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The True Cost of Coal

Coal Dust Storms: Toxic Wind

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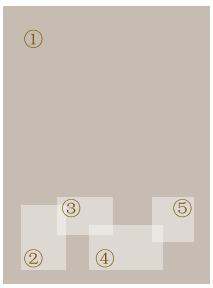


Captions of the cover photos:

1. A cow herder during a dust storm at the coal ash disposal site of the Yuanbaoshan Power Plant, Chifeng, Inner Mongolia. March 13, 2011. ©Liu Feiyue/Greenpeace

2. Villager Liu Sanhu wipes off a handful of dust in his family home, in Houshi'erquan Village, near the Fengzhen Power Plant's coal ash disposal site, Inner Mongolia. March 10, 2011. ©Liu Feiyue/Greenpeace

3. Beijing's worst dust storm in four years, March 20, 2010. ©CFP

4. Dust-filled air does not prevent these children from playing after school in a village near the Yuanbaoshan Power Plant's coal ash disposal site, in Chifeng, Inner Mongolia. March 13, 2011. ©Liu Feiyue/Greenpeace

5. Flue gas desulfurization gypsum is transported from the power plant and dumped into the coal ash disposal site, in Huinong, Shizuishan, Ningxia. March 8, 2011. ©Liu Feiyue/Greenpeace


A heavy dust storm is approaching Golmud, Qinghai Province, at 19:51 on May 14, 2010 © CFP

Many people in northern China hoped that there wouldn't be any dust storms in the spring of 2010. However, on March 16, in Gansu province, the government issued a yellow dust storm warning. The storm arrived first in Minqin and then enveloped the whole province.

At about the same time, strong winds swept up dust from the Mongolian plateau across the northwest and north of China, crossing the Yellow River, the Yangtze River, and the provinces of Hubei, Hunan, Anhui, Zhejiang and Fujian, to finally land as far afield as Hong Kong and Taiwan.

The dust storm affected an area of about 1.8 million square kilometers, home to about 270 million people in China, according to the State Forestry Administration's Desertification Monitoring Center. The National Climate Center of the China Meteorological Administration confirmed that the dust storm crossed oceans, affecting the Korean Peninsula and Japan. It was the largest dust storm of the past five years[1].

This year, on March 18, Beijing suffered its first dust storm of 2011. It is predicted that 16 to 19 dust storms will hit northern China this spring. While this figure is slightly lower than the average of the past few years, there is a greater possibility that the storms will be more violent, according to the State Forestry Administration's website. It looks very dark on the dust storm front and the emergency response work will be very tough[2].

These sand storms originate in the arid and semi-arid areas of northwest China and Central Asia. Strong winds carry sand and dust into the north and east of China, damaging the health of people and livestock, and damaging industrial and agricultural production.

But there is a chilling fact about these dust storms that most people do not know. A lot of the dust they carry is composed of coal ash and other coal combustion pollutants, which are picked up by the wind as the storm passes through heavily polluting coal-burning areas such as Shanxi, Shaanxi and Inner Mongolia.

Coal ash dumped in disposal sites without proper handling can be easily whipped up into the atmosphere by strong winds, mixing into dust storm and traveling thousands of kilometers. But even more worrying is that coal ash contains a high concentration of heavy metals and other toxic pollutants, including arsenic, selenium, lead and mercury. The presence of coal ash has transformed the physical and chemical composition of dust storms, posing a serious threat to public health.

Because of this danger, Greenpeace is calling on the government to introduce effective coal ash pollution control measures to prevent secondary dust pollution and to reduce environmental and public health hazards. In the long term, Greenpeace is calling on China to tighten coal-combustion pollution control and to adjust its energy structure so that it gradually moves away from its excessive reliance on coal.

1. Coal Dust Storms

The sandstorms that originate in Central Asia and northwest China normally pass through Inner Mongolia, Shaanxi, and Shanxi, among other places, en route to northern and eastern China.

Since 2000, Professor Zhuang Guoshun of the Atmospheric Chemistry Research Center in Fudan University in Shanghai has been monitoring the content of sandstorms in Beijing, Shanghai and other urban areas far from the source of the sand storm. He has discovered that as well as sand and soil from the northwestern deserts and the Loess plateau, the storms also carry a large number of specific pollutants, including arsenic (As), antimony (Sb), selenium (Se), lead (Pb), sulfur compounds and organic pollutants[3]. When the storms hit land, they increase the concentration of these contaminants by as much as dozens of times from background levels.

Coal burning is the major source of arsenic and selenium in the atmosphere. The pollutants discovered in the sandstorms are typically found in by products of coal combustion. They have been picked up by winds in the coal-polluted areas of China (Inner Mongolia, Shanxi and Shaanxi, etc.), mixed into the sand storm, and deposited on cities far away, seriously damaging regional air quality.

• Coal-combustion pollution levels

Professor Zhuang collected dust samples before, during and after sandstorms in early March of 2010 in Shanghai. He found that during sandstorms, the concentrations of arsenic, lead, selenium, sulfur and other pollutants commonly found in by products of coal combustion significantly increased (Figure 1). These pollutants are released into the atmosphere with flue gas or they are deposited in bottom ash and fly ash, which are dumped in the ground or in ponds outside the power station[6].

The increase in the concentration of coal combustion-derived pollutants in sand and dust storms has been repeatedly borne out by research over the past few years. See Table 1.

The table shows the concentrations of arsenic, lead, selenium, and sulfur for Total Suspended Particulate (TSP) and Lung Inhalable Particulate Matter (PM2.5). The dust samples were collected during sandstorm and non-sandstorm weather over the past 10 years in Shanghai and Beijing. The data clearly shows that the concentrations of these typical coal-combustion pollutants are up to dozens of times higher during sandstorms than they are on storm-free days. The data clearly illustrates that coal-combustion pollutants were transported by sandstorms to eastern cities and could bring serious environment impact.

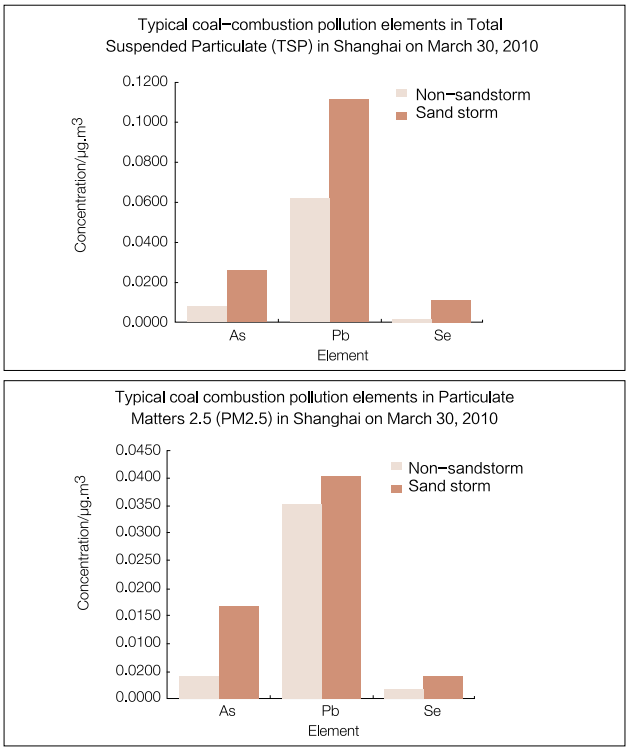


Figure 1. Comparison of the concentration of arsenic (As), lead (Pb) and selenium (Se) for Total Suspended Particulate (TSP) [4] and Lung Inhalable Particulate Matter (PM 2.5) [5] during sandstorm and non-sandstorm weather in Shanghai on March 30, 2010

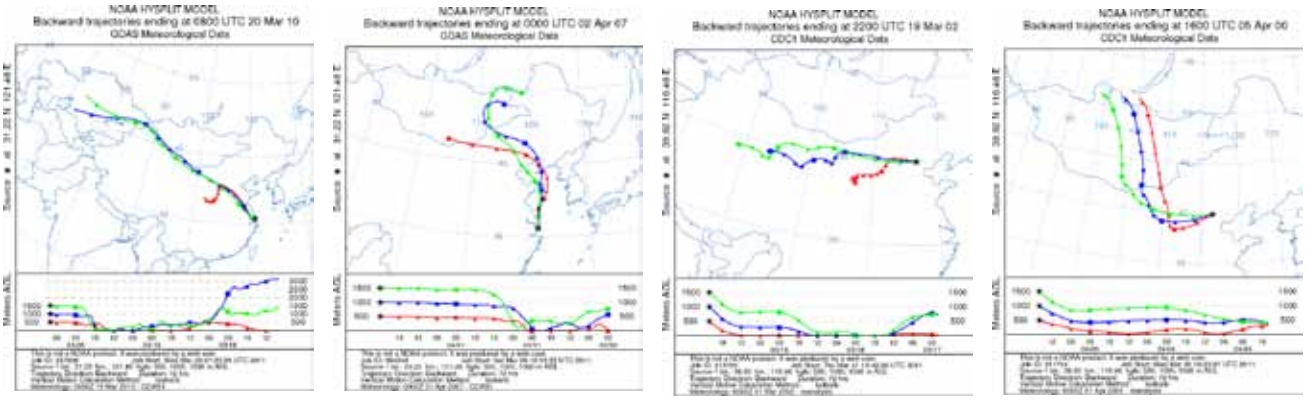
Table 1.Comparison of concentrations of the typical coal pollutants, arsenic (As), lead (Pb) and selenium (Se), in Total Suspended Particulate (TSP) [4] and Lung Inhalable Particulate Matter (PM 2.5) [5] in sandstorm and non-sandstorm weather in Shanghai and Beijing.

* ND: no data

Element	Location	Date	TSP		Factor increase	PM2.5		Factor increase
			Non-sandstorm	Sandstorm		Non-sandstorm	Sandstorm	
			Concentration/μg·m-3			Concentration/μg·m-3		
As	Shanghai	2010-3-20	0.0077	0.0258	2.4	0.0041	0.0169	3.1
		2007-4-2	0.0068	0.3704	53.5	0.0045	0.1803	39.1
	Beijing	2002-3-20	0.0356	0.2470	3.51	0.0300	0.0827	1.0
		2000-4-6	0.0601	1.65	27	ND	ND	ND
Pb	Shanghai	2010-3-20	0.0620	0.1112	0.8	0.0353	0.0405	0.1
		2007-4-2	0.0660	0.2084	2.2	0.0482	0.1593	2.3
	Beijing	2002-3-20	0.2270	0.4620	2.93	0.2200	0.2720	0.5
		2000-4-6	0.0418	0.2990	7.0	ND	ND	ND
Se	Shanghai	2010-3-20	0.0017	0.0109	5.5	0.0019	0.0023	0.2
		2007-4-2	ND	ND	ND	ND	ND	ND
	Beijing	2002-3-20	ND	ND	ND	ND	ND	ND
		2000-4-6	0.0117	0.3970	32	ND	ND	ND
S	Shanghai	2010-3-20	1.762	13.19	6.5	1.131	3.305	1.9
		2007-4-2	4.0634	4.6948	0.2	2.3468	6.4753	1.8
	Beijing	2002-3-20	5.83	50.00	8.58	4.99	12.70	2.55
		2000-4-6	2.50	9.88	4.0	ND	ND	ND

• The routes taken by sandstorms overlap with major coal industry regions

Figures 2 and 3 below show that sandstorms originating in Northwest China and Central Asia pass through coal mining industry and coal-fired power plant intensive areas (Shanxi, Shaanxi and Inner Mongolia, etc.) thus creating toxic coal dust storms that are finally dumped on urban areas in northern and eastern China.



A. Sandstorm pathway to Shanghai on March 20, 2010

B. Sandstorm pathway to Shanghai on April 7, 2007

C. Sandstorm pathway to Beijing on March 20, 2002

D. Sandstorm pathway to Beijing on April 6, 2000

Figure 2: Invasion pathways of sandstorms from northern China to Beijing and Shanghai

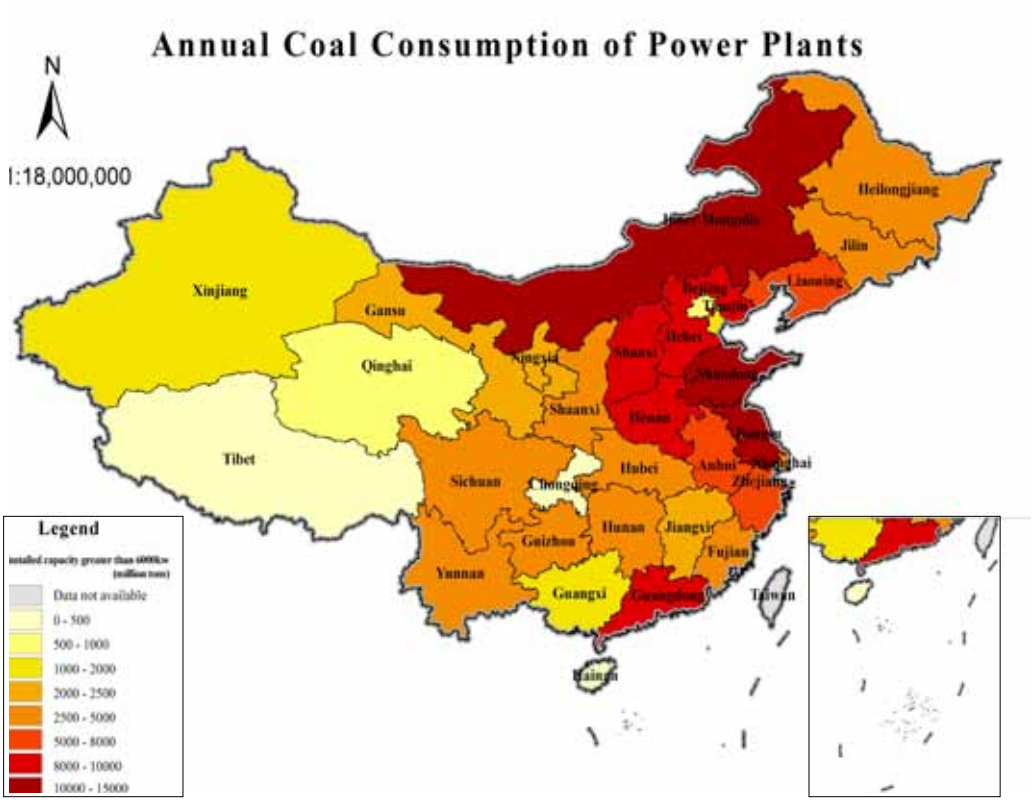


Figure 3: Distribution of Coal Combustion in China

• Coal dust storms pose a serious threat to human health


Dust storm in Tianjin, March 20,2010 © Xinhua new agency

When sandstorms pick up coal ash and other coal-combustion pollutants, they create toxic coal dust storms, which have a serious environmental impact on cities in northern and eastern China and threaten public health (see Figure 4).

"Sandstorms carry heavy metals and other toxic substances, including mercury, lead, cadmium, fluoride, sulfur and so on. Many of these are pollutants from coal burning. Although quantities are low, the heavy metals have a bioaccumulation feature – that is, they enter the human body and are not easily discharged. So they tend to accumulate in the body, and when they reach a certain concentration they will sicken that person. For example, lead harms the nervous system, causing behavioral and intellectual development defects in children. Mercury affects the nervous system, especially organic mercury. It directly passes through the blood-brain barrier and affects the brain, cerebellum, and central nervous system, resulting in movement, language and behavioral disorders. The human body is very sensitive to the presence of selenium. Small amounts of selenium are necessary for human health, and it also has an anti-cancer property, but an excessive intake of selenium can be harmful, causing selenium poisoning, which mainly damages the nervous system, liver and other organs. In Enshi in Central China's Hubei province, local coal contains a high concentration of selenium, and there have been many incidences of selenium poisoning among local residents."

--Professor Pan Xiaochuan, School of Public Health, Peking University

Mercury:

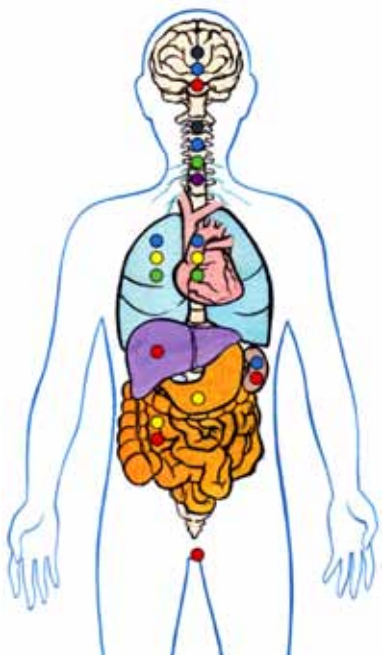
Mercury poses a particular risk to children, infants and fetuses. Impacts include nervous system damage and developmental defects like reduced IQ and mental retardation.

Chromium:

Ingestion of chromium can cause stomach and intestinal ulcers, anemia, and stomach cancer. Frequent inhalation can cause asthma, wheezing and lung cancer.

Selenium:

Selenium is used in many bodily functions but both deficiencies and excesses can be bad for one's health. Excess intake of selenium can result in a host of neurological effects including impaired vision, paralysis and even death.



Lead:

Exposure to lead can result in brain swelling, kidney disease, cardiovascular problems, nervous system damage, and even death. It is accepted that there is no safe level of lead exposure, particularly for children.

Arsenic:

Ingestion of arsenic can lead to nervous system damage, cardiovascular issues and urinary tract cancers. Inhalation and absorption through the skin can result in lung cancer and skin cancer respectively.

Boron:

Inhalation of boron can lead over the short-term to eye, nose and throat irritation. Ingestion of large amounts, however, can result in damage to the testes, intestines, liver, kidneys and brain, and eventually lead to death.

Other Toxicants

Antimony: Eye, skin irritation, stomach pain, ulcers, lung disease

Cadmium: Emphysema, kidney disease, hypertension, lung cancer

Molybdenum: In animals, slowed growth, low birth weight, infertility

Thallium: Nervous system damage, lung, heart, liver and kidney problems

* Children are particularly at risk

Figure 4 Health Impacts of Coal Toxicants[7]

2. The dangers of coal ash

• Toxic coal ash pollution

Coal ash is the byproduct of coal-fired power plants. For every four tons of coal burned, one ton of coal ash is generally produced[8].

Greenpeace began investigating coal ash pollution in China in June 2010. It collected and analyzed coal ash samples from 14 thermal power plants on the mainland. The results were published that September in "The True Cost of Coal – An Investigation into Coal Ash in China", the first such study made in China.

In 2009, China burned more than three billion tons of coal. More than half of this amount was consumed by the thermal power industry. According to conservative estimates, the production of coal ash in China reached 375 million tons that year. This is more than twice the total amount of solid urban waste produced every year in China.

Coal ash particles have a very small diameter, usually between 0. 5~300μm[9], and more than 20% of coal ash particles have a hollow structure, making them easy to be picked up by wind. Even low wind speeds are capable of carrying coal ash. Irrespective of whether the coal ash has undergone dry or wet processing, unless it is contained in a well-sealed facility, the coal ash can be carried off by wind and creates secondary air pollution. This poses a serious hazard to residents nearby.

In fact, since coal ash particles are very small, they can dry up easily. When the surface humidity of coal ash is less than 7%, it can be easily transported by wind for distances of up to thousands of kilometers. When wind speeds reach 5.5 to 7.9 meters per second (that's magnitude four), they can carry coal ash for distances up to 100,000 to 150,000 square kilometers[10]. A large sand storm is usually formed when wind speeds reach magnitude eight, or about 25 meters per second. Under these conditions, coal ash pollutants can spread over an even wider area. A large number of open-air coal ash disposal sites is now one of the key sources of big sand storms[11-12].

Meanwhile, the hazardous heavy metals and radioactive substances in coal is often concentrated in the combustion residue. It is can be estimated that 45% of the arsenic, 70% of lead and 31% of selenium contained in raw coal will be enriched in coal ash after combustion[13]. Various concentrations of arsenic, selenium, cadmium, lead, mercury and other heavy metal pollutants were found in all coal ash samples, both dry and wet, collected by Greenpeace from the 14 power plants. Therefore, as a source of dust in sandstorms, improperly handled toxic coal ash is a lot more dangerous than ordinary sand and soil.

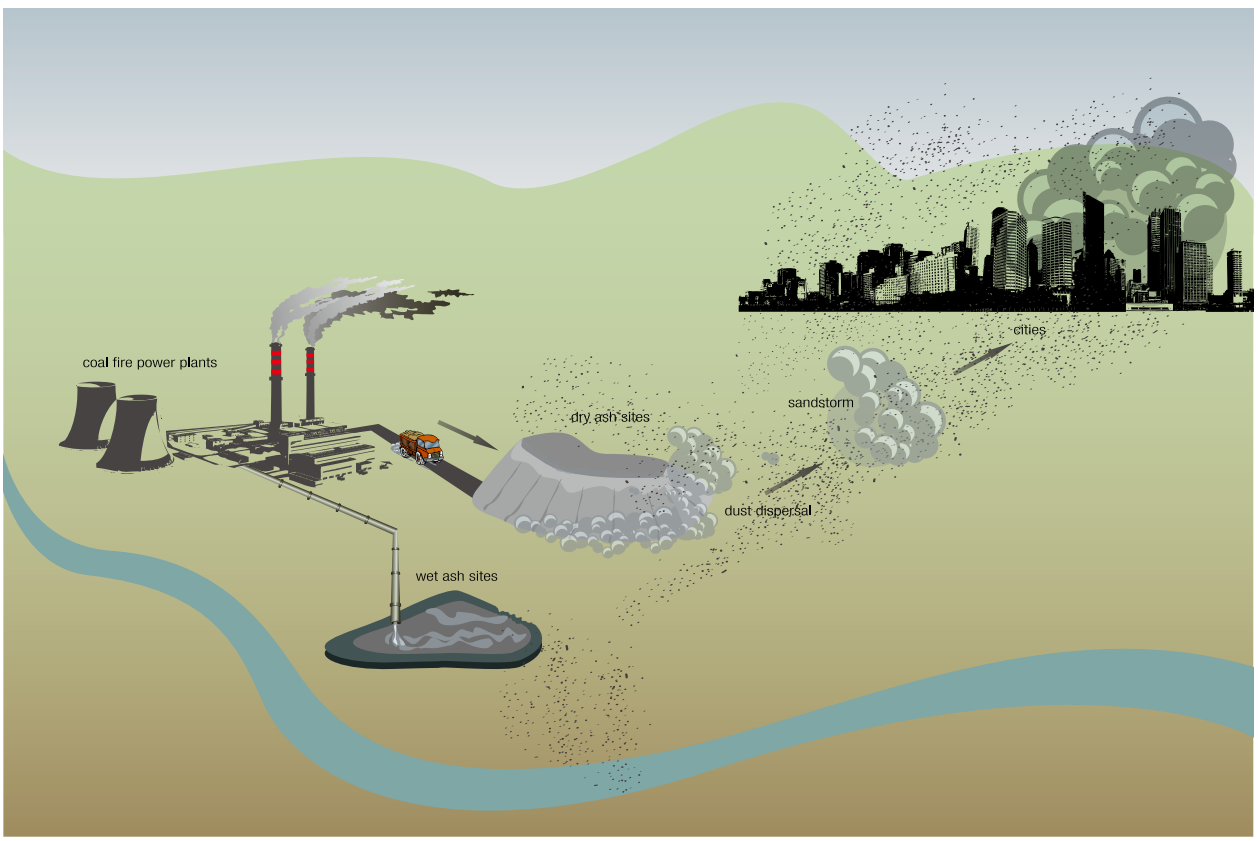


Figure 5. Schematic diagram of power plant pollutant emissions

• Huge quantity of coal ash can be carried in the wind

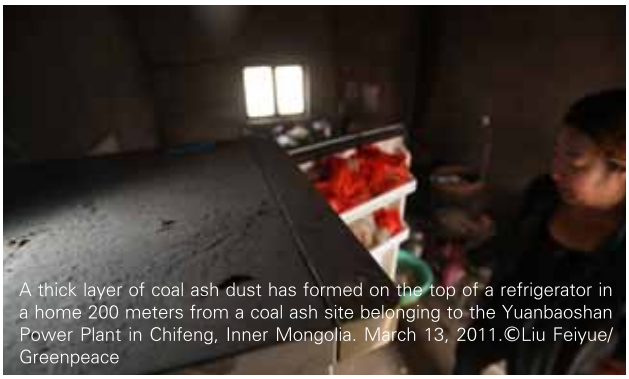
On May 5, 1993, at 2pm, a super-heavy sand storm hit the Hexi Corridor in Gansu province. It lasted until 8pm and left a “black storm” collective memory among locals. The average wind erosion depth of the 33.3 hectare coal ash site belonging to Yongchang Power Plant was 50 centimeters, meaning that 166,000 cubic meters of coal ash had been picked up by the wind[14]. If that coal ash was dumped in Tiananmen Square, it would create an even blanket 38 centimeters thick over the Square.

The coal ash site belonging to Yongchang is comparatively small when set against the coal ash sites of many large thermal power plants in Shanxi and Inner Mongolia. Of the 16 coal ash disposal sites that Greenpeace examined last year and this spring, all were bigger than Yongchang’s site.

According to Greenpeace calculations, there are nearly 800 thermal power plants (6MW or above) in 10 provinces and regions that lie along one of the northern China dust routes. Their coal ash can be considered a potential source of toxic dust storms, threatening people’s health and the environment.

• Coal ash sites: bare to the wind

The key to preventing winds from picking up toxic coal ash is to improve the management of the open-air coal ash disposal sites. Greenpeace investigations in 2010 and 2011 found that most thermal power plants simply dump coal ash into open-air dumps and have no basic measures in place to prevent secondary dust dispersal. A few plants sprinkle water on the sites to moisten the ash, but the effect is limited. Many dry ash sites in southern China merely rely on rainfall to stop the waste from being dispersed into the environment. In wet ash sites, only a small area of the pond, near the mouth of the water pipe, is kept wet. The rest of the ash easily dries up by evaporation. Once it is dry, it gets picked up by winds and becomes secondary dust. Villages and farmland near these coal ash ponds are seriously polluted by coal ash dust. Many local residents complained to Greenpeace that they suffer from skin and respiratory diseases.



A thick layer of coal ash dust has formed on the top of a refrigerator in a home 200 meters from a coal ash site belonging to the Yuanbaoshan Power Plant in Chifeng, Inner Mongolia. March 13, 2011.©Liu Feiyue/ Greenpeace

Flue gas desulfurization gypsum is disposed at a landfill near Huinong Power Plant of Shizuishan, Ningxia, in March 8,2011©Liu Feiyue/ Greenpeace

1 Much coal dust found in this year’s dust storm , *CCTV Economic 30 Minutes,* http://finance.sina.com.cn/g/20100405/22467692017.shtml

2 *Northern China likely to see super large dust storm*, China News Service http://www.chinanews.com/gn/2011/03-21/2919044.shtml

3 *The Composition, Source, Distribution Size and Global Impact of Sandstorms in China in 2000*, by Zhuang Guoshun, Guo Jinghua, Yuan Hui, Zhao Chengyi, Science Bulletin, 2001,46 (3),191-197

4 TSP Refers to total suspended particulate in the air, aerodynamic equivalent diameter ≤ 100 micron. It is a common pollution indicator in air quality assessments.

5 PM2.5 refers to particulate matter in the atmosphere with a diameter ≤ 2.5 microns. It is also known as lung inhalable particulate matter. Compared with larger atmospheric particles, PM 2.5 is smaller, very poisonous, last for a long time in the atmosphere, and is capable of being transported for long distances.

6 Coal ash is a byproduct of coal burning, and includes fly ash (the dust collected by the flue gas precipitator), and bottom ash or slag, discharged from the bottom of the boiler. Dust which is not captured by the precipitator enters into the atmosphere with the flue gas. Coal ash is either flushed into a pond and stored as wet disposal or transported to landfill as dry disposal.

7 "Coal Ash: The Toxic Threat to Our Health and Environment", *Physicians for Social Responsibility*, September 2010

8 Greenpeace, *The True Cost of Coal –An Investigation into Coal Ash in China*, September 2010

9 *Progress on Coal Ash Reutilization Research*, China Concrete Network, http://www.chinaconcretes.com/news/list.asp?id=32859&Page=2

10 *"Coal Ash: The Environment Villain, Road and Construction Hero", Science and Technology Daily*, http://www.stdaily.com/kjrb/content/2010-02/05/content_154315.htm

11 *Coal Ash Harm and Comprehensive Management in Yongchang Power Plant,* Yan Ping, GuoZhizhong, WangJihe, Zhang Shicai and Wang Dawei, Gansu Forestry Research Institute, Gansu Desert Control Research Institute, Chinese Desert, March 1996

12 "Desert and Desertification in China, " Wang Tao, 2002, Hebei Science and Technology Press, P496

13 "The Distribution of 15 Types of Trace Elements in Coal Combustion", Wang Qichao, Shao Qingchun, Kang Shulian, Wang Zhigang and Zou Shantong, Chinese Academy of Sciences, Changchun Institute of Geography, Northeast China Institute of Coal Industry Environmental Conservation, Fuel Chemistry and Technology, April 1996, No. 2

14 Harm and Countermeasures of Super Sand storms in Gansu, Zhao Xingliang, Chinese Academy of Sciences, Lanzhou Institute of Desert Research, Journal of Desert Research, 1993 Volume 13 No. 3

3. Stop toxic coal dust storms

Coal ash pollution has become a serious problem in China for two reasons. Firstly, because there is no specific law dealing with it, coal ash is treated as a general industrial solid waste. Secondly, most of the attention focuses on coal ash's reutilization rather than the environmental impact of the waste itself. These factors contribute to ineffective law enforcement and a growing pollution problem.

Coal ash management policies focus on the reutilization of the material. Reutilization policies have been strengthened while environmental regulations are still comparatively weak. In fact, the environmental protection department does not have a tracking system in place to supervise the treatment of coal ash, especially as regards the reutilization rate, how much of it is placed in disposal, and how it is treated. Coal ash environmental problems are regarded as being under the reutilization of resources.

According to the "General Industrial Solid Waste Storage and Disposal Site Pollution Control Standards", coal ash environmental management measures include anti-seepage, diversion, drainage, leachate (dissolved toxins) treatment and groundwater monitoring. However, in reality, whatever methods you use, it is very difficult to completely prevent coal ash dust dispersal, as well as leachate from polluting the surrounding land. China still has no coal ash dust pollution control measures nor a system in place that would daily monitor and manage the problem in coal power plants.

Greenpeace recommendations:

(1) The government should overhaul the way coal ash pollution is treated. It should set up systems to obtain detailed information on the scale of the coal ash pollution problem and its potential harm to public health. It should also punish every coal ash disposal site that has improper protections to prevent coal ash pollution of any kind. After the overhaul, a deadline should be set for making required improvements to stop coal ash pollution in the short term.

(2) Regulations to prevent coal ash pollution should be introduced as soon as possible. Along with the present Coal Ash Utilization Regulations, the new Coal Ash Pollution Prevention Regulations should aim to create a comprehensive and effective management system to stop coal ash pollution as well as to improve its reutilization. Specific standards on coal ash disposal site pollution control should be issued, focusing on ash leachate pollution and dust control.

(3) Strengthen day-to-day pollution law enforcement and monitoring of coal power plants and their coal ash disposal facilities. This should include monitoring of dust pollution, coal ash leachate and groundwater pollution, and it should be part of the environmental protection departments' day-to-day tasks. Fines, which should be adjusted to reflect the serious environmental and health risks of coal ash pollution, should also be levied on all parties that fail to comply.

In the long term, Greenpeace is calling on China to tighten coal combustion pollution control and to adjust its energy structure so that it gradually moves away from its excessive reliance on coal.

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