China chemical safety case study: Metals pollution from a steel plant complex in Beihai, Guangxi Province

In the frame of the EU-funded project: Strengthening the capacity of pollution victims and civil society organizations to increase chemical safety in China (China Chemical Safety Project)

IPEN and Green Beagle

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Introduction

Plans for China's rapid economic development include the coastal area of Guangxi Province known as the Beibu Gulf Economic Zone. Premier Wen Jiabao signed approval for an economic development plan for the area in 2008 and the State Council subsequently upgraded it to a national development area. The plan is to make this zone a logistics base for China- ASEAN manufacturing and trade as well as an important part of China's Western Development Program.[1]

China is the world's largest steel producer with more than 700 million tonnes in 2012 and almost half of global production. [2] Hebei Province is the country's largest steel producer with 180 million tonnes in 2012 – 25% of China's total output.[3] Hebei is also a significant pollution source for neighboring Beijing (for photos see[4]). Longer-range plans include cutting steel producing capacity in Hebei Province by more than 67 million tonnes to reduce pollution.[5] The reduction in capacity in Hebei appears to be compensated for by growth in steel manufacturing in other provinces – including Guangxi Province.

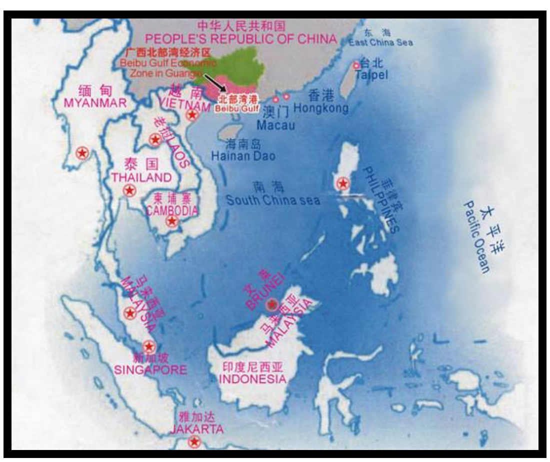
Chromium dust coats the entrance to the Chengde plant; photo by Zhang Haiyan

Steel manufacturing is a key part of the industrial development plan for Guangxi Province. This is facilitated by the presence of manganese ore deposits in the Province and also the deepwater port that permits the import of nickel ore from Indonesia and the Philippines.[6] Nickel is a major raw material for steel production and China imports a cheaper substitute for nickel known as nickel pig iron, also known as “dirty nickel”.[7] Nickel pig iron is a mixture of low-grade nickel ore, coking coal, gravel, and sand.[8] The mixture is smelted and sintered in an energy-intensive process to remove impurities to obtain ~ 4% - 13% pure nickel which is used in steel manufacturing.

This case study focuses on continuing pollution problems from a large steel manufacturing facility and accompanying nickel alloy plant in Beihai City in Guangxi Province. The case study also illustrates the broader issue of metals pollution in China. According to the Ministry of Agriculture, farming on land almost the size of Belgium has been stopped due to metals contamination, and approximately 12 million tonnes of grain are polluted by metals every year in China.[9]

The Chengde Group

Xinggang Town was a quiet fishing village, where villagers worked and lived in contentment and happiness. Unfortunately, the quietness of this village disappeared rapidly after Chengde Ferronickel Stainless Steel Co began operations in 2011. The company is one of four subsidiaries of the Chengde group, which also includes Beihai Chengde Metal Stamping Co (hot rolling mill), Beihai Chengde Zongwei Co (processing of steel slag into cement), and Guangxi Chengde International Trade Co (raw material purchasing and product distribution). The Chengde Group is itself a joint venture of the Guangxi Beibu Gulf International Port Group and Foshan Chengde Stainless Steel Co. Beihai is one of four ports with a planned handling capacity of 100 million tonnes.[10] Note that Guangxi Beibu Gulf International Port Group is a State-owned company with ambitious expansion plans to serve as a key link between China and Southeast Asia.[11]



Location of the Beibu Gulf Economic Zone in Guangxi Province; map from company website[12]

Chengde is among the largest iron and steel producers in Guangxi. With a total investment of 16.0 billion yuan, the plant occupies over 200 hectares in area and has over 3,000 workers. According to the company, Chengde produces 1.2 million tonnes of nickel-chromium alloy slab per year with an output value of 15 billion RMB.[13] Production capacity is expected to increase to 3 million tons per year. It is a large operation that includes sintering, a rotary kiln- submerged arc furnace, initial refining, AOD refining and rolling systems, plus auxiliary utilities for the main production facilities, such as oxygen stations, water treatment, power supply and distribution, etc. Chengde has severely polluted the local environment during production due to construction over a period of time and incomplete environmental measures. This case study focuses on its pollution in Xinggang Town, Tieshangang District, Beihai City, in the Guangxi Zhuang Autonomous Region.

Starting operations without a permit

Chengde started operations in November 2009 – one year before getting an approved environmental impact assessment (EIA) report on its new materials production project. The company began pilot production in March 2011. Ironically, the period of making public information on environmental acceptance of the production project (Phase 1) was November 10-17, 2011 – long after the company started operating.

Hazardous dust and ash from Chengde covers soil in the woods opposite to the ash dumps; photo by Zhang Haiyan

Ongoing pollution

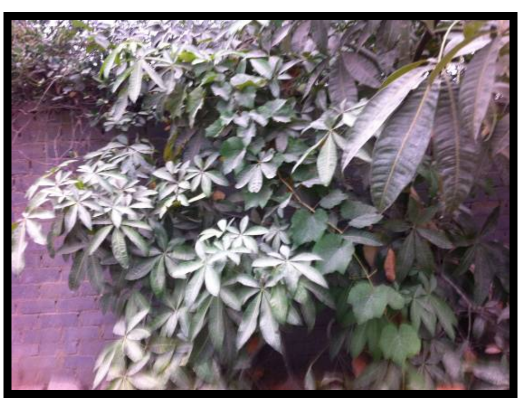
Chengde generates large amounts of wastes from chromium smelting in the process of nickel-chromium alloy production. These residues are designated as hazardous wastes.[14] A desulfurization unit exhausts more than five hundred kilograms of ash per day. According to Chinese law, dust release and waste dumping are prohibited and hazardous wastes must be managed in strict accordance with State regulations. However, Chengde has simply dumped toxic hazardous waste into ash dumps that are disorderly and completely non-standard, with leakage and dust release everywhere. Toxic dust flies from these dumps before falling into the surrounding community areas, contaminating courtyards, soil and vegetation. As a result, part of the surrounding land has been gradually destroyed. A lot of residential houses have been filled with stinky gases illegally emitted by the company. Nearby residents have complained that the air is too dirty to breathe, the water too contaminated to drink, and the land so polluted it is no longer arable. Many people have been forced to move elsewhere.

Chengde's waste dump disperses toxic metals and dust; photo by Zhang Haiyan

Chengde is on the list of major State-controlled sources of pollution in Guangxi. The local government has admitted that Chengde has caused dust pollution but surprisingly insists that it disposes of pollutants in a compliant manner. The local government has measured nitrogen oxides, sulfur dioxide and particulate matter at a Chengde unit with a 64.2% workload.[15] The Beijing Municipal Environmental Protection Bureau (BHEPB) has conducted environmental monitoring around Chengde since August 2011 and has concluded that, "*We believe that Chengde Nickel* *has not caused severe pollution to the surroundings, as there have been no significant changes in environmental quality except for dust since it started operations*." [16] Note that metals pollution has not been mentioned by either government bureau.

Chromium dust coats the inside of the Chengde facility; photo by Zhang Haiyan

Studies of pollution from steel manufacturing provide a different picture than the assessment by government bureaus. A study in Jordan found the highest levels of lead, zinc, cadmium, iron, copper, and chromium in soil near steel manufacturing plants.[17] Indian researchers found that the highest levels of cadmium in milk were found in cows grazing near a steel manufacturing plant.[18] A study in Taiwan measured volatile organic compounds in steel manufacturing and found a long list of toxic substances in air including toluene, 1,2,4-trimethylbenzene, isopentane, m,p-xylene, 1-butene, ethylbenzene, and benzene.[19]



Toxic dust from the Chengde factory settles on plants
in the community, photo by Zhang Haiyan

The US Toxics Release Inventory can provide an example of how polluting a steel plant can be – even in a developed country with regulatory infrastructure. For example, in 2013, a single US Steel plant in Gary, Indiana estimated releases of 4,026,361 kg zinc, 4,018,065 kg manganese, 1,451,495 kg nitrate compounds, 198,025 kg chromium compounds, 187,940 kg lead compounds, 172,475 kg ammonia, 13,006 kg benzene, 9271 kg cadmium, and 6988 kg arsenic, among many other pollutants. [20] In addition, the company estimated that this single plant generated 41,110,440 kg of wastes in 2013 – the majority of which was burned.[21]

Waste dumped from the Chengde factory; photo by Zhang Haiyan

Measuring metals pollution in the Chengde community

Community concerns about dust pollution, waste dumping and what toxic metals and chemicals they might contain increased substantially over the years of plant operation. Ironically, Chengde built a slag treatment plant in the summer of 2014, but dust pollution is still increasing, perhaps due to the ineffectiveness of the treatment and/or increased production.[22] The Project focused on providing the affected community the one thing that no one seemed to be able to help with: publically available information about the nature of the contamination. Project personnel used a portable X-ray fluorescence (XRF) analyzer to measure metal levels in nearby villages of Shangpotou, Xiapotou and Chongtou on October 13-14, 2013 and December 21, 2014 respectively.

Annex 1 shows the measurements of chromium, nickel, and zinc in areas near the plant. The data indicates the following:

- High levels of chromium, nickel and zinc are found on residents' homes near the facility. Chromium levels up to 29 times the regulatory limit are found on the roofs of nearby homes. These levels exceed the Czech regulatory limit for light soils by 88-fold. Nickel levels up to 5934 ppm were found on residents' homes – nearly 30 times the Chinese regulatory limit and nearly 100 times the Czech regulatory limit for light soils. Zinc levels up to 1771 ppm were also found – nearly 3.5 times the Chinese regulatory limit and 14 times the Czech regulatory limit for light soils.
- Surface soil in some cassava fields contains chromium and nickel near or above Chinese regulatory limits. One sample exceeded the Czech regulatory limit for light soils for chromium by more than 2.5 times and nickel by 1.8-fold.
- Chromium is found in dust along village roads at levels nearly 10 times the Chinese regulatory limit and 30 times the Czech regulatory limit for light soils.
- Woods near the facility contain up to 2701 ppm chromium – nine times the Chinese regulatory limit and 27 times the limit in the Czech Republic for light soils. The woods also contain up to 1191 ppm nickel – nearly six times the Chinese regulatory limit and approximately 20 times the limit in the Czech Republic for light soils. Zinc is also present at levels up to 2827 ppm – nearly six times the Chinese regulatory limit and approximately 22 times the limit in the Czech Republic for light soils.
- High levels of chromium can occur in the plant's slag dump. These include samples showing levels up to twice the Chinese regulatory limit and six times the Czech regulatory limit for light soil.

Taken together, the data indicates that the rampant dust pollution in the surrounding communities is actually toxic metal pollution. Metals are found on homes, roads, woods, fields, and in the company's slag dump. In addition, photos (above) reveal that dust found to contain high levels of chromium outside the plant also covers the inside of the facility.

In addition, toxic metals are not the only pollutants released by steel manufacturing and nickel alloy plants. As indicated in the example from the US plant above, toxic chemicals such as benzene, a known human carcinogen, are released by these facilities. Furthermore, the Stockholm Convention has identified sinter plants in the iron and steel industry as a sector, *"for comparatively high formation and release"* of persistent organic pollutants such as dioxins, furans, PCBs, hexachlorobenzene, and pentachlorobenzene.[23]

Impacts of toxic metals

The widespread presence of metals in dust in the surrounding communities obviously poses a high likelihood of human exposure and raises concerns for impacts on human health. Three metals predominated in the survey; chromium, nickel, and zinc.

Photos and data show the widespread presence of chromium in the factory area and surrounding community. This is because chromium ore is used in steel production. Note that the XRF analyzer measures total chromium and does not distinguish between the two common forms of chromium; chromium III and chromium VI.[24] Chromium III is an essential element in humans but can display moderate toxicity in acute animal tests.[25] Chromium III also causes reproductive damage in animal studies.[26] Chromium VI is a known human carcinogen.[27] [28] For example, a California EPA study of a village in Liaoning Province with contaminated drinking water demonstrated that chromium VI is a stomach carcinogen.[29] Other effects of chromium are shown in Table 1. Steel production releases the highly toxic chromium VI form and this raises concerns for the rampant chromium pollution in the community. In addition, the two forms of chromium can be rapidly converted back and forth – so chromium III in contaminated dust can be easily converted to more toxic chromium VI as pH rises.

Nickel compounds are known human carcinogens and studies indicate that workers in the nickel refining industry develop nasal and lung cancers as a result of exposure.[30] Other effects include contact dermatitis and lung inflammation in humans and decreased survival of offspring and sperm damage in animal studies.[31] [32] The presence of very high nickel levels in dust on the roofs of homes in the community indicates a high potential for exposure. In 2014, MEP and the Ministry of Land Resources in China released a startling report revealing that 16% of the country's soil was polluted, including 19% of the farmland.[33] Nickel was one of the most common pollutants cited along with cadmium and arsenic. [34]

Dust and soil sampling also revealed samples containing high levels of zinc. Zinc is an essential trace element for human nutrition. However, high doses of zinc can be harmful. Inhaling large amounts of zinc as dust or as fumes from welding is associated with metal fume fever – a disease that is usually reversible.[35] Other effects associated with long-term excessive zinc intake include anemia, leucopenia, lymphadenopathy, esophagitis, gastritis, hypertension, and depletion of copper and iron.[36] On skin contact, zinc can cause blistering and permanent scarring and it is also a strong eye irritant. [37]

Table 1 indicates that metals associated with steel manufacturing pose a variety of potential health risks – and some are quite serious. Exposure in children is a special concern due to vulnerability during development and higher rates of hand to mouth activity, which increases exposure.

Table 1. Some impacts of metals associated with steel production

Metal	Impacts
Arsenic	Inorganic arsenic is a known human carcinogen with links to lung, skin, and bladder cancers.[38] Studies of human exposure show increased incidence of lung, liver, and heart diseases, lung cancer, and infant mortality.[39] Arsenic exposure in humans is also associated with diabetes.[40] Low to moderate exposures in humans are associated with skin lesions, high blood pressure, and neurological dysfunction.[41] Arsenic exposure is correlated with lower IQ in children.[42]
Cadmium	Cadmium is a known human carcinogen and associated with cancers of the breast, kidney, lung, pancreas, prostate and urinary bladder.[43] The State of California recognizes cadmium as a reproductive toxicant.[44] [45] Cadmium is taken up by various crops including potatoes, root crops, leafy vegetables, and fruits. Other toxic endpoints include lung damage, renal dysfunction, hepatic injury, bone deficiencies, and hypertension.[46]
Chromium	There are two common forms of chromium; chromium III and chromium VI. Chromium III is an essential element in humans but can display moderate toxicity in acute animal tests.[47] Chromium VI is a known human carcinogen.[48] Dermal exposure to chromium VI can cause dermatitis and ulceration of the skin and chronic inhalation or oral exposure can decrease lung function and affect the liver, kidney and immune systems. [49] Lab studies link chromium VI to birth defects and reproductive problems.[50]
Lead	Lead is a well-known neurotoxicant with no safe level of exposure.[51] The harms from childhood lead exposure are irreversible and persist into adolescence and adulthood.[52] Lead has sensory, motor, cognitive and behavioral impacts, including learning disabilities; attention deficits; disorders in a child's coordination, visual, spatial and language skills, and anemia.[53]
Manganese	Manganese is an essential human nutrient. However, inhalation can damage the nervous system resulting in tremors, speech disturbance, attention impairment, and uncoordinated muscle operation. [54] Other effects include liver disease, impaired male fertility, and birth defects.[55] There is increasing interest and concern that manganese exposure at low levels leads to brain changes similar to Parkinson's disease.[56] [57] Workers in the steel industry and surrounding communities are especially vulnerable to manganese exposure.[58]
Mercury	Mercury is a well-known neurotoxicant that damages the kidneys and many body systems including the nervous, cardiovascular, respiratory, gastrointestinal, hematologic, immune, and reproductive systems.[59] The developing nervous system is especially vulnerable to damage from mercury and exposure can lead to loss of IQ, abnormal muscle tone, and losses in motor function, attention, and visual – spatial performance.[60]
Nickel	Nickel compounds are a known human carcinogen and studies indicate that workers in the nickel refining industry develop nasal and lung cancers as a result of exposure.[61] Other effects include contact dermatitis and lung inflammation in humans and decreased survival of offspring and sperm damage in animal studies.[62] [63]
Zinc	Zinc is an essential trace element for human nutrition. However, high doses of zinc can be harmful. Inhaling large amounts of zinc as dust or as fumes from welding is associated with metal fume fever – a disease that is usually reversible.[64] Other effects associated with long-term excessive zinc intake include anemia, leucopenia, lymphadenopathy, esophagitis, gastritis, hypertension, and depletion of copper and iron.[65] On skin contact, zinc can cause blistering and permanent scarring and it is also a strong eye irritant. [66]

Toxic water

Villagers alerted Project personnel to possible water contamination from the Chengde facility. In 2013, water sampling revealed a series of interesting findings. First, water collected from slag waste sprayed with water showed extremely alkaline levels with pH levels of 13 – 14 (clear sample in photo below). On October 27th, Green Beagle staff invited officers from the Environment Protection Bureau to collect samples from a well that villagers suspected was waste water from the plant. The company claimed that the well was "only" distilled water from a coal gas station and the Environment Protection Bureau reported that except for color, all other pollutant levels met national standards. This water, claimed to be "clean," is the second bottle from the left in the photo below. The water sample was red at first then turned black after one month. The question of why the company's operations are visible in a local community's well water did not get answered. The third bottle from the left in the photo below was sampled from an abandoned well near the plant with a bad odor. This sample was very alkaline at pH 8 – 9 and started black but gradually became milky white. The plant claimed that some municipal waste had been the source of this problem. Unfortunately, water pollution also extended to open waterways such as a nearby creek in the village of Shangpitou. A sample of creek water is fourth from the left in the photo and showed a very acidic pH of 2. The fifth sample from the left in the photo was collected by villagers in 2012 and reportedly resulted from illegal waste-water discharge by the company.

Water samples collected near the plant; photo by Zhang Haiyan

Promise to resettle villagers not fulfilled

Chengde officially started operations in August 2011 after getting their permit. Interestingly, the company and local environmental officials forecasted gross contamination in the community. A local government document reveals that in July 2011, the Tieshangang District Government and the Tieshangang Coastal Industrial

Zone Management Committee made a written commitment to resettle villagers living within the 1,000-meter safety distance from the new materials facility of Chengde by December 31, 2011. [67] Neither the company nor the local government acted on this commitment.

Resettlement-relevant banners are seen throughout the surrounding rural areas, photo by Zhang Haiyan

Conclusion

The Beihai case study provides opportunities for improvements in several areas:

EIA enforcement and permitting needs enforcement actions

The Chengde Nickel project was kicked off nearly a year before it received the EIA permit. This is a severe violation of China’s environmental protection law. Furthermore, Chengde Nickel has violated a legal provision that pollution control measures shall be designed, implemented and put into operations at the same time as is the main facility. It did not build a slag treatment plant until nearly three years after it began production. Finally, despite committing to resettling residents the weak regulatory “safety” distance of 1000 meters, no actions have been taken since the promise was made in 2011.

Information Transparency

Apart from occasional instances of pollution made public by the competent environmental authorities, dust from the company contains significant amounts of heavy metals such as nickel, zinc and, especially, chromium, which has the potential for great harms to human health, and should be made known to the community. The public right to information is a key chemical safety principle but Xinggang Town has never been informed that Chengde Nickel emits dust containing toxic metals. Chengde Nickel should regularly provide accessible, free information on pollutant emission and transport.

Resettlement Progress

The resettlement of villagers living within the legally-defined 1,000-meter "safety distance" from Chengde Nickel's new materials facility should have been completed by December 31, 2011. So far, nothing has happened. The company and competent local authorities should pay sufficient attention to the environmental protection bureau's reports on pollution caused by this company and urge it to finish the resettlement task as soon as possible in 2015, after evaluating what a truly safe distance might actually be.

Responsibility and Compensation

Liability and compensation is a key principle of chemical safety.[68] In 2010, the Governing Council of the United Nations Environment Programme (UNEP) developed guidelines for national legislation on liability and compensation.[69] China participated in the meeting and its consensus decision to endorse the guidelines. The decision acknowledges Rio Principle 13 and seeks to operationalize Rio Principle 16, the polluter pays principle. Company responsibilities include strict liability for damages either by commission or negligence. The Guidelines grant both individuals and public authorities the right to claim compensation, including for damage to property and economic loss. According to Chinese Civil Law, for environmental pollution cases if the plaintiff can prove the existence of polluting activities and damage to property and health, then the defendant should take the responsibility to disapprove the causal relationship between the pollution and damage. In this case, residents living within 1km of the plant should be removed, but since the company and local government did not fulfill their commitment, residents absorbed pollution instead of being moved. The local government and the company should compensate these people.

Effective remediation

Chengde has effectively contaminated the surrounding communities with toxic metals and should bear the financial and technical responsibility for a full clean-up. Effective remediation requires careful evaluation of the site, professional methods for removal, sampling to insure cleanliness of the remaining soil, and sound management of the wastes. Equally important is modification of plant operations to stop further releases of toxic dust from the plant.

Media reports

Local government's official response to volunteer's report of water pollution
http://blog.sina.com.cn/s/blog_81c8ad310101qt0z.html

About the plant's investment in environmental protection, mentioning villagers' complaint
http://factory.ytbxw.com/news_21473.html

Wechat media's report on NGO action
http://mp.weixin.qq.com/mp/appmsg/show?__biz=MzA4MDA2NTQxMQ==&appmsgid=10013073&itemidx=1&sign=5ee6e4aee801b5770e6e6ccc261acf92&3rd=MzA3MDU4NTYzMw==&scene=6#wechat_redirect

Local government's official response to volunteer's report of air pollution:
http://mp.weixin.qq.com/mp/appmsg/show?__biz=MzA4MDA2NTQxMQ==&appmsgid=10013073&itemidx=1&sign=5ee6e4aee801b5770e6e6ccc261acf92&3rd=MzA3MDU4NTYzMw==&scene=6#wechat_redirect

Annex 1. Measurement of metals near the Chengde plant

Table 1. Chromium content in soil and dust near the Chengde facility: Group 1

Sample ID	Type	Chromium (ppm) 铬	China[a] regulatory limit for chromium in soil (ppm)	Czech[b] regulatory limit for chromium in soil (ppm)
2 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	2,514	300	100/200
3 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	1,712	300	100/200
4 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	2,264	300	100/200
5 10/13	Same as 4 w surface soil removed	53	300	100/200
6 10/13	Nearby w surface soil removed	607	300	100/200

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995).[70]
[b] These are limits for agricultural land for light soils/other soils.

Table 2. Chromium content in soil and dust near the Chengde facility: Group 2

Sample ID	Type	Chromium (ppm) 铬	China[a] regulatory limit for chromium in soil (ppm)	Czech[b] regulatory limit for chromium in soil (ppm)
2 10/14	Gray sample from the steel plant's slag dump	565	300	100/200
3 10/14	Re-measure #2	645	300	100/200
4 10/14	Re-measure #2	618	300	100/200
5 10/14	Roof dust samples from a nearby resident	3,179	300	100/200
6 10/14	Re-measure #5	3,725	300	100/200
7 10/14	Re-measure #5	7,231	300	100/200
9 10/14	Re-measure #5	2,953	300	100/200
10 10/14	White samples from the steel plant's slag dump	190	300	100/200
11 10/14	Re-measure #10	180	300	100/200
12 10/14	Re-measure #10	180	300	100/200
13 10/14	Dust samples (dry) from corners on the roof of a villager's house (over 300 meters away from the factory site, according to visual estimation)	2,941	300	100/200
14 10/14	Dust samples (dry) that have soaked in rainwater on the roof of the same house	7,023	300	100/200
15 10/14	Dust samples from another villager (not yet soaked)	4,195	300	100/200
16 10/14	Yellowish red dust from on the roadside north of the factory site	3,170	300	100/200
17 10/14	Re-measure #16	2,804	300	100/200
18 10/14	Re-measure #16	2,792	300	100/200
19 10/14	Surface soil in the dense woods 30 meters away from the roadside north of the factory	520	300	100/200
20 10/14	Adjacent to the aforesaid location, with slightly lower canopy closure	1,091	300	100/200
21 10/14	Surface soil under dense plants in a piece of cassava field	263	300	100/200
22 10/14	Re-measure #21	269	300	100/200
23 10/14	The edges of the cassava field	252	250	100/200
24 10/14	Surface soil under dense plants in a piece of cassava field	73	250	100/200
25 10/14	The same location, with the top layer of surface soil removed	96	250	100/200
26 10/14	The same location, with digging to a depth of 2 cm	35	250	100/200

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995).[71]
[b] These are limits for agricultural land for light soils/other soils.

Table 3. Chromium content in soil and dust near the Chengde facility: Group 3

Sample ID	Type	Chromium (ppm) 铬	China[a] regulatory limit for chromium in soil (ppm)	Czech[b] regulatory limit for chromium in soil (ppm)
2 12/21	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	2,701	300	100/200
3 12/21	A corn field in Xiapotou Village, with digging down to 20 cm	33	250	100/200
4 10/13	Re-measure #3	61	250	100/200
5 10/13	Surface soil from a cassava field in Xiapotou Village	61	250	100/200
10 10/13	Re-measure #5	60	250	100/200
11 10/13	A cassava field in Xiapotou Village, with digging down to 20 cm	128	250	100/200
13 10/13	Re-measure #11	101	250	100/200
14 10/13	A cassava field in Chongtou Village, with digging down to 10 cm	69	250	100/200
15 10/13	Re-measure #14	87	250	100/200
16 10/13	Dust from the roof of a villager's house in Xiapotou Village	4,091	300	100/200
17 10/13	Re-measure #16	4,157	300	100/200
18 10/13	Dust from the roof of a villager's house in Chongtou Village	8,846	300	100/200
19 10/13	Re-measure #18	8,029	300	100/200
20 10/13	Re-measure #2	2,613	300	100/200
21 10/13	A cassava field in Xiapotou Village	ND	250	100/200
22 10/13	Re-measure #21	ND	250	100/200
23 10/13	A cassava field in Xiapotou Village	ND	250	100/200

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995).[72]
[b] These are limits for agricultural land for light soils/other soils.
ND = not detected

Table 4. Nickel content in soil and dust near the Chengde facility: Group 1

Sample ID	Type	Nickel (ppm) 镍	China[a] regulatory limit for nickel in soil (ppm)	Czech[b] regulatory limit for nickel in soil (ppm)
2 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	939	200	60/80
3 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	621	200	60/80
4 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	996	200	60/80
5 10/13	Same as 4 w surface soil removed	ND	200	60/80
6 10/13	Nearby w surface soil removed	267	200	60/80

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995); note that for farming fields the limit is 50 ppm and for slag or dust the limit is 200 ppm.[73]
[b] These are limits for agricultural land for light soils/other soils.
ND = not detected

Table 5. Nickel content in soil and dust near the Chengde facility: Group 2

Sample ID	Type	Nickel (ppm) 镍	China[a] regulatory limit for nickel in soil (ppm)	Czech[b] regulatory limit for nickel in soil (ppm)
2 10/14	Gray sample from the steel plant's slag dump	51	200	60/80
3 10/14	Re-measure #2	54	200	60/80
4 10/14	Re-measure #2	60	200	60/80
5 10/14	Roof dust samples from a nearby resident	1,684	200	60/80
6 10/14	Re-measure #5	1,964	200	60/80
7 10/14	Re-measure #5	1,705	200	60/80
9 10/14	Re-measure #5	1,710	200	60/80
10 10/14	White samples from the steel plant's slag dump	32	200	60/80
11 10/14	Re-measure #10	49	200	60/80
12 10/14	Re-measure #10	51	200	60/80
13 10/14	Dust samples (dry) from corners on the roof of a villager's house (over 300 meters away from the factory site, according to visual estimation)	1,393	200	60/80
14 10/14	Dust samples (dry) that have soaked in rainwater on the roof of the same house	2,200	200	60/80
15 10/14	Dust samples from another villager (not yet soaked)	1,584	200	60/80
16 10/14	Yellowish red dust from on the roadside north of the factory site	71	200	60/80
17 10/14	Re-measure #16	78	200	60/80
18 10/14	Re-measure #16	80	200	60/80
19 10/14	Surface soil in the dense woods 30 meters away from the roadside north of the factory	134	200	60/80
20 10/14	Adjacent to the aforesaid location, with slightly lower canopy closure	247	200	60/80
21 10/14	Surface soil under dense plants in a piece of cassava field	106	60	60/80
22 10/14	Re-measure #21	101	60	60/80
23 10/14	The edges of the cassava field	83	60	60/80
24 10/14	Surface soil under dense plants in a piece of cassava field	65	60	60/80
25 10/14	The same location, with the top layer of surface soil removed	70	60	60/80
26 10/14	The same location, with digging to a depth of 2 cm	ND	60	60/80

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995); note that for farming fields the limit is 50 ppm and for slag or dust the limit is 200 ppm.[74]

[b] These are limits for agricultural land for light soils/other soils.

ND = not detected

Table 6. Nickel content in soil and dust near the Chengde facility: Group 3

Sample ID	Type	Nickel (ppm) 镍	China[a] regulatory limit for nickel in soil (ppm)	Czech[b] regulatory limit for nickel in soil (ppm)
2 12/21	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	1,191	200	60/80
3 12/21	A corn field in Xiapotou Village, with digging down to 20 cm	72	60	60/80
4 10/13	Re-measure #3	55	60	60/80
5 10/13	Surface soil from a cassava field in Xiapotou Village	52	60	60/80
10 10/13	Re-measure #5	58	60	60/80
11 10/13	A cassava field in Xiapotou Village, with digging down to 20 cm	72	60	60/80
13 10/13	Re-measure #11	78	60	60/80
14 10/13	A cassava field in Chongtou Village, with digging down to 10 cm	63	60	60/80
15 10/13	Re-measure #14	61	60	60/80
16 10/13	Dust from the roof of a villager’s house in Xiapotou Village	1,651	200	60/80
17 10/13	Re-measure #16	1,649	200	60/80
18 10/13	Dust from the roof of a villager’s house in Chongtou Village	5,934	200	60/80
19 10/13	Re-measure #18	4,512	200	60/80
20 10/13	Re-measure #2	1,100	200	60/80
21 10/13	A cassava field in Xiapotou Village	ND	60	60/80
22 10/13	Re-measure #21	ND	60	60/80
23 10/13	A cassava field in Xiapotou Village	ND	60	60/80

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995); note that for farming fields the limit is 50 ppm and for slag or dust the limit is 200 ppm.[75]
[b] These are limits for agricultural land for light soils/other soils.
ND = not detected

Table 7. Zinc content in soil and dust near the Chengde facility: Group 1

Sample ID	Type	Zinc (ppm) 锌	China[a] regulatory limit for zinc in soil (ppm)	Czech[b] regulatory limit for zinc in soil (ppm)
2 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	527	500	130/200
3 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	422	500	130/200
4 10/13	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	605	500	130/200
5 10/13	Same as 4 w surface soil removed	54	500	130/200
6 10/13	Nearby w surface soil removed	209	500	130/200

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995).[76]
[b] These are limits for agricultural land for light soils/other soils.
ND = not detected

Table 8. Zinc content in soil and dust near the Chengde facility: Group 2

Sample ID	Type	Zinc (ppm) 锌	China[a] regulatory limit for zinc in soil (ppm)	Czech[b] regulatory limit for zinc in soil (ppm)
2 10/14	Gray sample from the steel plant's slag dump	ND	500	130/200
3 10/14	Re-measure #2	ND	500	130/200
4 10/14	Re-measure #2	ND	500	130/200
5 10/14	Roof dust samples from a nearby resident	1,484	500	130/200
6 10/14	Re-measure #5	2,650	500	130/200
7 10/14	Re-measure #5	1,465	500	130/200
9 10/14	Re-measure #5	1,511	500	130/200
10 10/14	White samples from the steel plant's slag dump	ND	500	130/200
11 10/14	Re-measure #10	ND	500	130/200
12 10/14	Re-measure #10	ND	500	130/200
13 10/14	Dust samples (dry) from corners on the roof of a villager's house (over 300 meters away from the factory site, according to visual estimation)	1,024	500	130/200
14 10/14	Dust samples (dry) that have soaked in rainwater on the roof of the same house	1,358	500	130/200
15 10/14	Dust samples from another villager (not yet soaked)	960	500	130/200
16 10/14	Yellowish red dust from on the roadside north of the factory site	ND	500	130/200
17 10/14	Re-measure #16	ND	500	130/200
18 10/14	Re-measure #16	ND	500	130/200
19 10/14	Surface soil in the dense woods 30 meters away from the roadside north of the factory	115	500	130/200
20 10/14	Adjacent to the aforesaid location, with slightly lower canopy closure	189	500	130/200
21 10/14	Surface soil under dense plants in a piece of cassava field	113	300	130/200
22 10/14	Re-measure #21	117	300	130/200
23 10/14	The edges of the cassava field	163	300	130/200
24 10/14	Surface soil under dense plants in a piece of cassava field	81	300	130/200
25 10/14	The same location, with the top layer of surface soil removed	74	300	130/200
26 10/14	The same location, with digging to a depth of 2 cm	47	300	130/200

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995).[77]
[b] These are limits for agricultural land for light soils/other soils.
ND = not detected

Table 9. Zinc content in soil and dust near the Chengde facility: Group 3

Sample ID	Type	Zinc (ppm) 锌	China[a] regulatory limit for zinc in soil (ppm)	Czech[b] regulatory limit for zinc in soil (ppm)
2 12/21	Surface soil in the eucalyptus woods north of the slag dump of the steel plant	2,827	500	130/200
3 12/21	A corn field in Xiapotou Village, with digging down to 20 cm	20	300	130/200
4 10/13	Re-measure #3	30	300	130/200
5 10/13	Surface soil from a cassava field in Xiapotou Village	32	300	130/200
10 10/13	Re-measure #5	34	300	130/200
11 10/13	A cassava field in Xiapotou Village, with digging down to 20 cm	78	300	130/200
13 10/13	Re-measure #11	86	300	130/200
14 10/13	A cassava field in Chongtou Village, with digging down to 10 cm	41	300	130/200
15 10/13	Re-measure #14	44	300	130/200
16 10/13	Dust from the roof of a villager's house in Xiapotou Village	753	500	130/200
17 10/13	Re-measure #16	692	500	130/200
18 10/13	Dust from the roof of a villager's house in Chongtou Village	1,771	500	130/200
19 10/13	Re-measure #18	1,251	500	130/200
20 10/13	Re-measure #2	2,707	500	130/200
21 10/13	A cassava field in Xiapotou Village	ND	300	130/200
22 10/13	Re-measure #21	ND	300	130/200
23 10/13	A cassava field in Xiapotou Village	ND	300	130/200

[a] Level III norm (the critical value ensuring agricultural and forestry production as well as the normal growth of plants) in the Soil Quality Standard (GB15618-1995).[78]
[b] These are limits for agricultural land for light soils/other soils.
ND = not detected

About the China Chemical Safety Project

This is an EU-funded project of IPEN with partner Green Beagle that aims to strengthen the capacity of civil society organizations and communities impacted by pollution to increase chemical safety in China. The Project (also known as the China Chemical Safety Project) is being implemented in China over two years with total EU funding of €344,580 and EU contribution of 77.84% of the total cost.

The Project includes:

- Improving capacities of impacted communities and civil society organizations for involvement in policy making
- Training on public participation in environmental impact assessment
- Generating new publicly available data about pollution and impacted communities that contribute to increased implementation of local and national chemical safety policies
- Raising awareness on emissions-related pollution

European Union

Strengthening the capacity of pollution victims and civil society organizations to increase chemical safety in China (China Chemical Safety Project) is funded by the European Union. The contents of this report are the sole responsibility of the IPEN and Green Beagle and can in no way be taken to reflect the views of the European Union.

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