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Soil pollution prevention and control measures in China

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Abstract

Soil pollution is a major problem in China. This paper describes the policies that the government has undertaken to remedy the situation, by either preventing additional pollution, or reducing the existing pollution levels. First, China is honing the legal framework to protect arable lands, control sources of pollution, and assess, manage and clean up polluted sites. Second, the government has made steps to improve the identification and monitoring of pollution sources. Third, the government has promoted chemical and biological technologies to lower the level of soil pollution. In spite of these efforts, there are still considerable challenges. First, China has considerable economic, social, and environmental diversity, so uniform top-down designed policies are likely to face considerable problems in many areas. Second, the local institutions trusted with the soil pollution cleanup have little understanding about clean soil standards, the right technology for soil inspection and treatment, and the management strategies for vast areas of land. In addition, the costs of cleaning up the land are staggering, with estimates ranging from CNY 6 to 11 trillion, with little potential for cost recovery from soil rehabilitation.

Keywords: *soil pollution, pollution prevention, China*

Rezumat. Măsuri de prevenire și control al poluării solului în China

Poluarea solului este o problemă majoră în China. Lucrarea de față descrie politicile implementate de guvern spre a remedia situația, fie prin prevenirea poluării adiționale, fie prin reducerea nivelului existent de poluare. În primul rând, China își pune la punct cadrul legal pentru protejarea terenurilor arabile, pentru controlul surselor de poluare și pentru evaluarea, managementul și reabilitarea siturilor poluate. În al doilea rand, guvernul a întreprins acțiuni pentru îmbunătățirea identificării și monitorizării surselor de poluare. În al treilea rând, guvernul a promovat tehnologii chimice și biologice cu scopul de a scădea nivelul de poluare a solului. În ciuda acestor eforturi, încă există provocări semnificative. China este caracterizată printr-o considerabilă diversitate economică, socială și environmentală, deci politicile uniforme de tip *top-down* pot întâmpina probleme serioase în multe areale. Mai mult, instituțiile locale responsabile cu reabilitarea siturilor afectate de acest tip de poluare nu dispun de cunoștințele necesare cu privire la standardele pentru soluri nepoluate, de tehnologia potrivită pentru inspecția și tratamentul solurilor, sau de strategiile de management al unor suprafețe extinse. In plus, costurile pentru reabilitarea terenurilor sunt foarte mari, estimările fiind între 6 și 11 trilioane CNY, iar potențialul de amortizare a cheltuielilor prin reabilitarea solului este redus.

Cuvinte-cheie: *poluarea solului, prevenirea poluării, China*

Introduction

In 2013, Beijing's lawyer Dong Zhengwei requested soil pollution data from the Ministry of Environmental Protection, including information on the causes and methods for dealing with the problem. The request was declined on the grounds that the data was a "state secret". Nevertheless, at the end of 2013, the government released limited information on soil pollution, partly because of the strong public reaction against that refusal. Despite the lack of details, the released data caused widespread concern (He, 2014a). In April 2014, the government issued a more comprehensive report about the country's soils (He, 2014b). The report shows that 16.1 per cent of the soil samples (19.4 per cent for agricultural soils) are contaminated with organic and chemical contaminants, as well as heavy metals and metalloids such as lead, cadmium, and arsenic (Zhao et al., 2014). Chinese officials say that an area the size of Taiwan is so polluted that farming should not be allowed there at all (Wong, 2014).

Removing the pollutants from the soil requires concerted efforts. The rehabilitation of polluted soil is a major challenge, especially if the pollutants are heavy metals. Polluted air is blown away and polluted water flows down rivers, so if the emissions stop, the pollutants in the air and water will dilute. On the other hand, pollutants in the soil will remain there for decades, if not treated. This means that efforts and expenses to alleviate the soil pollution problems may eventually far exceed those made to address air and water pollution (Delang, 2016a, 2016b). As Zhuang Guotai, the head of the Ministry of Environmental Protection's Department of Nature and Ecology Conservation, said, "In comparison with efforts to clean up air and water pollution, we've hardly got started with soil. But once the market is opened up, soil remediation will be on a far bigger scale than either air or water cleanup" (He, 2014a).

This paper describes the approach used by the government to tackle the problem of soil pollution. It first delves into the development of the legal framework, which has been lacking until relatively recently. This also involves the re-classification of soil use, to limit the impact of soil contamination. It then looks at the efforts expended identifying and monitoring the sources of pollution. Next, the paper discusses the technologies being developed and applied to reduce soil pollutants. Existing technologies are expensive, so China is also making an effort to develop cheaper technologies, given the extent of the problem (20 million ha of arable land are contaminated), and the likely costs involved (between CNY 6 and 11 trillion). Finally, it deals at the challenges that exist, given China's political organization and level of economic development, to address soil pollution.

Development of the legal framework

Although the authorities were a little slow to realize the magnitude of the soil pollution problem in China, there are now hopeful signs that the government is starting to deal with the problem (He, 2014c). Urgent action is needed, as the heavy metals and metalloids are already entering the food chain. The solutions start with more stringent laws, better technology to treat the soil, and additional funding (Zhao et al., 2014).

Laws about soil pollution

There is a lack of regulations governing soil pollution prevention and control in China, and without laws directly addressing these issues, cases can only be tried as a national tort or criminal offence, which does not ensure environmental remediation. Furthermore, the tort law is ineffective, and criminal laws addressing soil pollution are rarely invoked (Drenguis, 2014).

The government has made some efforts to introduce laws that directly address soil pollution. For example, in 1995, it approved a law (promulgated the following year) on the prevention and control of environmental pollution by solid waste, which also considered soil protection (Mu et al., 2014). However, this law is weakly enforced because the articles are ambiguous, the fines insufficient, and local governments have no incentive to enforce the laws (Drenguis, 2014).

Drenguis (2014) argues that while seemingly well-intentioned, the laws are more akin to policy statements than substantive legal requirements. For example, Article 55 of the Solid Waste Law does not define what "relevant provisions" or "specified periods of time" refer to when discussing the management of hazardous waste. By the same token, in Article 32 of the Environmental Protection Law, the steps the government ought to take to dispose of or eliminate hazardous materials have not been specified (Drenguis, 2014: 15). Similarly, Wang Jin, a professor at Peking University and an expert in environmental law, pointed out that Chinese laws look great at first glance, but are ineffective when it comes to their implementation (Wang, 2010). The ambiguities resulted in many counties and towns continuing to dispose waste without any treatment (Drenguis, 2014).

More recently, there has been growing attention to the problem of soil pollution, in particular in Hubei Province. In 2016, Wang Jianming, deputy director of Hubei Provincial People's Congress, expressed concerns that China has no specific legislation relating directly to soil protection, which limits the country's soil pollution control and prevention strategies (Zhou and Liu, 2016). Consequently, the 12th Hubei Provincial People's Congress passed the country's first set of regional laws and guidelines relating to soil pollution prevention. Shortly afterwards, China's 13th Five-Year Plan, published in March 2016, pledged that the country would give priority to cleaning up contaminated soil used in agriculture (Hou et al., 2017). It also promised to strengthen its soil pollution monitoring systems and promote new clean-up technologies (Stanway, 2016). According to Yuan Si, vice-chairman of the Environment Protection and Resources Conservation Committee (EPRCC) of the National People's Congress (NPC) Standing Committee, in 2017 a bill relating to soil pollution prevention will be introduced to the Standing Committee of the NPC (State Council, 2016b). He also emphasized the need for specific laws directed at soil contamination, because the lack of laws weakens the government's efforts to reduce soil contamination, which, in some parts of China, threatens water and food safety. Laws relating to the prevention of soil contamination will specify the division of responsibilities among government agencies, plans for establishing a survey and control system, and foster the allocation of larger amounts of monetary assistance, among other things (State Council, 2016b).

Soil Ten Plan

The "Soil Pollution Prevention and Remediation Action Plan" (also called Soil Ten Plan) was issued by the State Council on May 31, 2016 with the aim of comprehensively improving the quality of China's soils by the mid-21st century (State Council, 2016a). The plan aims to address five key tasks: "1) prioritizing the protection of arable lands, 2) controlling the sources of pollution, 3) assessing and managing polluted sites, 4) carrying out soil remediation methods on testing sites, and 5) strengthening the control and maintenance of the soil environment" (China Water Risk, 2014). The action plan lays out ten headline actions split into 35 categories and 231 specific points that should help to achieve the target of making 95 per cent of the currently contaminated land fit to reuse either for agricultural purposes or for new urban development. The action plan lists the following objectives (China Water Risk, 2016):

1. Key objectives & targets:

- To bring soil contamination under control by 2020, manage soil contamination hazards by 2030, and create a favourable ecological cycle by 2050;
- To ensure that over 90 per cent of the contaminated land can be utilized safely by 2020, and increase this rate to 95 per cent by 2030;

- Local governments need to finalize a detailed work plan and submit it to the group of ministries that developed the Plan by 2016;
- To set up national-level soil environmental quality monitoring points and monitoring networks by 2017;
- To set up soil environmental quality monitoring points to cover all the cities and counties by 2020;
- To establish laws and a regulation system related to soil pollution prevention and control by 2020.

2. Key pollutants to be monitored:

- Heavy metals: cadmium, mercury, arsenic, lead, and chromium;
- Organic pollutants: PAHs (Polycyclic aromatic hydrocarbons) and petroleum hydrocarbons.

3. Industrial pollution:

- To complete the investigation on the distribution and environmental impacts of contaminated industrial land use by key industries by 2020;
- By 2020, heavy metal emissions from key polluting industries should drop by 10 per cent from the 2013 level;
- To encourage the recycling of electronics, plastic, and packaging waste.

4. Agricultural pollution:

- To finalize the provincial soil remediation plan and the assessment methods of soil remediation efforts by 2017;
- To finalize the investigation of the total area of contaminated farmlands and the assessment of its impacts on agricultural products by 2018;
- To achieve zero increase of fertilizer and pesticide use in major crops. Effective utilization rates to reach 40 per cent and above. Coverage of fertilizer application based on soil sampling to reach 90 per cent and above by 2020;
- Over 75 per cent of large-scale livestock farms to be equipped with waste management facilities by 2020;
- Irrigation water to comply with farmland irrigation water quality standards (China Water Risk, 2016)

While the objectives are wide-ranging, many environmental experts and campaigners are disappointed about the lack of details in the document, claiming that it will be challenging to link the ultimate targets and the individual objectives of the plan, or to foresee from the specifications alone if the described targets would be reached. Chen Nengchang, a researcher at the Guangdong Institute of Eco-environment and Soil Sciences, said that no details have been provided on the standards that are going to be used to calculate the levels of contamination, what "safe to use" levels refer to, and if the implementation of the plan will be sufficient to achieve the targets (Zhang, 2016).

Environmentalist group Greenpeace also declared that additional legal measures need to be added to China's soil contamination action plan to make it more effective. China will set up a special fund dedicated to combating soil pollution, amounting to about CNY 5 trillion, based on its calculations of the average cost estimates in treating one hectare of land (Miranda, 2016). The action plan requires more financial input from the government, as well as the use of public-private partnerships, but the exact details on how this can be achieved and the private sector's contribution to the plan have yet to be clarified (Zhang, 2016). The government has set aside CNY 450 billion to tackle the multitude of problems with polluted soil (Li, 2016). However, the lack of laws and regulations may result in corruption and lead to the mismanagement of the massive investments into soil remediation.

Re-classification of soil use

In the Soil Ten Plan, agricultural soils are classified into three categories to maintain the safety of crops and livestock products: 1) non-contaminated and slightly contaminated soils, whose protection will be given priority, 2) mildly and moderately contaminated soils, which will be treated and classified as safe to use, and 3) severely contaminated soils, which will be brought under strict control (State Council, 2016a). By the end of 2017, "the technical guidelines for the categorization of the environmental quality of arable land will be released. By the end of 2020, arable land and agricultural products shall be concurrently monitored and evaluated based on a detailed survey of soil contamination, and such categorization will be promoted nationwide, starting with the pilot projects" (Soil Ten Plan, 2016: 9). While the plan aims to ensure a safe environment for agricultural production by categorizing agricultural land, issues of the reclassification of land go beyond agriculture.

In cities, many former industrial sites have been abandoned because of contamination concerns. Between 2001 and 2009, at least 98,000 industrial plants were closed and relocated across the country. Many of the industrial plants were highly polluting state-owned factories that were built during the Great Leap Forward (Drenguis, 2014). These former industrial zones have been re-classified for residential use, which poses health risks to both construction workers and the future residents. Besides, these health hazards of pollution are not limited to industrial land. Many real estate developers are hoping for the reclassification of contaminated farmlands so they can be used for non-agricultural purposes (He, 2014a). Although Chinese law requires the soil to be analyzed for contaminants before large construction projects commence, this requirement is generally ignored. One widely publicized case happened in 2007 in Wuhan (Hebei Province) after a former pesticide factory site was repurposed for residential use. Construction works were suspended after a worker suffered serious chemical poisoning.

Following the incident, the government was compelled to refund the purchase price of the building site, pay a CNY 130 million reimbursement to the development company, and spend nearly CNY 300 million to clean up the poisonous materials from the area (He, 2014a).

Identifying and monitoring the pollution sources

Identifying and controlling the major sources of pollution is the first step towards addressing the problem (State Council, 2016a). Between 2006 and 2010, the Ministry of Land and Resources (MLR) and the Ministry of Environmental Protection (MEP) carried out the most comprehensive survey of soil pollution in China. A statistical report of the quality of the nation's soil was published in 2014, in which 16 per cent of approximately 10,000 testing sites from 1,500 sampled areas were found to exceed the standards. However, the details of contaminated areas and the associated contaminants were never revealed. As a result, local governments, companies, and the general public are currently unaware of the severity of the country's soil pollution problem. In addition, some academics argue that the survey fails to reflect the real extent of pollution. According to the estimates of Gao Shengda, the editor of the website "China Environmental Remediation", the number of contaminated sites in China ranges between 300,000 and 500,000, which is 30-50 times the number of surveyed sites included in the 2014 report (Zhang, 2016).

In April 2016, hundreds of children at an elite private school in Changzhou, Jiangsu Province, fell ill after the opening of a new campus next to a former chemical plant site (Li, 2016). Following that incident, the first map of soil contamination conditions of the country was published by the IPE based on its pollution database, which identified 4,500 companies across 13 polluting industries, including the chemical, mining, and metal industries (Figure 1) (Zhang, 2016). The map showed that there were 3,998 state-controlled pollution sources and 502 non-state controlled ones. Besides, 729 chemical industrial parks were marked on the map (Zhang, 2016). The IPE also produced a map (Figure 2) of the level of *risk from soil contamination based on the location of 4,500 companies in key industries and over 700 industrial zones.*

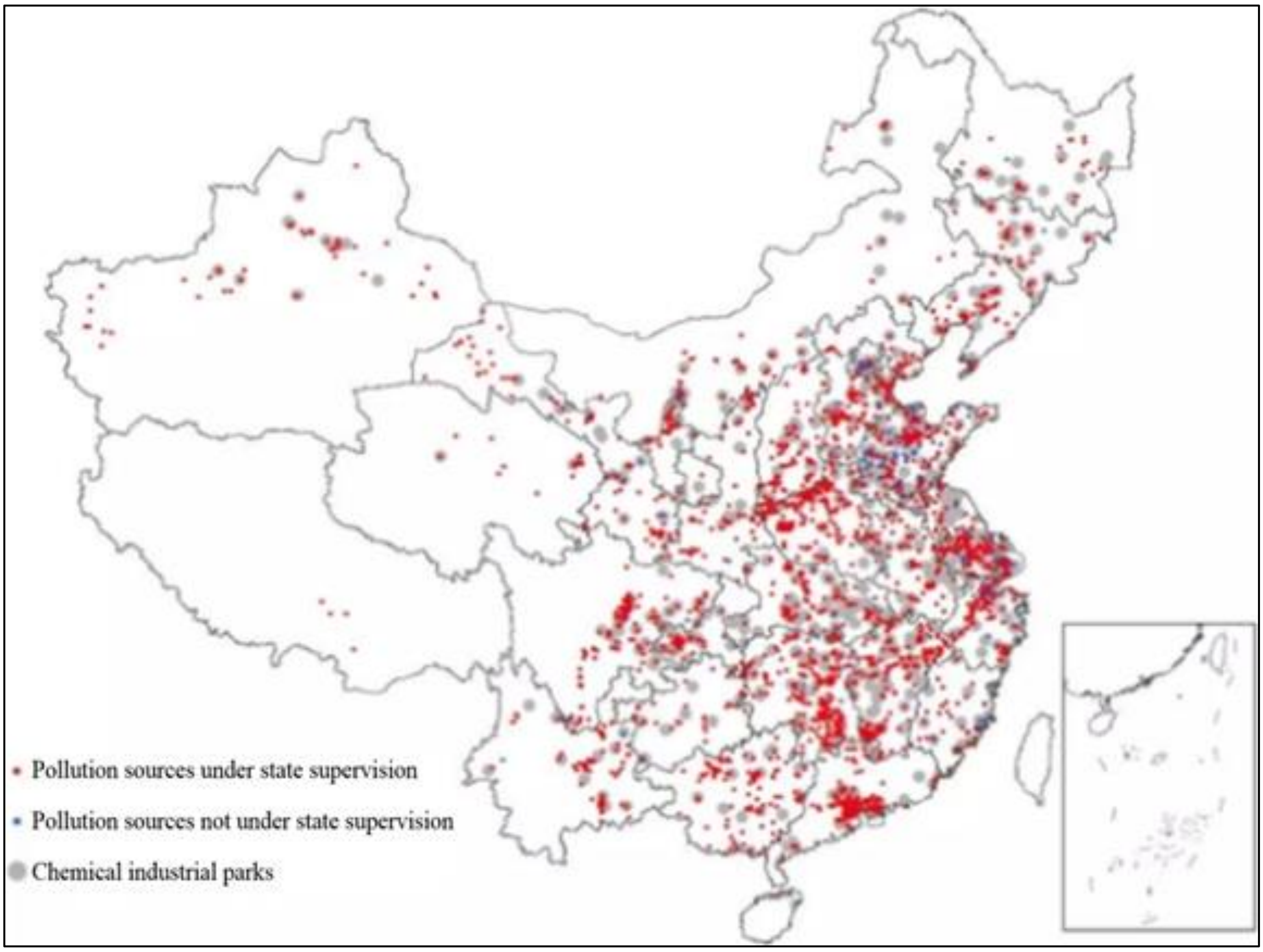

Figure 1: Location map of pollution sources
Source: Zhang (2016)

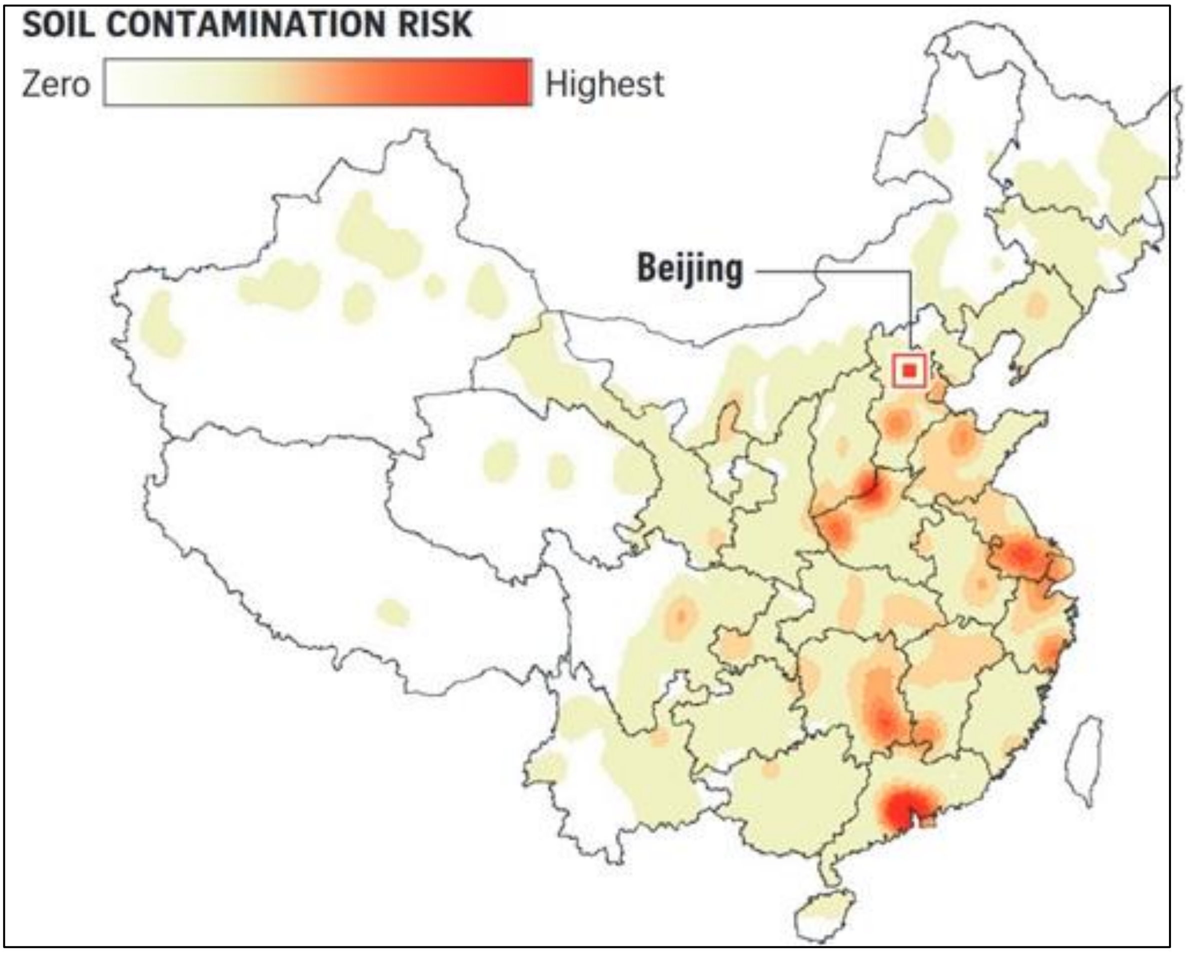

Figure 2: Map of soil contamination risk based on the locations of 4,500 companies in key industries and over 700 industrial zones
Source: Zhang (2016)

According to the Soil Ten Plan, new surveys will be conducted to identify the sources of soil pollution and prevent the problem from worsening. By 2018, a new survey will identify the total areas polluted, the distribution of polluted farmland, and the impacts of soil pollution on agricultural products. On the other hand, by 2020, the location of and the environmental risks at key industrial sites will be ascertained. In addition, by 2020, a soil quality control system will be set up throughout China to monitor every region across the country. After that, a survey will be conducted every decade by the Ministry of Environmental Protection along with other government agencies (including the National Development and Reform Commission, the National Health and Family Planning Commission, the Ministry of Industry and Information Technology, the Ministry of Land and Resources, and the Ministry of Agriculture) to monitor the overall soil quality of China (Soil Ten Plan, 2016). In addition, the action plan includes provisions for better information sharing with the public. A comprehensive database will be established using data collected from the Ministry of Environmental Protection, the Ministry of Land and Resources, and the Ministry of Agriculture, and mobile internet tools will be deployed to receive data updates in real time (State Council, 2016a). However, even though government departments have set goals to build a database and give people access to information about soil conditions, the exact details of the information to be provided have not yet been specified.

Controlling the number of polluting enterprises

China's first officially accepted plan for controlling the heavy metal pollution of a specific area was implemented in the Xiangjiang River basin (Hunan Province) in 2011. Its goals were to halve the number of heavy-metal polluting enterprises in the Xiangjiang River basin by 2015 compared to the 2008 levels, to invest CNY 59.5 billion and complete 927 projects between 2012 and 2015 to control the industrial pollution in the area, and to decrease the amount of heavy metal emission by 50 per cent by 2015 (Hu et al., 2014). The plan failed: though pollution source reduction is a good way of controlling soil pollution, it is very difficult for the local governments to implement the policy because local governments depend on incomes from industries (He, 2014b). Furthermore, a change in the local GDP rather than a change in pollution levels is the most important indicator to evaluate the performance of local officials. Since farming can only generate low incomes in China, local officials are reluctant to close the larger, more profitable companies, even if they generate high levels of pollution.

The conflicts between the local government and local environmental-protection officials are also of great concern. In May 2010, six officials of the local Environmental Protection Bureau—including the bureau chief—were removed from office by the government of Guzhen County (Anhui Province), because they carried out three checks on a firm over a period of 20 days. The local government blamed the Environmental Protection Bureau officials for undermining their efforts to attract investors. According to a local law in Anhui Province, environmental authorities are required to obtain a permission before conducting checks, a policy that provides protection against unexpected checks to the largest energy consumers and polluters (Wang, 2010).

Similarly, Wong (2013) reports how in Hengyang (Hunan Province) a large heap of industrial waste has ruined farmlands and caused outraged comments from villagers on the internet. However, the factories are closely tied to government officials, and in the eyes of Hunan officials, the industries surrounding Hengyang are fundamental to maintaining Hunan's leading role in nonferrous metal production. The farmers do not expect to see improvements (Wong, 2013).

The Soil Ten Plan has set goals to strengthen the regulation on pollution sources. According to the plan, the government will "strictly implement the heavy metal pollutant emission standards […]; take stronger measures for the supervision and inspection of enterprises; and the […] enterprises that do not meet [the] standards after [they] have been updated will be suspended or permanently stopped" (Soil Ten Plan, 2016: 21). Considering the current situation of weak laws and enforcements, it is doubtful these goals will be fulfilled.

Promotion of technologies to reduce soil pollutants

Soil remediation projects are only beginning to be implemented. Liu Yangsheng, the secretary general of the Heavy Metals and Environmental Remediation Committee of China's Environmental Protection Industry Association, expressed his fear that the rehabilitation of heavy-metal polluted soil will be a long and slow process due to the ill-defined evaluation standards, rudimentary technology, and lack of funding. He also pointed out that costly techniques are unlikely to be widely adopted due to the magnitude of heavy metal contamination in the country. Also, overseas rehabilitation techniques that may be effective for small areas are not applicable to the vast polluted areas in China (He, 2014a). According to the Soil Ten Plan, 200 pilot projects will be launched to test soil pollution treatment and remediation technologies by the end of 2020. Once the pilot projects are completed, the results will be evaluated, and the best technologies will be selected (Drenguis, 2014). Both chemical and biological approaches may be used.

Chemical approaches

In China, the most commonly used chemical strategy to reduce the amounts of heavy metals absorbed by plants is liming. Liming is the application of calcium- and magnesium-rich materials which neutralize soil acidity and increase the activity of soil bacteria (Tyler and Olsson, 2001). Liming also manipulates the phytoavailability of metals, reducing the amount of metals that is taken up by the plant (Zhao et al., 2014). The technique of liming acidic soils should be applied particularly on lands heavily polluted by high-risk contaminants, such as Cd and Pb. When lime is applied to the soil, the heavy metal pollutants will oxidize, which lessens the chances of the plant roots absorbing them (Stanway, 2014). There are a variety of liming materials on the market with different reaction rates, acid neutralizing capacities, and costs. The application of several rounds of liming material over successive crop seasons may increase the pH to the desired level, but its over-application may also result in harm to plant life (Zhao et al., 2014).

Biological approaches

There are also biological methods for soil remediation. For example, the metal pollutants can be detoxified using microorganisms to transform their valences, precipitate chemicals outside of the cells, or enzymatically reduce metals by metabolic processes, rather than absorb them. An alternative method is phytoremediation: the planting of specific plants such as willows, birches, and leguminous plants, which absorb and remove the pollutants from the soil. The plants can then be harvested, processed and disposed of. Besides being cheaper than physicochemical procedures, this approach also has the advantage of permanently removing the pollutants from the soil. However, for such methods to be applicable to the vast areas of polluted agricultural soils in China, they need to be both efficient and cost-effective, because farmers can neither afford to invest in expensive soil remediation techniques nor suspend their farming activities for years (Lone et al., 2008). As Chen Nengchang, a soil remediation specialist at the Guangdong Institute of Eco-Environment and Soil Sciences explains, cultivating non-food grains would clean the soil over time. However, producing sufficient grain for its large and growing population is of prime concern to the government, so shifting to the production of non-food grains is only proposed for the more heavily polluted soils (He, 2014a).

According to He (2014a), the Foshan Jinkuizi Plant Nutrition Company has pioneered a technique for soil remediation with the specific purpose of rehabilitating China's heavy metal-contaminated soils. The company has developed a microorganism capable of changing the ionic property of heavy metals in the soil, thus deactivating the contaminants. The company argues that their technique is cost-efficient, easy to use, its application does not create secondary pollutants, and is already available in commercial form. In another possible breakthrough, the Guangdong Geoanalysis Research Center has developed a new material, Mont-SH6, which it claims is capable of absorbing heavy metal pollutants such as lead, cadmium, zinc, mercury, and copper. According to Liu Wenhua, chief engineer at the research center, the new product is capable of reducing the cadmium levels of the soil by more than 90 per cent, and the material's cost of production is low: the remediation process for 0.6 ha of cadmium-polluted rice fields would cost about CNY 33,000. However, according to Liu, mass production could reduce these costs to CNY 2,200-3,300 (He, 2014a).

Although experiments with micro-organisms and plants that are capable of absorbing soil pollutants are promising, it is questionable how effective they will be, given the extent of the problem (Stanway, 2014). Also, there isn't a universal solution for the country's polluted soils. For example, a species of Indian mustard has been shown to be effective in absorbing selenium, and Chinese ferns can accumulate arsenic, but they have little impact on other pollutants.

Challenges

The central government has shown a strong determination to address China's issues of soil pollution, however, significant results are yet to be seen (Kong, 2015). Disagreements between local governments are one reason for the delay of a nationwide policy. Unlike air and water pollution, soil pollution can be more effectively tackled with regional strategies than through an overarching national approach. The geological properties of soil differ from region to region, and local authorities must figure out the most suitable strategies for the local conditions. For instance, some areas might naturally have higher concentrations of metals, in which case a better way to mitigate risk is to ensure the land is used appropriately, rather than through soil remediation. Moreover, unlike air and water, soil does not travel, which means that provincial governments can manage their own soil without the need for cross-border coordination. Also, the heavy reliance of soil management policies on researchers, laboratories, and equipment can most easily be met by provincial-level governments (Kong, 2015).

Indeed, some scholars argued that regionally implemented policies can more efficiently meet the needs of China's cities and provinces, compared to top-down political directives. Shanghai was the first local government to establish its own soil policy. The city developed its clean soil standards in 2007 in the run-up to the World Expo 2010. This set of standards has since become a valuable reference for other cities, indicating that the central government should provide stronger incentives to selected provincial governments to develop their own strategies and become pioneers in soil protection policies. By focusing investment on a couple of selected provinces, relevant skills and mechanisms can be developed more efficiently (Kong, 2015).

Apart from the difficulty in implementing uniform policies across local governments, experts in the field suggest that technical barriers have been a major hindrance for provincial governments. There are various contaminants, including heavy metals like cadmium or lead, volatile organic compounds (VOCs) such as benzene, persistent organic pollutants (POPs) coming from different chemicals and pesticides, and waste left by fossil fuel combustion. All these pollutants require different techniques to be removed from the soil. Besides, many local institutions are confused about clean soil standards, the right technology for soil inspection and treatment, and management strategies for vast areas of land. Local governments may need more guidance from the central government to overcome such barriers (Kong, 2015).

Besides the technological and legislative challenges, the biggest difficulty is the funding of soil remediation projects. The costs of cleaning up the polluted land are indeed staggering. In 2015, the central government assigned a budget of CNY 2.8 billion for anti-pollution programs across 30 prefecture-level cities, but experts claim this amount is far from sufficient. According to Lan Hong, an professor at Renmin University, "even with cheap restoration methods, it would take CNY 300,000 per hectare of land polluted by heavy metals, which means at least CNY 6 trillion is needed" (Deng and Leng, 2016). On the other hand, the Jiangsu Institute of Environmental Industry estimated that China's soil remediation industry is a market that could reach CNY 757 billion between 2014 and 2020, financed almost entirely by government subsidies (He, 2014a). Zhuang Guotai, the head of the Ministry of Environmental Protection's Department of Nature and Ecology Conservation estimated that the total cleanup costs could eventually reach CNY 11 trillion. Although there are some available remediation techniques, the country needs more low-cost technologies to tackle a problem of this magnitude (Stanway, 2014).

While investors can impose a fee for cleaned wastewater, it is difficult to do so for clean soil, so there is the potential for only a small cost recovery from soil rehabilitation. The involvement of developers who are interested to clean up polluted urban sites could mean a possible funding solution, but this possibility has had limited results so far (Hornby, 2015). This raises the problem of obtaining private funds for soil rehabilitation.

Wangxia Hui, one of the MEP directors, pointed out that until now the responsibility of the parties joining forces against soil pollution has not been clarified. Soil pollution prevention and control is one of the responsibilities of many different government departments, including environmental protection, development and reform, science and technology, finance, land, housing construction, and agriculture, but there has not yet been a good mechanism for all these parties to work together. For example, when preparing an urban and rural development plan, most local planning authorities do not give soil quality sufficient consideration. Finally, public participation in soil protection is limited due to the lack of appropriate mechanisms for the public to know the extent of soil pollution (Guo and Dai, 2016).

Conclusions

Soil pollution is the outcome of various natural factors and human activities that result from people's inadequate use of land resources and the "grow first, clean up later" attitude prevalent in China (Currell, 2013). This attitude is proving very expensive now that soil pollution has reached critical levels. Chinese people are concerned about the quality of the food, and China is forced to import food from other countries. Efforts to restore and clean up the soil are underway, but it is an expensive and time-consuming process.

Soil pollution is different from soil degradation in that it is more difficult to identify, it is directly related to economic activities (whether the excessive use of pesticides, or industrial emissions), and it is more expensive to remediate. China's rapid economic growth and disregard for its environmental problems, partly originating from China's desire to put an end to poverty, and partly on the assumption that the inflicted damage could be repaired later at a relatively cheap cost, has resulted in about one-fifth of the country's cropland already severely contaminated. The Chinese government has finally decided that the "clean up later" period has arrived, and China's State Council has recently instructed that over 90 per cent of the contaminated land should be safe to use by 2020, and 95 per cent by 2030, as part of the Soil Ten Plan.

A further problem which prevents soil pollution from being easily tackled is that on the one hand, soil pollution is a direct result of air emissions from manufacturing industries, so emissions have to be curbed by regulating and, if necessary, fining or closing these industries. On the other hand, these same manufacturing industries provide the bulk of the taxation to the local governments, so a threat of leaving the area if regulated or fined may stop the local governments from acting. Furthermore, if the companies actually do close, the government may be starved of the funds needed to clean up the pollution, and the companies may just open in other provinces with less stringent standards. These are clear contradictions that may prevent a successful outcome of the government's soil rehabilitation efforts. Nevertheless, the regulations reflect the country's determination to finally address its soil pollution problems. If the central government provides enough financial support and establishes and enforces concomitant laws, the goals would likely be achieved (Deng and Leng, 2016).

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