

Financing Models for Soil Remediation

Financing Models for Soil Remediation in China



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Cover design is based on soil symbols used in mapping soil types.

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ABOUT THIS REPORT

This is a part of a series of outputs of a 4-year project, Financing Models for Soil Remediation, carried out by the International Institute for Sustainable Development (IISD), the Norwegian Institute for Water Research (NIVA), and the Chinese Academy of Environmental Planning (CAEP), in association with the Centre for International Climate and Environmental Research (CICERO), and the International Institute of Green Finance (IIGF) of China Central University of Finance and Economics (CUFE) with support from the Norwegian Ministry of Foreign Affairs. The project aims to support the implementation of China's priorities and its policy development process through institutional partnerships, mutual learning and exchange, strengthening of capacity especially in government institutions, and the effective demonstration of results on the ground in implementation of China's environmental priorities. The overall objective of the project is to harness the full range of green finance approaches and vehicles to the task of managing the associated risk and funding the remediation of contaminated soils in China.

This series of reports focus on the financial vehicles available to attract investment to environmental rehabilitation of degraded land, and the financial reforms needed to make these vehicles a viable and desirable means of investing in land rehabilitation. We draw on best practices worldwide in funding environmental rehabilitation, with special focus on the design and use of financial mechanism to attract private investors, share the risk and offer a clear benefit from the rehabilitated land. This report is written by Zhanfeng Dong, Aiyu Qu, Yunting Duan, Hongxiang Li, Zilin Yuan and Zhixin Guo.

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1 Current Situation of Soil Remediation Financing in China

1.1 Current Situation of Soil Pollution in China

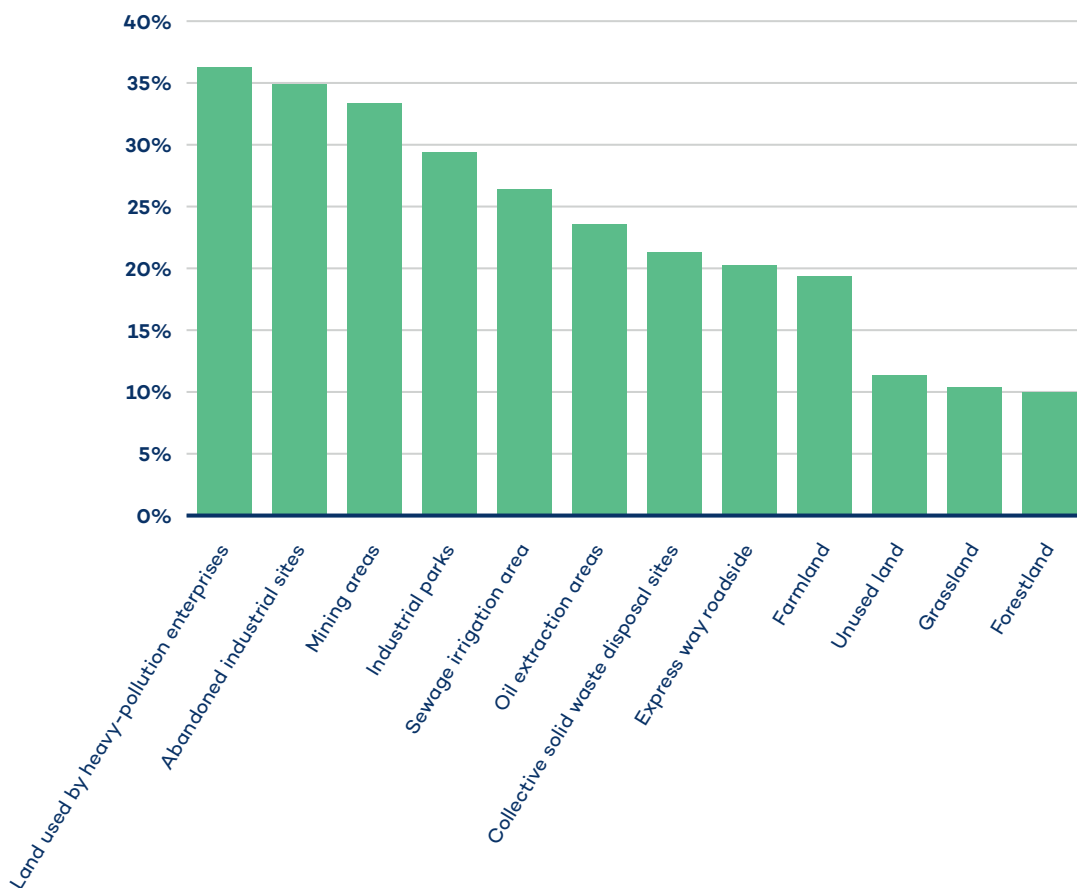
1.1.1 Status of Soil Pollution in China

On April 17, 2014, the Ministry of Environmental Protection and the Ministry of Land and Resources jointly released the “National Bulletin of Soil Pollution Status Survey,” China’s first nationwide survey on soil pollution status. Its findings help show the general situation of soil environment in China:

(1) The general situation of soil is not positive, with particularly serious soil pollution in some regions. Contaminated soil makes up 16.1 per cent of the total, including 1.1 per cent of which is seriously contaminated. Generally speaking, soil pollution in southern China is more serious than in the north, especially in the Yangtze River Delta, the Pearl River Delta and the old industrial base in the northeast, with large area of heavy metal pollution in the southwest and south central areas. The content of cadmium, mercury, arsenic and lead in soil increases gradually in a band ranging from the northwest to southeast and from northeast to southwest.

(2) There are different percentages of soil pollution in different types of land, typical land and the adjacent land. Firstly, the percentages of soil contamination in farmland, forest land, grassland and unused land are 19.4 per cent, 10.0 per cent, 10.4 per cent and 11.4 per cent respectively, reflecting the low quality of the soil environment in China. Secondly, there exists the outstanding problem of heavy soil pollution caused by enterprise production and abandoned sites after industrial mining (Figure 1).

Figure 1. Non-attainment Rates of Soil Contamination Sites by Type



(3) Soil contamination is dominated by inorganic pollution, followed by organic pollution, supplemented by a small proportion of compound pollution. The excessive ratios of eight types of inorganic pollutants such as cadmium, mercury, arsenic, copper, lead, chromium, zinc and nickel are 7 per cent, 1.6 per cent, 2.7 per cent, 2.1 per cent, 1.5 per cent, 1.1 per cent, 0.9 per cent and 4.8 per cent respectively; and the excessive ratios of three types of organic pollutants including hexachlorocyclohexane (HCH), dichlorodiphenyltrichloroethane (DDT) and polycyclic aromatic hydrocarbon (PAHs) are 0.5 per cent, 1.9 per cent and 1.4 per cent respectively.

(4) Contamination by the heavy metal cadmium is getting worse, with levels increasing by more than 50 per cent in China. The survey results showed that eight types of inorganic heavy metal pollutants (such as cadmium, mercury, arsenic, copper, lead, chromium, zinc and nickel) account for 82.8 per cent of the total excess, with cadmium the most serious, accounting for 7 per cent over the standard. Cadmium contamination is increasing nationwide: in the southwest and coastal regions, cadmium content has increased by more than 50 per cent, and in the north, northeast and western regions, it has increased by 10–40 per cent.

In 2015, the Land Reform Centre of the Ministry of Land and Resources and the Social Science Literature Publishing House jointly issued the “Blue Paper of Land Reform: China Land Improvement Development Research Report (Vol. 2),” which noted that of China’s existing 2 billion *mu* (133 million hectares) of farmland, a considerable portion is moderately or severely contaminated, with heavily contaminated soil making up nearly 20 per cent, most of which is not suitable for cultivating. The problem of soil pollution is increasingly serious, and it is urgent to initiate the soil remediation program.

1.1.2 Overall Situation of Soil Remediation in China

China’s soil pollution control and remediation is in the pilot demonstration stage.

In January 2013, the General Office of the State Council issued the “Notice on the Arrangement of the Recent Work of Soil Environmental Protection and Comprehensive Management.” which clearly pointed out that the pilot demonstration of pollution control and remediation should focus on the surrounding areas of large and medium-sized cities, heavy metal pollution prevention and control areas, and the surrounding areas of centralized drinking water sources. The survey report noted that 42 pilot projects were launched in 2013, with 19 government and 23 corporate projects. Only two of the projects are operating with total costs of over 100 million yuan (USD 15.16 million): most projects are small and medium-sized. In 2015, the Ministry of Environmental Protection chose 10 provinces to initiate soil pollution control and remediation pilot demonstration projects to support 38 key areas of heavy metal pollution control; it decided to continue to carry out the heavy metal pollution survey in agricultural production land areas, involving 1.623 billion *mu* (108.2 million hectares) of land. In Changsha, Zhuzhou and Xiangtan, a pilot project of heavy metal-contaminated farmland remediation and crop planting structure adjustment involves 1.7 million *mu* (0.11 million hectares) of land. In Xinjiang, Gansu and other four provinces (autonomous regions) as well as Xinjiang Production and Construction Corps., the agricultural film recycling demonstration pilot project involves about 12 million *mu* (0.8 million hectares) of land. In 2016, in 17 provinces (autonomous regions and municipalities) Tianjin, Hebei, Liaoning, Zhejiang, Jiangxi, Shandong, Henan, Hunan, Guangdong, Guangxi, Hainan, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang, a total of 142 pilot projects have been initiated using the special fund for soil pollution prevention and control.

Heavy metal pollution control has achieved preliminary success.

In 2011, the State Council approved the “Xiangjiang River Basin Heavy Metal Pollution Control Implementation Plan,” which is the first regional heavy metal pollution control pilot program approved by the State Council. In 2014, the Central Government’s No. 1 Document clearly proposed to “start pilot work of heavy metal-contaminated farmland remediation.” First, in Hunan province, the Changsha–Zhuzhou–Xiangtan region was chosen for a pilot project with a special subsidy from the Central Government for supporting farmland protection and quality improvement, aiming to realize good-quality rice production in heavy metal-contaminated farmland through strengthening farmland quality construction and soil remediation.

In accordance with the basic principle of “local conditions, government guidance, farmers volunteer and income insurance,” the pilot project has been carried out with scientific and rational technical paths along with supporting measures. For instance, soil improvement, fertility cultivation and other agronomic measures have been adopted to ensure that the heavy metal content in rice does not exceed the limit. The Central Government’s No. 1 Document issued in 2015 once again explicitly requires carrying out the farmland quality protection and improvement actions and enhancing the heavy metal-contaminated farmland remediation actions. Therefore, it is important to carry out large-scale and contiguous treatment of heavy metal-contaminated land. China is currently implementing a number of pilot projects for large-scale and contiguous treatment of heavy metal pollution in Changsha–Zhuzhou–Xiangtan region (Hunan), Guixi (Jiangxi), Huangjiang (Guangxi), Daye (Hubei) and other places. In the process of heavy metal pollution control and soil remediation in these areas, certain successes have been achieved in heavy metal bioactivity reduction (e.g., cadmium content reduction) and total heavy metals reduction.

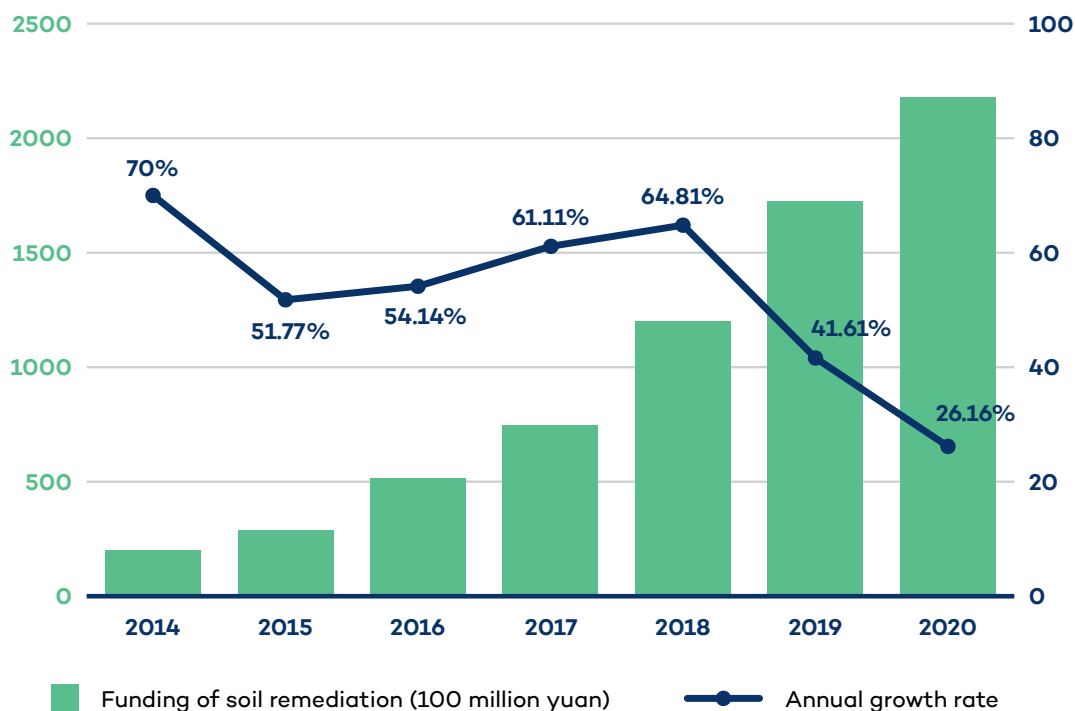
Mining geological environment restoration and comprehensive control has achieved positive results, with financial pressure as the primary concern.

Since 2001, the state has taken a series of measures, including: the organizing of thorough investigation, the promulgation of the “Mining Geological Environmental Protection Regulations” (2009); the implementation of the “Mining Geological Environment Protection and Control Plan” (2009); the promotion of the special control program; mine greening actions; the construction of national mine parks; the establishment of the mining geological environment restoration deposit system, the initial construction of the economic mechanism for development compensation and protection. As of 2015, the central and local governments and enterprises had invested more than 90 billion yuan (USD 13.7 billion), more than 800,000 hectares (ha) of mining geological environment had been restored, and the mining geological environment in a number of resource-exhausting cities had been effectively restored. On July 1, 2016, the Ministry of Land and Resources, the Ministry of Industry and Information Technology, the Ministry of Finance, the Ministry of Environmental Protection, and the State Energy Bureau jointly issued the “Guidance on Strengthening the Mining Geological Environment Restoration and Comprehensive Control” (MLR et al., 2016) which clearly stated: “all levels of local finance must increase the capital investment and broaden the channels of fundraising, and actively explore the use of PPP mode, third-party contracting and social capital investment. (Chapter 1 Article 2 and Chapter 2 Article 3)” According to incomplete statistics from the China Environmental Protection Network, by the end of 2008, in China’s 113,108 mines, up to 3.325 million ha of land had been damaged through mining activities, while 35.33 billion tonnes of solid waste had been generated. For technologies to be used for mine land restoration, based on the minimum cost estimates, heavy metal-contaminated mine soil remediation will require a minimum investment of 0.54 trillion yuan (USD 82.4 billion), and the maximum capital demand would be 3.46 trillion yuan (USD 528.2 billion).

China’s soil remediation market is still emerging, but the development trend is promising.

According to statistics, about 43.75 per cent of China’s soil remediation projects are small, mostly with an investment of 50 million yuan (USD 7.58 million) or less. Large-scale projects with a budget higher than 200 million yuan (USD 30.32 million) account for only 18.75 per cent. Compared with the United States and Europe, which have restored 30,283 and 80,700 contaminated sites respectively, China has restored no more than 200 sites. The soil remediation market is still in the embryonic stage, but the development trend is pretty good. **Market size and the number of enterprises are both increasing simultaneously.** In 2015, signed contracts for soil remediation reached 2.128 billion yuan (USD 322.5 million), an increase of 67 per cent compared to 1.274 billion yuan (USD 193.1 million) in 2014. The number of enterprises engaged in soil remediation in China has exceeded 900, nearly twice the 500 that were involved in 2014. More than 100 soil remediation projects were carried out in China in 2015. According to China’s industrial information network, it is expected that from 2014 to 2020, the domestic soil remediation market will grow to 685.6 billion yuan (USD 103.89 billion). Profiting from huge development potential and preferential policies for soil remediation, more and more companies have entered the soil remediation industry. As of May 2017, there were more than 2,600 companies with soil-related businesses, making it one of the hottest areas in the environmental protection industry.

Figure 2. China’s Soil Remediation Market Forecast (2014–2020)



Data source: “China’s Soil Remediation Market Survey and Development Trend Assessment Report (2015-2020).”

1.1.3 Challenges for Soil Remediation in China

The sheer size of China’s soil pollution control and remediation market means a large demand for funds. For soil remediation of contaminated sites, tremendous capital will be required. However, since the “12th Five-Year Plan,” only 30 billion yuan (USD 4.546 billion) of Central Government funding is allocated to the task of soil remediation in the environmental protection plan, and mainly for urban but not rural areas’ eco-environmental protection, which means a big gap. International experience has shown that soil contamination control is more expensive than water and air pollution control. For example, in the United States in the 1990s, investment in contaminated site restoration was USD 100 billion; European and American countries’ experience also shows that the ratio between the cost of soil protection, the cost of sustainable land management (focusing on risk prevention and control) and the cost of site restoration is basically 1:10:100. On the other hand, China is facing the serious problem of soil pollution for historical reasons. Therefore, whether it is for existing pollution reduction and potential pollution control or for risk prevention, a lot of investment will be needed—soil remediation may need a total investment amounting to dozens of trillion yuan, and the existing soil remediation funds are insufficient to meet the needs of soil pollution control.

China’s historical legacy of soil pollution responsibility is not clear, the polluter pays principle is impractical, and all levels of governments are facing pressure.

Most of China’s agricultural farmland pollution is caused by the transfer of industrial pollutants from urban to rural areas, so it is difficult to define responsibility. Coupled with unclear historical soil quality baselines, most of the former landowners have either closed their factories long ago or the enterprises are being restructured, and it is thus impossible to confirm the persons or entities responsible for the soil pollution. In addition, even if the main body responsible for soil pollution is defined, the principle of “polluter pays” cannot force the polluters to pay all the cost of soil remediation and pollution damages, because the relevant costs may be beyond the financial ability of the responsible main body, especially for major soil pollution incidents or the emergence of soil pollution hazards after a long incubation period. Therefore, the soil remediation costs for historically contaminated sites and contaminated farmland have to be borne by the government, which is a major burden for all levels of government.

Unlike many developed countries in the west, China's public land ownership to a certain extent easily results in the ambiguity of rights and responsibility regarding soil pollution (and site contamination) prevention.

The land ownership system adopted by western developed countries such as the United States, United Kingdom and Germany is based on private ownership, comprising land ownership, various forms of land tenure or other types of land rights, in which the use of land is the basis for determining land ownership, and the owner has the right to use the land. This is helpful in tracking the accountability of soil pollution. For instance, the U.S. Comprehensive Environmental Response, Compensation, and Liability Act (the so-called "Superfund" Act) states that there are four types of parties responsible for land pollution treatment, known as "potential responsible persons" including: the owner and operator of the brownfield site; the owner and operator of the brownfield site when the contaminants are being disposed; the person who deals with the contaminants on the brownfield site (usually the manufacturer of such contaminants); and the person who transports and chooses to deal with such contaminants on the brownfield site (Jia, 2015). The main responsible bodies are classified based on the concept of "potential responsible person." In practice, the potential responsible persons involve almost all the people related to land pollution, i.e., the land owner, the land operator, the land user (such as the person disposing of the contaminants). In this way, polluters' responsibilities are enhanced to the maximum extent to ensure the responsible main body's accountability. China's public land ownership has, to a certain extent, led to the ambiguity of pollution control rights and responsibilities, and the existing legislation lacks clear provisions on how to punish the main body responsible for land pollution, which has resulted in the phenomenon that land users are solely pursuing economic interests, ignoring their responsibility to protect the land and control (and prevent) pollution. The lack of land pollution accountability provisions in legislation has made it even more difficult to control land pollution in China. Therefore, China must not simply and mechanically mandate one single party in the legislation (such as the landowner), to bear the responsibility of treating and restoring contaminated sites, because it will lead to the evasion of responsibility and is not conducive for pollution control.

Since legal and regulatory standards are nonexistent or incomplete, the main body responsible for soil pollution in China is difficult to define. It is impossible to raise all funds needed for soil pollution treatment based simply on the principle of "polluter pays."

China has not yet promulgated a special law on soil pollution prevention and control—the existing relevant provisions on soil pollution prevention and control are seen in different laws and regulations, such as laws on environmental pollution control, natural resources protection regulations and agricultural regulations. For example, in the "Environmental Protection Law" (China Legal Publishing House, 2014); "Law on Prevention and Control of Environmental Pollution by Solid Waste" (Law Press China, 2016); "Agricultural Law" (Law Press China, 2013); "Grassland Law" (China Legal Publishing House, 2013); "Law of Land Administration" (China Legal Publishing House, 2017) and "Law on Quality and Safety of Agricultural Products" (Law Press China, 2010; 2016). there are some provisions on soil pollution prevention and control, but there are no special laws or regulations on soil pollution accountability. Therefore, the main responsible body is not easy to define, and it is difficult to directly track down the persons responsible for soil pollution or identify the level of soil contamination. China's existing soil environmental protection standards are not well defined. For example, the "Environmental Quality Standard for Soils" (China Standards Press, 1996) released in 1996, only states provisions on agricultural soil standards. There is no provision for contaminated site redevelopment and use standards; the "Environmental Quality Risk Assessment Criteria for soil at manufacturing facilities" (China Environmental Science Press, 1999) promulgated in 1999 can only be applied to the assessment of soil environmental quality during the stage of enterprise location selection and the production process, which does not include the soil standards for the redevelopment of contaminated sites and the development of residential land. In 2012, the Ministry of Environmental Protection, the Ministry of Industry and Information Technology, the Ministry of Land and Resources and the Ministry of Housing and Urban–Rural Construction jointly issued the "Notice on Safeguarding the Environmental Safety in Redevelopment and Utilization of Industrial Enterprise Sites" (MEP 2012 [140]) (Ministry of Environmental Protection, Ministry of Industry and Information Technology, Ministry of Land and Resources & Ministry of Housing and Urban–Rural Construction, 2012) which stated that enterprises relocated after 2012 shall be responsible for the restoration of the contaminated sites. As to the land transfer transactions before 2012, there is no provision on who is responsible for the restoration of contaminated sites and the costs. Especially for contaminated sites whose ownership has been transferred for multiple times, it is impossible to lock

down the responsibly person, the polluter pays principle is not applicable and the costs for contaminated sites restoration have to be borne by the government.

Comparatively speaking, the level of soil remediation technology, construction capacity and engineering experience for restoration of contaminated sites in China lags about 40 to 50 years behind that of developed countries.

In foreign countries a specialized and practical system of soil remediation technologies has already been established, a complete soil remediation industry chain and market has been formed, the soil remediation techniques and materials are mature, and they have complete equipment, professional experts and engineering staff. In contrast, China's soil remediation technology R&D and engineering applications are still in the initial stages. In the beginning, they were limited to the use of cement kiln and landfill technology, and gradually we have developed the mainstream technologies such as thermal desorption, chemical oxidation, gas extraction, curing/stabilization techniques, as well as an engineering system applicable to in situ and ectopic processing. In terms of farmland utilization, China's level of soil remediation technology R&D for contaminated farmland restoration is basically the same as that of western developed countries. As of the "10th Five-Year Plan," with support from the Ministry of Science and Technology, China carried out a number of technology research and demonstration projects in phytoremediation, agronomic resistance control, chemical regulation, agronomy and chemistry that are integrated for realizing soil pollution control and remediation. These technologies include: heavy metal-contaminated farmland phytoremediation technology, low-accumulation varieties of agronomic resistance control technology, water and fertilizer regulation technology, as well as other technologies for safe use of farmland. China has also developed technologies for organic contaminated farmland soil bioremediation and plant-microbial joint remediation. In general, China's soil pollution control and remediation technology level and engineering experience is at the "practice, improve, explore and integrate" stage.

In general, soil remediation and treatment require diversified modes of financing. Due to the large capital demand for soil remediation and treatment, it is impractical to rely on government finance alone. Many developed countries are actively expanding financing sources with innovative investment and financing mechanisms. The United Kingdom has promulgated policies to encourage the private sector to engage in the soil remediation industry. As a result, 60 per cent of remediation funds come from social capital investment (Ma et al., 2015). The United States has established the Superfund for contaminated site management and remediation, and its diversified financing includes the regular payment of funds from the Federal Reserve, material tax on highly polluting products, an environmental tax paid by large-scale enterprises, and fund interest (among other means). For instance, since the establishment of the Superfund in 1995, in all financing channels, tax revenues accounted for 67.5 per cent, government funding accounted for 17.3 per cent, and other sources accounted for 15.2 per cent (Jia, 2015). The social financing is helpful in supplementing the capital needed for cleaning up contaminated sites and compensating the contamination victims. In order to encourage enterprises to invest in soil pollution control, Japan has developed a set of effective support mechanisms. In February 2006, Japan's policy investment bank, Sumitomo Trust Bank, the professional soil pollution control company Green Planet and three other institutions jointly established Japan's first special fund for contaminated soil recycling, which is used to acquire and treat urban industrial sites contaminated by hazardous substances (Sina.com, 2006).

1.2 China's Soil Pollution Prevention and Control Policies

1.2.1 National Policies

As early as 2008, the Ministry of Environmental Protection of the People's Republic of China issued the "Opinions on Strengthening the Prevention and Control of Soil Pollution (MEP [2008] p. 48)," which put forward that "the management system framework of soil pollution prevention and control policies, laws and regulations should be established by 2010." In order to strengthen the work of heavy metal pollution prevention and control, in November 2009, the General Office of the State Council forwarded the "Guidance on Strengthening the Prevention and Control of Heavy Metal Pollution" (State Council, 2009) jointly promulgated by the Ministry of Environmental Protection and other ministries. All regional governments and relevant departments, in accordance with the arrangement of the State Council, have been actively providing more policy support and financial support for steadily pushing forward the work of heavy metal pollution prevention

and control. In order to ensure the environmental safety of the redevelopment and utilization of industrial enterprise sites, on November 27, 2012, the Ministry of Environmental Protection, the Ministry of Industry and Information Technology, the Ministry of Land and Resources and the Ministry of Housing and Urban-Rural Construction jointly issued the “Notice on Safeguarding the Environmental Safety in Redevelopment and Utilization of Industrial Enterprise Sites” (MEP et al., 2012) in which it is required to “carry out soil remediation activities and define the responsible main body in accordance with the principle of ‘polluters repair.’” (Article 7) And on May 28, 2016, the State Council promulgated the “Soil Pollution Prevention and Control Action Plan,” (State Council, 2016) which is the guideline for current and future work of national soil pollution prevention and control. The “Action Plan” proposes the following:

... first construct six pilot zones for comprehensive prevention and control of soil pollution, and the 200 pilot projects of soil remediation technology application should be implemented in phases; based on government and social capitals cooperation (PPP) mode, use the government finance as the leverage to motivate the investment of more social capitals in soil pollution prevention and control; actively develop green finance, policy and development-oriented financial institutions should be encouraged to play the guiding role in supporting major soil pollution prevention and control projects; and encourage qualified soil remediation enterprises to issue stock shares. (Article 26, 28-29)

On December 29, 2017, the 31st Meeting of the Standing Committee of the 12th National People's Congress reviewed the “Law on the Prevention and Control of Soil Pollution of the People's Republic of China (Draft for Second Deliberation).” Article 68 of the draft states:

“The state establishes a fund system for the prevention and control of soil pollution. The establishment of central and provincial soil pollution prevention and control funds is mainly used for soil pollution control in agricultural land, soil pollution control that cannot be identified by those responsible for soil pollution or land users and other matters stipulated by the government”. Article 69 of the draft states: “The state encourages financial institutions to scale up credit for the management, control and remediation projects relating to soil pollution risks.”

The Action Plan provides legal protection for soil remediation financing, and social capital investors are increasingly willing to invest in soil remediation.

Table 1. Soil Remediation Policy Documents and Main Content

Policy	Date of Issuance	Issued By	Main Content
“Opinions on Strengthening the Work of Soil Pollution Prevention and Control”	2008.6.6	MEP	<p>Focusing on soil remediation of farmland and contaminated sites, especially abandoned industrial sites in urban areas;</p> <p>By 2020, complete the national survey of soil pollution status and establish the soil environmental monitoring network; establish the regulatory system framework for soil pollution prevention and control policies, laws and regulations;</p> <p>By 2015, establish the management system of soil pollution prevention and control supervision.</p>

Policy	Date of Issuance	Issued By	Main Content
“Notice of the State Council on Forwarding the ‘Guidance of the Ministry of Environmental Protection and Relevant Ministries on Strengthening the Work of Heavy Metal Pollution Prevention and Control’” (SC [2009] 61)	2009.11	General Office of the State Council	Defining the tasks and goals for the work of heavy metal pollution prevention and control, as well as relevant policy measures.
“The 12th Five-Year Plan for the Comprehensive Prevention and Control of Heavy Metal Pollution”	2011.2	State Council	Identifying 14 key provinces (Inner Mongolia, Jiangsu, etc.), 138 key areas and 4,452 key enterprises for conducting comprehensive prevention and control of heavy metal pollution; By 2015, the emissions of heavy metals such as lead, mercury, chrome, cadmium and metal arsenic should be reduced by 15 per cent over 2007.
“Notice on the Organizing of Historical Heavy Metal Pollution Control Projects for Application of 2012 Central Budget Investment”	2012.2.14	NDRC	For projects of which the local enterprises are responsible for conducting soil remediation, a subsidy of no more than 30 per cent of the total investment will be provided; for projects of which the locally based central enterprises are responsible for conducting soil remediation, a subsidy of no more than 45 per cent of the total investment will be provided.

Policy	Date of Issuance	Issued By	Main Content
“Xiangjiang River Basin Heavy Metal Pollution Control Implementation Plan” (2012-2015)	2012.6.27	Hunan Provincial Government Office	By end of 2015, try to realize 70 per cent reduction of total emission of heavy metals (lead, mercury, cadmium, arsenic, etc.) based on the level of 2008. 856 projects shall be implemented during the “12th Five-Year Plan” period, with a total investment of 50.5 billion yuan (USD 7.6524 billion).
“Notice on Safeguarding the Environmental Safety of Industrial Enterprise Site Redevelopment”	2012.11.27	Ministry of Environmental Protection, Ministry of Industry and Information Technology, Ministry of Land and Resources, Ministry of Housing and Urban–Rural Construction	It is proposed to implement the principle of “polluter pays,” i.e., polluting bodies shall be responsible for carrying out soil remediation.
“Work Plan for Soil Environmental Protection and Comprehensive Control in Next Stage”	2013.1.23	State Council	By 2015, complete the survey report of China’s soil environmental status; By 2020, establish the national soil environmental protection system.
“Measures for the Management of Mining Geological Environment Restoration Special Fund” ([2013] 80)	2013.3.27	Ministry of Finance, Ministry of Land and Resources	A special fund shall be established for mining geological environment restoration projects and relevant expenses.

Policy	Date of Issuance	Issued By	Main Content
“Opinions of the General Office of the State Council on Promoting the Third-party Treatment of Environmental Pollution”	2015.1	General Office of the State Council	For the first time, the remediation of contaminated sites was included in the scope of treatment. It is recommended that third-party treatment be introduced using the environmental performance contract service model.
“Soil Pollution Prevention and Control Action Plan”	2016.5.28	State Council	Select six pilot areas for conducting comprehensive prevention and control of soil pollution; increase the investment and innovate the financing mode such as PPP mode, so as to motivate more social capital firms to invest in soil remediation projects; actively develop green finance; policy and development-oriented financial institutions should play the guiding role in providing support to major soil remediation projects; qualified soil remediation enterprises shall be encouraged to issue stocks.
“Soil Environmental Management Measures for Contaminated Sites”	2016.12.31	MEP	To clarify regulatory priorities, make sure that all parties fulfill their duties, and stipulate that environmental investigation covers risk assessment, risk management and control, treatment and remediation, and supervision and management.

Policy	Date of Issuance	Issued By	Main Content
“Soil Remediation Plan (2016–2020)”	2017.2	Ministry of Land and Resources NDRC	To ensure that 400 million mu (26.7 million hectares) of high-standard farmland is built, and strive to build 600 million mu (40 million hectares) of high-standard farmland; the basic farmland remediation rate in the country reaches 60 per cent; 20 million mu (1.3 million hectares) of arable land is restored; 200 million mu (13.3 million hectares) of low- and medium-grade arable land is transformed; 6 million mu (0.4 million hectares) of rural construction land is reorganized; 6 million mu (0.4 million hectares) of underused land is transformed and developed; 400-600 million mu (26.7-40 million hectares) of high-standard farmland is built and the total investment is 0.72–1.08 trillion yuan (USD 109.2–163.7 billion).
“Soil Management Measures for Agricultural Land (Trial)”	2017.9.25	MEP	It stipulates soil environmental survey, monitoring, classification of soil quality in agricultural land, priority conservation, risk management and control or treatment and remediation, emergency management and other contents.
Request for Comments on the Soil Pollution Prevention and Control Law (Draft for Second Deliberation)	2017.12.29	Legislative Affairs Commission of the Standing Committee of the National People's Congress	It clearly specifies the responsible persons for soil pollution, defines the principle of prevention and control, identifies the technical route and the technical standards, and stipulates how to properly make use of the government–market relationship to ensure the long-term sustainability of pollution control and prevention.

Box 1. The Action Plan for Prevention and Control of Soil Pollution

Objectives: By 2020, the national trend of soil pollution aggravation shall be basically contained, the overall soil environmental quality shall be stable, farmland and construction land's soil environmental safety shall be basically guaranteed, and soil environmental risks shall be under basic control. By 2030, the national soil environmental quality shall be stable and improving, farmland and construction land's soil environmental safety shall be under effective protection, soil environmental risk shall be under full control. By middle of the century, the overall soil environmental quality shall be improved, and virtuous circle of the ecosystems shall be realized.

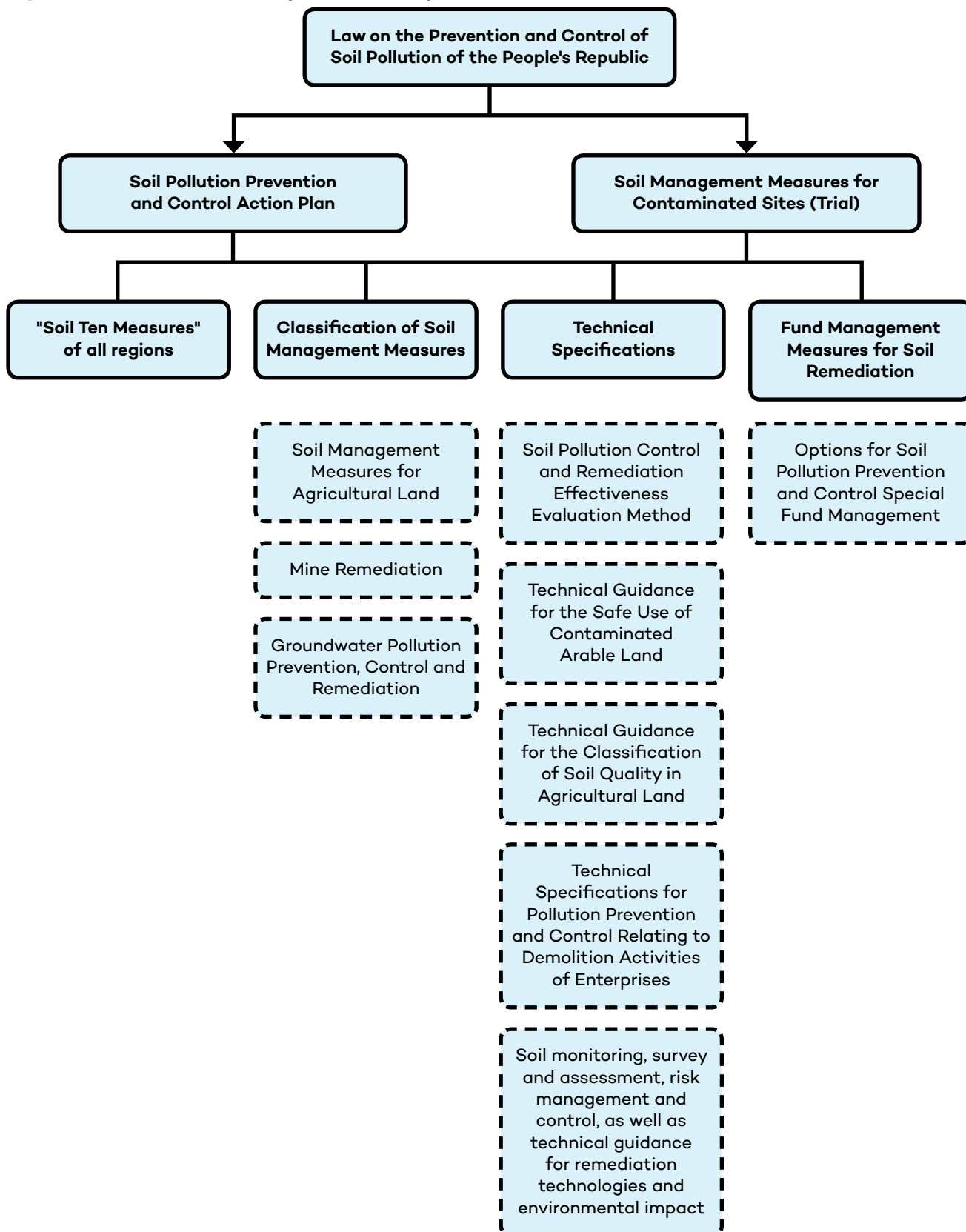
Main indicators: By 2020, the safe utilization rate of contaminated farmland should be around 90 per cent, and the safe utilization rate of contaminated sites should be over 90 per cent. By 2030, the safe utilization rate of contaminated farmland should be over 95 per cent, and the safe utilization rate of contaminated sites should be over 95 per cent.

Main contents: (1) To carry out soil pollution survey to master the status of soil environmental quality; (2) To promote the legislation of soil pollution prevention and control and establish and improve the regulatory standard system; (3) To carry out farmland classification management and protect the environmental safety of agricultural production; (4) To implement the construction land approval management and prevent the risk to human settlements; (5) To strengthen the protection of non-contaminated soil and strictly control the trend of new soil pollution; (6) To strengthen pollution control and enhance the soil pollution prevention; (7) To carry out pollution control and soil remediation activities and improve the regional soil environmental quality; (8) To enhance scientific and technological research and development efforts and promote the development of environmental protection industry; (9) To use the government's leading role in building the soil environmental management system; (10) To strengthen the system of performance evaluation and the system of accountability tracking.

China's mineral resources development has caused serious impact and damage on the geological environment, and at this stage China's financial resources at all levels are insufficient to meet the demand for mine geological environmental restoration and comprehensive treatment. On July 1, 2016, the Ministry of Land and Resources, the Ministry of Industry and Information Technology, the Ministry of Finance, the Ministry of Environmental Protection and the State Energy Bureau jointly issued the "Guidance on Strengthening the Mining Geological Environment Restoration and Comprehensive Treatment" (MEP, 2016) **which clearly states that governments at all levels should increase the capital investment and expand the funding channels, so as to provide necessary support to the restoration of geological environment of the abandoned mines or those closed for policy reasons. Under the policy guidance, more social capital firms shall invest in mining geological environment restoration, diversified investment and financing modes shall be formed for mining area's eco-environmental protection and pollution control.**

The idea of the Law on the Prevention and Control of Soil Pollution of the People's Republic of China was first put forward in 2014 and is now entering a critical final stage. In March 2017, comments were requested for the law and it is expected to be introduced in mid-2018. This will set up standards, inputs and approaches for soil pollution prevention and control from a legislative perspective. During the Thirteenth Five-Year Plan period, there will be more supporting policies, along with the "Soil Ten Measures" and the Law on the Prevention and Control of Soil Pollution of the People's Republic of China, to form a complete policy system, including relevant laws and regulations, technical guidance, data investigation and treatment pilot projects. The future soil remediation industry will form a specific and systemic architecture (Figure 3), from the legislative level to the implementation level, to the final management methods, technical specifications, and policies of all provinces and municipalities; and a truly effective policy system will be in effect.

Figure 3. Future soil remediation policies will be systematic



Source: Forward Business and Intelligence Co. (2017).

1.2.2 Regional Policies

At present, provincial work plans have been released by the governments of 32 provinces (autonomous regions and municipalities) such as Beijing, Tianjin, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Guangdong, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Hunan, Hubei, Henan, Xinjiang, Hainan, Hebei, Shandong and Tibet. In each work plan it is proposed to attract more social capital firms to participate in soil pollution prevention and control through diversified financing, such as PPP. Policy and development-oriented financial institutions should play a guiding role for supporting the implementation of major soil pollution prevention and control projects, so as to encourage heavy metals-related high environmental risk enterprises to invest in environmental insurance liability insurance.

The progress of local construction of soil pollution prevention and control laws and regulations is rather slow. In 2015, Fujian province issued the “Fujian Province Soil Pollution Prevention and Control Measure” (Fujian Provincial People's Government, 2016) which is China's first local regulation on soil pollution control.

In 2016, Hubei province issued the “Hubei Province Soil Pollution Prevention and Control Regulation” (Hubei Provincial People's Government, 2016), which requires that

people's governments at or above the county level should establish a special fund for soil pollution prevention and control through integrating the government fund, land transfer income, sewage discharge fees. The government fund and social capitals should be combined to guarantee a diversified capital investment and safety mechanism. (Article 4)

Jilin, Hunan, Guangdong and other provinces are also developing local soil pollution prevention and control regulations respectively. The legislation provides legal protection for the implementation of soil remediation investment and financing. The establishment of a special fund for soil pollution prevention and control in Hubei province provides a financial guarantee for the soil remediation, which may be used as a reference for other regions to construct laws and regulations on soil remediation and financing.

1.3 Soil Remediation Green Financing Policies

1.3.1 Green Financing Policies Focusing on Traditional Financing Instruments

Green finance is an increasing global trend. On September 21, 2015, the CPC Central Committee and the State Council issued the “Overall Plan for Ecological Civilization System Reform,” (CPC Central Committee and the State Council, 2015). which includes for the first time the requirement “to establish China's green financial system.” Under such circumstances, we list below the important measures of the existing domestic green financial policies in promoting green investment.

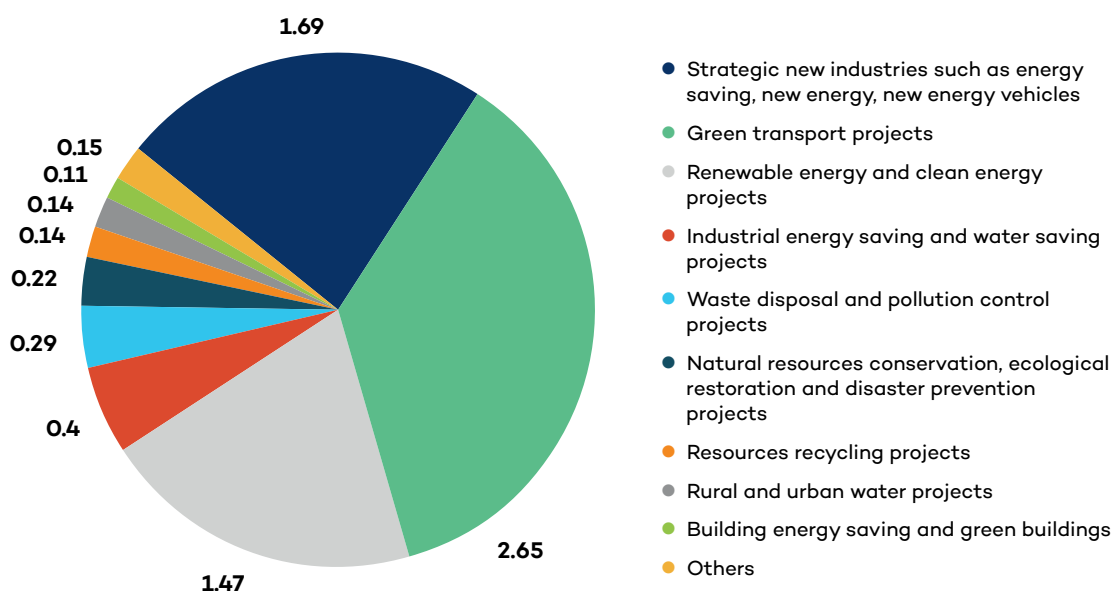
Green credit is the most important mode of green financing. In recent years in banking sector, the financial institutions have begun to use green credit as the starting point to innovative credit products and adjust the credit structure, so as to provide active support to energy conservation and environmental protection, and initial effects have been achieved. On February 24, 2012, the China Banking Regulatory Commission (CBRC) issued the “Guideline on Green Credit” (CBRC, 2012, p. 4), which required that

the banking financial institutions should carry out the comprehensive green credit assessment at least once in two years; the banking financial institutions should focus on the hazards and risks related to their clients and their key affiliates in the construction, production and business activities that might affect the environment and the society, including the environmental and social problems related to energy consumption, pollution, land, health, safety, resettlement, ecological preservation and climate change, etc.

In the same year, the CBRC promulgated the “Guideline on the Performance Evaluation of Banking Financial Institutions” (CBRC, 2012), requiring financial institutions to set up social responsibility indicators in their own performance evaluations. In order to effectively prevent the environmental and social risks caused by credit loss

and adverse effects (while ensuring the success of green credit work), on February 7, 2013, the CBRC issued the “Opinion Concerning the Green Credit Work” (CBRC, 2013, p. 40), in which it proposed “to provide active support to the development of green, recycling and low-carbon industries.” In the same year, the CBRC formulated the “Green Credit Statistics System” (CBRC, 2013, p. 185), which required that all banks produce statistics on the enterprises that present major environmental and safety risks, including the amount of corporate loans, the amount of energy conservation and environmental protection project and service loans. In June 2014, the CBRC issued the “Key Assessment Indicators for Green Credit Implementation Performance” (CBRC, 2014, p. 186), which is to be used as the basis for green bank ratings. In 2016, the CBRC was dedicated to the task of instructing the banking association to develop a green bank evaluation system, so as to provide the green banking evaluation mechanism for the financial institutions to actively carry out green financing business and carry out environmental and social risk management. According to the statistics released by the CBRC in 2016 press conference, as of the end of June 2016, the total green credit balance of 21 major banking financial institutions was 7.26 trillion yuan (USD 1.1001 trillion), accounting for 9.0 per cent of the total loans. (Xinhua08.com, 2016) At present, the pollution control and soil remediation industry has a large demand for capital—the financial institutions will play an active role in guiding the flow of social capital firms and the allocation of financial resources, to ensure heavy asset investment in the pollution control and soil remediation industry.

Figure 4. Distribution of Green Credit Loans in China (unit: trillion yuan)



Source of data: Xinhua08.com (2016)

Green bonds represent the most promising mode of green financing, and the market is developing fast. On December 22, 2015, the People’s Bank of China issued the “Announcement on the Issuance of Green Financial Bonds,” in which the qualification requirements for the Chinese financial institutions to issue green financial bonds as well as the procedures are given. Attached to the “Announcement” is the “Catalog of Green Bond Supporting Projects (2015 edition)” (PBC, 2015) compiled by the China Finance Society’s Green Finance Committee, which is also the first document on the definition and classification of green bonds in China. This version of the Catalog includes six types of project, including pollution control projects. On December 31 of the same year, the State Council’s Development and Reform Office issued the “Notice on the Issuance of Green Bonds” (State Council’s Development and Reform Office, 2015) mainly for supporting the issuance of green bonds for soil remediation projects, signifying that the channel for soil remediation industry’s debt capital market financing has been opened up. At present, China’s green bonds mainly include financial bonds, non-financial corporate debt financing instruments, enterprise bonds, corporate bonds and green structure financing tools, such as the green credit asset securitization program and the green project profitability asset support program (Table 2).

Table 2. Green Bond Supporting Projects

“Catalog of Green Bond Supporting Projects”	“Guidelines for Green Bond Issuance”
<p>Energy Saving</p> <p>Including energy-efficient facilities construction projects and energy-saving technological transformation projects, etc., for achieving reduction of energy / water resources / raw materials consumption in unit products or services, or for reduction of pollutants generated from the use of resources and reduction of carbon dioxide and other greenhouse gases, so to achieve environmental benefits.</p>	<p>Technical Renovation for Energy Saving and Emission Reduction</p> <p>Including coal-fired power plant’s ultra-low-emission nuclear energy-saving transformation, as well as the use of waste heat and other residual heat, upgrading coal-fired boiler’s energy-saving environmental protection, improving motor system’s energy efficiency, improving enterprise energy efficiency, green lighting, etc.</p>
	<p>Green Urbanization Projects</p> <p>Including green building development, building industrialization, existing building’s energy-saving transformation, construction of sponge cities,[*] intelligent cities, smart grids, energy-absorbing vehicle charging facilities etc.</p>
<p>Pollution Prevention</p> <p>Through the construction of desulfurization, denitrification, dust removal, sewage treatment and other facilities, as well as other types of comprehensive environmental management measures, achieve the objectives of pollution reduction and environmental pollution control, as well as protection, restoration and improvement of the environment.</p>	<p>Pollution Control Projects</p> <p>Including wastewater treatment facilities and other environmental infrastructure construction projects, atmosphere, water and soil pollution control projects, hazardous waste, solid waste and industrial tailings disposal projects.</p>
	<p>Eco-Agriculture and Forestry Projects</p> <p>Including projects for the development of organic agriculture, eco-agriculture, special economic forest, forestry economy, forest tourism, etc.</p>
<p>Resources Conservation and Recycling</p> <p>Including projects for tailings and associated mine reuse, industrial and agricultural production waste utilization, waste metal, non-metallic resources recycling and re-manufacturing, with the aim of improving resource utilization to achieve resource conservation and reducing environmental damage.</p>	<p>Circular Economy Development Project</p> <p>Including projects of industrial parks recycling renovation, waste recycling, as well as agricultural circular economy, re-manufacturing industry, etc.</p>
	<p>Water Resources Conservation and Unconventional Water Resources Development and Utilization</p> <p>Including water-saving transformation, seawater (brackish water) desalination and reclaimed water utilization projects.</p>

* Refers to cities that have good "resilience" in adapting to environmental changes and coping with natural disasters caused by rain. It can also be called "water elastic city."

“Catalog of Green Bond Supporting Projects”	“Guidelines for Green Bond Issuance”
<p>Clean Transport</p> <p>Including railway and urban rail transit construction, clean fuel production facilities construction, new energy vehicle promotion and other activities, with the aim of reducing the transport sector’s intensity of greenhouse gas emissions and pollutant emissions, so as to achieve energy saving and emission reduction benefits.</p>	<p>Energy Saving and Environmental Protection Industry Projects</p> <p>Including projects of energy conservation and environmental protection, major equipment, technology industrialization, contracted energy management, energy saving and environmental protection industry base (park) construction.</p> <p>Low-carbon Industry Projects</p> <p>Including low-carbon technology and equipment industrialization projects, low-carbon product production projects, low-carbon services-related construction projects.</p>
<p>Clean Energy Use</p> <p>Through the use of solar energy, wind energy, water energy, geothermal energy, marine energy and other renewable energy, replace the use of fossil energy and reduce the emission of pollutants and carbon dioxide generated from fossil energy development, production and consumption; through the use of clean energy such as natural gas, realize pollutant reduction benefits.</p>	<p>Clean and efficient use of energy. Including coal, oil and other energy-efficient clean use.</p> <p>New Energy Development and Utilization Projects</p> <p>Including the development and utilization of water energy, wind energy, nuclear energy, solar energy, biomass energy, geothermal energy, shallow low-temperature energy, ocean energy, air energy, etc.</p>
<p>Ecological Conservation and Climate Change Adaptation</p> <p>Through the comprehensive soil loss control, ecological restoration and disaster prevention and control, nature reserves construction, etc., realize the improvement of eco-environmental quality, disaster prevention and mitigation, protection of biodiversity and other environmental benefits; through afforestation, forest-tending management and protection, construction of ecological husbandry and fishery and infrastructure construction, adapt to the impact of climate change.</p>	<p>Ecological Civilization Demonstration Projects</p> <p>Including the resources conservation, circular economy development, environmental protection and ecological construction projects to be carried out in ecological civilization demonstration areas.</p> <p>Low-carbon Development Pilot Demonstration Projects</p> <p>Including low-carbon energy, low-carbon industry and low-carbon transport and low-carbon building pilot projects at provincial, municipal, community and industrial park levels, as well as low-carbon construction and carbon management platform construction projects.</p>

Table 3. List of Green Bonds

Type of Bond	Enterprise Bonds	Non-financial Enterprises' Debt Financing Tools	Financial Bonds	Overseas Green Bonds Issued by Domestic Financial Institutions	Corporate Bonds	Green Energy Bonds
Short Form	17 Longhu Green Bond 01	16 Dun'an GN002	16 Pudong Green Financial Bond 01		G16 Three Gorges 1	G16 Beijing Enterprises 1
Issued By	Chongqing Longhu Enterprise Development Co., Ltd	Dun'an Holdings Group Co., Ltd.	Shanghai Pudong Development Bank	Bank of China, London Branch	China Three Gorges Group Co., Ltd.	Beijing Enterprises Water Group Limited
Location of IPO	Interbank market	Interbank securities market	Interbank securities market	London Stock Exchange	Shanghai Stock Exchange	Shanghai Stock Exchange
Date of Issuance	2017.2.17	2016.11.29	2016.1.27	2016.11.3	2016.8.26	2016.8.1
period	5 years	3 years	3 years	3 years	3 years	8 years
Rating	AAA/AAA	AA+/AA+	AAA/AAA	Aa3	AAA/AAA	AAA/AAA
Third-Party Certification	--	China Bond Rating Co., Ltd.	Ernst & Young	Ernst & Young	Ernst & Young	Green Finance

Type of Bond	Enterprise Bonds	Non-financial Enterprises' Debt Financing Tools	Financial Bonds	Overseas Green Bonds Issued by Domestic Financial Institutions	Corporate Bonds	Green Energy Bonds
Trustee	China Bond	Shanghai Clearing House	China Bond		CSDC	CSDC
Underwriter	CITIC Construction	Industrial Bank Co., Ltd.	Guotai Jun'an Securities		CITIC Securities	CITIC Construction
Use of Fund	Fixed asset investment and working capital for green building projects	Supplementary fund for energy saving, wind power and photovoltaic projects; for replacing wind power projects' bank loans	By end of 2016, a total of 50 billion yuan (USD 7.5767 billion) has been raised, of which more than 40 billion yuan (USD 4.0613 billion) shall be used for energy conservation, pollution control and clean transport projects, the remaining 9 billion yuan (USD 1.3638 billion) is idle.		Fund for hydropower project construction	For green industry project construction, operation, acquisition and repayment

Source of data: Zhang, 2017.

As of 2007, China has been implementing a pilot program of environmental pollution liability insurance, signifying the initiation of green insurance. Since 2007 when the State Environmental Protection Administration and the China Insurance Regulatory Commission jointly issued the “Guidance on the Work of Environmental Pollution Liability Insurance,” (SEPA, 2007) a number of local policies on environmental pollution liability insurance have been promulgated, and the pilot programs of environmental pollution liability insurance have been carried out accordingly. For example in Zhejiang, Hunan and Guangdong, the implementation of environmental pollution liability insurance is mainly focused on the chemical pollution and heavy metal pollution-related industries. Since 2013 when the Ministry of Environmental Protection and the China Insurance Regulatory Commission jointly issued the “Guidance on the Implementation of the Pilot Programs of Environmental Pollution Compulsory Liability Insurance,” a number of local guidelines have been consecutively promulgated in Beijing, Shandong, Shaanxi, Liaoning, Xinjiang, Jiangxi, Qinghai and Guizhou. At present, except for Fujian, Heilongjiang, Tianjin, Ningxia and Tibet, most provinces have been carrying out environmental pollution liability insurance pilot programs. On the whole, in different regions, various industries have been carrying out environmental pollution liability insurance pilot programs **involving almost all types of polluting enterprises, but mainly including heavy metals and hazardous chemicals production and operation units as well as hazardous waste generation, collection and disposal enterprises.** The implementation of environmental pollution liability insurance pilot programs has been effective. According to statistics, in 2014, the China’s 22 provinces, 70 million yuan (USD 10.6073 million) was paid for environmental pollution liability insurance for a total amount of 5.5 billion yuan (USD 833.4 million) (Xinhuanet, 2015).

1.3.2 Other Financing Policies Focusing on Innovative Financing Instrument

PPPs (public–private partnerships) are promoted in investment and financing innovation. In 2014, the Ministry of Finance and the National Development and Reform Commission consecutively issued five documents to promote the implementation of PPP mode, these documents are: “Notice of the Ministry of Finance on the Issues Concerning the Promotion of Public–Private Partnership” (MOF, 2014, 76), “Notice of the Ministry of Finance on the Instruction of Public–Private Partnership (Pilot)” (MOF, 2014, 113), “Notice of the Ministry of Finance on the Regulation of PPP Contract Management” (MOF, 2014, 156), “Notice of the Ministry of Finance on the PPP Procurement Management Measures” (MOF, 2014, 215), “Guidance of the National Development and Reform Commission on the Implementation of Public–Private Partnership” (NDRC, 2014, 2724). **The promulgation of these five documents signifies the arrival of PPPs.** Among these five documents, the promulgation of the “Notice of the Ministry of Finance on the Instruction of Public–Private Partnership (Pilot)” (MOF, 2014, 113) is most effective in promoting the operation of PPP projects. **The PPPs are useful in utilizing social capital firms for meeting funding demand and promoting soil remediation financing.** On April 25, 2017, the General Office of the National Development and Reform Commission issued the “Notice on the Printing and Distribution of the ‘Guidance on the Issuance of Special Bond for Public–Private Partnership (PPP) Projects’” (NDRC, 2017, 730), which is useful in guiding social capital firms to invest in PPP project construction and promoting the supply of public goods and services, so as to encourage enterprises to issue bonds to support PPP project construction.

In fact, local implementation of PPP pilot projects dates back even earlier—in 2000, the Shanghai Municipal Government promulgated the “Opinion on Further Servicing the Nation and Expanding A Number of Policies on Opening the Domestic Market” (Shanghai Municipal Government, 2000) which clearly states that various types of investors, including private businesses and private capital firms, are encouraged to participate in the operation of infrastructure construction in the form of sole proprietorships, joint ventures, partnerships, joint operations, stock buying or franchising, etc. In recent years, with the trend of promoting further cooperation between social capital firms and government funds, a series of normative administrative documents focusing on infrastructure construction have been developed. Under such circumstances, a number of local normative documents have been promulgated accordingly in many provinces (autonomous regions and municipalities) such as Beijing, Guangdong, Hunan, Henan, Anhui, Zhejiang, Jiangsu, Fujian, Hubei, Hebei, Jiangxi, Shanxi, Gansu, Liaoning, Sichuan, Yunnan, Guizhou, Shaanxi, Xinjiang and Hainan. And among the PPP projects approved and announced by each province, the total investment in waste disposal and sewage treatment

and comprehensive environmental pollution control has reached tens or hundreds of billion yuan. **The promulgation of these supporting policies and measures has provided a good basis and reference for the local exploration of soil remediation PPP projects, and under the guidance of these documents, a large number of social capital firms have entered into the pollution control and soil remediation industry in the form of PPP project investment.**

2 Practice and Exploration of Soil Remediation Patterns in China

2.1 Remediation + Development

2.1.1 Brief Introduction

The “Remediation + development” pilot demonstration occurs when the soil remediation enterprise and the developer work as a whole cooperatively to contract for contaminated site restoration and development. After land restoration (and in market transactions), the value-added part shall be treated as the income for the soil remediation enterprise. The biggest advantage of “remediation + development” pilot demonstration is the introduction of the market capital firms: soil remediation costs are borne by the developers, and the burden of soil remediation cost on the government is reduced. However, the shortcoming is precisely the same—since the developers are the payer and there are no corresponding laws and regulations on the soil remediation market, without rigid system constraints, the developers are motivated to put soil remediation funds for other use; therefore the quality of soil remediation cannot be ensured. On the other hand, the long cycle of soil remediation means higher risk management requirements for the developers, who might be eager to pursue profits and implement lower standards for soil remediation.

The mode of the “remediation + development” pilot demonstration is widely used in industrial soil remediation market, but rarely used in the mining industry’s soil remediation market and farmland restoration market. The main reason is that industrial soil remediation is often carried out for contaminated sites from industrial restructuring, factory relocation, and the restored industrial sites are often put into civilian use with a large space for value appreciation. Therefore, enterprises have an incentive to carry out soil remediation to improve the land value, reflecting the concept of “Beneficiaries pay.” In contrast, mining land and farmland have little space for value appreciation due to their location and use limit, and so enterprises show little willingness for soil remediation. As a matter of fact, financing mainly depends on the local finance, and the local governments are facing financial pressures. In future, the soil remediation market will be further explored for discovering new business modes to meet the demand for financing.

2.1.2 Successful Project Demonstration of R+D Mode in China

(1) “Remediation + Development” Demonstration of Industrial Sites After Enterprise Relocation

In recent years, Beijing has been vigorously implementing the restructuring policy of “reducing the secondary industry and developing the tertiary industry,” with a large number of industrial enterprises moved out of the downtown area. According to the “Beijing Olympic Action Plan • Eco-Environment Special Plan,” by 2008, about 200 enterprises in the southeast and inside the Fourth Ring should be relocated. After the completion of the industrial enterprises relocation, 8,000,000 m² land shall be available in the urban area of Beijing (Huanbao, 2016). The relocated enterprises are mostly coking, chemical or smelting enterprises representing decades of industrial production, and the plant sites and surrounding land have been seriously polluted with industrial waste stocking pollution and heavy metal soil pollution. These contaminated sites are a threat to human health and ecological safety, but the advantageous geographical location of the contaminated sites signifies an inevitable trend for redevelopment for commercial and residential use. As of 2006, Beijing had chosen nearly 100 sites around the North Fourth Ring and Songjiazhuang transport hub for conducting analysis, and 20 of them had conducted soil remediation. These site restoration projects are very expensive. Take Beijing Construction Engineering Environmental Restoration Co., Ltd. for example, from 2007 to date, more than 2 billion yuan (USD 0.3 billion) have been invested by this company, mostly from government finance (Huanbao, 2016).

(2) Developer Bidding for Site Restoration and Profit Making

In 1980s, Beijing Red Lion Paint Factory was built on the site whose former owner was an insecticide plant in 1950s. According to the evaluation results conducted by a relevant agency, the total quantity of

contaminated soil was 140,000 m³ (Hjxf, 2009). The investor Vanke Group won the bid and bought the land for building price-limit housing.¹ As specified in the bidding document, the successful bidder must implement the contaminated soil disposal plan formulated by the Beijing Municipal Environmental Protection Bureau and develop a corresponding supervision plan to avoid secondary soil pollution. Vanke Group contracted the 140,000 m³ contaminated soil remediation project to Beijing Construction Engineering Environmental Restoration Co., Ltd., who has finished the cleaning up with the use of cement kiln incineration curing technology. The whole remediation process was under the supervision of the Beijing Municipal Environmental Protection Bureau, who conducted the acceptance check and put on record the monitoring results. In the end, Vanke Group made a profit through the sale of real estate.

2.1.3 Advantages of the R+D Mode

Remediation + development represents the “beneficiaries pay” principle. Its advantages include: First, the use of expected added value from land redevelopment as a source of public investment is an effective way of financing. On the one hand, it conforms to the basic principles of urban land value-added income distribution; on the other, it is an effective way of financing, a great release of government financial pressure. Second, it is a relatively fair method. The concept of “beneficiaries pay” complies with the principle of fairness. Third, it is effective in curbing the landowner’s opportunistic practice; at the same time, the land tenure cost is improved for promoting more effective use of land to obtain return on investment. Fourth, the payer is also the supervisor, the project construction gets more public participation and supervision, higher transparency is helpful in ensuring the successful project implementation.

2.1.4 Challenges of the R+D Mode

Getting land developers to pay for soil remediation comes with a number of disadvantages: First, the land developers are not specialized in soil remediation—they cannot act as the land owners or undertake professional remediation and management work; second, land developers are concerned about land development and reuse rather than remediation effects. They are inclined to consider their self-interest and reduce the remediation cost, and they may dispose of contaminated soil inappropriately; third, some illegal developers may collude with the assessment agency to raise the site restoration costs to steal state funds for land transfer payments. It is difficult for government regulators to control such behaviour. Therefore, non-transparent land transfer and corruption are unavoidable.

2.2 Polluter Pays

2.2.1 Brief Introduction

According to the principle of “polluter pays” in China, all units and individual operators discharging pollutants into the environment must pay a certain fee in accordance with government regulations and standards to internalize the external costs caused by their behaviour, which is a measure to make polluters to take actions to control pollution. It is practical to adopt this mode for contaminated sites with the responsible main body being defined. According to this mode, the responsible main body shall raise funds or pay for the majority of the costs for soil remediation and hire a qualified professional engineering company to carry out the soil remediation project—the relevant government department will both supervise and conduct the acceptance check.

In China, the producers, collectors, transporters and relevant entities that have caused pollution do not currently bear the corresponding responsibilities, a fact that is one of the biggest obstacles to the restoration of contaminated sites. Therefore, we must establish as soon as possible the “polluters repair” responsibility system and use the law to confirm the responsible main body, in order to realize the implementation of the principle of “polluter pays” and make it a more central source of financing.

¹ Price-limit housing is a kind of commodity house with limited price (area). It mainly solves the housing difficulties of low- and middle-income families. It is a temporary measure to limit high housing prices, not affordable housing.

In order to establish the principle of polluter pays in China, first we must scientifically define the legal “responsible party” and make it clear that this party is responsible to pay for the pollution damage because of its no-fault liability, a responsibility with a retrospective legal effect. When the responsible party is not defined, the national or local government shall use special funds to pay for the cost of environmental remediation, and ultimately the responsible party shall repay the costs according to law. Without the principle of polluters repair, once the urbanization process slows down or if land prices decline, the source of financing will be stretched, and the task of site restoration will not be sustained. Therefore, the establishment of a “liability confirmation system” is the only effective way to avoid this phenomenon.

2.2.2 Successful Demonstration of the Polluter Pays Mode in China

(1) Pilot Demonstration of “Polluters Repair” in Zijin Mine

On July 3, 2010, copper acid water accidentally leaked from the Zijin copper mine wet gas plant of Fujian Zijin Mining Group, 9,100 m³ sewage flew into Tingjiang river, causing the death of a large number of cage fish in part of the polluted river. Preliminary statistics show that in Tingjiang river basin, in Mianhuatan reservoir only, about 3.78 million *jin* of fish are dead or poisoned (Baidu Encyclopedia, 2010). The acidity value of the polluted soil is nearly 10,000 times of the normal value, and the copper ion concentration is extremely high. BGE (Beijing GeoEnviron Engineering & Technology, Inc) China proposed the adoption of “vertical barrier” technology as the key control technology for soil remediation and site transformation. The project was completed in 2013, and the construction area was 1,300,000 m². After the site restoration, a total of 830 million yuan (USD 126 million) was invested in the three-year renovation, in which 200 million yuan (USD 30.3 million) was used for renovating the wet process production line and the pipelines, more than 600 million yuan (USD 91 million) was used for renovation of the tailings, the reservoir and the sewage treatment system. In addition, more than 80 million yuan (USD 12.1 million) was invested in vegetation restoration in an area of 10,800 *mu* (720 ha), the unit cost was 7,400 yuan/*mu* (USD 16,840/ha). As confirmed by BGE (Beijing GeoEnviron Engineering & Technology, Inc.), the income has reached 127 million yuan (USD 19.3 million) (Huanbao 2016).

(2) 100 Million Yuan Restoration of the Contaminated Site in Zhejiang

A chemical plant in Zhejiang province was ordered to move out of the urban area by 2010, for which it received hundreds of millions of yuan as compensation. In December 2010, the municipal centre of land reserve issued a notice requiring this plant to conduct soil remediation for the contaminated site, and the remediation costs shall be borne by the company. According to the site restoration program developed by the Zhejiang Academy of Environmental Sciences, the soil remediation cost was more than 100 million yuan (USD 15.16 million), which shall be paid from the relocation compensation (Tian et al., 2012).

In this case, the entity responsible for the site contamination is clear, and the production and operation of the company is normal. There was no liquidation or property rights transfer except for the relocation, for which the company received significant compensation. Therefore, the company was able to pay the significant costs of site restoration.

2.2.3 Advantages of the Polluter Pays Mode

As long as the responsible main body is defined, it is practical to establish a polluters repair responsibility system and use the law to confirm the responsible main body: this helps underscore the principle of “polluter pays” and makes it an important source of financing.

2.2.4 Challenges of the Polluter Pays Mode

First, identifying polluters is challenging.

At present, various parties are held responsible for site restoration in China. According to the China Environmental Restoration Network survey, the polluters include the polluting companies and their parent

holding groups; if the enterprises have been relocated, then the land reserve units and developers are also responsible (Tian et al., 2012). At present, the legal and technical means for tracing and identifying the polluters are limited. On the other side, the site restoration process is long and expensive. Even if the responsible main body is defined, as long as there is lack of a detailed and feasible fundraising mechanism, the actual implementation will be very difficult.

China's contaminated sites are concentrated in the old industrial bases, whose companies face problems such as high energy consumption, heavy pollution, rudimentary technology and poor economic returns. To implement the national policy of industrial enterprises relocation without affecting urban development, it is necessary to solve the safety, environment and land resources problems, and conduct industrial restructuring and upgrading of production processes. However, according to the polluters repair principle, the enterprises having caused site contamination before the relocation shall be held responsible for paying the expensive costs for site restoration, which is not practical in China.

Secondly, the social operation costs of implementing the polluter pays principle are high.

Site restoration requires a lot of money, and according to this principle, we must first define the polluters, and administrative expenses for tracking down the polluters (and the judicial resources needed for confirming the responsible main body) are almost as high as the restoration costs. The high social operation costs actually mean the taxpayers are put into the list of responsible parties, which will affect the normal production and operation of enterprises, and even lead to bankruptcy of small businesses, ultimately violating the efficiency value of the law.

Thirdly, if the polluting units have been relocated or gone bankrupt, it would be problematic to hold the successor responsible, because the innocent people might be implicated.

The nature of soil pollution is long-term and hidden, and its harmfulness will not appear in the short term. If the polluting enterprises have been relocated or gone bankrupt, upon the discovery of soil pollution, the operators are not the polluters. In China, it is stipulated by law that the landowner and successor are to assume responsibility, with the local people's government undertaking minor responsibility. However, it is doubtful whether the landowner, the occupier or the successor should take responsibility, and there is no such principle, otherwise new unfairness will be created and an innocent party will be implicated.

2.3 Public–Private Partnerships (PPPs)

2.3.1 Brief Introduction

Public–private partnerships (PPPs) are a form of public–private cooperation for providing public services. They represent a long-term cooperation mechanism based on the concept of risk and benefit sharing. When a private institution participates in a project, the government does not transfer the project responsibilities completely to the private partner, and all parties involved share the responsibilities and financing risks. PPPs make full use of the advantages of government and private institutions and maximize the efficiency of resources. PPPs are a “win-win” modern financing mode.

The PPP mode can be used in the field of soil remediation. Under this mode, private enterprises and private capital firms are encouraged to cooperate with government funders to participate in soil remediation. The transformation from government operation to environmental protection business operation mainly includes the procurement of soil remediation environmental services from environmental protection enterprises by the government. The relationship between the environmental protection enterprises and the government is no longer a one-way supplier of financial subsidies, but a relationship between commercial contracting parties. On the government side, debt pressure is reduced, the inefficiency of non-specialized operation is avoided, and the environmental management risks are shared; for their part, environmental protection enterprises can greater market share, but they have to share environmental management risks.

There is incentive for the government, the industrial enterprises and the environmental protection enterprises to promote PPP and third-party soil remediation. Environmental protection enterprises can obtain more soil remediation market share and contribute to the upgrading of the scale of soil remediation industry, and at the

same time they have to take the risk of soil remediation. Enterprises with rich experience in soil remediation thus have more competitive advantage.

The success of PPPs in dealing with soil pollution control depends mainly on three factors:

1. Whether the government is active in promoting the PPP. It will be very difficult to promote PPP implementation of projects without government support. At present, there is municipal and county-level PPP project performance evaluation, which is conducive to the implementation of soil remediation PPP projects.
2. Whether the social capital firms are active. Incentivizing the participation of social capital firms mainly depends on the suitability and profit-generating point. The development of profit-generating points for soil remediation projects is the key to get social capital firms involved.
3. National policy measures. The degree of services provided by finance, taxation, financing and administrative policies will affect the smooth implementation of soil remediation PPP projects.

2.3.2 Successful Demonstration of the PPP Mode in China

(1) Pilot Demonstration of PPP mode in Yuetang

In January 2014, Yuetang district Government and Xiangtan Urban and Rural Construction Development Group jointly established the Xiangtan Development Investment Co., Ltd., which cooperated with the majority shareholder of Yongqing Environmental Protection Co., Ltd. – Hunan Yongqing Environmental Protection Group and jointly invested 100 million yuan (USD 15 million) for setting up the Xiangtan Zhubu Port Eco-Environment Management Investment Co., Ltd (Finance.sina.com. 2014). The new company focuses on heavy metal pollution, offering comprehensive treatment project investment, management and services, such as demolishing of abandoned plants, contaminated site cleanup, contaminated site restoration, finishing and infrastructure construction. The 28 companies in the old industrial zone of Zhubu Port were closed by end of 2014. After the completion of contamination cleaning up, the old industrial zone of Zhubu Port will be developed as a new eco-town, and the participating parties will be repaid from the added value of land. For example, project investment for phase 1 heavy metal pollution treatment engineering is 798 million yuan (USD 121 million), after which 606 *mu* (40.4 ha) of land shall be released, and the local land price is 1.8 million yuan/*mu*, so the project will generate about 1.091 billion yuan (USD 165.4 million) of economic benefits. Within a period of 3–5 years, the Yuetang Pilot Demonstration Project will need a total investment of 9.5 billion yuan (USD 1.44 billion) for conducting soil remediation. Funding sources include the Xiangjiang River Basin heavy metal pollution control special bonds, the national heavy metal pollution control environmental protection funds, bank financing and corporate capital firms (Sohu.com, 2016a)

According to the new tasks and requirements of environmental protection and improvement, Xiangtan Development Investment estimated that 9.415 billion yuan (USD 1.427 billion) will be invested in the implementation of the next project phase, including three types of project activities: comprehensive environmental pollution control in the Zhubu Port area (enterprise relocation, environmental pollution control), relocation compensation and infrastructure construction. Specifically, 4.284 billion yuan (USD 649.2 million) (including corporate tax revenue) will be invested in comprehensive environmental pollution control, 3.475 billion yuan (USD 526.7 million) shall be used for compensating collective house demolition and relocation, and 1.656 billion yuan (USD 251 million) for infrastructure construction. The project construction will last three years. According to the estimation, the company has developed the next phase financing plan (see Table 2) (Xtftztg.com, n.d.).

Table 4. Yuetang Zhubu Port Soil Remediation Project Funding Plan

Year	2017	2018	2019
Planned Fund	4.615 billion yuan (USD 699.5 million)	3.8 billion yuan (USD 576 million)	2.0 billion yuan (USD 303.1 million)
Source of Fund	975 million yuan (USD 147.8 million) from policy bank (China Development Bank), credit approved	2.4 billion yuan (USD 363.8 million) from policy bank (CDB), (1.2 billion yuan (USD 181.9 million) paid)	0.8 billion yuan (USD 121.3 million) special bond: expected issuance, PPN, commercial paper
	0.7 billion yuan (USD 106.1 million) from city commercial bank (Huarong Xiangjiang), credit approved	0.8 billion yuan (USD 121.3 million) from Minsheng Bank, being paid	3 billion yuan (USD 454.7 million) special fund, phase-3 fund 1 billion yuan (USD 151.6 million)
	0.4 billion yuan (USD 60.63 million) from import & export bank (Bank of Beijing), credit approved	0.7 billion yuan (USD 106.1 million) from Changsha Bank, being paid	0.2 billion yuan (USD 30.31 million) from trust fund and rental income
	0.43 billion yuan (USD 65.17 million) from Industrial Bank, credit approved	3 billion yuan (USD 454.7 million) special fund, phase-2 fund 1 billion yuan (USD 151.6 million) being paid	
	0.51 billion yuan (USD 77.3 million) from trust fund and rental income	0.1 billion yuan (USD 15.16 million) annual allocation from provincial finance, to be approved	
	0.6 billion yuan (USD 90.94 million) special bond, under preparation		
	3 billion yuan (USD 454.7 million) special fund, phase-1 fund 1 billion yuan (USD 151.6 million) under negotiation		
Total	3-year funding: 10.415 billion yuan (USD 1.5786 billion)		

2.3.3 Advantages of PPPs

Firstly, PPPs are effective in alleviating the government's financial pressure in soil remediation financing.

The use of PPPs for soil remediation will incentivize social capital firms to participate, and the supplementary funds will help alleviate the government's financing difficulties. Using PPPs, financial institutions will provide more loans for the project construction—in particular, the policy banks will relax the admission conditions of soil remediation projects, such as expanding the scope of financing guarantees, prolonging the loan life, reducing interest, etc. At the same time, the government will give enterprises an extended term for franchising and profit making in exchange for their investment in infrastructure construction, which is conducive to reducing financing costs and extending the financing period.

Secondly, the use of PPPs for attracting private capital investment helps share investment risks.

Under this mode, the private sector cooperates with the government to form companies to meet special purposes, and the contract-based SPCs (Special Purpose Companies) participate in the construction, operation and management of the soil remediation project. In joint ventures between the public and the private sectors, the government is mainly responsible for some non-decentralized risks such as policy risks, planning risks and abnormal risks caused by changes in financial market interest rates. Private institutions are mainly responsible for technical risks, financial risks, operational risks, the cost of overruns and environmental risks caused by normal changes in some market conditions. Under this mode, the government gives policy support to the private institutions and defines their respective responsibilities and risks through a sound legal and regulatory system, while at the same time encouraging the private institutions to actively use their advanced management experience to improve the effects and efficiency of soil remediation and reduce the risks during the whole project period, including the background investigation and demonstration, project design, project construction and post-project management.

Thirdly, PPPs are more flexible in attracting diversified investment entities.

The private sector provides assets and services, while government departments will have more funds and skills to facilitate the investment and financing reform. Meanwhile, private sector participation in the projects will promote innovation in project design, construction and facility management, which is helpful in improving efficiency and disseminating the best management concepts and experience.

2.3.4 Challenges of PPPs

First, regulations on environmental PPPs need to be strengthened.

Unlike municipal, water and other infrastructure projects, PPPs in the field of environmental protection need stronger regulatory measures to guarantee environmental benefits. In particular, for those that involve the use of portfolio resources development, the relevant regulatory requirements must be clarified in the contract design stage, to ensure that social capital firms invest in PPP projects. In addition, PPP project performance evaluations should be carried out regularly. According to the evaluation, the prices or subsidies should be adjusted according to the contract terms. Performance evaluation should not only be carried out on the social capital firms' side: government performance should also be integrated into the performance evaluation system in order to strengthen the government's fulfillment of responsibilities. In addition, an independent, transparent, accountable and professional government and social capital firm cooperation project supervision system should be established, and information disclosure and public participation should be encouraged, in order to form a multi-party supervision mechanism.

Secondly, the supply quality and efficiency of environmental PPP projects needs to be improved.

Considering the existing low efficiency of environmental protection investment, for environmental PPP projects the ultimate goal is improving quality. It is necessary to ensure that PPPs can improve the quality and efficiency of environmental public services supply, and relevant measures for improving the supply quality and efficiency should be undertaken. It is necessary to combine supply quality (effect) with the full life-cycle costs and consider the difference in the cost of fiscal expenditure under the same quality and effect.

Thirdly, the investment return mechanism needs to be improved.

The system of “users pay” should be improved, including the affirmation of values and rights and the transaction flow to form a revenue stream and contribute to future investment return. A fair and equitable market environment with unified standard should be established through improving a number of market mechanisms, including the bidding system. Take Xiangtan Yuetang project in Hunan province as an example: an investment of 9.415 billion yuan (USD 1.427 billion) is needed for this project, and the three-year investment’s interest rate is about 10 per cent. After the project implementation, the restored land area is only 1.74 km². The income from the land transaction is not enough to cover the project investment, and it is difficult for the district finance to keep balance within its scope of financial resources. Therefore, financial support from higher governments is necessary (Xtfztg.com, n.d.).

2.4 Green Bonds

2.4.1 Brief Introduction

Green bonds are those raised primarily to support green industry projects. The green bonds currently active in China’s capital market are:

1. Green financial bonds: Securities issued by legal institutions in accordance with the law, and the raised funds are used for supporting the green industry and repaying the capital and interest as agreed. The issuance of green bonds must be approved and supervised by the People’s Bank of China (“Central Bank”).
2. Green enterprise bond: The raised funds are mainly used for supporting energy-saving emission reduction technological transformation, green urbanization, clean and efficient energy use, new energy development and utilization, circular economy development, water conservation, unconventional water resources development and utilization, pollution prevention and control, eco-agriculture and forestry, energy saving and environmental protection industry, low-carbon industry, ecological civilization demonstration and low-carbon pilot demonstration, etc. The issuance of green enterprise bonds must be approved and supervised by the National Development and Reform Commission (NDRC).
3. Green corporate bonds: Green corporate bonds are issued in the stock exchange, and the raised funds are used to support the green industry. The issuance of green corporate bonds shall be approved and supervised by the Stock Exchange or the China Securities Regulatory Commission (CSRC). The investment in the ecological environment takes a long time to get a return, so the green bond period will usually cover the entire construction and operation period. Issued green bonds are currently mostly long-term financing bonds.

Gradually, the issuance of green corporate bonds has been used as a domestic soil pollution control financing mode, and its application has become increasingly popular. According to the “Green Bond Issuance Guideline” (National Development and Reform Commission, 2015), soil pollution control is listed as one of the key areas for supporting the issuance of green bonds. In the future, we may consider the issuance of soil pollution control special bonds. After project implementation, after the land is released or value appreciation, the land transfer payments shall be used as the main source of funding for repaying the special bond capital and interest.

2.4.2 Successful Demonstration of Green Bonds in China

ISSUANCE OF HEAVY METAL POLLUTION CONTROL SPECIAL BOND IN HUNAN

In recent years, in order to complete the Xiangjiang River Basin heavy metal pollution control tasks, all levels of government in Hunan province have issued heavy metal pollution control special bonds, with more than 10 billion yuan (USD 1.516 billion) used for the implementation of 100 projects, including a number of soil remediation projects. At present, most of these projects have been completed or are under construction, which is a successful exploration of a new way to raise funds for the prevention and control of heavy metal pollution.

In 2011, the State Council approved the implementation of the “Xiangjiang River Basin Heavy Metal Pollution Control Implementation Plan” (the “Xiangjiang Plan”), in which three major tasks have been defined: to ensure

the safety of people's livelihood, to control industrial pollution sources, and to conduct pollution treatment for historical contaminated sites. In total, 927 key projects were developed, and the total investment demand was 59.5 billion yuan (USD 9.0162 billion). At that time, successful fundraising is the key factor for realizing successful implementation of the Xiangjiang Plan. In order to solve the problem of financing, the Plan proposes the issuance of corporate bonds. In accordance with the Plan, Hunan provincial government and relevant departments implemented new measures to attract social capital firms to participate in pollution control. The issuance of heavy metal pollution control bonds is the first trial in China to explore new ways to raise funds for pollution control.

As of 2012, all levels of government in Hunan province began to prepare for the issuance of heavy metal pollution control bonds in the region of Xiangjiang River Basin. By end of 2015, a total of 12.5 billion yuan (USD 1.8945 billion) special bonds had been issued, including: 1.6 billion (USD 242.5 million) by Hengyang city, 1.8 billion (USD 272.8 million) by Xiangtan city, 1.5 billion (USD 227.3 million) by Suxian district of Chenzhou city, 1.8 billion (USD 272.8 million) by the high-tech zone in Chenzhou city, 1.5 billion (USD 227.3 million) by the high-tech zone in Chenzhou city (phase II), 1.8 billion (USD 272.8 million) by Beihu district of Chenzhou city, 1.2 billion (USD 181.9 million) by Lengshuijiang city, and 1.3 billion (USD 197 million) by Linxiang city. There are 70 comprehensive pollution control projects and 30 urban environmental infrastructure construction projects related to the issuance of green bonds, with a total investment of 26 billion yuan (USD 3.9406 billion) (Xtfztg.com, n.d.).

According to the survey results, Xiangjiang River Basin heavy metal pollution control bonds are usually issued by investment and financing companies established by the municipal governments. The credit rating of these companies is AA+ or higher, and the total size of the issued bonds is no higher than 40 per cent of the company's net assets, with a period of seven years. The bond interest rate is determined by the market, and the interest rates are determined through two-way inquiry (6.2 per cent~7.2 per cent). The bond buyer is the unit investor. The interest payment is once every year, and the capital is repaid 20 per cent annually, starting from the end of the third year until the end of the seventh year, together with the same year's interest.

Box 2. Soil Remediation Project of the Contaminated West Plant of Hunan Nantian Industry Co., Ltd.

Project Background: The former Hunan Nantian Industry Co., Ltd. was formerly the Hunan Pesticide Factory established in May 1950. Its production was stopped in 2003, and it went bankrupt the same year. In September 2013, Xiangtan Industry Investment and Development Group Co., Ltd. invested as the main body to pay for the bankruptcy restructuring and pollution control costs for land redevelopment and utilization. The project's total investment was about 152 million yuan (USD 23.0376 million). Xiangtan Industrial Investment and Development Group Co., Ltd. is the project construction unit, Beijing Construction Engineering Environmental Restoration Co., Ltd. is the project construction contracting party. In addition, a number of research institutions and professional agencies are contracted for conducting the project risk assessment, project environmental protection supervision, project engineering supervision and so on. After the future completion of soil remediation, the land will be used for redevelopment and utilization, such as green landscaping and tourism development.

Source of funding: The project's funding comes mainly from three sources: 350 million yuan (USD 53.0488 million) from the heavy metal pollution control corporate bonds, 50 million yuan from the soil pollution control special fund, and 19.86 million yuan (USD 3.0101 million) from the Global Environmental Facility's special fund for POPs disposal.

Main difficulties: In addition to the 390 million yuan (USD 59.1 million) costs for company restructuring (including relocation compensation, etc.) and 190 million yuan (USD 28.79 million) project fund for soil remediation, the funding gap is still large. During the survey, the project leader has repeatedly stressed that the main factors affecting the project process is the lack of funding: it is difficult to raise more funds from the investors, and international fundraising will take a long time due to strict requirements and complicated procedures. It is expected that the state will provide more support.

2.4.3 Advantages of Green Bonds

The domestic green bond market is gradually growing bigger.

As of 2016, the relevant domestic regulatory authorities had issued a number of green bond-related policy documents, and the issuance of green bonds had been approved consecutively by these authorities. By end of 2016, the scale of the issued green bonds in the Chinese bond market amounted to 205.231 billion yuan (USD 31.1064 billion), including 53 financial bonds, corporate bonds, medium-term notes, international institutional bonds and asset-backed securities issued by 33 institutions. In addition, financial institutions are increasingly willing to issue more green bonds. Compared with ordinary bonds, the core of green financial bonds is that, by combining government guidance and marketization constraints new green financial development mechanisms (featured by policy guidance and incentives as well as social reputation and market constraints), have been formed, which is an effective way of incentivizing more issuance of green bonds from commercial banks. On January 27, 2016, Shanghai Pudong Development Bank issued China's first green financial bond: the total amount of the 3-year bond is 20 billion yuan (USD 3.051 billion), the annual fixed interest rate is 2.95 per cent, over-subscription is higher than 200 per cent. From the beginning of the year to early September 2016, the total scale of green financial bonds and corporate green bonds issued in China has reached 112.79 billion yuan (USD 17.0954 billion), accounting for 36 per cent of the global green bond issuance in the same period. China has become the largest green bond market in the world (Yang & Shen et al., 2017) indicating that green bonds as an important means of financing has been widely recognized.

Fundraising is quick and effective.

Pollution control special bonds can quickly raise funding from the bond market. According to the "Green Bond Issuance Guideline," in terms of green bond approval, the examination and approval of green bonds issuance may be accelerated and simplified, which has greatly improved efficiency. In addition, existing approval policies and admission conditions have been adjusted, and the issuance of green bonds is no longer under an index limit. Moreover, all levels of governments have been providing policy support to encourage social capital firms to participate in green project construction, innovation of bond varieties is incentivized, and equity investment enterprises and funds are encouraged to invest in green projects. According to the Xiangjiang Plan experience, as a new mode to raise funds for pollution control, the issuance of heavy metal pollution control special bonds has effectively alleviated funding pressure, and a large number of soil remediation projects have been implemented as planned. In recent years, Hunan province has seen continuous improvement of environmental quality, in which the effective control of heavy metal pollution risks is an important part.

2.4.4 Challenges of Green Bonds

There is pressure for capital and interest repayment.

The special bonds of heavy metal pollution control in Hunan province, for example, are actually a type of government borrowing. The basis of the bond issuance lies in the future income compensation from land appreciation. In the initial design of the program, it is considered a mode of capital and interest repayment, but the funds are mainly used for regional sewage treatment plants and pipe network construction, river pollution control, enterprise relocation, historical waste disposal, soil remediation and other relevant projects: after the land is restored or its value appreciated, the land transfer payments are to be used as the main source of fund for capital and interest repayment. However, in practice, a certain number of projects reflect historical problems, and the government is responsible for carrying out pollution control projects such as the West Plant zone soil remediation project of Hunan Nantian Co., Ltd.. For such projects, the costs for soil remediation are high but the land appreciation space is small, and thus the future income from land transfer payments or project operation is hardly enough to repay the capital and interest, which means bigger risk for future debt repayment.

Domestic issuance of green bonds lacks transparency.

Compared with common international practice, the domestic issuance of green bonds needs to improve transparency via publicly disclosed documents. For example, some reports are limited to simple phrases such as "issued as planned," and "no change of the fund use" (Sohu.com. 2016a). In addition, domestic standards for evaluating green projects are not uniform, project transparency is limited and the degree of international recognition is low—all related to the fact that China's green bond market started late, available data are fragmented and unstandardized.

2.5 Industrial Funds

2.5.1 Brief Introduction

The term “funds” here refers to funds established for the purpose of ecological construction and environmental protection. They include government, investment and social welfare funds. The government fund for environmental protection refers to a special fund that is mainly funded by the government and managed through a purely administrative management organization or an independent, profit-making organization, with environmental protection as its main goal. Capital that is raised by the government fund for environmental protection is based on the “polluter pays” principle, which mainly comes from taxes or charges and is relatively stable; its use is similar to the special fund for environmental protection that comes from government revenue, reflecting its special purpose. Government funds can be well matched with current policies and are relatively easy to operate. The U.S. Superfund and the Soil and Groundwater Pollution Remediation Fund in Taiwan are typical government special funds that mainly address funding for remediation of “brown blocks” and prevention and control of soil and groundwater pollution. An investment fund is first formed by an investment institution, and through the issuance of beneficiary certificates or stock certificates by the institution, idle funds in the society can be pooled and operated. Investors can share the added value part of the fund according to the proportion of their investment, which makes the fund for-profit as well as a commercialized investment and financing model. Social welfare funds are mainly funded by internal and external institutions, organizations and the public; the funding sources are unstable so that they mainly support purely public services and do not have financing issues.

Based on the above-mentioned three types of funds for environmental protection, a comprehensive fund and a hybrid fund can be derived. Given the nature of government funds and the fact that government representatives participate in the management of funds, the goal of the funds’ operation must take into account both the government’s demand for environmental public services and the profit demand of social capital firms (rather than solely seeking profits). This type of fund is funded under the guidance of government revenue and gives full play to the role of the market in the collection and use of funds. It also encourages social capital firms to invest in environmental protection so as to address financing problems, mobilize the market's enthusiasm for environmental protection, and provide a breakthrough in corporate financing, ease government fiscal pressure and improve the efficiency of environmental protection investment. In terms of project management, the transfer of management responsibility to more professional banks or other economic entities can reduce the government's project supervision and management pressure to a certain extent and improve project management. The Clean Water State Revolving Fund is a typical hybrid fund. It uses financial funds as the main source of funds, and uses interest income and investment profit as supplementary sources (Lu et al., 2016). It provides low-interest or non-interest bearing loans for the construction and maintenance of public sewage treatment plants, non-point source and estuary management and other qualified projects to mainly solve the problem of corporate financing, playing an important role in encouraging social capital in environmental investment.

2.5.2 Successful Project Demonstration of an Industrial Investment Fund

The first industrial investment fund of China's soil remediation industry is under preparation. In 2017, a total of five well-known environmental protection companies in the industry signed a strategic cooperation framework agreement and jointly established the “Easy-to-Remediate Brownfield Industry Fund” (Sohu.com. 2017b). The total size of the fund is expected to be 10 billion yuan (USD 1.516 billion), of which the first offering of the fund should be no less than 1 billion yuan (USD 151.6 million). According to the original intention, in terms of the fund’s project investment, each party will conduct a comprehensive evaluation of the project and regularly present an appropriate project to the industry fund through a fixed platform; the fund management agency is responsible for investigating and evaluating the project and holding a project investment seminar to discuss whether to participate in the investment. In terms of project investment, all parties plan to make comprehensive assessments, select one or two pilot cities, make contact with local governments via the industry fund platform, focus on the concept of “City Betterment and Ecological Restoration,” respond to expanding models such as PPP, and build pilot and demonstration projects from multiple dimensions, including urban ecological planning, comprehensive environmental remediation and redevelopment, and soil pollution restoration.

2.5.3 Advantage of the Environmental Protection Fund

The environmental protection fund is a flexible and effective environmental investment and financing model that can improve government performance regarding financial resources for environmental protection, implement the principle of environmental responsibility, give full play to the role of market mechanisms in the field of environmental protection, and facilitate the overall implementation of environmental protection strategies.

The authority of the fund's legal status is critical. The special funds for environmental protection set up by foreign countries are established by laws passed by the highest authorities of the country. Australia has even set up special funds through special laws passed by the National Parliament (Li 2007). Securing a higher place in the legal system of the laws under which special funds for environmental protection can be established guarantees the authority of the laws establishing the funds and implementation in practice.

A clear division of labour within the management organization and strict liability mechanisms are also important. After a special fund for environmental protection has been established according to law, there needs to be a corresponding agency to manage it. The fund mainly encourages environmental protection through certain economic means. In the process of operation, there are various risks in the use of funds, and the environmental protection goals to be achieved by the fund need to be evaluated. This requires a strict management structure. Clarity of the management organization is also embodied in the determination of liability, which requires that there must be strict division of responsibilities for the problems that arise during the operation of the fund to promote healthy operation.

For the management of environmental protection funds, there is a relatively strict management system, with transparency as the primary principle. Some set up special management committees, such as Japan, and some did not set up special committees, but there are officials who manage the funds, and the use of the funds is supervised by the Congress (National Parliaments), such as the Netherlands and the United States (Lu et al., 2016). From the perspective of fund operation and management, countries with economies in transition have paid great attention to fund project management and transparency of funds.

The direction of fund use is concentrated in the field of environmental protection. The direction of the use of various types of funds for environmental protection is mainly to improve air and water quality, waste disposal and other environmental areas, which can be grouped into four categories. First, to restore environmental quality deteriorated because of pollution; second, to prevent the occurrence of pollution, including the development of anti-pollution technologies, incentives for pollution improvement and equipment monitoring pollution; third, to compensate pollution victims; fourth, administrative expenses required for the operation of the fund itself, such as the payment of staff salaries and other administrative expenses.

2.5.4 Disadvantage of the Fund

The purpose of setting up the fund is to make profits. Soil remediation projects have long implementation periods and low returns. In the actual establishment and operation of the fund, means of ensuring that the fund's income may become part of the fund itself need to be further discussed.

2.6 Land Ticket System

2.6.1 Brief Introduction

The term "land ticket" refers to reclaiming land used for rural housing, ancillary facilities, township enterprises, rural public facilities and public services that stand idle for cultivated land that meets the requirements for planting crops. The construction land vacated after rigorous acceptance and appraisal by the land management department will be matched with certificates for the same area issued by the land and housing management department, which is called the "land ticket." Since December 2008, Chongqing Municipality has started a trial land ticket transaction system (360doc.com. 2017). The operation of the Chongqing land ticket process mainly covers the following steps: First, the competent municipal authority of land and resources management

determined the scale and layout of construction land based on the overall plans for land use; second, the land management departments of districts and counties invited the public to participate in joint decision making to assess the idle rural housing and ancillary facilities as the target to be reclaimed by farmers; After the village or villagers' land reclamation was strictly checked and accepted by the land management department, the land management authority shall set up the city's unified transaction benchmark price for urban and rural construction land for reference by both parties to the transaction. All legal persons and natural persons with independent civil capacity can purchase land tickets through open bidding. Other than a small amount of taxes and fees, the vast majority of income is claimed by farmers. This is an attempt by the local government relating to rural land circulation. It has certain reference value for reclaiming agricultural land and controlling pollution.

2.6.2 Successful Project Demonstration of the Land Ticket System

Since the implementation of the land ticket system in Chongqing in 2008, a market-based incentive mechanism for land reclamation has been established, with the objective of protecting cultivated land and realizing the value of farmers' land, to guide farmers to voluntarily reclaim unused rural construction land into cultivated land. After ensuring development of the countryside, the surplus land will be publicly traded on the market via the land ticket system, which can be used within the scope of urban and rural planning and construction. As of the end of December 2015, a total of 172,900 acres of land tickets have been sold, totaling 34.566 billion yuan (USD 5.2379 billion) (Zhonghongwang.com, 2016). The land ticket system not only solved the problem of insufficient funds for relocation of rural households in remote mountainous areas, but also greatly promoted local economic development. Of 18 villages in Mawu Town, Shizhu County, Chongqing, there were 11 villages with zero collective economic income and seven villages with income of less than 10,000 yuan (USD 1,516) per village each year just a few years ago. Three years after the implementation of the reclaiming rural construction land process, 61.61 million yuan (USD 9.336 million) of land ticket income has contributed to the towns' collective economy. Each village had an average income of 3.42 million yuan (USD 0.5182 million), which has greatly promoted local socioeconomic development while mobilizing the enthusiasm of farmers for reclaiming unused land.

2.6.3 Advantage of the Land Ticket System

The land ticket system can effectively solve the serious problem of unused land in rural areas, and the imbalance between burgeoning demand and insufficient supply. Chongqing's land ticket transaction system has facilitated circulation of construction land between rural and urban areas by incentivizing the corresponding market mechanism. This has certain practical significance for breaking the bottleneck of land resources in urban development.

The land ticket system is conducive to the protection of cultivated land. China's per capita arable land area is less than 1 acre, so the limited arable land resources must be protected. The land ticket system has greatly promoted the protection of cultivated land resources through the method of "occupy first and subsidize later" and put an end to the waste of rural land resources. The extent of its success promoted the increase of rural cultivated land. To a certain extent, it has promoted the increase of rural cultivated land.

The land ticket system has greatly increased farmers' income. By reclaiming unused land, farmers can increase their income from land ticket transactions. The system has promoted the transfer of the rural labour force, increased the funds for agricultural investment and greatly fueled urban-rural integrated development.

2.6.4 Disadvantage of the Land Ticket System

Implementation of land reclamation is not guaranteed. The premise of land ticket transactions is that while rural construction land is transformed into land for urban construction, the amount and quality of cultivated land cannot be changed. However, the quantity and quality of reclaimed land cannot be fully guaranteed. As a policy executor, the administrative department may care more about the amount of cultivated land at the time of reclamation, and thus ignore the quality of reclaimed cultivated land and the future protection of the land.

There are also problems caused by premium distribution. At present, in accordance with the relevant regulations, there is not much profit left for farmers after passing through various intermediate links. The interests of farmers are not taken into account, and it is necessary to discuss the establishment of a set of scientific premium distribution mechanisms so that farmers can get more benefits.

2.7 Foreign Investment

2.7.1 Brief Introduction

With the diversification of funding channels, local governments have begun to explore the use of international funds for pollution control financing. Specifically, the investment of international funds into the field of soil remediation is usually through two channels: first, loans from the World Bank, Asian Development Bank and other international institutions; second, all kinds of international special funds and grants.

2.7.2 Successful Demonstration of the Foreign Investment Mode in China

(1) Use of World Bank loans for industrial site restoration in Zhuzhou, Hunan

In early 2016, the World Bank approved a USD 150 million loan to the Hunan Zhuzhou Qingshuitang heavy metal pollution control project, which will be used for cleanup and soil remediation activities at old industrial contamination sites Zzxhjt.com (2017). The loan funds are mainly used for soil remediation, waste residue disposal, water sediment disposal, contaminated soil replacement, as well as the construction of a contaminated soil landfill, pool sediment dewatering tanks, solid waste landfill and the Environmental Information and Demonstration Centre.

Zhuzhou city is located in the eastern part of Hunan province, and the lower part of the Xiangjiang river is one of China's eight major industrial bases established in the 1950s. Qingshuitang Industrial Zone is dominated by lead and zinc smelting and heavy chemical industries. The development of the smelting industry in the past 60 years has caused serious heavy metal pollution in the industrial area of Qingshuitang, and has been listed in the "Xiangjiang River Basin Heavy Metal Pollution Control Implementation Plan" as the national pilot project area for conducting heavy metal pollution control. The location of Hunan Zhuzhou Qingshuitang heavy metal pollution control project is in the core of Qingshuitang regional pollution control area. The project implementation period is from 2016 to 2021. It is expected that the direct beneficiaries will include 6,237 residents in the project area and 262,000 residents in the surrounding Shifeng district. In addition, nearly 300,000 residents of Zhuzhou city and its peripherals will also benefit from improved food safety. The project is managed by Zhuzhou City Project Management Office and implemented by Zhuzhou Circular Economy Investment and Development Group Co., Ltd. Under the supervision of the Project Implementation Office, the Office acts as project owner and is responsible for the project's daily activities.

Since approval of the project in April 2016, the project environmental impact report has been reviewed by the World Bank, and after receiving the amendment opinions of the World Bank, the Nanjing Guohuan Science and Technology Co., Ltd. has been commissioned to carry out an environmental impact assessment (EIA) on Qingshui and Tongxia areas' upgrading work. In early 2017, the revised EIA report has been finished. In February 2017, the revised EIA report and all the conclusions were published on the Internet in accordance with the requirements specified in OP/BP4.01 "Environmental Assessment," which is one of the World Bank's top 10 safeguard policies Zzxhjt.com (2017). The public is invited to comment on the report and give recommendations. The project implementation progress has so far been smooth.

(2) Non-Point Source Pollution Control in Guangdong

In August 2011, the Guangdong Agricultural Non-point Source Pollution Control Project was shortlisted by the National Development and Reform Commission and the Ministry of Finance to apply for loans from the World Bank. This is the first project for carrying out agricultural non-point source pollution control using the loans from the World Bank. The total planned investment is USD 213 million (approximately 1.32 billion yuan),

including 100 million dollars loan from the World Bank, 108 million dollars from the Guangdong provincial finance and the project implementation units, and 5.1 million dollars from the Global Environment Facility (GEF) (DAGP, 2016). The project construction period is five years, and the 20-year repayment starts from the sixth year of the project implementation. Project implementation is planned in 30 villages and towns in two cities and six counties in Guangdong province: overall, 280,000 mu of farmland has been restored. Huizhou, Jiangmen and Heyuan cities have been chosen as the three pilot areas for demonstration of livestock waste management, after which the project will be implemented in 300 livestock farms. The main objective of the project is to reduce the discharge of pollutants to waterbodies in the farming and livestock breeding industry, explore the establishment of long-term mechanism of agricultural non-point source pollution control, so as to protect the agricultural and rural ecological environment, improve the comprehensive agricultural production capacity and to promote a sustainable increase of farmers' income. It is estimated that after five years of project implementation, by 2018, emissions of chemical oxygen demand (COD) and ammonia nitrogen shall be reduced by 45,000 tons and 5,000 tons respectively, a significant contribution to the improvement of the agricultural and rural production and living environment in Guangdong province. On March 13, 2014, the inception ceremony was held in Guangdong Provincial Bureau of Agriculture to announce the kickoff of the World Bank loan to the Guangdong agricultural non-point source pollution control.

Since the implementation of the project, phased achievements have been made. According to information from the Guangdong Province Agricultural Non-point Source Project Implementation Office, as of the end of October 2016, a total of 292,775 mu (19,518 ha) of farmland has been restored, an increase of 70.2 per cent over the end of 2015. In 2014 and 2015, 72,000 mu (4,800 ha) and 172,000 mu (11,467 ha) of farmland were restored respectively (DAGP, 2017). In three years, the accumulated area of restored farmland reached 537,000 mu (35,800 ha). Altogether, 150 livestock farms have participated in the project, including 69 environmental protection farms and 71 ecological preservation farms. Monitoring results show that the first batch of farm waste disposal systems is running well: compared with baseline monitoring results, each year 12 farms can reduce 1,855.2 tons of COD emissions and 325.2 tons of ammonia nitrogen emission. In addition, project activities such as technical training and publicity have brought some good secondary effects. According to survey results, in 2016, 48.34 per cent of the respondents have developed the habit of returning the packaging waste back to the designated agricultural stores, 44.86 per cent of the respondents will place package bags into the village's collection point or garbage site. (DAGP, 2017) According to the current situation of project implementation, agricultural non-point source pollution control has brought tangible benefits for local farmers. In 2016 in the pilot project areas, the farmers have realized an average yield of early rice of 381.82 kg/mu, an increase of 35.52 kg or 10.25 per cent over 2015. Other crops have also realized production increase, the yield of potato was increased by 26.35 per cent, sweet corn and vegetable yield was increased by 11.88 per cent and 11.34 per cent respectively. At the same time, protective farming has realized significant production increase, in Taishan and Boluo, the 2016 yield of early rice was increased by 22.6 per cent and 40.5 per cent respectively, and the income was increased by 575.24 yuan/mu (1,306 dollar/ha) and 703 yuan/mu (1,597 dollar/ha) respectively. Income increase benefits have brought the project management the confidence for future loan repayment—compared with industrial contaminated site restoration projects, farmland pollution control projects face less pressure in loan repayment.

2.7.3 Advantages of the Foreign Investment

Longer term and low interest rates of foreign loans.

In the case of the World Bank loans, the maximum term for hard loans is 20 years, the average term is 17 years, with a five-year grace period. The annual capital and interest repayment starts from the sixth year, and in the first five years only interest payment is required. The maximum term for soft loans is 50 years, with a 10-year grace period, i.e., there is no need to repay the capital within the first 10 years, and the annual repayment (twice a year) starts from the 11th year. In addition, the World Bank loans are mainly derived from the paid-in capital from its Member States, mostly from mid- and long-term bonds issued in the capital market. As the bonds have a higher credit rating, the financing costs are lower than those of other banks, and thus the loan interest rate is lower.

Project implementation is conducive to capacity building.

International institutions have their own mature system in project management, with the project implementation progress. Chinese managers can learn from their valuable engineering management and project operation experience. In addition, this is an effective way of communicating with international experts: through mutual visits and training, domestic personnel have the opportunity to open up to the international field of business and improve their skills.

The process is conducive to the standardization of bidding modalities in China.

The procurement and use of international funds should comply with the corresponding guidelines and tender documents to facilitate the regulation of the domestic international bidding and procurement, so as to promote the improvement of domestic bidding procedures and organizing mode to meet the international standards.

2.7.4 Challenges of Foreign Investment

Excessive provisions and demands have resulted in difficulties in the use of foreign funds.

International institutions have a complete set of regulatory requirements for the use of funds, most of which are too complicated for Chinese local departments and enterprises. Due to the complexity of the review procedures, the requirements often cannot be met, resulting in lengthy approval process. This phenomenon is prevalent in China: for example, during the Xiangtan project survey, the West Plant zone pollution control project of Hunan Nantian Industry Co., Ltd. has obtained a special loan of 19.8 million yuan (USD 3 million) from the GEF for persistent organic pollutants (POPs) disposal. However, after multiple visits from GEF staff, the project management party still do not know how to use the fund. The poor communication between both parties has resulted in the phenomenon of “not knowing how to use international funds” (Xtol.cn, 2018).

Coordination difficulties have caused a slow project cycle.

The use of funds from international institutions means double the difficulty: the project is subject to approval by domestic authorities as well as the investor’s auditing. If project preparation and approval is not synchronized, it might cause some delay. Domestically, foreign investment programs have to be examined and approved by the National Development and Reform Commission, and soil remediation projects have to be reviewed and approved by the Ministry of Environmental Protection; international institutions also need to carry out a thorough review of the project finance, economy and EIA report. In the case of the Zhuzhou project, since the approval of the project the EIA report has had to be revised with consideration of public opinion, and every step must be conducted in accordance with the requirements of the World Bank. The project is carried out in an orderly manner, but the progress is very slow.

3 Conclusions

3.1 Existing Problems and Challenges for Soil Remediation Financing in China

With the continuous improvement of China's market-oriented economic system, the co-treatment of soil remediation by enterprises, developers and government has become an inevitable trend. However, at present the country's system environment of soil remediation is not fully available, the market mechanism is not in place, an effective financing mechanism is missing, and the rate of return on investment of soil remediation projects is generally low. Therefore, social capital firms do not have an incentive to enter into the field of pollution control and soil remediation, and it is difficult to realize industrialization, marketization and specialization of soil remediation.

The small scale of investment and low efficiency of financing pose challenges.

In recent years, China's total investment in soil pollution control has been increasing year by year, mainly reflected in the increase in financial expenditure: from 2006 to 2010, 1 billion yuan (USD 151.6 million) from the Central Government was used for the first national soil pollution survey; in March 2013, 827 million yuan (USD 125.32 million) from the central finance was used for the national survey of heavy metal pollution in agricultural production land; in March 2014, 1.156 billion yuan (USD 175.2 million) from the Central Government was used as a special fund to support the pilot project of soil remediation and planting structure adjustment in Changsha–Zhuzhou–Xiangtan area in Hunan province. From 2005 to 2014, total investment in soil testing and fertilization projects from the central finance was 7.8 billion yuan (USD 1.182 billion) (Shi & Wu, 2015a). During the “12th Five-Year Plan” period, a total of 30 billion yuan (USD 4.546 billion) from Central Government funds was used for national soil remediation, accounting for about 4 per cent of total environmental investment in this period. Judged from the current work of soil pollution prevention and control, the whole society has realized the hazard of soil pollution. However, compared with water pollution and air pollution control, investment is far from meeting the soil pollution control and contaminated site restoration demand.

There are limited investment and financing channels.

At present, pollution control and soil remediation projects rely mainly on funds from the central and local governments, financial institutions and build-operate-transfer (BOT) and PPP project financing—funds from other channels only account for a smaller proportion. Investment and financing of soil pollution in China comes mainly from the government: investment from foreign capital firms and idle private capitals² is rare, and the use of this part of funds is not effective. Most of funding for soil remediation projects is obtained through direct government investment and indirect financing (loans). However, compared with the loans, the proportion of government direct investment is too small, with no special funds from the government revenues established for soil pollution prevention and control. The existing special funds—such as the Central Government environmental protection special fund, the main pollutant emission reduction special fund, the Central Government rural environmental protection special fund and the heavy metal pollution prevention and control special fund—are seldom used for soil environmental protection. The use of foreign capital firms is also problematic. The forms of foreign investment available in China are limited, and the total amount is small. The main forms include foreign government assistance and grants and loans from the World Bank, and the total number is very limited. China's private capital market is underdeveloped and imperfect, and the capital market's information asymmetry and market admission mechanism have become the main factors obstructing the entrance of idle private capitals into the field of soil pollution prevention and control. At the same time, the state's capital investment is not working well in activating and attracting more social capital investment, and the idle private capitals have not been fully used.

² Mainly refers to private enterprise and personal funds.

The investment and financing bodies' rights and responsibilities are not defined, and the input-output mode is not clear.

In China's existing environmental protection investment system, the environmental rights and responsibilities between the government, enterprises and individuals are not defined, there is no input-output or cost-return accounting mechanism, the principles of "polluter pays" and "user pays" are not fully reflected, and it lacks a sound fundraising and investment management mechanism. Soil pollution control relies mainly on government funds scattered across various departments, the capital application process is long and complicated, and the added value of the fund cannot be guaranteed. The funding sources are limited, social channels are not utilized for financing, it is not possible to use financial instruments to realize value increase, and it is difficult to meet the large fund demand for soil remediation. Existing soil remediation funds lack the ability to make timely payment for soil remediation and damages.

There is insufficient use of market mechanisms and an incomplete investment and financing mechanism.

At present in China, the investment and financing market mechanism has not been formed in the pollution control and soil remediation industry. First, the pricing system is imperfect—since price and value are separated from each other, the government approval of prices is not based on the real value. This unreasonable pricing mechanism has restricted the inflow of funds because only profit-generating projects are the target of capital investment. Secondly, the investment management system is flawed, as there is no clear distribution of rights and responsibilities between the government and enterprises. The government has been exercising two rights at the same time, and the traditional investment mechanism with the characteristic of administrative examination and approval remains the same. The basic role of the market in resources allocation has not been fully utilized, all of which has resulted in a lack of confidence among enterprises in investing in the pollution control and soil remediation industry. On the other hand, due to the increased demand for soil remediation financing, external participation in investment has hit a bottleneck.

There is a lack of supporting policies and an incomplete legal and regulatory system.

China has promulgated a series of policies on soil environmental protection; however, with social and economic development, the existing policies cannot fully adapt to the current situation of soil remediation industry development. For example, there is no relevant fee and tax exemption and other policy incentives supporting the development of the soil remediation industry. The amount of sewage charges paid by enterprises to the government is much lower than the cost of corporate investment in pollution control, which has led to the phenomenon that enterprises are willing to be fined rather than purchase necessary equipment. Meanwhile, soil remediation-related fee exemptions and reward terms are not clear. Therefore, a large number of private capital firms are hesitant to get involved in the field of soil remediation. The environmental protection laws and regulations on soil environmental protection are flawed, which—combined with the high risks of the pollution control and soil remediation industry—means there is no effective driving force for enterprises to invest in pollution control and soil remediation industry; in addition, due to the lack of strong environmental law enforcement, enterprises will not voluntarily increase their investment in pollution control. All of these factors have seriously affected the normal development of the pollution control and soil remediation industry.

3.2 Prospects for Soil Remediation Financing in China

China is vigorously promoting the reform of soil remediation investment and financing mechanisms, and all regions are actively exploring innovations—experience has been obtained and positive progress made. However, the existing soil remediation investment and financing mechanism and mode cannot fully play the role of social capital firms in meeting the funding demand. In order to further promote China's soil remediation investment and financing, to mobilize local enthusiasm, attract social capital firms and expand effective investment, the following aspects are to be enhanced:

- **Promote the establishment of an effective financing mechanism for soil pollution prevention and control.** The financial investment in soil pollution prevention and control should be increased, the distribution of rights and responsibilities and financial authorities between the Central Government and local governments in soil environmental protection should be reasonably defined, rigid constraints

on each level of government's environmental budget should be formed, the newly increased financial income of the government should be more invested in soil environmental protection, and the Central Government should establish as soon as possible a special national soil pollution control fund. In terms of fund operation mode, the form of government fund should be transformed into the form of mixed fund. Not only should the government increase its financial investment, its function as "seed fund" should also be utilized. With the use of various policy measures, more and more social capital firms should be attracted to invest in environmental protection.

- **Government, financial institutions and enterprises should work together to form a diversified investment structure.** First, at the government level, the governments at all levels should change the inertial thinking of "government is the main body investing in soil pollution prevention and control, enterprises are the supporting role" and actively develop incentive policies for providing a good investment environment for financial institutions, enterprises and individuals. Diversified investment and service methods shall be created for various types of environmental protection investors, and all financial institutions, enterprises and individuals should be included in the investment entity group. Secondly, financial institutions—and especially policy banks—may appropriately lower the requirements for local soil remediation enterprises to apply for loans, and vigorously support pollution control and soil remediation investment projects and credit financing. Thirdly, in accordance with the principle of "polluter pays," the enterprise's responsibility in investing in soil pollution prevention and control should be defined for pushing forward the process of contaminated site restoration.
- **Broaden the channels of soil remediation investment and financing and improve the total amount of soil remediation financing.** In the field of soil remediation investment, first define the source of financing—i.e., the main investors, including the government, polluting enterprises, financial institutions, securities markets and the public. **Government:** increase financial investment and optimize the structure of fiscal expenditure, play the government's role in guiding the scientific and rational use of funds, so as to improve the efficiency of fund use. **Financial institutions:** provide loans and concessional loans to state-owned enterprises (SOEs) or large enterprises, and provide "green loans" to small and medium-sized enterprises (SMEs), or provide support to soil remediation projects through the issuance of green bonds. **Securities market:** through the issuance of green bonds, national bonds, stocks, etc., absorb the idle social capital to invest in soil remediation projects, which is also a funding channel for soil remediation enterprises. **The public:** participate in soil remediation by purchasing the environmental lotteries issued by the government, enterprises or financial institutions or purchasing the environmental protection fund.
- **Improve the soil remediation investment and financing structure and define the relevant environmental rights and responsibilities.** Soil pollution reflects the external economic underperformance of social and economic activities. It is critical for the government, enterprises and the public to make concerted efforts and reasonably define their respective rights and responsibilities in the field of soil remediation investment and financing. **Government:** develop soil environmental protection laws and regulations, establish the soil environmental quality monitoring network, carry out a soil assessment survey and soil environmental information release to promote public education, and play a leading role in typical soil remediation demonstration work. **Enterprises:** bear the main body responsibility for soil pollution reduction, pay for relevant environmental damages, carry out soil environmental protection technology, equipment and product development and provide soil remediation consultation services. **The public:** voluntarily supervise the enterprises' pollution behaviour, actively participate in the work of land development EIA assessment, and purchase organic green food.
- **Explore effective soil remediation financing modes and innovate soil remediation financing products.** The indirect mode of government funding plus bank loans will not be able to meet the large capital demand of soil pollution control, which requires innovative investment and financing to absorb the surplus social capital. Establish a soil remediation green capital market, actively promote the use of PPPs in the field of soil remediation, and use government funding to mobilize more social capital firms to invest in soil pollution prevention and control. Some regions may consider the establishment of local soil pollution prevention and control special fund and the platform of soil remediation investment. Based on the pilot implementation of environmental pollution liability insurance in the early stage, carry out a pilot program of environmental pollution compulsory liability insurance in key industries and enterprises, and make full use of the insurance tools to disperse the environmental risks for soil remediation enterprises.

- **Improve the government's basic service capacity and improve the soil remediation investment and financing supporting policies.** Improve the government's supervision capability to ensure the open and transparent supervision of the soil remediation fund use; standardize the procedure of fund application and implement specialized demonstration procedure to ensure the rational use of investment funds; according to the characteristics of soil remediation projects and investors, design feasible and flexible modes of investment, and develop corresponding procedures to meet the demand of diversified investment modes. Improve the soil remediation investment and financing supporting policies: in terms of financial policies, develop and implement incentive financial policies for promoting the production of organic fertilizers, comprehensive use of waste plastic film, recycling of pesticide packaging waste, etc.; in terms of financing policies, develop the supporting policies, environmental protection enterprises with promising prospects and higher environmental benefits should be given priority in initial public offerings (IPOs), and private capital firms should be encouraged to actively participate in the process of environmental financing.

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