource base that has been harnessed at an unprecedented level over the last fifty years. Domestic minerals fuelled much of China's early industrialization and were a major component of Chairman Mao's early plans for development of the country. Judith Shapiro (2001), in her landmark volume Mao's War Against Nature, described how Mao had been willing to even donate royalties from his own writing to ensure that the mineral resources of Panzhihua (located 350 kilometers north of Yunnan's capital Kunming) were developed to the fullest extent.

Raw materials have been pivotal in most cycles of large-scale industrialization through either export revenues or for their necessity in infrastructure development. For China, primary industries, particularly mining have been essential, for infrastructure development. The natural resource endowments of the country are enormous and with the rapid growth of technologies and investment opportunities by domestic and foreign companies, mining has grown phenomenally in China over the past decade. In 2006, mineral mining accounted for 4.8 percent China's gross domestic product (GDP) and mineral trade accounted for 21.6 percent of the country's total trade (USGS, 2007).[3] Coal mining is also a huge industry in China with production increasing about 66 percent between 2001 and 2006.[4] Due to concerns about climate change there has been considerable research already on this sector and the country is reforming this sector. However, given the low cost of coal and its relative abundance, it is more likely that China will invest in ways to mitigate coal mining impacts with "clean coal" technology investment rather than reducing coal production.[5]

THE MAJOR PLAYER: IRON

Iron ore has always been the backbone of infrastructure development because of its importance in steel manufacturing. China is the world's leading producer of pig iron[6] and crude steel (34 percent of global total), with an output that is more than the combined total production of Japan, the United States, and Russia (which ranked second, third and fourth, respectively).[7] Steel production is highly energy intensive and thus results in the need

for even greater mining of coal—a highly polluting industry—which accounts for nearly 70 percent of China's energy demand.

In addition to increasing the demand for coal, the iron ore bonanza has had unexpected manifestations such as the rise of "magnet fishing" in the streams of Anhui Province. Community members are flocking to streams with magnets extended on fishing poles to find lumps of iron ore washed down from waste rock at nearby mines, hoping that the rising price of iron will allow them to sell the lumps and earn more than fishing—in great part due to the fact that fish stocks decrease in rivers where mine tailings are dumped.[8]

Figure 1 shows the rapid rise in China's iron ore production from domestic mining. Within five years, China's share of global iron ore production has more than doubled, but is now expected to slow down as stocks are depleted and the government attempts to temper the impact of such rapid growth on the environment and communities. However, the growth of minerals production is not confined to iron ore. The range of nonrenewable materials that are being extracted in China is staggering in some areas.

Exports

The connection between pollution and exports is also highlighted by Chinese government officials. For example, in 2007 Hu Chunli, director of the government's Industrial Development Research Institute, noted:

> As much as 20 percent of China's energy consumption goes into producing products for export. The Chinese government is determined to curb the excessive export of high energy-consumption and environment polluting products such as steel products. Policies may include further increasing export taxes, export licenses and restrictions on steel product projects.[9]

Small-Scale Mines

Small-scale mines employ an estimated six million people and account for large shares of mining in many sectors. An estimate by a Canadian researcher in 2005 concluded that more than 75 percent of China's bauxite, 65 percent of manganese, 51 percent of phosphate, and 43 percent of coal mining is mined at the small scale (Gunson, 2005). Additionally, the iron ore content of the ores on average has been declining, which means mines must operate—and pollute—longer to earn profits. Large-scale mines account for about 20 percent of total iron ore production, while medium- to small-scale mines produce the bulk of the ore. According to data collected by the United Nations Conference on Trade and Development there are 48 major mines, while there are close to 8,000 total iron mines in the country, most of which produce ore of less than 30 percent iron content (UNCTAD, 2007, p. 33-35).

ENVIRONMENTAL HEALTH AND SAFETY

Occupational Health

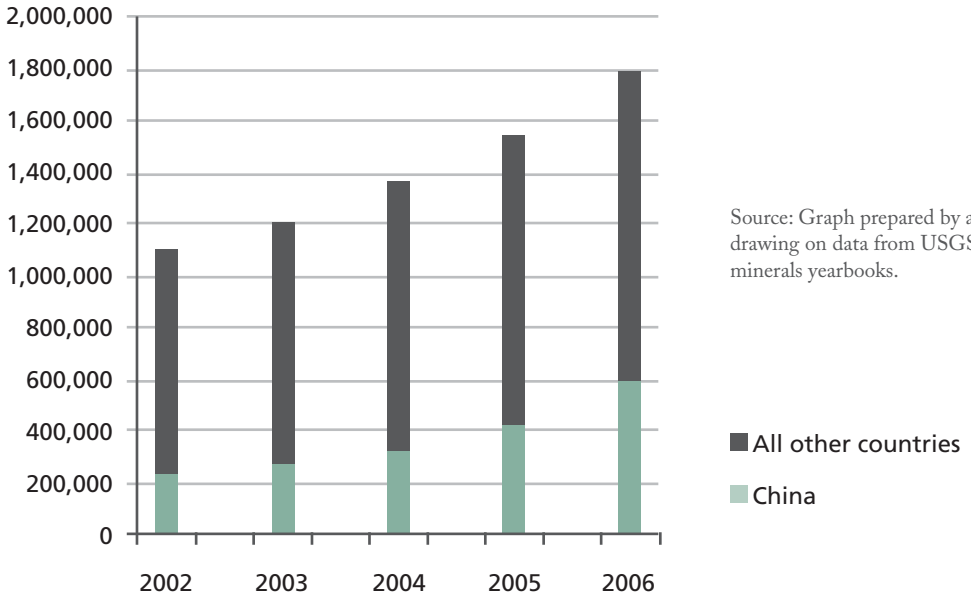
Global attention on Chinese mining has been largely focused on occupational hazards in the coal mining industry, which has an unenviable safety record. Indeed the health and safety performance for Chinese coal mining is orders of magnitude worse than global standards. For example, a study by the U.S. National Energy Technology Laboratory in 2006 concluded that for every one fatality per unit of coal produced in the United States, the comparable rate in China is between 200 and 250.[10] Changes in the mining laws; a projected investment of $60 billion from 2007 to 2011 on safety improvement mechanisms; and the closure of around 23,000 small coal mine with poor safety records are expected to make substantive improvements in this arena (Basu, 2008). The United Nations Development Programme also has

Table 1: China's 2007 Production of Nonferrous Metals

NONFERROUS METALS	MILLIONS TONS	PERCENTAGE CHANGE OVER 2006
Zinc	3.4	18.9% Increase
Copper	3.14	Same
Lead	2.44	5.7% Increase
Electrolytic Aluminum	11.16	34.6% Increase
Alumina	17.77	48.7% Increase
Lead	2.44	5.7% Increase

Source: Source: China Mining Association, 2008
Note: In 2007, production of the top 10 nonferrous metals in China was 21.31 Million Tons, representing an approximately 20 percent increase over the previous year (China Mining Association, 2008).

Figure 1: China's Iron Ore Production as a Share of Global Production (Thousands of Metric Tons)



Source: Graph prepared by author drawing on data from USGS minerals yearbooks.

started a $14.42 million project for improved coal mining safety education and training in the five Chinese provinces of Anhui, Guizhou, Henan, Liaoning, and Shanxi.[11] According to official accident data released in 2008, the accident rate has already gone down by 20 percent through these measures, though Chinese mining unions have often disputed accident reporting accuracy.[12]

Pollution

While some progress is apparent on the health and safety front, the environmental impact of mining still remains unresolved. One particular area of concern with regard to environmental pollution is the growth of small- and large-scale gold mining. Though during the height of the communist era, gold mining was banned as a diversionary extravagance, extraction of gold can be traced back in Chinese history to the Song Dynasty. Since 2007, China is now the world's largest gold producer (surpassing South Africa which held the top spot since 1905), to meet its demand for the prized metal, which jumped 23 percent, making it also the world's second-largest consumer after India. Using mercury for the amalgamation process to extract gold from rock is widespread in China at mines big and small and represents a major concern for bioaccumulation in freshwater fish that are a primary source of protein for many communities. While mercury is generally well-recovered in large-scale mining processes that use amalgamation, with an emission factor of ~0.79-g per gram of gold production, far less of the toxic metal is recovered in the small-scale mining process, resulting in an emission factor of ~15-g per gram of gold production (Streets, 2005).

Those mines that do not use mercury use cyanide for processing the gold, which has its own share of environmental and health concerns. There have been several accidents involving cyanide spills at Chinese gold mines in recent years. In September 2007, a house built on top of a cyanide pool in a gold mining area of Henan Province collapsed and 9 people died by falling into a two-meter deep pool of cyanide solution.[13] A hydrogen cyanide gas leak from a gold mining plant in Beijing's suburban district of Huairou killed three people and left another 15 hospitalized in 2004. Three years earlier, 11 tons of liquid sodium cyanide leaked into a tributary of the Luohe River in Henan Province.[14] The potential for tort litigation in this area may lead to some changes in regulatory enforcement of cyanide safety, but so far no major legal settlements have been documented.

Safe Closures

With thousands of mines all over the country in these boom years, Chinese environmental officials should pay more attention to closure and remedia-

Table 2: China's Exports and Imports of Nonferrous Metals (2007)

NON-FERROUS METAL	EXPORTS (PERCENT CHANGE)	IMPORTS (PERCENT CHANGE)
Copper	119,000 Tons (-50.9%)	12.26 Million Tons (+93%)
Copper Concentrate		3.46 Million Tons (+26.8%)
Aluminum	490,000 Tons (-50.9%)	203,000 Tons (-50.7%)
Alumina		3.94 Million Tons (+24.9%)
Lead Concentrate		945,000 Tons (+14.5%)
Zinc Concentrate		1.55 Million Tons (+178.1%)

Source: Source: China Mining Association, 2008
Notes: In 2007 the total export quantity of Cu, copper products, Al, aluminum products, Zn, Sn, Sb, and Mn) was 3.18 million tons, representing a 11.5% year on year decrease.

tion issues. Since mining is inherently obsolescent, closure and ecological restoration of mining projects is a necessary part of the planning process for new ventures. Without such planning, companies can walk away from a legacy of pollution with impunity. Consider the example of mercury mining in China, which officially ceased in 2001 after 600 years of operations all over the country, particularly in Guizhou, Shanxi, Henan and Sichuan. More than 100 Mt of calcines and other waste rocks have been produced as a result of the mercury mining in Wanshan District (Guizhou Province) alone, which was the "mercury capital" of the country. As a result of the mining, the soil concentration of mercury in the surrounding area is 24.3 to 348 mg/kg, which is 16 to 232 times the maximum mercury concentration allowed for soils in China. Mercury concentrations in adjoining waterways were also found to be highly elevated over six years after the mining stopped, ranging from 3.2 to 680mg/L. Given the biopersistence of mercury, the concentration of methylmercury in grains from this region is also as high as 0.14 mg/kg (Jiang et al., 2006). While health agencies usually allow for up to 0.5 mg/kg of mercury in meat products such as fish, a lower amount in carbohydrates such as grains can be far more potent because of a higher volume of carbohydrate consumption in human diets.

THE CHALLENGE

A major challenge to combating environmental pollution from mining is data. Data on pollution from mining is hard to obtain because impact categories are highly diffuse and dependent on the kind of mineral being extracted. Second, researchers gather most of the data on pollution in open access areas rather than at point sources. In such measurements there are often competing sources of pollution, which make ambient measurements hard to trace to a particular source. Most of the studies in this regard have been done in Yunnan, which has a high mining footprint and is also a biodiversity hotspot and hence of considerable research interest.

There has been an increase in the overall land acreage being used for agriculture, which has led to serious concerns that farm runoff will make it more difficult to analyze mine pollution. A recent study of agricultural expansion in Yunnan estimated that from 1960 to 2003 the push towards increased crop yield led to a 99-fold increase in fertilizer usage and doubling of pesticide usage. Interactions between these agricultural chemicals and pollutants from mines in waterways and lakes makes impact categorization more difficult (Li et al., 2007). Careful monitoring of effluent from pollution sources and waterways will be essential in years to come to identify the sources of major impact and to direct enforcement action or policy reform accordingly.

Although China's growth is being built on the assumption of continued mining, it is clear that past mining practices cannot be sustained in the future. The government has identified 60.7 billion tons of iron ore reserves, and is expected to identify more than 100 billion tons with better exploration techniques. The Ministry of Land and Resources, is now using international models to explore new deposits which could also increase estimates of China's identified reserves of copper ore by 20 million tons and bauxite by 200 million tons by the end of 2010 (USGS, 2007). All the new projects that will commence in coming years for these reserves will hopefully be planned with greater care if the country is to avoid an ecological crisis of immense proportions.

PROSPECTS FOR GREENING CHINA'S MINING INDUSTRY

The Chinese government has recognized the human and environmental threats that mining poses to the country and has begun to target those threats from several fronts. First, the government appears to be cognizant of the energy inefficiencies within the steel manufacturing system and has been taking measures to reduce the energy consumption of the sector as well as energy intensity (the total energy consumption per unit of GDP). According to the government's own calculations, the overall consumption of energy by China's major steel producers fell by 8.8 percent in 2007 and energy intensity fell by 2.78 percent for the first half of 2007 (which is still below the government's target of 4 percent). Aluminum production, which is also highly energy inefficient in China, is rapidly on the rise due to the expansion of smelting capacity and bauxite mining (there are currently over 300 bauxite mines in the country).[15]

It is difficult to gauge whether these recent improvements in energy efficiency have led to significant reductions in pollution, for data on air and water pollution have only recently become more accessible, but the quality of this data is uneven (*Editor's Note: See lead feature article in this volume*). The Chinese government has prioritized energy efficiency to increase energy security and decrease the pollution associated by coal burning.

Second, there appears to be a marked shift from polluting domestic mining production to imports. Box 1 highlights some of the data in this regard for 2007, which shows that some decline in mineral mining is occurring as the country shifts towards imports. The shift to importing metals is partly demand driven but also cost and environmental considerations. Many of the most profitable mines are now in Africa and environmental regulatory compliance is minimal, often reducing production costs. China's investment in Zambia has been particularly striking with an $800 million investment in the copper mining sector announced by President Hu Jintao in 2007.[16]

Moving Forward

The first step to improve environmental performance in the Chinese mining industry will entail exerting regulatory authority over all mining areas. Over the last three years, the Ministry of Land and Resources has identified over 65,000 unlicensed mines, 4,500 unauthorized excavations, about 1,000 unauthorized prospecting sites, and over 1,300 illegal transfer issues of mining rights. The ministry has shut down over 8,000 illegal mines over this time period, but many quickly reopen (Basu, 2008).

A coherent policy will also be needed to institutionalize the small-scale mining sector in China. With the help of the British government and the World Bank, there has been some movement to mainstream this sector through the establishment of a Chinese branch of an international program called "Communities and Small-Scale Mining." Led by researchers at the Chinese Academy of Sciences, this program aims to focus on this sector to improve its potential for providing livelihoods as well as increasing its environmental and social performance.[17]

Making the connection between the environmental and human costs of mining and direct economic impacts on other competing sectors may also improve the performance of the mining sector at multiple levels. The resources of the southeastern mountainous regions of the country have been particularly important in this regard and continue to play a pivotal role in China's economic development. However, this is also the most environmentally sensitive and ethnically diverse part of the country. Tourism has thus flourished in this area as well and there has been growing concern about the negative impact pollution from extractive industries might have tourism. While mining and tourism sectors can coexist, continuing deterioration of environmental indicators may start to have a negative impact on the tourist economy as well (Huang, 2008).

The mining sector has played a pivotal role in propelling China to Olympian heights of development by most measures. However, the environmental impact of this rush now needs greater scrutiny from the government as well as from the international community to ensure that the ecosystems are not irreparably damaged by extraction and can be restored to a state of biotic and social functionality.

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NOTES

1. Text quoted by Ottens, 2005.

2. Speech before the China Mining Congress, November 15, 2006.

3. Most aggregate statistics have to rely on data from the Chinese government which has come under some scrutiny by researchers such as Sinton, 2001. However, we have little alternatives in terms of other sources and where possible field work has been used to verify the likely veracity of aggregate data.

4. China Heat Net. (October 2006). "How big is China's coal production?" (In Chinese). [Online]. Available: http://www.chihe18/1161092171216116.htm.

5. The Wilson Center commissioned a research paper in this regard in 2007, accessible online at: http://www.wilsoncenter.org/topics/docs/coalmining_april2.pdf

6. The term "pig iron" refers to the first intermediary product extracted from raw ore through heating in a blast furnace with a form of carbon called "coke." In early production, the molding of the ingots along a central runner resembled suckling piglets and gave the product its unlikely name.

7. Most of this iron accounting for this production is believed to be mined in China but figures on actual mine output from Chinese mines versus scrap usage and iron imports are not delineated. China is also the world's largest scrap (over 5 million metric tons annually) worth nearly $5 billion in 2006 (USGS, 2007).

8. Reuters News Service: Angling for Iron Ore in China's Streams, October 23, 2007.

9. Quoted in an article for Interfax China Metals: October 19, 2007 at: http://www.minesandcommunities.org/article.php?a=8253.

10. This estimate was based on annual data from 2005 and average statistics across numerous years would be a preferable comparison. Michael Moser, "Coal Mine Safety in the U.S. and China." Presentation at Resources for the Future, Washington DC, February 1, 2006.

11. The project details are available at UNDP's China website: http://www.undp.org.cn/

12. News story on fatality loss from Forbes magazine, January 13, 2008. [Online]. Available: http://www.forbes.com/afxnewslimited/feeds/afx/2008/01/13/afx4524639.html.

13. Reuters News service, September 28, 2007.

14. Cyanide incidences are tracked by the Mineral Policy Institute in Australia: http://www.mpi.org.au/campaigns/cyanide/cyanide_spills/.

15. Mineral Zone http://www.mineralszone.com/minerals/bauxite.html.

16. "China launches mining program in Zambia." (2007, February 4). *The Washington Post*. http://www.washingtonpost.com/wp-dyn/content/article/2007/02/04/AR2007020400536.html

17. See the web site of the program in Chinese: http://www.casmchina.org.