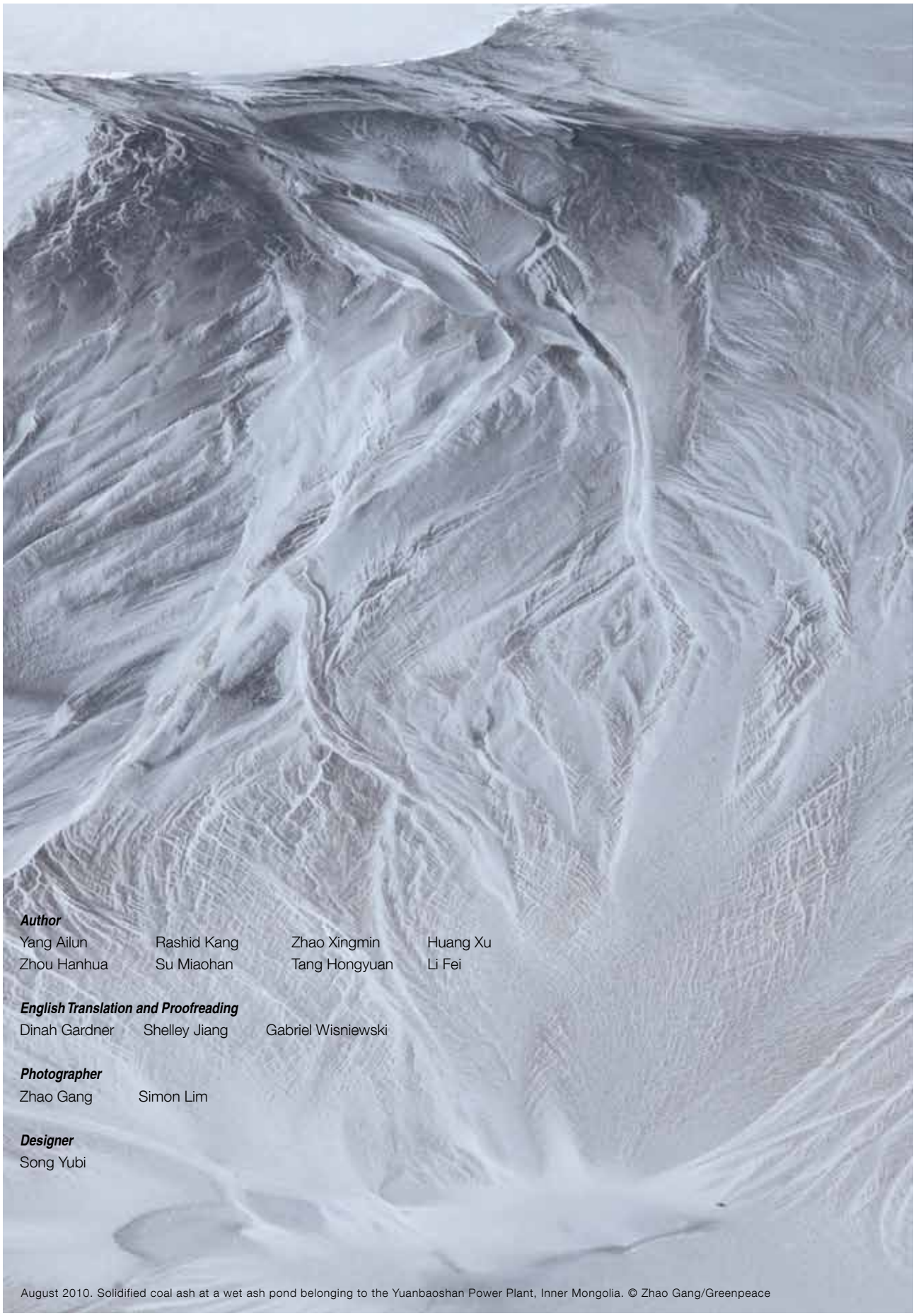
GREENPEACE 绿色和平

The True Cost of Coal

— An Investigation into Coal Ash in China

2010



Author

Yang Ailun Rashid Kang Zhao Xingmin Huang Xu
Zhou Hanhua Su Miaohan Tang Hongyuan Li Fei

English Translation and Proofreading

Dinah Gardner Shelley Jiang Gabriel Wisniewski

Photographer

Zhao Gang Simon Lim

Designer

Song Yubi

August 2010. Solidified coal ash at a wet ash pond belonging to the Yuanbaoshan Power Plant, Inner Mongolia. © Zhao Gang/Greenpeace

September 2010. A month earlier, part of a coal ash dam collapsed at the Shentou Number 2 Power Plant, Shanxi province, flooding ash slurry over 600 mu (40 hectares) of farmland. © Zhao Gang/Greenpeace

June 2010. A Greenpeace activist takes a sample at the Shentou Number 2 Power Plant, Shanxi province. © Zhao Gang/Greenpeace

Key Findings

1.Coal ash production has grown by 2.5 times in the eight years since 2002, when China began to rapidly expand its installed capacity of coal-fired plants. Coal ash is now the country's single largest source of solid industrial waste.

2.In 2009, China produced in excess of 375 million tons of coal ash, equivalent to more than twice that year's urban waste production. The total volume came to 424 million cubic metres (m3) – enough to fill one standard swimming pool every two and a half minutes or one Water Cube (National Aquatics Center) every day.

3.Climate change increases the risk of extreme weather events like heavy rains and floods. These events in turn increase the risk of disasters at coal ash disposal sites, which, with their vast quantities of harmful waste, become a grave danger to public health and the environment.

4.In this investigation, Greenpeace detected more than 20 different kinds of harmful substances (heavy metals and chemical compounds) in samples collected from the coal ash disposal sites of 14 power plants across the country.

5.Greenpeace estimates that the total coal ash waste produced by China's coal power sector each year contains 358.75 tons of cadmium, 10,054.25 tons of chromium, 9,410 tons of arsenic, 4.25 tons of mercury and 5,345.5 tons of lead. Altogether, that's 25,000 tons of heavy metals.

6.In samples of surface water taken near ash disposal sites, Greenpeace detected pollutants in excess of concentrations stipulated in the "Environmental Quality Standards for Surface Water" and "Standards for Irrigation Water Quality" at four out of six power stations.

7.In samples of underground well water taken near ash disposal sites, Greenpeace detected pollutants in excess of concentrations stipulated in the "Sanitary Standards for Drinking Water" at three out of eight power stations.

8.The majority of the 14 power stations investigated failed to observe site selection criteria when locating their coal ash disposal sites. Many of the coal ash disposals had inadequate measures to prevent dust dispersal, leakage and run-off of pollutants into the environment.

9.While it is widely believed that over 60% of coal ash is reutilized in China, in reality the rate is likely less than half of this. This deceptive impression results from the reporting of false data by the power companies as well as inadequate government supervision, and is one of the key reasons for the long neglect of the problems of coal ash pollution in China.

10.China lacks effective policy to monitor coal ash once it is reutilized and recycled into other products. There is a severe lack of safeguards for public health in regards to harmful substances found in bricks and other products made from coal ash.

Preface

Some 200 years ago, coal helped to bring about the industrial revolution and advance the development of modern civilization. Today, coal is still part of the backbone of world economic growth. In 2009, China – home to one-fifth of the global population – consumed over 3 billion tons of coal, more than any other country in the world and more than three times greater than the amount used by the second-ranked country, the U.S. Over 70% of China's energy needs are met by coal. Over the last two decades, coal has provided a crucial energy foundation for the country's economic boom.

Seen from another angle, however, China's staggering, coal-powered economic ascent comes with huge environmental, social and economic costs. Coal pollution has already become the country's biggest environmental problem. Three years ago, in association with several other organizations, Greenpeace published a report called The True Cost of Coal, which examines China's coal use from a macroeconomic perspective. That report showed the total external cost of coal used in 2007 alone to be RMB 1.745 trillion, equivalent to 7.1% of China's GDP. Every ton of coal burned that year cost RMB 150 in environmental damages. This figure does not even include the substantial costs associated with climate change, which coal combustion emissions of carbon dioxide and other greenhouse gases help fuel.

Building on that report, in August 2010 Greenpeace collaborated with the Chinese Centre for Disease Control and Prevention to publish The True Cost of Coal – Air Pollution and Public Health, a new research report geared at educating the Chinese public about the health threats of air pollution from coal combustion.

This latest report, The True Cost of Coal – An Investigation into Coal Ash in China, focuses on a long-ignored type of coal pollution. An inevitable byproduct of coal power generation, coal ash is also China's largest single source of industrial solid waste. In 2009 alone, China generated at least 375 million tons of coal ash – more than twice the amount of urban domestic waste produced in the same time period. Coal ash is also toxic, containing large quantities of pollutants such as heavy metals and radioactive substances, which pose a huge threat to both the environment and public health.

However, because of regulatory loopholes and poor policy implementation by governments and industry, coal ash's environmental problem has long been over-looked and underestimated. One of the key issues is that coal ash re-utilization rates have been widely exaggerated to over 60%. The reality, however, is that the rate is likely not even half that.

To better understand the current state of coal ash pollution in China, Greenpeace conducted an onsite investigation into 14 power plants across the country, collecting samples of coal ash for analysis and conducting interviews with specialists, industry and government departments. We present this research with the hope that it will help lead to improvements in China's coal ash pollution prevention legislation, strengthen environmental law enforcement and provide a valuable source of information. At the same time, we hope that it will encourage more policy makers and researchers to pay more attention to this topic.

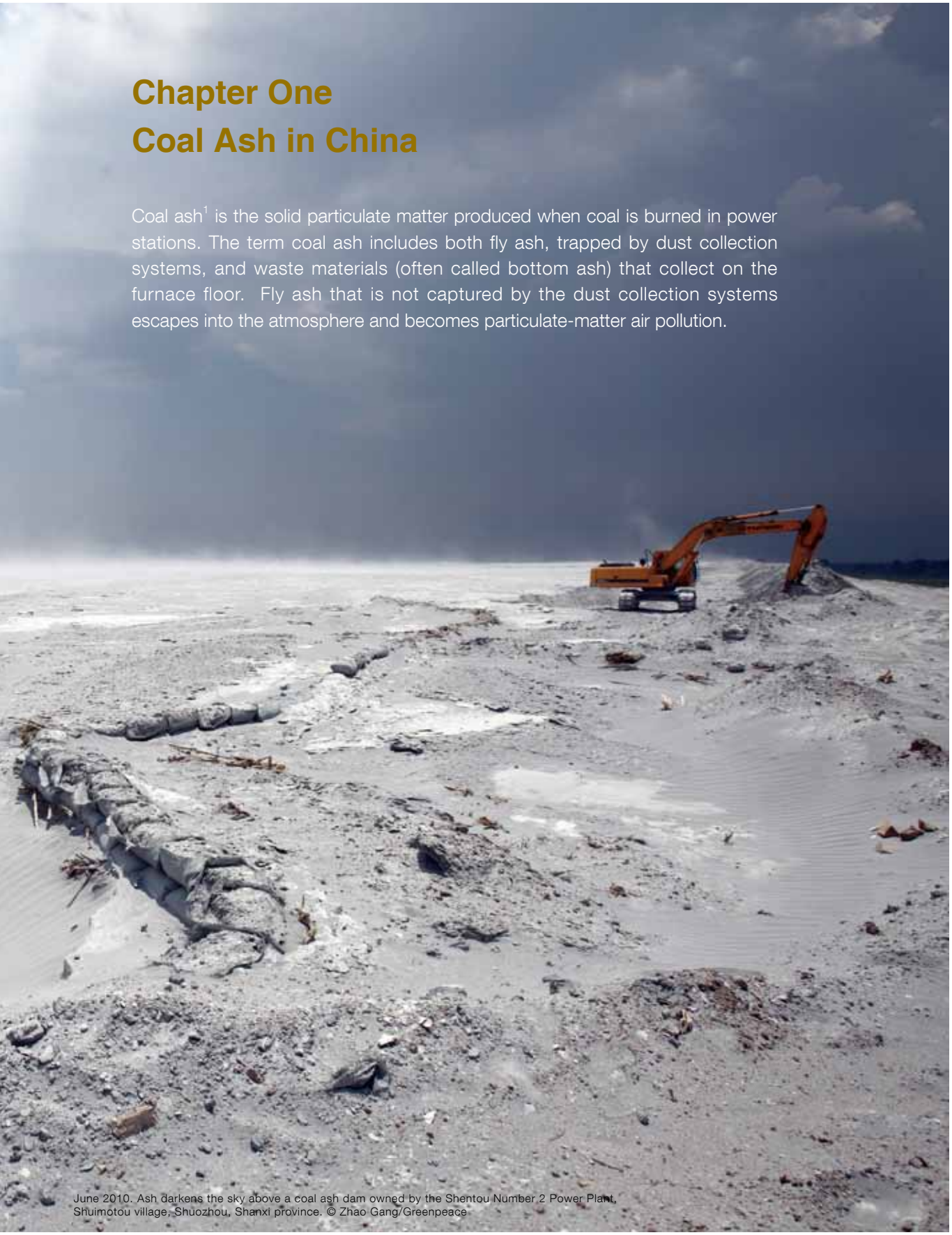
We would like to extend our special thanks to Professor Zhou Hanhua and his team at the Law Institute of the Chinese Academy of Social Sciences for providing policy analysis and legal recommendations. We would also like to thank Mr Hao Zhibang, an Inner Mongolia environmental protection senior engineer, who offered advice and guidance during the writing of this report. Finally, we would like to thank our volunteers Ma Zhiyao and Zhang Zheng for meticulously and patiently checking the data in this report.

Due to limitations in time and research capability, this report definitely has room for improvement. We sincerely welcome and value any suggestions from experts, people in the industry and other readers for improvements.

Climate & Energy Campaign team, Greenpeace China
September 2010

Chapter One
Coal Ash in China

Coal ash[1] is the solid particulate matter produced when coal is burned in power stations. The term coal ash includes both fly ash, trapped by dust collection systems, and waste materials (often called bottom ash) that collect on the furnace floor. Fly ash that is not captured by the dust collection systems escapes into the atmosphere and becomes particulate-matter air pollution.



June 2010. Ash darkens the sky above a coal ash dam owned by the Shentou Number 2 Power Plant, Shuimotou village, Shuozhou, Shanxi province. © Zhao Gang/Greenpeace

1. Current situation

China has long been over-dependent on coal for its energy needs. Currently, more than 70% of China's energy is generated by burning coal, and as the economy continues to grow at a fast rate, so too does its coal consumption. The power sector is one of the largest consumers of coal, with more than half of national coal consumption going towards electricity generation.

Coal ash is the inevitable waste product from coal combustion. Generally speaking, every four tons of coal burned produce one ton of coal ash[2]. In 2009, China consumed more than three billion tons of coal, more than half of which was used to generate electricity. Using conservative estimates, the coal ash produced that year reached 375 million tons. This is equivalent to more than twice the urban domestic waste produced in the same year[3] and a volume of 424 million cubic metres[4]—enough to fill one standard swimming pool every two and a half minutes or one Water Cube (National Aquatics Center) per day.[5]. If not dealt with properly, such enormous quantities of coal ash pose a dangerous threat to China's environment and public health.

There are two methods to dispose of coal ash. It can be buried in an "impoundment" on land procured by the power station either as wet ash disposal (in an ash pond) or dry ash disposal (in a dry landfill). Or it can be recycled (comprehensive utilization) into other materials, such as concrete and other construction materials.[6]

2. Coal ash pollution

(1) The composition of coal ash

Coal contains harmful heavy metals and radioactive substances, which are left behind after combustion in coal ash in much higher concentrations. The main chemical components of coal ash are silicon dioxide, aluminium oxide, calcium oxide, magnesium oxide, potassium oxide, sodium oxide, sulfur trioxide and partially burned organic matter[7]. Coal ash also contains antimony, arsenic, boron, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium and vanadium, among other heavy metals and radioactive elements such as radium, thorium, and uranium.

(2) Air pollution

About 20% of coal ash particles are hollow, making them easily dispersible by wind. Regardless of whether dry or wet disposal methods are used, without a properly enclosed storage system, coal ash can easily be scattered into the atmosphere as secondary dust pollution. This will have serious consequences for people living downwind of the coal ash impoundment. When wind speeds reaches level four (5.5-7.9 m/s), coal ash can spread over an area spanning 100,000 and 150,000 square kilometre (km^2)[8]. Thus, coal ash-induced air pollution can affect areas far from their original location. The strong northwestern winds originating from provinces such as Inner Mongolia, Shanxi and Xinjiang, where big coal and power industries are located, further intensifies the spread of coal ash pollution towards southeastern China[9].

(3) Water pollution

If the impoundment is not properly secured against leakages, pollutants in coal ash can leach into the groundwater. This is especially common at wet ash ponds, where the coal ash is mixed with water. As the coal ash soaks in the water, the heavy metals and other harmful substances can leach out into the earth, ultimately seeping into the groundwater. This can cause the contamination of local water sources, the discharge of suspended matter into drinking wells, the fluoridation and alkalization of water and so on. Coal ash can also be blown by the wind into rivers and lakes.

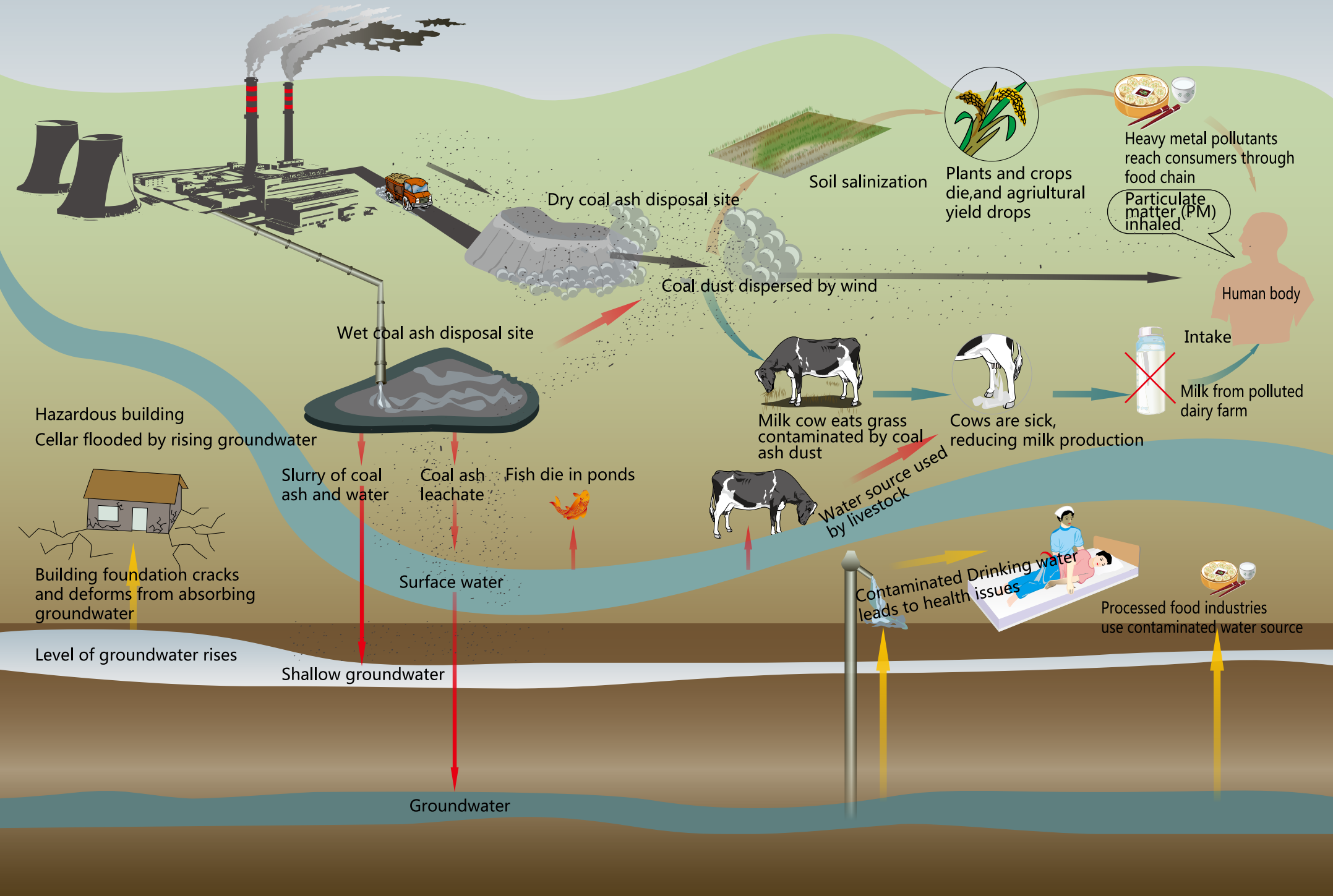
(4) Soil pollution

As China continues to expand its fleet of coal-fired power plants, the problem of coal ash disposal is becoming increasingly serious. Scattered by wind across the lands, coal ash can cause soils to turn alkaline, which damages agricultural production and the ecology. The spilled coal ash can seep into nearby fields, reducing yields or even killing crops.

(5) Human health impacts

Figure 1 shows how coal ash pollution from a coal-fired power plant can threaten human health, either by directly entering the body or indirectly through contamination of the food chain. Coal ash can pollute the environment through many channels, including air, water and soil.

Figure 1 Coal Ash Pollution Chain



Even when coal ash has been recycled into tiles or other building materials, it can still threaten human health.

Once the heavy metals and other harmful substances from coal ash build up to a certain concentration in the body, they can cause many serious diseases (see Table 1). The radioactive elements in coal ash also pose a threat to human health. Present in naturally occurring coal, thorium and uranium are not changed chemically by combustion and are left behind as contaminants in coal ash. Radioactive elements are about three times more concentrated in coal ash than in "raw" coal[10].

(6) Geological hazards

Most coal ash waste deposits are deeper than 20 metres, while the height of an ash dam is usually around 30 metres. Heavy rains, floods or other natural disasters increase the chance of accidents such as ash dam collapse, landslides and mudslides. In the event of such disasters, the heavy metals and other pollutants in coal ash can leak into the environment and threaten human health. As the frequency of extreme weather events is increasing with climate change, it is beyond doubt that the likelihood of coal ash disasters will only grow as well.

Harmful substances	Health impacts
Antimony	Eye irritation, heart damage, lung problems
Arsenic	Cancer, skin lesions, hand warts
Barium	Gastrointestinal problems, muscle weakness, heart damage
Beryllium	Lung cancer, pneumonia, respiratory problems
Boron	Reproductive problems, gastrointestinal problems
Cadmium	Lung disease, kidney disease, cancer
Chromium	Cancer, ulcers and other stomach problems
Cobalt	Lung, heart, liver and kidney problems; dermatitis
Copper	Respiratory and nervous system damage, liver disease
Lead	Nervous system damage, brain damage, development and behavioural problems
Manganese	Nervous system damage, muscle problems, neurological problems
Mercury	Cognitive deficiency, stunted growth, behavioural problems
Molybdenum	Mineral imbalance, anemia, developmental problems
Nickel	Cancer, lung problems, allergic reactions
Selenium	Birth defects, impaired bone growth in children
Vanadium	Birth defects; lung, throat and eye problems
Zinc	Gastrointestinal and reproductive problems
Chlorides	High blood pressure
Fluorides	Dental fluorosis, skeletal fluorosis
Nitrates	Reacts in stomach to form carcinogenic substances
Sulphates	Stimulates the gastrointestinal tract

Table 1 The health impacts of key harmful substances present in coal ash[11]

December 2008. The site of the coal ash spill at the Kingston Fossil Fuel Plant, Tennessee, US. © Wade Payne /Greenpeace

Example of coal ash dam disasters:

Kingston Fossil Fuel Plant, Tennessee, U.S.

On December 22, 2008, in the U.S. state of Tennessee, the retaining wall of a five-hectare ash pond collapsed, spilling 500 million gallons (2 million cubic metres) of coal ash. The spill destroyed houses, polluted the earth, rivers, and air, causing hundreds of millions of dollars in losses. According to the Tennessee Valley Authority, owner of the Kingston Fossil Fuel Plant, the ash spill covered more than 160 hectares of road and lands, affecting an area greater than the 1989 Exxon Valdez oil spill. It took six weeks to clean up the accident[12].

Cases of ash dam failures in China:

In 2009, a dam belonging to the Jiangdian Coal-fired Plant failed, causing a large surface impoundment of coal ash to collapse (Jiangyou city, Sichuan province)[13].

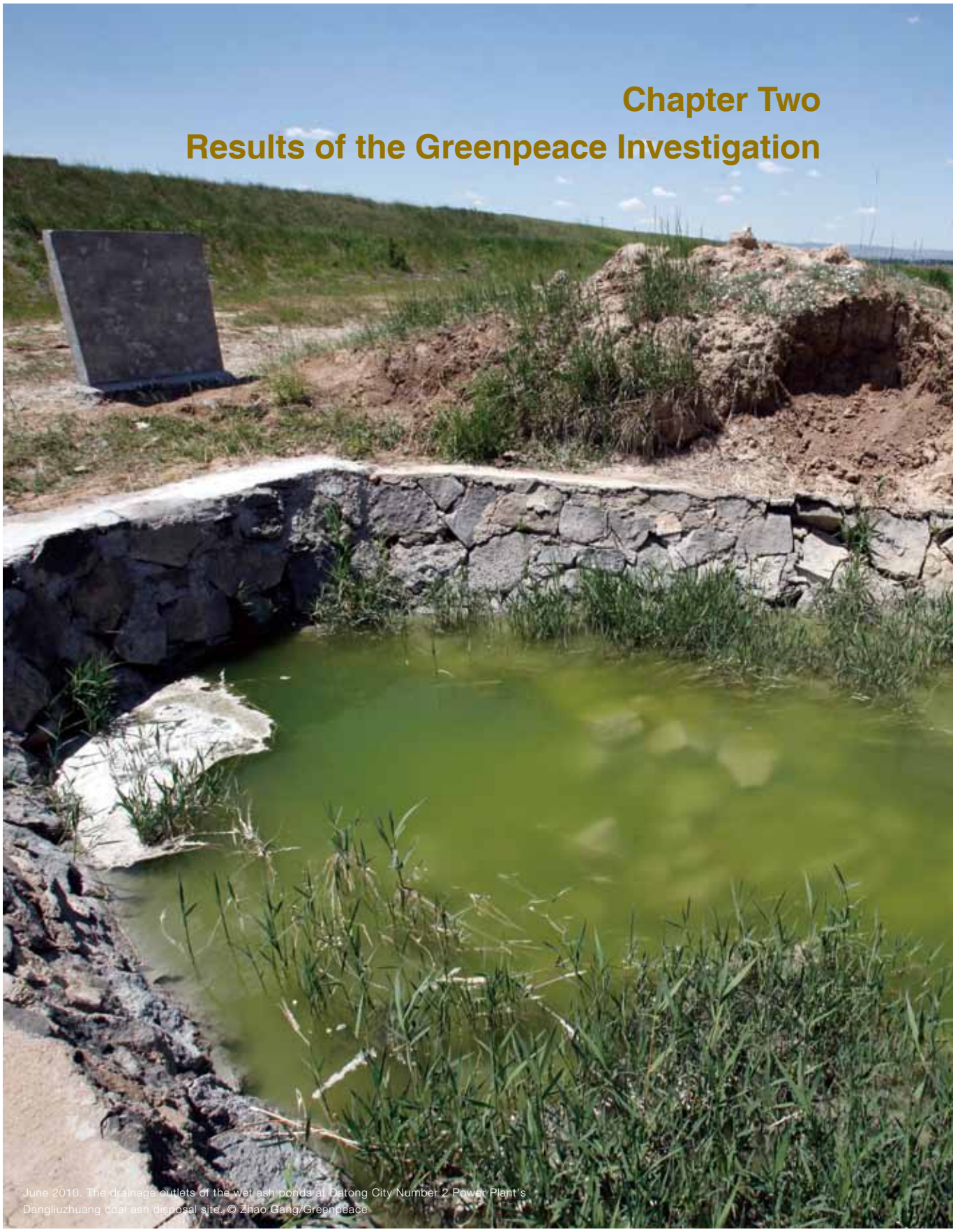
In 2006, a 30-metre deep ash dam failed at the Pan County Power Plant when a retaining wall near the bottom gave away. All the coal ash contained flooded out, pouring directly into the Tuozhang River, part of the Pearl River system. According to experts ' estimates, in the space of a few minutes about 300,000 tons of ash slurry spilled directly into the Tuozhang River, polluting both the Tuozhang and Beipan Rivers[14,15].

In 2006, an ash dam belonging to the Chenming Paper Factory failed, spilling over 110,000 cubic metres of coal ash. The ash slurry flooded 12 hectares of farmland and flowed into the Tumenjiang River (Longjing city, Jilin province)[15].

In 2005, the collapse of a 40-metre-high ash dam at the Neijiang Power Company of the China Huadian Group caused the death of a worker. After the collapse, the edge of the ash dam had moved forward by 30 metres (Neijiang city, Sichuan province)[16].

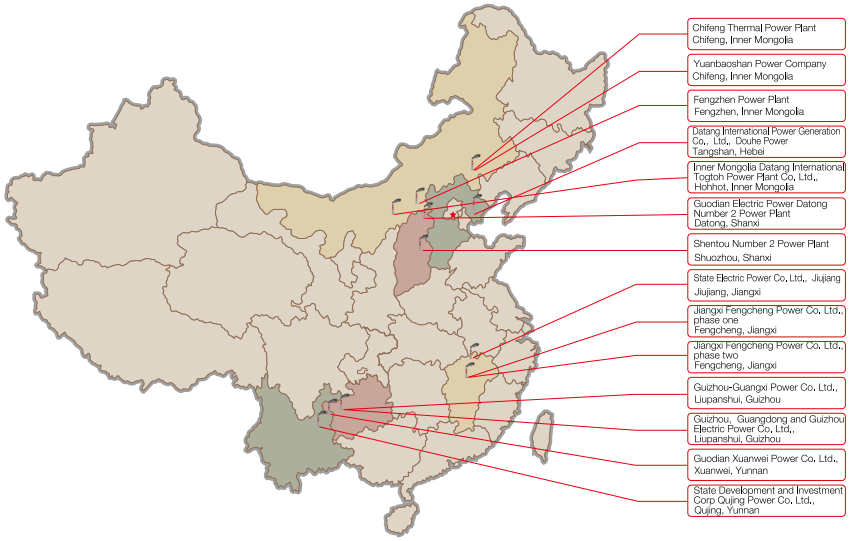
In 2004, an ash dam of the Nayong Power Plant failed at its lower part (Liupanshui city, Guizhou province)[17].

Chapter Two
Results of the Greenpeace Investigation



June 2010. The drainage outlets of the wet ash ponds at Datong City Number 2 Power Plant's Dangliuzhuang coal ash disposal site. © Zhao Gang/Greenpeace

To gain a better understanding of the current state of China's coal ash pollution, Greenpeace conducted investigations at impoundments owned by 14 coal-fired power stations from January to August this year (see table 2.1). When selecting power stations, we made efforts to choose samples from a range of different regions, operational ages, installed capacities and parent companies. Seven of the power plants are in northern China; three are located in central China; four are in southwestern China. Eight power plants belong to the country's "big five" power companies (China Datang, China Guodian, China Huadian, China Huaneng, and China Power Investment). The starting years of operation for the plants spans from 1963 to 2005. The total installed capacity of the 14 power plants is 26.15 GW, or about 4% of the current installed capacity of China's coal-fired power plants[18].



Name		Parent company	First year of operation	Location	Installed capacity (10 MW)	Annual production of coal ash (10, 000 tons)[19]
1	Datang International Power Generation Co., Ltd., Douhe Power (Douhe Power Plant)	China Datang Corporation (Datang)	1973	Tangshan, Hebei	135	170
2	Chifeng Thermal Power Plant	China Power Investment Corporation (CPI)	1963	Chifeng, Inner Mongolia	30	30
3	Fengzhen Power Plant	China Huaneng Group (Huaneng)	1986	Fengzhen, Inner Mongolia	120	50
4	Yuanbaoshan Power Company (Yuanbaoshan Power Plant)	CPI	1978	Chifeng, Inner Mongolia	210	160
5	Inner Mongolia Datang International Togtoh Power Plant Co. Ltd., (Togtoh Power Plant)	Datang	1995	Hohhot, Inner Mongolia	540	459
6	Shentou Number 2 Power Plant	State Grid Corporation of China (State Grid)	1988	Shuozhou, Shanxi	200	145
7	Guodian Electric Power Datong Number 2 Power Plant	China Guodian Corporation (Guodian)	1978	Datong, Shanxi	370	73
8	State Development and Investment Corp Qujing Power Co. Ltd., (Qujing Power Plant)	State Development and Investment Corporation (SDIC)	1998	Qujing, Yunnan	120	190
9	Guodian Xuanwei Power Co. Ltd., (Xuanwei Power Plant)	Guodian	1958	Xuanwei, Yunnan	180	118
10	Guizhou-Guangxi Power Co. Ltd., (Panxian Power Plant)	Guangxi Development & Investment Company Ltd and Guizhou Development and Investment Company Ltd	1993	Liupanshui, Guizhou	100	93(calculated from the plant's annual coal consumption for electricity generation)
11	Guizhou, Guangdong and Guizhou Electric Power Co. Ltd., (Pannan Power Plant)	Guangdong Yudean Group and Guizhou Jinyuan Group	2003	Liupanshui, Guizhou	240	192(calculated from the plant's annual coal consumption for electricity generation)
12	State Electric Power Co. Ltd., Jiujiang (Jiujiang Power Plant)	Guodian	1977	Jiujiang, Jiangxi	110	60
13	Jiangxi Fengcheng Power Co. Ltd., phase one (Fengcheng Number 1 Power Plant)	Jiangxi Investment Company and Guodian	1993	Fengcheng, Jiangxi	120	200
14	Jiangxi Fengcheng Power Company phase two (Fengcheng Number 2 Power Plant)	Jiangxi Provincial Investment Group Corp and Jiangxi Ganneng Company	2005	Fengcheng, Jiangxi	140	50

Table 2.1 Key data on the 14 power plants investigated by Greenpeace, 2010

Onsite investigations by Greenpeace focused on three key areas: 1) the heavy metals and chemical compounds contained in the coal ash; 2) the pollutants found in water sources close to the coal ash disposal site; 3) the management of the coal ash disposal site.

1. Investigation of the components of coal ash

In order to minimize the interference of any external environmental influence on the coal ash samples, Greenpeace staff took care to collect only coal ash that was newly discharged to inside or outside the disposal site. The analysis was arranged by the Greenpeace Research Laboratory at the University of Exeter[20]. In this investigation, Greenpeace detected more than 20 different kinds of harmful substances (heavy metals and chemical compounds) in samples collected from the coal ash disposal sites of the 14 power plants across the country. See Table 2.2 for a summary of the results.

Every year, through the burning of coal, power plants release a substantial quantity of harmful substances into our environment. While the concentration of heavy metals and other toxic substances in coal ash is not so high compared to that of some types of industrial pollution, the scale of coal ash production is so great as to make it a highly serious pollutant indeed. What's more, coal ash's effects on the environment and human health are usually long-term and chronic, and thus even more likely to escape notice.

Many heavy metals and harmful pollutants are not formally monitored under China's environmental laws, and related standards are lacking, rendering pollution-prevention measures even less effective. However, the government is starting to pay more attention to heavy metal pollution. At the end of 2009, seven government bodies, including the Ministry of Environmental Protection, put forward the "Guiding Principles on Strengthening the Prevention and Control of Heavy Metal Pollution." This document focused on pollution by lead, mercury, cadmium, chromium and arsenic (a metalloid).

Table 2.3 displays the results of testing for these five heavy metals in the samples from the 14 power stations. Using rough estimates[22], China's coal power generation sector produces enough coal ash waste every year to contain 358.75 tons of cadmium, 10,054.25 tons of chromium, 9,410 tons of arsenic, 4.25 tons of mercury and 5,345.5 tons of lead. Altogether, that's a total of 25,000 tons of heavy metals. It is important to note, however, that the margin of error in using such estimation methods is undeniably high, as heavy metal content varies depending on the type of coal burned by the coal-fired plant.

2. Water quality near coal ash disposal sites

To test for coal-ash pollution in water sources near the disposal sites, Greenpeace staff collected water samples from the discharge outlets of ash ponds or surface water close to ash ponds at six power plants. Greenpeace staff also collected samples from underground well water near the ash-disposal sites of eight power stations. The samples were tested for the presence of heavy metals and other harmful pollutants. See Table 2.4 for a summary of the findings.

Research conducted in China and overseas[23] has shown that the action of wind and rain can cause poisonous heavy metals inside coal ash (such as cadmium, chromium, arsenic, mercury, and lead) to leach or dissolve into water systems. As coal ash accumulates in an ash pond and soaks in alkalized water over a long period of time, an increased concentration of poisonous heavy metals leaches out from the coal ash. This can result in the pollution of nearby soil, surface water and groundwater.

This investigation assessed water samples from the discharge outlets of coal ash ponds and surface water taken close to the ash ponds against the "Environmental Quality Standards for Surface Water" and "Standards for Irrigation Water Quality" (see Table 2.5). The well water samples were assessed against "Sanitary Standards for Drinking Water" (See Table 2.6).

Surface water samples taken from four power stations out of six showed concentrations of pollutants that exceeded levels stipulated in the "Environmental Quality Standards for Surface Water" and "Standards for Irrigation Water Quality". Water samples from Douhe Power Plant had traces of fluorides 233% higher than the concentration allowed by the "Environmental Quality Standards," while water samples from Chifeng Thermal Power Plant contained fluoride at concentrations 187% higher than that allowed. As for the "Standards for Irrigation Water Quality," water samples from Douhe Power Plant contained fluoride at concentrations of 67% over the maximum, while the Chifeng Power Plant's water sample showed boron at concentrations of 29% over the maximum and fluorides at 43% over the maximum. At Fengzhen Power Plant, boron exceeded maximum concentrations by 400%, and at Datong Number Two Power Plant, boron exceeded concentrations by 17%.

Of the samples of underground well water taken from near eight power stations, three of them contained concentrations of pollutants that exceeded levels set by the "Sanitary Standards for Drinking Water." At Douhe Power Plant, the concentration of nitrates was 36% over the maximum; at Chifeng Thermal Power Plant, boron was found in concentrations 80% over the maximum; at Yuanbaoshan Power Plant, boron concentrations exceeded the maximum by 270%, molybdenum concentrations by 103%, nitrate concentrations by 74%, and fluoride concentrations by 180%s.

Power plant	Sampling site[21]	Metals and chemical compounds detected
Douhe Power Plant	Lijiayu coal ash disposal site	Barium, boron, chromium, cobalt, copper, lead, manganese, nickel, vanadium, zinc, sulphates, fluorides
Chifeng Thermal Power Plant	Dongjiao Badui coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, fluorides, chlorides
Fengzhen Power Plant	Fengzhen coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, fluorides, chlorides
Yuanbaoshan Power Plant	Yuanbaoshan coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, fluorides
Togtoh Power Plant	Togtoh coal ash disposal site	Barium, boron, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, vanadium, zinc, sulphates, fluorides
Shentou Number 2 Power Plant	Shentou coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides, chlorides
Datong Number 2 Power Plant	Tian village coal ash disposal site	Barium, boron, chromium, cobalt, copper, manganese, molybdenum, nickel, vanadium, zinc
	Dangliu village coal ash disposal site	Barium, boron, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, vanadium, zinc, sulphates, fluorides
Qujing Power Plant	Wayao coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides
Xuanwei Power Plant	Miaohou coal ash disposal site	Aluminium,arsenic,barium,beryllium,boron,cadmium,calcium,chromium,cobalt,copper,iron,lead,lithium,magnesium,manganese,molybdenum,nickel,phosphorus,potassium,selenium,sodium,strontium,titanium,vanadium,zinc, sulphates, fluorides, chlorides
Panxian Power Plant	Number 4 coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides
Pannan Power Plant	Jialuji coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides
Jiujiang Power Plant	Phase 2 Weijiachong coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides
Fengcheng Number 1 Power Plant	Phase 1 coal ash disposal site	Aluminium, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides, chlorides
Fengcheng Number 2 Power Plant	Phase 2 Yun village coal ash disposal site	Aluminium, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, sodium, strontium, titanium, vanadium, zinc, sulphates, fluorides, chlorides

Table 2.2 Heavy metals and chemical compounds found in coal ash samples from 14 power plants

Power plant		Annual Production of Heavy Metals (estimates in tons)				
		Cadmium	Chromium	Arsenic	Mercury	Lead
1	Douhe Power Plant	-	18.70	-	-	10.20
2	Chifeng Thermal Power Plant	0.47	7.92	19.02	-	2.27
3	Fengzhen Power Plant	0.46	20.12	9.13	-	21.53
4	Yuanbaoshan Power Plant	1.82	40.56	64.56	-	10.11
5	Togtoh Power Plant	-	26.99	-	-	59.67
6	Shentou Number 2 Power Plant	0.48	5.95	5.74	-	15.40
7	Datong Number 2 Power Plant	-	5.45	-	0.17	8.03
8	Qujing Power Plant	1.80	34.20	43.20	-	9.61
9	Xuanwei Power Plant	1.00	28.54	19.60	-	7.52
10	Panxian Power Plant	1.85	28.30	72.19	-	13.30
11	Pannan Power Plant	3.54	67.20	131.81	-	32.64
12	Jiujiang Power Plant	0.31	8.94	4.37	-	2.78
13	Fengcheng Number 1 Power Plant	2.32	100.5	-	-	17.30
14	Fengcheng Number 2 Power Plant	0.296	8.80	6.78	-	3.46
Sub-total		14.35	402.17	376.4	0.17	213.82
Estimated national production		358.75	10054.25	9410.00	4.25	5345.50

Table 2.3 Presence of the five nationally targeted heavy metals in coal-ash sites at 14 power plants

Power station	Sample location	Heavy metals and compounds detected
Douhe Power Plant	Lijiayu coal ash disposal site (surface water sample)	Barium, boron, iron, molybdenum, titanium, vanadium, zinc, nitrates, chlorides, fluorides
	Ganyugou village (well water sample)	Barium, boron, zinc, nitrates, chlorides, fluorides
Chifeng Thermal Power Plant	Dongjiao Badui coal ash disposal site (surface water sample)	Barium, boron, manganese, molybdenum, zinc, nitrates, chlorides, fluorides
	Dongjiao Badui village (well water sample)	Barium, boron, molybdenum, zinc, nitrates, chlorides, fluorides
Fengzhen Power Plant	Fengzhen ash disposal site (surface water sample)	Aluminium, barium, boron, cadmium, calcium, chromium, copper, iron, lithium, magnesium, nickel, potassium, sodium, strontium, zinc, sulphates
	Jiuquan village (well water sample)	Aluminium, barium, boron, calcium, chromium, iron, magnesium, mercury, molybdenum, potassium, sodium, strontium, zinc, sulphates
Yuanbaoshan Power Plant	Xinglongpo village (well water sample)	Barium, boron, molybdenum, zinc, nitrates, chlorides, fluorides
Shentou Number 2 Power Plant	Shuimotou village (well water sample)	Barium, calcium, chromium, copper, magnesium, potassium, sodium, strontium, zinc, sulphates
Datong Number 2 Power Plant	Dangliu village ash disposal site (surface water sample)	Aluminium, barium, boron, cadmium, calcium, chromium, copper, lithium, magnesium, nickel, potassium, sodium, strontium, zinc, sulphates
Xuanwei Power Plant	Miaohou village (well water sample)	barium, calcium, magnesium, potassium, sodium, strontium, sulphates
Jiujiang Power Plant	Phase 2 Weijiachong coal ash disposal site (surface water sample)	Aluminium, barium, boron, calcium, chromium, copper, iron, magnesium, manganese, nickel, potassium, sodium, strontium, zinc, sulphates
	Yujiahe village (well water sample)	Aluminium, barium, calcium, magnesium, potassium, sodium, strontium, zinc, sulphates
Fengcheng Number 1 Power Plant	Phase 1 coal ash disposal site (surface water sample)	Aluminium, barium, boron, cadmium, calcium, chromium, copper, iron, lithium, magnesium, nickel, potassium, sodium, strontium, zinc, sulphates
	Houtanggang village (well water sample)	Aluminium, barium, calcium, magnesium, manganese, nickel, potassium, sodium, strontium, titanium, vanadium, zinc, sulphates

Table 2.4 Heavy metals and other compounds found in water samples collected near coal ash disposal sites

Power station	Pollutant	Maximum concentration allowed in surface water[24](ug/L unless stated otherwise)	Maximum allowed concentration in irrigation water[25](ug/L unless stated otherwise)	Detected concentration(ug/L unless stated otherwise)	Percentage excess for surface water pollutant	Percentage excess for irrigation water pollutant
Douhe Power Plant	Fluorides	1500	3000	5000	233%	67%
Chifeng Thermal Power Plant	Boron	-	3000 [26]	3870	-	29%
	Fluorides	1500	3000	4300	187%	43%
Fengzhen Power Plant	Boron	-	3000	15000	-	400%
Datong Number 2 Power Plant	Boron	-	3000	3510		17%

Table 2.5 Pollutants detected at concentrations exceeding standards in surface water samples

Power Station	Pollutant	Maximum concentration allowed in drinking water[28](ug/L unless stated otherwise)	Detected concentration (ug/L unless stated otherwise)	Percentage excess
Douhe Power Plant	Nitrates	20 (mg/L)	27.12 (mg/L)	36%
Chifeng Thermal Power Plant	Boron	500	898	80%
Yuanbao Shan Power Plant	Boron	500	1850	270%
	Molybdenum	70	142	103%
	Nitrates	20 (mg/L)	34.72 (mg/L)	74%
	Fluorides	1 (mg/L)	2.8 (mg/L)	180%

Table 2.6 Pollutants detected at concentrations exceeding standards in underground well water samples [27]

August 2010. Villagers are forced to drink relatively expensive bottled water after coal ash seepage from Yuanbaoshan Power Plant contaminated the groundwater.
© Zhao Gang/Greenpeace

July 2010. A Greenpeace activist samples water from a well near the Hongqiaopu coal ash disposal site of the Xuanwei Power Station, Yunnan province. © Simon Lim/ Greenpeace

3. Investigation on the environmental management of coal ash disposal sites

Coal ash is treated as a solid industrial waste in China, with the main regulations governing its management laid out in the "Standards for Pollution Control on the Storage and Disposal Sites for General Industrial Solid Waste." These standards cover storage and handling, site selection, design, operations management, site closure, and pollution control and monitoring. However, from Greenpeace's onsite investigations, we discovered that the majority of coal ash disposal sites had far from adequate site selection and preventative measures against dust dispersal, leakages and run-off of pollutants.

(1) Site selection

According to Regulation 5 in the "Standards for Pollution Control on the Storage and Disposal Sites for General Industrial Solid Waste," sites for a coal ash-disposal facility "should be consistent with the locality's overall planning requirements, be located downwind of industrial and residential areas, and be at least 500 metres away from the nearest residential area."

However, during Greenpeace's onsite investigations, we discovered that the majority of ash disposal sites were much closer to the nearest villages than 500m. At Douhe Power Plant, the coal ash disposal dam was less than 50 metres away from Lijiayu village as the crow flies. There are villages on all four sides of the coal ash disposal sites of Shentou Number 2 Power Plant, Pannan Power Plant, Fengzhen Power Plant, Yuanbaoshan Power Plant, Datong Number 2 Power Plant, Fengcheng Number 1 Power Plant and Fengcheng Number 2 Power Plant. Some well-known dairy farms are located very close to the ash disposal sites of Fengzhen Power Plant and Yuanbaoshan Power Plant, while at Chifeng Thermal Power Plant and Jiujiang Power Plant, the ash disposal sites are located within city boundaries, where the population density is very high. Dongjiao Badui village is located less than 50 metres downwind of Chifeng Thermal Power Plant's coal ash disposal site.

(2) Prevention of dust dispersal

During the investigation, we discovered that in the water-scarce region of northern China, coal ash disposal sites tend not to be equipped with effective safeguards (such as water spraying) to prevent the wind dispersal of dry ash. In the southern areas, power plants will add water to coal ash to prevent the wind dispersal of dry ash. But this measure has limited effectiveness, with nearby villages and farmland still receiving various levels of dust pollution from the coal ash sites.

Villagers living near the 14 power plants investigated in this study all said that they suffered from skin disease and respiratory diseases (including lung problems). Near the ash disposal sites of Fengzhen Power Plant, Yuanbaoshan Power Plant, Togtoh Power Plant, Shentou Number 2 Power Plant, Fengcheng Number 1 Power Plant and Fengcheng Number 2 Power Plant, cows and sheep suffered from diarrhoea, reduced milk, a fall in birth rates and increased mortality, possibly from eating grass contaminated by coal-ash dust pollution. A substantial amount of dust floats down and contaminates neighbouring fields, causing soil salinization.

(3) Leakage prevention

To prevent the leakage of general solid industrial waste and leachate, ash disposal sites are required to "construct

retaining walls, embankments, etc, use natural or man-made impermeable materials, and if necessary, install leachate treatment facilities. At least three water-quality monitoring wells should be established near the coal ash storage and handling facility to assess leachate pollution of groundwater".

Because all the ash disposal sites at the 14 power stations in this investigation had already started operations, it was impossible for Greenpeace to conduct a technical analysis of their leakage prevention facilities. Datong Number 2 Power Plant was the only one that was currently building a new coal ash disposal site. During Greenpeace's fieldwork, workers were in the process off laying out anti-leakage lining. These 15-centimetres-width liners were laid down at the bottom of the newly constructed ash dam and bonded piece by piece with only adhesive materials, which lack the effectiveness to prevent leakage in the long run.

Suspended matter, fluoridisation and alkalization were also found in water samples taken from village well water near the coal ash disposal sites of Douhe Power Plant, Chifeng Thermal Power Plant, Fengzhen Power Plant, Yuanbaoshan Power Plant, Shentou Number 2 Power Plant and Jiujiang Power Plant. Because ground water was contaminated by leachates from coal ash disposal sites, villagers were forced to change their source of drinking water, with some people having no choice but to buy relatively expensive bottled water.

In addition, the building foundations of houses in Lijiayu and Ganyugou villages near Douhe Power Plant and Shuimotou village near Shentou Number 2 Power Plant had cracked and deformed from the absorption of rising ground water due to increasing water-level pressure from the coal ash dams. The majority of these houses are now becoming uninhabitable.

(4) Run-off prevention

In June 2006, the ash dam at the Pannan Power Plant in Guizhou province (one of the 14 power stations Greenpeace investigated in 2010) failed. About 300,000 tons of ash slurry directly flowed into the Tuochang River.

While investigating Shentou Number 2 Power Plant, Qujing Power Plant and Fengcheng Number 1 Power Plant, Greenpeace discovered that their coal ash disposal sites did not have a secure dam structure, and in some cases not even a retaining wall. In August 2010, two months after our onsite investigation, a 100-metre section of ash dam gave way at the Shentou Number 2 Power Plant in Shanxi province. Toxic coal ash sludge spilled out, submerging about 120 hectares of fields.

We also discovered that the coal ash disposal sites of Fengcheng Number 1 Power Plant and Fengcheng Number 2 Power Plant are both located within the flood zone of Fengcheng city. In the event of a flood, it is very likely that coal ash could pollute a substantially larger area of farmland and residential land.

August 2010. Coal ash-contaminated grass has severely impacted the health of milk cows at dairy farms near the Yuanbaoshan Power Plant, Inner Mongolia. Here Mrs. Chen shows us a dead calf. © Zhao Gang/Greenpeace

Chapter Three

Government Agencies Responsible for Handling Coal Ash

Coal ash is either recycled into other materials (comprehensive utilization) or disposed of in a coal ash impoundment. The two government agencies that are most closely connected with coal ash management are the National Development and Reform Commission (NDRC) and the Ministry of Environmental Protection (MEP). The NDRC is responsible for managing coal ash utilization while the MEP is concerned with preventing coal ash from polluting the environment.

July 2010. Hongqiaopu dry ash disposal site of the Xuanwei Power Plant, Yunnan province. © Simon Lim/Greenpeace

1. The National Development and Reform Commission

Originally, the State Economic and Trade Commission was responsible for handling coal ash utilization at the central government level. The NDRC has now taken over these responsibilities. This is the main government body in charge of energy conservation and circular economy development. On the matter of coal ash, the NDRC's main duties are "to promote sustainable development strategies and to be responsible for comprehensive emissions reduction and energy conservation coordination work; to oversee planning and coordinate the execution of the policies on the development of circular economy, the conservation of energy resources, and comprehensive utilization measures; to participate in drawing up ecological construction and environmental protection plans; coordinate the major issues associated with ecological construction, conservation of energy resources and comprehensive utilization; and harmonize environmental protection and clean production-related promotional tasks."

•Development and Planning Division

The Development and Planning Division's key responsibilities are to draw up a mid-to-long-term plan that provides the fundamental principles for the national economic and social development. Within this framework, it could develop plans that provide clear direction for the handling of coal ash disposal and the prevention of environmental pollution within a specific timeframe.

•Regional economic departments, Department of Western Region Development, and the Department of Northeastern Region Revitalization

Regional economic departments, the Department of Western Region Development, and the Department of Northeastern Region Revitalization all have similar functions. They are responsible for drawing up plans for the ecological construction and environmental restoration of specific regions and other related coordination tasks.

•The Department of Resource Conservation and Environmental Protection

The Department of Resource Conservation and Environmental Protection is divided into seven departments: the General Office, the Energy Conservation and Emissions Reduction Office, the Energy Conservation Office, the Water Conservation Office, the Development of Circular Economy Office, the Comprehensive Utilization Office and the Environmental Protection Office. Of these, the Energy Conservation and Emissions Reduction Office, the Comprehensive Utilization Office, and the Environmental Protection Office are responsible for handling coal ash.

2. The Ministry of Environmental Protection

The ministry is divided into 14 departments. Those responsible for handling coal ash are the Department of Science, Technology and Standards; the Department of Total Pollutants Control; the Department of Environmental Impact Assessment; the Department of Environmental Monitoring; and the Department of Pollution Prevention and Control.

•The Department of Science, Technology and Standards

The Department of Science, Technology and Standards is chiefly responsible for taking charge of technology-related environmental protection work; the development of national environmental standards, environmental benchmarks and technical specifications; and guiding and promoting the development of a circular economy and environmental-protection industry. Within the department, the Environmental Standards Administration is responsible for environmental standards covering the handling of coal ash, while the Environmental Technology Division is responsible for guidance on coal ash comprehensive utilization technology. For example, the Department of Science, Technology and Standards organized the drafting of "HJ-BAT-001 Best Available Technology for the Prevention of Pollution from Coal-Fired Power Plants Technical Manual (Trial Implementation)" which provides a relatively detailed explanation on coal ash comprehensive utilization technology.

•The Department of Total Pollutants Control

The Department of Total Pollutants Control's main responsibilities are to draft and oversee the implementation of a permit system aimed at controlling the total emissions of major pollutants, to propose total emissions control planning, to assess the total pollutants reduction situation, and to collect environmental statistics and identify pollution sources. With regard to coal ash, it is responsible for the control of pollution emissions during coal combustion.

•The Department of Environmental Impact Assessment

The Department of Environmental Impact Assessment's main responsibilities are to plan and oversee environmental impact assessments, to evaluate policies' environmental impacts, to supervise and manage the qualifications of environmental impact assessment bodies, and to temporarily suspend the approval of environmental assessments for those regions that have either exceeded pollution standards, seriously damaged the environment, or have not yet completed ecological restoration tasks. These apply to all construction projects, excluding emissions-reduction and ecological-restoration projects.This department is also responsible for conducting environmental impact assessments on coal-fired power plant construction projects.

•The Department of Environmental Monitoring

The Department of Environmental Monitoring's main responsibilities are to oversee environmental monitoring, to investigate and evaluate national environmental issues, to take responsibility for issuing early-warning forecasts, and to take charge of the national environmental monitoring network and the national environmental information network. The department is also responsible for issuing public notices at all stages of national environmental situations. Regarding coal ash pollution, the department is responsible for providing timely information so that measures can be adopted to control it.

•The Department of Pollution Prevention and Control

The Department of Pollution Prevention and Control's main responsibilities are to draw up and organize legislation and regulations to prevent the pollution of water, air, soil, noise, light, odour, solid waste, chemicals and vehicular emissions; to enforce the registration of pollutant discharges; to monitor the environmental management mechanism that assesses water quality in cross-provincial border river areas; and organize and draw up related pollution prevention and control plans and monitor the situation. The department is responsible for the specific work connected with the prevention of pollution from industrial sources and from solid waste. Of all the MEP departments, this department is the most directly concerned with the prevention of coal ash pollution.

Chapter Four
Current Problems

June 2010. Coal ash disposal site of the Togtoh Power Station, in Hohhot, Inner Mongolia. © Zhao Gang/Greenpeace

1. Growing hand-in-hand: coal-fired power plants and coal ash waste

Coal ash is the inevitable by-product of burning coal, and as the country expands its coal-fired power sector, the amount of coal ash waste is also increasing. The coal-fired power industry's explosive rise began in 2002, driven by the fast pace of economic development and market demands. At the end of 2002, China's installed capacity of electricity generation was 357 GW[29]. This year it is expected to exceed 900 GW[30], of which more than 70% is coal-fired power. In other words, over the past eight years, the installed capacity of coal-fired plants has grown by an annual average of over 47.5 GW. That's equivalent to building a new coal-fired power plant every week. Such a speed is unprecedented in the world.

This expansion of power generation has created the foundation for the country's economic rise, helping to reduce poverty and raise living standards. But at the same time, China's heavy dependency on coal has created worrying environmental consequences. Over the last eight years, with the coal-fired power sector's rapid expansion, the amount of coal ash produced has increased by over 2.5 times. Coal ash is now the single biggest source of solid industrial waste in China, and it has become an enormous challenge for environmental management.

2. Exaggeration of coal ash utilization results in underestimation of coal ash pollution

In the early stages of China's industrial development, provisions on the handling of coal ash were quite extensive. After the 1980s, the comprehensive utilization of coal ash was aggressively developed, with the concept of "combined storage-use" gradually becoming the guiding principle behind coal ash management. As China entered the 21st century, however, greater emphasis was placed on "scientific development" and environmental protection, and governments at all levels began focusing on coal ash utilization. This has resulted in the guiding principle behind coal-ash handling becoming, simply, "utilization".

In 2005, the Chinese government put forward the "Eleventh Five Year Plan (2006-2010): Guiding Principles behind the Comprehensive Utilization of Resources." It states that "by 2010, the rate of comprehensive utilization of solid industrial waste should reach 60%; within this, the rate of coal-ash comprehensive utilization should reach 75%." In 2007, a "State Council Notice on Energy Conservation and Emissions Reduction Comprehensive Work Plan" also stipulated that "by 2010, the rate of comprehensive utilization of solid industrial waste should exceed 60%." This included coal ash. After the announcement of these key goals at the central government level, many regional governments also included this 60% target into their own provincial or regional objectives. In addition to setting objectives, central and many local governments also introduced measures to advance coal ash utilization[31], such as establishing special funds, offering tax benefits and other preferential policies.

Because the government's utilization target was set fairly high and included appropriate incentives, these preferential policies have helped to increase the country's coal ash utilization capacity. Despite this, however, coal ash utilization has lagged far behind the growth in coal-ash production. Manufacturing building materials with recycled coal ash waste is more expensive than with conventional materials, and consequently, these additional costs have made it impossible to increase coal ash utilization as much as desired in such a short time. In reality, the utilization rate of coal ash is far below 60%. Based on interviews with companies and experts, research, and ground investigation, Greenpeace estimates that the real utilization rate of coal ash is only about 30%. This means that at least 262.5 million tons of coal ash needs to be stored in impoundments every year.

Unfortunately, this serious discrepancy between coal ash utilization objectives and reality has received little attention. The problem has arisen not only out of the difficulties of verifying data from the coal-fired plants, but also from loopholes in existing policies.

The power sector's exaggeration of coal ash utilization rates is a prevailing problem. Under the existing policy framework, it is the users of coal that are responsible for improving the rate of coal ash utilization. This approach allows power plants to casually "adjust" their figures in order to fulfill the utilization target of 60% under the pressure of political demands.

The other problem is that although power companies must submit their data to the NRDC, the MEP and the Statistics Office every year, under current laws and regulations it is not clear who is in charge of verifying that data. Also, China has not assigned legal culpability to individuals or corporations who falsely report coal ash utilization data.

These problems have created a false impression that China is recycling most of its coal ash waste – and therefore coal ash causes limited environmental damage. This has led both the government and the public to

seriously overlook the scale and degree of coal ash pollution in China.

3. Flaws in Environmental Pollution Prevention and Control Policies

In China, coal ash falls under the management of solid industrial waste. The policy most closely related to the prevention of coal ash pollution is the "Law on the Prevention and Control of Environmental Pollution from Solid Waste," (revised 2004). The MEP is responsible for its enforcement. Other existing relevant environmental laws are the "Environmental Protection Law," "Air Pollution Prevention and Control Law" (revised 2000), "Water Pollution Prevention and Control Law" (revised 2008), "Marine Environment Protection Law" (revised 1999), "Environmental Impact Assessment Law," "Law on the Prevention and Control of Radioactive Pollution," and a variety of local and regional statutes What is noteworthy about this is that they are all part of the basic framework of laws on environmental protection and resource utilization. Nevertheless, as the content of these basic laws is fairly general, they are difficult to apply in practice.

Of those used, the "Standards for Pollution Control on the Storage and Disposal Sites for General Industrial Solid Waste" is the most relevant. These mandatory standards are primarily concerned with preventing the dispersal, leakage or run-off of pollutants. However, coal ash is different from other types of solid industrial waste. Because China's power sector is overly reliant on coal, the amount of coal ash produced is enormous, resulting in a huge amount of toxic substances (such as heavy metals, etc) being released into the environment. As the coal power industry expanded over the last few decades, much of the resulting coal ash waste has been stored in impoundments, which creates a significant risk of pollutant dispersal, leakage or run-off. Consequently, it is crucial that pollution-prevention technology requirements for coal ash impoundments be even higher in order to minimize the health and environmental threats from coal ash.

In addition to the "Standards for Pollution Control on the Storage and Disposal Sites for General Industrial Solid Waste," more than 20 national and industry standards are currently in use or are being drawn up. Only a minority of these is mandatory; the others are voluntary standards that industries are merely encouraged to adopt. Therefore, irrespective of the content of these standards, their effectiveness is too limited to serve as a strong control to the practices of coal-fired plants. This is one of the main reasons that it is very difficult for China to make any major headway on preventing coal ash pollution.

There is a clear need for China to further improve its pollution control legislation because existing laws and regulations on the prevention of coal ash pollution are difficult to apply in practice, and the implementation of standards is neither targeted nor compulsory.

4. Weakness in Environmental Law Enforcement

Flaws in pollution prevention and control policies seriously hamper the enforcement of legislation on coal ash. We have seen an evolution in China's coal ash management, which has moved toward emphasizing utilization. The powerful economic ministries and their resource-utilization

July 2010. The wet coal ash pond of the Fengcheng Number 1 Power Plant, in Jiangxi province, is right next to a residential area. © Simon Lim/Greenpeace

June 2010. Bricks made from coal ash at the Yuanbaoshan Power Plant, Inner Mongolia. © Zhao Gang/Greenpeace

policies have grown stronger, while the environmental ministries and their environmental protection legislation have been relatively weakened. The implementation space for environmental protection legislation has continuously shrunk. Comprehensive utilization work is given more and more attention and resources, whereas pollution control work has been marginalized. At the same time, there has been a lack of cooperation mechanisms between the bodies governing comprehensive utilization and pollution control.

Considering the severity of China's coal ash problem, MEP law enforcement methods appear relatively weak. The most common method is to levy a pollution charge. The "National Standards and Management Practices for Sewage Fee Collection" stipulates that: "if either non-specialized storage facilities or handling facilities, as well as specialized storage facilities or handling facilities, do not meet environmental protection standards on the discharge of industrial solid waste (that is, they are unable to prevent pollutant dispersal, leakage or run-off), a one-off solid waste emissions fee will be levied." One ton of discharged coal ash carries a 30 yuan fee. Here, the standards used are those governing the construction of facilities to prevent the dispersal, leakage or run-off of pollutants. Specifically, it refers to the "Standards on the pollution control of regular industrial solid waste storage and disposal sites."

In practice, unless a coal-fired plant fails to build any kind of coal ash storage facility, or is discovered directly discharging coal ash waste into water sources or engaged in other very serious polluting behaviour, the chances of it being charged pollution fines are extremely low. Even if it is charged RMB 30 per ton, this is not an effective deterrent. But because of a lack of effective regulations, apart from levying fees, the MEP has no other recourse to force a coal-fired plant to improve its coal ash storage facilities.

Moreover, when a coal-fired plant is selecting a site for its coal ash impoundment, the MEP-led environmental assessment is often just a formality. Sometimes construction of the coal-fired plant starts without even its environmental impact assessment being approved. Greenpeace investigations in the field have also uncovered that some local environmental bureaus have ignored the environmental laws, creating a lack of enforcement in environmental monitoring.

5. The absence of comprehensive utilization and environmental administration

Since the 1990s, there have been major developments in administrative laws and regulations aimed at encouraging the comprehensive utilization of coal ash. The most relevant of these are the "Eleventh Five-Year-Plan on National Environmental Protection," "Law to promote Circular Economy", "National Policy Outline on Technology for Comprehensive Utilization of Resources" and the "Administrative Measures on the Comprehensive Utilization of Coal Ash" (revised in 1994).

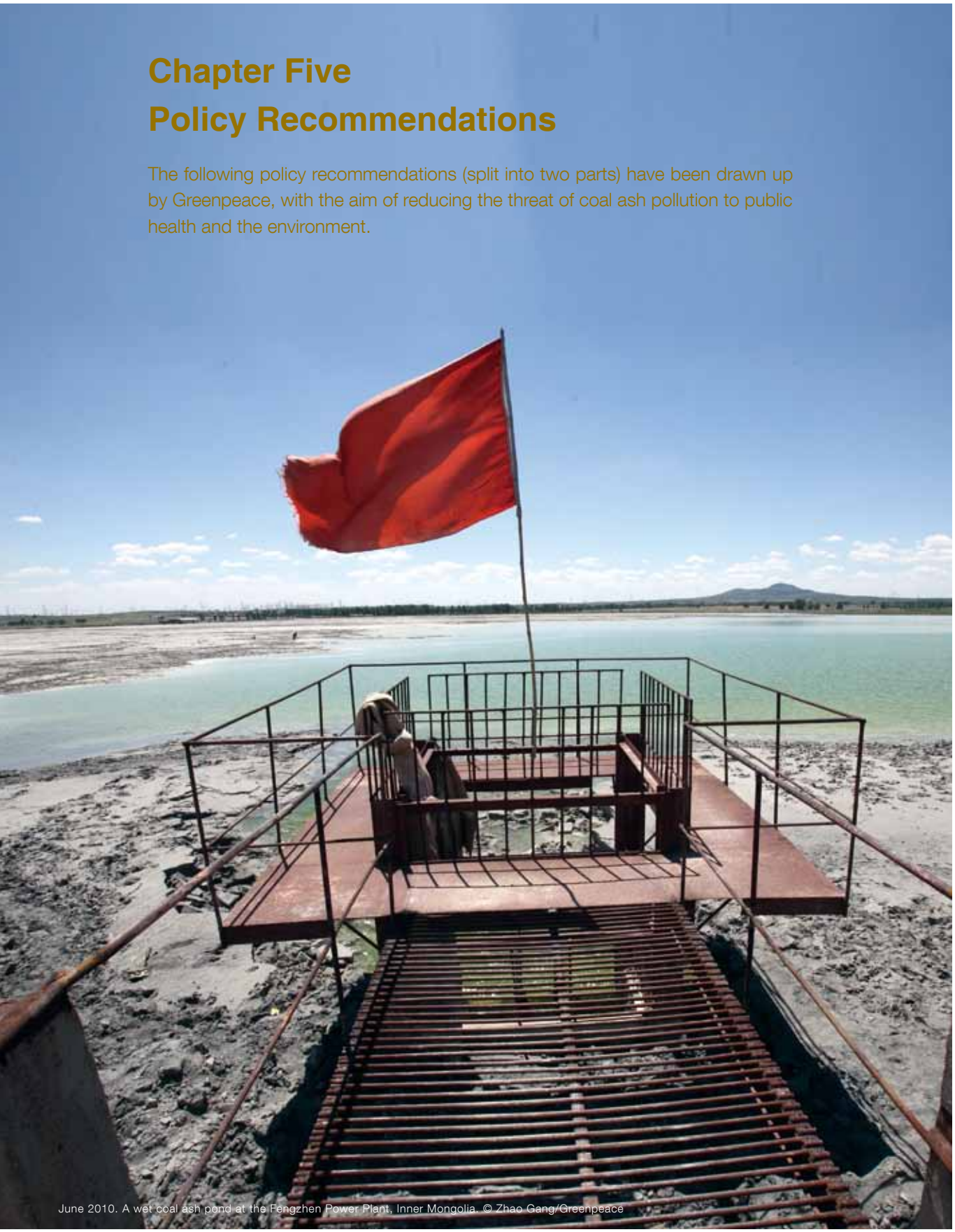
In addition, many local governments, including Beijing, Shanghai, Chongqing, Hebei, Shandong, Hunan, Guizhou, Nanjing, Fushun, Guangzhou, Datong, Dalian, Harbin, Wuhai, and Tangshan, have drawn up their own regulations on coal ash comprehensive utilization.

Coal ash contains harmful substances, which remain in the coal ash after being recycled and continue to threaten public health and the environment. However, according to China's current policy, once coal ash (a solid waste product) has been recycled into other byproducts or finished products (for example concrete, bricks, subgrade, dam materials, etc), it no longer falls under the jurisdiction of environmental protection laws on solid waste. This has created a gap in environmental protection legislation and government monitoring on coal ash utilization. Unlike the European Union, which regulates recycled coal ash products as commercial chemical products, China lacks such a corresponding regulation. There is an urgent need for such new rules and codes of conduct to be introduced in China.

At both the central and local government levels, existing legislation on the comprehensive utilization of coal ash pertains only to the utilization of resources, and fails to include plans for the supervision and management of harmful substances in coal ash when and after it's recycled. Of the 16 standards applied to coal ash utilization management, none has a comprehensive provision to deal with the levels of the toxic and radioactive elements present in coal ash waste. Although the ultimate purpose of comprehensive utilization is to protect the environment and to promote sustainable development, existing regulations fail to provide specific safeguards for the environment and human health.

Chapter Five
Policy Recommendations

The following policy recommendations (split into two parts) have been drawn up by Greenpeace, with the aim of reducing the threat of coal ash pollution to public health and the environment.



June 2010. A wet coal ash pond at the Fengzhen Power Plant, Inner Mongolia. © Zhao Gang/Greenpeace

1. Highlight and strengthen environmental law enforcement within the existing legal framework

1.The Standing Committee of the National People's Congress should incorporate the "Law on the Prevention of Environmental Pollution by Solid Waste" into the law enforcement, supervision, and inspection plan. They should also supervise and urge all regions and government departments to actively perform their legal duties. The intervention of the highest organ of state can strongly highlight the importance of preventing coal ash pollution to all parts of society.

2.The State Council should conduct a nationwide specialized, targeted corrective campaign on coal ash environmental pollution. This campaign should include: to conduct a comprehensive audit on the coal-fired plants' coal ash utilization rate to determine an accurate picture of the scale of coal ash waste; to focus on identifying deficiencies or weaknesses in environmental management facilities, as well as the potential causes of secondary geological disasters at coal ash disposal sites; and to set corrective deadlines for the above.

3.China should incorporate environmental management of coal ash into local government official's performance evaluation criteria; promote and implement administrative and local government accountability mechanisms; and strengthen the administrative authority of coal ash pollution management in a similar way to the handling of mine safety and accidents.

4.The MEP should strengthen enforcement of the "Law on the Prevention of Environmental Pollution by Solid Waste" as well as strengthen the monitoring and research of coal ash environmental pollution. They should provide the public with information on coal ash treatment that does not meet environmental protection standards through environmental information disclosure procedures; ensure proper investigation and punishment according to the law; and hold officials involved accountable.

2. Improve coal ash pollution management legislation

1.Based on the existing "Law on the Prevention of Environmental Pollution by Solid Waste," the State Council or the MEP can take the lead on formulating an implementable "Coal Ash Environmental Pollution Prevention and Control Measures." They should also operationalize the general provisions of the laws through administrative regulations or directive orders. The above proposed "Measures" should work in concert with the "Administrative Measures on the Comprehensive Utilization of Coal Ash" (revised in 1994) in order to promote the guiding principle of paying equal attention to the twin problems of utilizing coal ash and managing its environmental pollution.

China should learn from the experiences of the U.S., the E.U. and other developed countries in handling coal ash environmental pollution. This include: the careful selection of coal-fired plant and ash impoundment locations; the planning and setting of standards for environmental impact assessments, as well as methods for public participation; the management of coal ash pollution that complies with the "three-simultaneous system"[32] requirement; impermeable layer design requirements; monitoring groundwater and soil pollution; standards on the environmental monitoring of comprehensive utilization; standards for the conditions and qualifications of recycled components; scope and legal responsibilities of the subject of duty in environmental protection; supportive financial and taxation policies; fines and standards on coal ash pollution discharges; law enforcement mechanisms and procedures; planning for regulatory adjustments during interim periods; the relationship between old and new regulations; and more targeted and practical systems and standards. Based on the above proposed "Measures," China should draw up a complete new set of corresponding environmental standards on pollution prevention, or make existing voluntary standards mandatory, and ensure that each key part of the provisions has clear operational specifications and requirements.

2.The relevant legislation should increase the number of specialized provisions on coal ash treatment in order to break down tasks on coal ash pollution prevention and control and incorporate it into law. The following relevant laws are currently in the legislative process: "Land Management Law" (revised), "Air Pollution Prevention and Control Law" (revised), "Energy Law," "Law on Nature Reserves," "Environmental Protection Law," "Coal Law"(revised), and "Soil Pollution Prevention and Control Law," etc.

3.In the revision of the "Measures on the Comprehensive Utilization of Coal Ash," the experiences of the EU and other developed countries should be used as a reference point to explore the ways in which China can improve its handling of pollution prevention in coal ash utilization, implement a wide-ranging set of regulations to monitor the overall utilization production process, and fill the pollution and control legislative gap on coal ash utilization.

The MEP should be more actively involved in the revision of "Measures on the Comprehensive Utilization of Coal Ash" and other related legislation in order to ensure that pollution prevention and control objectives are reflected adequately in all policy legislation. At the same time, there is a need to establish a permanent information-sharing and communications mechanism between the NRDC and the MEP. Whenever it becomes difficult to automatically coordinate policy objectives between the two parties, they should immediately initiate an effective conflict-resolution mechanism.

4.China should take the next step in improving the coal pricing system through introducing a carbon tax, a resource tax or other relevant policies as ways to internalize the external costs of coal. At the same time, China should make great efforts to improve energy efficiency and develop the renewable energy. The government should promote the optimization of the national energy mix, and gradually move away from its over-dependency on coal as a surefire means of controlling coal ash pollution at its source.

Reference

1 Please refer to document “Administrative Measures and Implementation Regulations on the Comprehensive Utilization of Coal Ash in the Coal Industry,” 1996, Item 3

2 By converting from the China Electricity Council 2008 figures on total coal consumption (1.46 billion tons) and coal ash production (390 million tons) in the electricity sector, for every four tons of coal burned will produce one ton of coal ash.

3 Current China urban waste is roughly around 160 million tons per year.

4 One ton of coal ash equals to 1.13 cubic metres of volume (m3).

5 Volume of a standard swimming pool used in this report: Width 21m x length 50m x height 1.8m; volume of the Beijing Olympic Water Cubic Swimming Gym: Width 177m x length 177m x height 31m

6 Please refer to document “Administrative Measures on the Comprehensive Utilization of Coal Ash,” 1994, Item 3

7 China Electric Power Press, Manual on Energy Efficiency for Coal-fired Plant, 2009, pp 679-681

8 Science and Technology Daily, http://www.stdaily.com/kjrb/content/2010-02/05/content_154315.htm

9 For more details, please refer to the news article: There is more dust in this year sandstorm http://news.sina.com.cn/c/2010-04-05/234920011756.shtml

10 China Electric Power Press, Manual on Energy Efficiency for Coal-fired Plant, 2009, pp 680

11 China Environmental Science Press, Environmental Protection Department, National Pollution, Environment, Health Risk Directory—Chemicals Section, first edition, February 2009; http://www.atsdr.cdc.gov/toxfaqs/index.asp; http://www.lf.gov.cn/pub/htm/life/shuiwenxinxi/shuihuanjing/2006-04-24-7849.htm

12 http://www.treehugger.com/files/2008/12/tennessee-coal-ash-slurry-spill-48-times-bigger-than-exxon-valdez-spill.php

13 Jiangyou City Government website: http://www.my.gov.cn/jiangyou/288798823663271936/20090814/436090.html

14 Guizhou Electric Power Technology, No. 9, 2006

15 State Administration of Work Safety: http://www.chinasafety.gov.cn/newpage/Contents/Channel_4272/2006/0719/12287/content_12287.htm

16 For details please refer to http://news.sohu.com/20050414/n225176321.shtml

17 Guizhou Electricity News: http://www.gz.csg.cn/qkshow.aspx?id=11344&cid=193

18 Figures from the 2009 Annual Development Report on China Electricity Sector: As of the end of 2009, the installed capacity for China’s coal-fired power plants is 652.05 GW.

19 Data on coal ash production is sourced from Greenpeace investigations. Greenpeace staff was not successful in securing the needed

June 2010. Coal ash disposal site of the Togtoh Power Station, in Hohhot, Inner Mongolia. © Zhao Gang/Greenpeace

primary information for Xuanwei, Panxian, and Pannan power plants. For these three sites, coal ash production was calculated from their 2009 coal consumption data for electricity generation.

20 Details on the analysis of the samples will be provided in the science technical note by Greenpeace Research Laboratory.

21 Greenpeace conducted random samplings at the same site. Table 2.2 lists the types of metals and compounds found in the coal ash samples. Detailed sampling results are listed in appendix

22 This was done by correlating the quantities of heavy metals produced by the 14 power stations, which account for 4% of China's total installed capacity of coal power generation.

23 "Discussion of countermeasures on the underground water protection in the slag site of power plants," Municipal Administration and Technology 2003, Volume 5, Issue 3""Study on lixiviation properties of fly ash," Energy Environmental Protection 2005 Volume 19 Issue 5""Secondary pollution of chromium in powdery coal ash: an example of CR6+ in underground water around an ash site in a power station," Carsologica Sinica 2001 Volume 20 Issue 3; "Evaluation of Soil Pollution by Heavy Metals in Huainan Xinji Mining Area," Mining Safety and Environmental Protection 2008 Volume 35 Issue 1; "Distribution Characteristics of Soil Trace Elements in Shangyao Ash-field," Journal of Anhui University of Science and Technology 2006 Volume 26 Issue 3.

24 "Environmental Quality Standards for Surface Water" GB3838-2002: this list uses Class V water quality as a benchmark.

25 "Standards for Irrigation Water Quality" GB5084-2005

26 "Standards for Irrigation Water Quality" divides crops into three grades: for boron-sensitive crops (such as potatoes, winter squash, leeks, onions, and tangerines) the maximum concentration is 1,000ug/L; for boron-tolerant crops (such as wheat, corn green peppers, bok choy (Chinese cabbage), and scallions) the maximum concentration is 2,000ug/L; for crops that are strongly boron-tolerant (such as rice, turnips, oilseed rape, and cabbage) the concentration is 3,000ug/L.

27 Although many other heavy metals were detected during the analysis, they are not listed in this table because China has not drawn up corresponding standards for their regulation.

28 "Sanitary Standards for Drinking Water" GB 5749-2006

29 For more details, please refer to http://www.gov.cn/jrzg/2009-08/16/content_1393574.htm

30 For more details, please refer to http://news.xinhuanet.com/fortune/2010-05/21/c_12127936.htm

31 According to the "Administrative Measures on the Comprehensive Utilization of Coal Ash", Chapter 3

32 Also known as the "three-simultaneous steps". This is an integral part of China's environmental management system, which requires that all new construction projects and its required environmental protection facilities must be designed, built and put into operation at the same time.

Appendix 1

Company Name	Douhe Power Plant	Chifeng Thermal Power Plant	Fengzhen Power Plant		Yuanbaoshan Power Plant		Togtoh Power Plant		Shentou Number 2 Power Plant	Guodian Electric Power Datong Number 2 Power Plant		Qujing Pow
Sampling location	Lijiayu coal ash disposal site	Dongjiao Badui coal ash disposal site	Fengzhen coal ash disposal site		Xinglongpo coal ash disposal site		Togtoh coal ash disposal site		Shentou Number 2 Power Plant wet coal ash disposal site	Tian village coal ash disposal site	Dangliuzhuang coal ash disposal site	Qujing Pow disposal site
Type of sample	Dry ash	Dry ash	Wet ash	Wet ash	Wet ash	Wet ash	Dry ash	sulfur absorbed gypsum	Wet ash	Wet ash	Dry ash	Dry ash
Sample number	CC10001	CC10019	CC10015	CC10016	CC10020	CC10021	CC10007	CC10008	CC10013	CC10004a	CC10005	CC10025
Metals (unit: mg/kg)												
Aluminium	-	31500	47000	55400	18400	17500	-	-	11000	-	-	14300
Antimony	<5	<10	<10	<10	<10	<10	<5	<5	<10	<5	<5	<10
Arsenic	<20	63.4	16.8	19.7	26.2	54.5	<20	<20	4.1	<20	<20	26.6
Barium	158	348	712	780	335	291	134	17	160	127	259	112
Beryllium	-	2.89	5.75	6.23	2.65	2.25	-	-	1.41	-	-	4.14
Boron	43	118	571	671	109	98.9	83	122	72.6	39	64	13.2
Cadmium	<1	1.58	0.841	0.982	1.05	1.22	<1	<1	0.343	<1	<1	1.06
Calcium	-	115000	43800	49400	15600	12300	-	-	29000	-	-	17200
Chromium	11	26.4	37.9	42.6	25.7	25	6	19	4.25	8	7	19.4
Cobalt	9	7.34	14.2	16.6	11.6	10.5	4	<2	1.3	5	5	12.6
Copper	20	27.5	39.2	41	28.6	30.1	9	2	12.4	9	13	67.1
Hexavalent Chromium	<0.4	<0.400	<0.400	<0.400	<0.400	<0.400	<0.8	<0.8	<0.400	-	<0.8	<0.400
Iron	-	15800	22900	24700	47800	31600	-	-	15000	-	-	37100
Lead	6	7.56	40.8	45.3	5.7	6.94	13	3	11	<5	22	5.38
Lithium	-	9.5	91.6	85.1	7.94	7.08	-	-	27.6	-	-	16.4
Magnesium	-	4420	9800	11500	4360	3980	-	-	1950	-	-	1760
Manganese	322	274	335	364	565	352	84	43	83	105	116	485
Mercury	<0.2	<2	<2	<2	<2	<2	<0.2	1	<2	<0.2	0.46	<2
Molybdenum	<2	3.33	2.04	<2	4.94	4.64	5	<2	<2	3	9	6.44
Nickel	11	15.7	27.1	30.5	30.1	24.6	5	<3	5.59	7	6	26.9
Phosphorus	-	277	661	807	510	512	-	-	379	-	-	371
Potassium	-	3200	4400	4320	2330	2260	-	-	228	-	-	643
Selenium	<20	4.35	5.68	5.07	5.6	1.43	<20	<20	9.43	<20	<20	6.15
Silver	-	<10	<10	<10	<10	<10	-	-	<10	-	-	<10
Sodium	-	2620	6960	8340	1370	1150	-	-	127	-	-	262
Strontium	-	275	1160	1270	217	177	-	-	255	-	-	78.1
Thallium	<20	<3	<3	<3	<3	<3	<20	<20	<3	<20	<20	<3
Tin	-	<20	<20	<20	<20.0	<20	-	-	<20	-	-	<20
Titanium	-	1520	2020	2200	1170	1020	-	-	632	-	-	2190
Vanadium	32	53.5	85.2	92.2	86.3	70.8	20	4	23.2	23	28	103
Zinc	21	33.5	56.5	65.8	40.8	52.2	24	6	15.1	11	20	39.7
Compounds (unit: mg/kg)												
Sulphate	1410	-	-	-	-	-	3620	457000	21700	-	1380	3030
Fluoride	58	274	100	101	31.8	31.9	45. 9	2600	112	-	39. 9	40.7
Chloride	-	52	129	129	<20.0	-	-	-	147	-	-	<10.0

Note: "-" indicated the concentration is beyond the testing limits

er Plant		Xuanwei Power Plant		Panxian Power Plant		Pannan Power Plant		Jiujiang Power Plant	Fengcheng Number 1 Power Plant		Fengcheng Number 2 Power Plant	
er Plant coal ash e		Miaohou coal ash disposal site		Panxian Power Plant #4 coal ash disposal site		Zhaluji coal ash disposal site		Weijia coal ash disposal site	Fengcheng Number 1 Power Plant coal ash disposal site		Fengcheng Number 2 Power Plant coal ash disposal site	
	Dry ash	Dry ash	Dry ash	Dry ash	Dry ash	Dry ash	Dry ash	Dry ash	Wet ash	Wet ash	Dry ash	Dry ash
	CC10026	CC10022	CC10023	CC10027	CC10028	CC10029	CC10030	CC10031	CC10035	CC10036	CC10039	CC10040
	13900	16600	15000	21700	19900	20900	17500	14300	11300	11200	17100	17400
	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	20.4	7.4	25.9	77.6	77.1	85.2	52.1	7.29	<1	<1	12.9	14.2
	104	119	126	138	135	158	116	208	139	93.1	1110	1050
	4.3	3.77	3.25	5.2	4.59	4	3.48	1.35	1.11	1.24	1.59	1.49
	9.43	4.82	9.87	9.56	10.3	36.3	24.4	18.6	16.6	17.3	92	100
	0.843	0.611	1.09	1.94	2.02	2.2	1.49	0.513	1.17	1.15	0.574	0.61
	16800	22500	19700	46300	43500	30700	32700	12200	160000	152000	20700	21700
	18.5	23.1	25.4	30.7	29.9	39	31	14.9	47.8	52.7	17.6	17.6
	12.9	12.5	13.5	13	12.2	10.7	9.18	3.4	4.19	5.12	4.11	4.22
	62.2	58.9	66.1	104	98.4	79.2	62.6	17.8	40.3	46	20.9	21
	<0.400	<0.400	<0.400	<0.400	<0.400	<0.400	<0.800	<0.400	<0.800	<0.400	<0.400	<0.400
	38200	23700	22400	51400	48200	45200	46100	20300	88000	98500	18100	17500
	5.3	5.26	7.52	14.4	14.1	21.2	12.8	4.64	9.2	8.1	7.24	6.7
	15.8	8.53	8.18	19.6	19.3	25.2	20.5	23.3	19.2	20.8	28.6	28
	1750	2370	1950	3050	2810	2460	2270	2940	4290	3580	2300	2260
	493	479	506	721	687	353	380	235	512	511	229	233
	<2	<2	<2	<2	<2	<2	<2	<2	<2.00	<2	<2	<2
	5.68	2.19	5.58	3.07	3.3	11.3	6.98	<2	<2	<2	<2	<2
	27	27.4	28.6	34.1	32	30.4	26.4	14.4	32.8	34.5	13.7	13.7
	350	1300	1360	467	440	827	536	455	237	201	933	790
	649	850	718	1600	1470	1330	1090	1680	1130	883	1290	1330
	6.04	6.83	11.9	8.19	8.86	14.1	8.77	3.45	16.7	14.5	6.54	7.67
	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	259	133	123	537	524	450	364	308	234	202	358	355
	73.2	76.5	72.3	186	169	166	149	157	845	799	1730	1800
	<3	<3	<3	<3	<3	<3	<3	<3	<3.00	<3	<3	<3
	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	2260	2060	1700	2830	2450	2090	1870	606	572	657	801	867
	96.9	99.3	126	123	115	226	154	35.1	37	36.1	48.2	48.9
	39.9	29.5	46.7	55.1	52	64.7	42.9	17.7	17.4	22.1	21	22.1
	2570	2860	1390	5910	-	6170	4110	361	-	59800	2650	2580
	39.9	295	137	46.7	48.9	56.7	39.3	44.1	175	97.7	54.4	57.1
	<10.0	70.7	74.8	<10.0	<10.0	<10.0	<10.0	<10.0	<20.0	39.9	<10.0	<10.0

Appendix 2

Company Name	Douhe Power Plant	Chifeng Thermal Power Plant		Fengzhen Power Plant	Datong Number 2 Power Plant		Jiujiang Power Plant	Fengcheng Number 1 Power Plant	Environmental Quality Standards for Surface Water (GB3838-2002) category V	Standards for Irrigation Water Quality (GB5084-2005)
Sampling location	Lijiayu coal ash disposal site	Dongjiao Badui coal ash disposal site		Fengzhen Power Plant coal ash disposal site	Tian village coal ash disposal site	Dangliuzhuang coal ash disposal site	Weijia coal ash disposal site	Fengcheng Number 1 Power Plant coal ash disposal site		
Type of sample	Surface water	Wet ash	Surface water	Surface water	Surface water	Surface water	Surface water	Surface water		
Sample number	CC1002	CC1009a	CC10010	CC10017	CC1004a	CC10018	CC10034	CC10037		
Metals (unit: mg/kg)										
Aluminium	-	-	-	1360	-	300	338	69.30		
Antimony	<20	<20	<20	-	<20	-	-	-		
Arsenic	<50	131	<50	-	61	-	-	-	100	100
Barium	120	54	16	373	162	237	119	49.10		
Boron	2120	2650	3870	15000	5360	3510	104	874		3000
Cadmium	<5	<5	<5	0.282	<5	1.58	<0.100	0.302		
Calcium	-	-	-	181	-	472	25.3	54.5		
Chromium	<20	<20	<20	367	26	12.70	1.25	9.40		
Chromium (VI); hexavalent chromium	<50	<50	<50	-	<50	-	-	-		
Cobalt	<20	<20	<20	-	<20	-	-	-		
Copper	<20	<20	<20	1.92	<20	1.13	2.46	2.15		
Iron	49	51	<40	217	62	<30.0	305	36.10		
Lead	<50	<50	<50	<2.00	<50	<2.00	<2.00	<2.00		
Lithium	-	-	-	647	-	2650	<100	261		
Magnesium	-	-	-	16	-	8	4	2.10		
Manganese	<10	29	39	<10.0	<10	<10.0	59.4	<10.0		
Mercury	<2	<2	<2	<0.01	<2	<0.01	<0.02	<0.04		
Molybdenum	98	290	365	-	502	-	-	-		
Nickel	<20	<20	<20	1.02	<20	2.22	1.71	6.20		
Potassium	-	-	-	7.87		32.80	2.04	4.46		
Selenium	<200	<200	<200	-	<200	-	-	-		
Sodium	-	-	-	145	-	253	5.60	6.20		
Strontium	-	-	-	6270		6440	192	751		
Thallium	<200	<200	<200	-	<200	-	-	-		
Vanadium	43	27	<20	-	187	-	-	-		
Zinc	18	<10	11	<5.00	17.30	8.66	28.30	5.80		
pH	7.50	7.50	7.50	-	8.00	-	-	-		
Compounds (unit: mg/kg)										
Nitrate	15.42	46.31	8.41	-	105.90	-	-	-		
Chloride	134.9	42.0	40.0	-	313.9	-	-	-		250
Fluoride	5.0	3.1	4.3	-	6.2	-	-	-	1.5	3
sulphide	<0.01	<0.01	<0.01	-	<0.01	-	-	-		
sulphate	-	-	-	514	-	1290	46	92		

Note: "-" indicated the concentration is beyond the testing limits

Appendix 3

Company Name	Douhe Power Plant	Chifeng Thermal Power Plant		Yuanbaoshan Power Plant		Xuanwei Power Plant		Fengcheng Number 1 Power Plant	Sanitary Standards for Drinking Water (GB5749 2006)
Sampling location	Ganyugou village	Dongjiao Badui	Jiuquan village	Xinglongpo village	Shuimotou village	Miaohou village	Yujiahe County	Houtanggang village	
Type of sample	Underground well water	Underground well water	Underground well water	Underground well water	Underground well water	Underground well water	Underground well water	Underground well water	
Sample number	CC1003	CC10011	CC10032	CC10012	CC10014	CC10024	CC10033	CC10038	
Metals (unit: mg/kg)									
Aluminium	-	-	19.8	-	<10.0	<10.0	46.8	69.4	
Antimony	<20	<20	-	<20	-	-	-	-	
Arsenic	<50	<50	-	<50	-	-	-	-	
Barium	31	43	86.9	44	44.2	143	76	366	
Boron	54	898	116	1850	<100	<100	<100	<100	500
Cadmium	<5	<5	<0.100	<5	<0.100	<0.100	<0.100	<0.100	
Calcium	-	-	63.8	-	58.2	29.8	64.3	32.8	
Chromium	<20	<20	2.03	<20	2.33	<0.500	1.19	<0.500	
Chromium (VI); hexavalent chromium	<50	<50	-	<50	-	-	-	-	
Cobalt	<20	<20	-	<20	-	-	-	-	
Copper	<20	<20	<1.00	<20	19.9	<1.00	1.57	<1.00	
Iron	<40	<40	38.3	<40	<30.0	<30.0	47.2	<30.0	
Lead	<50	<50	<2.00	<50	<2.00	<2.00	<2.00	<2.00	
Lithium	-	-	<100	-	<100	<100	<100	<100	
Magnesium	-	-	37	-	24.8	13.1	14.4	4.76	
Manganese	<10	<10	<10.0	<10	<10.0	<10.0	<10.0	47.7	
Mercury	<2	<2	<0.01	<2	<0.02	<0.02	<0.02	<0.02	
Molybdenum	<20	34	-	142	-	-	-	-	70
Nickel	<20	<20	<1.00	<20	<1.00	<1.00	<1.00	3.99	
Potassium	-	-	0.331	-	1.43	8.12	5.57	5.59	
Selenium	<200	<200	-	<200	-	-	-	-	
Sodium	-	-	47.3	-	17.7	18.2	15.4	14.8	
Strontium	-	-	756	-	1230	337	326	163	
Thallium	<200	<200	-	<200	-	-	-	-	
Vanadium	<20	<20	-	<20	-	-	-	-	
Zinc	58	17	16.8	14	6.64	<5.00	5.88	<5.00	
pH	8.0	7.5	-	7.0	-	-	-	-	
Compounds (unit: mg/kg)									
Nitrate	27.12	16.71	-	34.72	-	-	-	-	20
Chloride	17.28	25.77	-	35.22	-	-	-	-	
Fluoride	0.2	0.7	-	2.8	-	-	-	-	1
sulphide	<0.01	<0.01	-	<0.01	-	-	-	-	
sulphate	-	-	43.9	-	46.3	32.8	72.5	24.2	

Note: "-" indicated the concentration is beyond the testing limits

100% Printed on 100% Recycled Paper

GREENPEACE 绿色和平

Add: 3/F, Julong Office Building, Block 7, Julong Garden, 68 Xinzhong Street,
Dongcheng District, Beijing, China 100027
Tel：+86 10 6554 6931
Fax：+86 10 6554 6932

www.greenpeace.cn