

## China's Soil Pollution Control: Choices and Challenges

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Starting in 2005, China's Ministry of Environmental Protection (MEP) and Ministry of Land and Resources (MLR) conducted a 9 year survey of contaminants in soils, which considered about two-thirds of the land across the Chinese mainland. According to the results, 19.4% of the farmland surveyed was classified as polluted<sup>1</sup> (Figure 1). Contamination of soil could have adverse implications for food security.<sup>2</sup> In recent years, concern about safety of agricultural produce exploded onto the public stage, especially after the frightening media stories about concentrations of the metal, cadmium in Hunan-grown rice in 2013.

Due to recent, rapid urbanization, China's demand for land to be developed has been increasing continuously. Consequently, previous industrial sites are often reclassified for urban development. The national survey indicated that one-third of sites in and around 690 highly polluting enterprises and 146 industrial parks are polluted.<sup>1</sup> Redeveloping these contaminated sites is a concern because of chronic risks to health of residents. It is noteworthy that China's worst explosion of warehouses in Tianjin on August 12, 2015 will

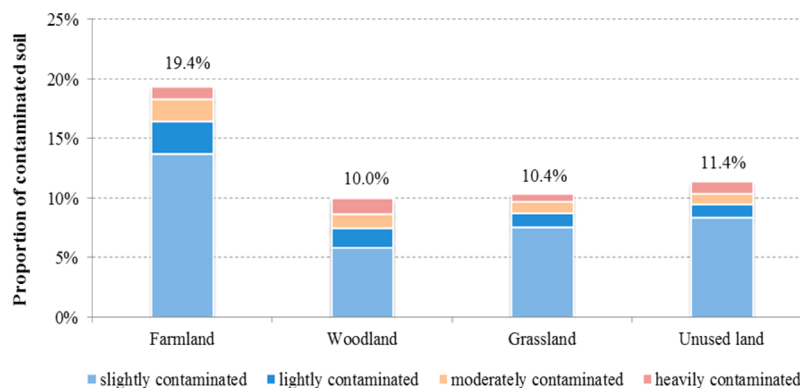
accelerate the process of moving and reconstruction of dangerous chemical storage and manufacturing facilities in this country's most populous area. This development will create more industrialized land while abandoning areas that are now contaminated.

Facing the alarming results of the national survey, the government has decided to take countermeasures to tackle soil pollution. On May 28, 2016, the State Council, the highest administrative organization of China, released the national action plan on prevention and control of soil pollution. Aiming to improve soil quality and ensure safe agricultural products and a healthy living environment for people, the blueprint sets two major deadlines. The first deadline involves stabilizing soil quality to ensure 90% of polluted farmland and industrial sites is safe to use by 2020. A second deadline involves making improvements to soil quality so that 95% of all contaminated land will be safe to use by 2030. The action plan indicates that China is fully engaged to stem contamination of soils and enter into a program of risk control and remediation of previously contaminated soils. However, due to a general lack of supervision, insufficient funds and lack of technology, achieving these lofty goals will not be easy.

Implementation is even more important than planning. In recent years, local governments have been eager to redevelop former industrial sites because land-transferring fees contribute to their income. In 2015, land-transferring fees accounted for 39.9% of income to local governments.<sup>3</sup> Only legal measures and a reform in China's environmental protection system will generate real binding force for tackling soil pollution during this process. In addition, 36 departments of the central government are currently involved in the action plan. But because of lack of legal requirements, respective responsibilities of each department have not been explicitly delineated. Furthermore, insufficient cooperation among various government agencies will hamper control of soil pollution. For instance, environmental monitoring of soil is now conducted by MEP, MLR and the Ministry of Agriculture based on their own needs independently. In order to promote efficiency of soil pollution

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**Figure 1.** Pollution status of soils in China.

control, China needs to place a greater emphasis on top-level design on sound regulations for communication and coordination among stakeholders with explicit descriptions of roles and responsibilities as well as authorities with appropriate powers and sanctions.

By 2020, China is scheduled to rehabilitate approximately 667 000 ha of contaminated farmland and reuse industrial sites after remediation. This effort will require a large amount of capital investment. In general, these costs should be paid by those responsible for the pollution, while as the owner of all land in China, government will also need to assist in paying for expenses for cleanup of polluted soil without subject of liabilities. In some eastern megacities, such as Shanghai, Nanjing and Hangzhou, there is sufficient financial support from land-transferring fees to remediate contaminated industrial sites that could be reused for property. However, with recent slowing of the overall Chinese economy and ongoing downturn in real estate prices, it is increasingly difficult in most inland areas to rely on the real estate market to provide funds for remediation. For farmland, remediation has relied mostly on government funding compared to social investment. But cleanup of agricultural soil is a time-consuming and expensive process that currently does not have a lot of momentum with local governments. Stable and sustainable financial resources are essential for success of this action plan. China needs to diversify financing channels, such as public-private partnership arrangement and pollution insurance, to bring in new sources of financing for funding soil pollution control.

The national action plan opens up a lucrative market for providing services, techniques and equipment for environmental investigation, monitoring and remediation of contaminated soils. China's vast territories with diverse types of soils and hydrogeological conditions necessitate different technologies and skilled talents. The national action plan stresses the role of science and technology. Thus, addressing pollution of soils in China is a unique platform for global scientists to promote new cleanup technologies, especially for function-directed and less energy intensive remedial technologies with greater cost-benefit ratios. Current international research is more focused on developing in situ, rather than ex-situ, remediation techniques.<sup>4</sup> In-situ remediation technologies, such as soil vapor extraction, thermal treatment and phytoremediation, are promising for future development in this increasing market.

For remediation of polluted farmland, there is a lack of effective and sustainable solutions that balance control of pollution with financial feasibility and farmers' livelihoods. Risk

alleviation and soil remediation of polluted farmland in China at such a large and complicated scale is certainly a big challenge. Ensuring safety of crops from contaminated farmland will involve several disciplines. Agronomists, ecologists, hydrogeologists and engineers will need to collaborate to explore potential scientific issues, including pollutant transport, transfer, transformation and bioaccumulation in crops, health of soil ecosystem and promising bioremediation approaches.

While the central government is dedicated to addressing pollution of soils, this will be challenging and thus China must rise to the above-mentioned challenges. However, it is never too late to start the fight against pollution. Meanwhile, scientific progress in assessing risks and remediation of contaminated soils, will benefit not only China, but also other developing countries in the world, especially countries in Africa and south Asia,<sup>5</sup> that are currently affected or will be affected by large-scale soil pollution.

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The authors declare no competing financial interest.

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