

Chapter 7 Developing Policies for Soil Environmental Protection in China

7.1 Status Quo and Development Trend of China's Soil Environment Protection

7.1.1 Status Quo of China's Soil Environment Protection

7.1.1.1 Development of China's soil environment protection

Since the People's Republic of China was founded, the country's soil environment protection can be roughly divided into the following stages (Figure 7-1).

7.1.1.1.1 The first stage (1949-1978)

Since the People's Republic of China was founded, the grain production has been facing huge challenges from the growing population. The country's priority for soil environment at this stage was to increase soil fertility and grain output. Since the 1960s, China began to produce and use massive organochlorine pesticides¹. With the use of chemical fertilizers and pesticides, concerns began to rise regarding China's soil environment in the early 1970s. In 1973 China held the first national environmental protection meeting at which the environmental problems existing in China were raised. Subsequently, the country gradually carried out investigations on pollution in key regions. Environmental quality assessments, pollution control and other research efforts were undertaken. A preliminary environmental management system was developed. At this stage, environmental problems focused on were mainly air and water pollution. Soil pollution was not a priority.

¹ *Report on Case Study on Soil Protection Strategies*, Study on Macroscopic Strategies of China's Environment: Task of Environmental Element Protection Strategies, 2008.

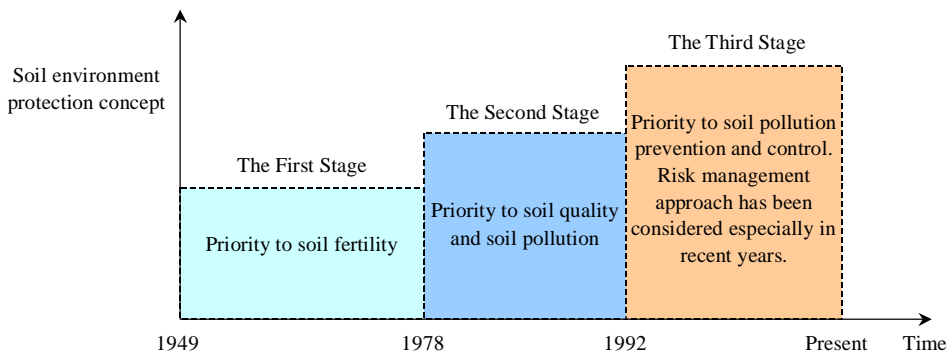


Figure 7-1 Chart of China's Development Stages of Soil Environment Protection

7.1.1.1.2 The second stage (1979-1992)

Since the implementation of China's reform and opening-up policy, rapid economic and social development had been made. Accordingly, soil environment protection entered into a new age of reform and innovation. More and more attention was paid to the soil pollution issue. China's overall system for environmental protection policies, laws and codes was being created. The law on soil pollution prevention in China's legislation is the Environmental Protection Law of the People's Republic of China (For Trial Implementation) issued in 1979. Also provisions on rational utilization of land are included the Constitution of the People's Republic of China, issued in 1982, and Land Administration Law of the People's Republic of China, issued in 1986. Relevant provisions on soil pollution prevention and control were included in the Law on Environmental Protection of the People's Republic of China issued in 1989. Soil environment and pollution became a priority at this stage.

7.1.1.1.3 The third stage (1993-Present)

In this stage, more and more attention was paid to the soil pollution prevention and control. And risk management approach has been considered especially in recent years. Since the United Nations Conference on Environment and Development in 1992, consensus of the world's nations is to implement a sustainable development strategy. In 1996, the State Council of the PRC issued a Decision of the State Council on Some Issues of Environmental Protection. This decision defined the orientation of China's soil environment protection in the age of sustainable development. In 2005, the State Council issued a Decision on Fulfilling the Concept of Scientific Development to Strengthen Environmental Protection, which requires a "focus on soil pollution prevention and control and the strengthening of environmental protection in rural areas". In 2006 the Ministry of Envi-

ronmental Protection carried out a special investigation on current situation and pollution control of soil throughout the country jointly with the Ministry of Land and Resources. Through a lot of investigation work, information on current situation, scope, key pollutants and level of soil pollution throughout the country has been obtained. Currently the investigation result is in process of statistics and analyses. When finished, the project will lay a foundation for supervision of soil environment in China. In 2008, the Ministry of Environmental Protection issued Opinions on Strengthening Soil Pollution Prevention and Control, which proposes measures for strengthening soil pollution prevention and control.

To facilitate effective prevention and control of soil pollution, China has successively organized and carried out a series of fundamental investigations. These investigations include the national soil environment background value survey, soil environment quality assessment of “Vegetable basket”² planting bases, main wastewater irrigation areas, pollution analysis and an overall national soil pollution status report. In addition, a series of standards and technical codes were prepared, issued and implemented. These include Standard for Soil Environment Quality and Technical Code for Soil Environment Monitoring. Emphasis was placed on strengthening monitoring over pollution sources, control of pollution sources, research on assessment of regional soil environment quality, and soil pollution risk management. Organized demonstration pilots for restoration and comprehensive harnessing of polluted soil were initiated. International exchanges and cooperation were pursued.

7.1.1.2 Main soil environment problems of China

Soil parent materials in China can be divided into two major categories—bedrock efflorescence and loose sediment. The bedrock efflorescence can be further divided into 4 types: light crystalline rock efflorescence, dark crystalline rock efflorescence, clastic sedimentary rock and corresponding metamorphic rock efflorescence, and calcic sedimentary rock and corresponding metamorphic rock efflorescence. The loose sediment includes 9 types: proluvium, red clay, alluvial deposit, lacustrine deposit, littoral sediment, coral reef deposit, loess, storm sand and glacial till. There are many soil types in China and almost all the main soil types of the world can be found in the country. According to the soil genesis classification method, China’s soil types have 12 soil orders, 61 soil types and 235 subtypes altogether.

Soil degradation is the main problems for China’s soil environment. Land productivity is reduced by unreasonable development and utilization. With substantial population growth and rapid economic development in recent decades, China’s soil degradation has been get-

² In 1988, the Ministry of Agriculture started this project against a background that the country could not produce enough non-grain food with rich diversity. http://www.gov.cn/jrzg/2010-03/28/content_1566658.htm

ting worse and worse. Soil degradation includes erosion, desertification, salting, sterility and pollution.

7.1.1.2.1 Soil erosion (water loss and soil erosion)

China is one of countries in the world having serious water loss and soil erosion. The areas with serious water loss and soil erosion include Loess Plateau, middle and upper reaches of Yangtze River, stone mountainous areas in North China (such as Taihang Mountainous Area), red earth hilly areas in South China, black soil areas of Northeast China, and intersection mountainous areas on the border of Sichuan, Yunnan and Tibet. According to Report on the State of the Environment in China 2009, China's existing area of water loss and soil erosion was up to 3 569 200 km², accounting for 37.2% of the total soil area, of which: the water erosion area was 1 612 200 km², accounting for 16.8% of the total soil area; and the wind erosion was 1 957 000 km², accounting for 20.4% of the total soil area.³ The soil erosion leads to reduction of soil fertility and deterioration of the ecological environment. The causes for China's water loss and soil erosion include natural factors, such as geography and hydrology, and human factors. The latter include some agricultural practices, deforestation, over-cutting of forest areas, heavy grazing of grassland, mining, road building and other large-scale capital construction.

7.1.1.2.2 Soil desertification

The soil desertification is a result of mutual actions of natural and human factors. China is one of the countries in the world with a vast distribution of deserts and desertified land. So far the area of desertified land nationwide is as high as 2 636 200 km².⁴ The serious desertification areas are mainly distributed in the north and northwest of China, especially in agriculture-husbandry cross-over areas. Generally these areas have such phenomena as excessive reclamation, grazing or cutting, affecting the ecological equilibrium. Serious desertification may result in the loss of overall land productivity, deterioration of the ecological environment and reducing China's agricultural production. One of main causes for desertification is the production activities of the mankind. So far the land desertification in some regions of China has been inhibited or improved effectively. The situation of 'destroying more than control' has been transformed into 'control equal to destroying'. The ecological regime of key control areas has been improved noticeably. The controlled area has been bigger than the destroyed area in a great majority of provinces. The total area of desertified land of the country has been transformed from an annual extension speed of 3 436 km² at the end of the

³ <http://jcs.mep.gov.cn/hjzl/zkqb>

⁴ http://www.moa.gov.cn/fwllm/jrsn/200906/t20090616_1292117.htm

last century to an annual reduction speed of 1 283 km².⁵

7.1.1.2.3 Soil salting

Soil salting refers to a process of salt accumulation in the soil. It mainly happens in areas with a dry, semi-dry or semi-humid climate or in coastal lowland areas vulnerable to being soaked and irrigated by seawater. The salinized soil area of China is about 3.69×10^7 hm², and arable land affected by salinization is mainly distributed in Huanghuaihai Plain, the west of the Northeast Plain, Hetao Area of the Yellow River, the inland area of Northwest China and coastal areas of East China. The area totals 6.24×10^6 hm², accounting for about 7% of the country's total land area.⁶ The majority of China's arable land is slightly salinized, without a big impact on agricultural production. A minority of the land is salinized in a medium or high degree, having a big impact on agricultural production.

7.1.1.2.4 Soil sterility

Soil sterility is one of the most fundamental results of soil erosion and degradation. The content of nutrient elements reduces from top to bottom in the soil profile. With increasing soil degradation, the content of organic substances, whole nitrogen and whole phosphorus in the soil decreases. In particular, the content of organic substances and nutrients in the red soil of the granite parent material is reduced. In the past few decades, China has made huge efforts in improving crop yields. The increase of grain yield requires more consumption of nutrients from the soil. These nutritive elements are brought out of the soil with harvest of the grain. Generally the organic content in China's arable land is low. Due to excessive reclamation, the nutrients in the soil are unbalanced due to a lack of organic substances, and the low input yet high output of the soil over time has led to the reduction of nationwide soil fertility. Reports of soil sterility can be found throughout the country. State of the Environment Reports undertaken from 2000 to 2007 have stated that over 50% of China's arable land is short of microelements, 51% is short of phosphorus and 60% is short of potassium. The average content of organic substances in China's arable land is 1.8%, with the content of organic substances in brown soil and earth more than 2 times lower than similar soil types in Europe.⁷

7.1.1.2.5 Soil pollution

At present China's overall situation of soil pollution is not optimistic. The soil pollution is serious in some areas. Heavily polluted soil posing risk to human health, safety and the environment is the legacy of enterprises or industries, mining areas, and commercial activity

⁵ <http://www.cctv.com/news/china/20050614/100231.shtml>

⁶ Xuelei Zhang and Zitong Gong, *Human-induced Soil Degradation in China*, Ecological Environment, Vol. 3, 2003.

⁷ <http://jcs.mep.gov.cn/hjzl/zkqb>

in cities and suburbs. The soil pollution is diversified, complex, can be historical or current, and inorganic or organic. There are many means of and complex reasons for soil pollution. Consequently, pollution control is rather difficult.

The system for soil environment supervision and management is not sound. The investment in soil pollution prevention and control is insufficient. The public awareness of soil pollution prevention and control is weak. Safety of agricultural products from contaminated areas is of concern. Mass events caused by soil pollution have increased year by year and soil pollution has become a key concern of the public affecting social stability.⁸

Currently the foundation for control of domestic pollution is weak in rural areas of China; the non-point pollution is increasingly getting worse; the industrial and mining pollution is being highlighted in rural areas; and the transformation of city pollution into rural areas tends to speed up. According to the 1997 Report on the State of the Environment in China, the pollution of China's arable land was rather severe. An estimated 10 million hectares has been polluted. According to the 2000 Report on the State of the Environment in China, 300 000 hectares of basic farmland protection areas that was sampled and monitored for harmful heavy metal found that 36 000 hectares were beyond the standard by 12.1%.⁹

The pollution of soil through industrialization is rather serious in China. The unreasonable disposal, storage or management of hazardous or other waste results in pollution of soil and groundwater. In China, heavily soil polluted and high risk areas have occurred in aggregation at or near heavy pollution enterprises or industries, mining areas and their surroundings, cities and suburbs¹⁰. In addition, pollution of soil caused by leakage of dangerous goods due to emergencies during production, traffic accidents or natural disasters further contributes to the problem. This study will address the soil pollution issue.

7.1.2 Characteristics and Causes of China's Soil Pollution

In all environmental elements, the soil is the final acceptor of pollutants. A lot of water and air pollution is transferred to or from the soil. Economic and social sustainability is directly affected by soil pollution. Soil pollution can be invisible and affect humans slowly over a long period of time. Soil pollution can also affect a population directly over a short period. A serious threat to social and economic sustainability, human health and national

⁸ The Ministry of Environmental Protection: *Opinions on Strengthening Soil Pollution Prevention and Control*, Document No. (2008)-48

⁹ <http://jcs.mep.gov.cn/hjzl/zkqb>

¹⁰ The Ministry of Environmental Protection: *Opinions on Strengthening Soil Pollution Prevention and Control*, Document No. (2008)-48

ecological safety exists if it is not addressed. The dangers of soil pollution are: reducing the available amount of healthy land resources; yield reduction of crops; pollution of agricultural products; threat to food safety; harm to the human health directly or indirectly; and other environmental problems.

7.1.2.1 Increasingly highlighted problems of soil environment

The CPC Central Committee and the State Council have paid great importance to the rural environment protection. Through many years of efforts, great strides have been made in rural environment pollution control and ecological protection. However, the present situation of China's rural environment is still very severe. Point source pollution from factories, industries, farms, and non-point pollution from fields is still adding to the problems created by historical practices. Transfer of industrial and city pollution to rural areas exacerbates the problem further having an impact on social stability. This has affected economic and social sustainability in China's rural areas.¹¹ Most garbage is directly piled on the fields or roads and even thrown into ditches and pools without any treatment. A great majority of domestic sewage is directly discharged onto the ground, into ditches or pools without any treatment. The site selection and layout of township enterprises is improper resulting in industrial pollution. The unreasonable use of chemical fertilizers and pesticides has led to heightened non-point pollution in some areas. Pollution from livestock and poultry breeding has been increasingly highlighted.¹²

With China's economic and social development, rapid urbanization, industrial restructuring and with implementation of the policy on 'scale down the secondary industry but scale up the tertiary industry' in recent years, a number of industrial pollution sites remained after relocation or abandonment of industrial enterprises in city centers and suburbs. In western countries such locations are often called "brownfields". Many of these sites have been redeveloped into residential environments but were not properly assessed or remediated to ensure public health, safety or the environment was protected. Since the 1990s, the relocation of large-scale industrial enterprises has taken place in most middle and big Chinese cities. Most of the sites, abandoned by those industrial enterprises due to relocation, shut-down or closedown, are located in the city centers and are attractive to developers. Toxic and harmful substances are in the sites' soil and underground water due to such out-of-date or malfunctioning equipment and poor management of any emissions or discharges including "running, bubbling, dropping and leaking" during production. Therefore, those sites have

¹¹ The State Administration for Environmental Protection: *Opinions on Strengthening Rural Environment Protection*, Document No. [2007]-77

¹² <http://jcs.mep.gov.cn/hjzl/zkgb>

become highly polluted and high-risk areas to public health, safety and the environment. After enterprises were relocated, some environmental pollution events adversely affecting local residents occurred due to pollutants or soil pollution.¹³

7.1.2.2 Complex causes for soil pollution

With rapid development in China's industrialization, urbanization and agriculture over the last 30 years, China's soil environment has been facing huge pressure. Pollution sources include: industrial (waste water, waste gas and waste residue); domestic waste from urban residents (domestic sewage and urban refuse); agricultural chemicals (pesticides, animal remedies, chemical fertilizers, growth substances, modifiers and additives); and waste from breeding of livestock and poultry. The soil pollution types are diversified, with coexistence of old and new pollutants and inorganic-organic chemical combinations. There are many reasons for soil pollution and the causes are complex, so the soil pollution control is rather difficult. In developed areas where industrialization development began earlier, the quality of partial or regional soil environment reduces more or less. Heavily polluted soil posing risk to human health, safety and the environment appears in areas of heavily polluting enterprises or industries, mining areas and surrounding areas, cities and suburbs.¹⁴

In China, the activities causing the site pollution include heavy chemical industry, oil extraction and distribution, mining, metal smelting, chemical production and use and industrial waste stockpiling, treatment and disposal. The sources and means of soil pollution of industrial enterprises and surroundings are mainly displayed in the following aspects: improper storage and use of production raw materials and intermediate products; discharge of environmental pollutants during production; discharge of atmospheric pollutants subsiding to the ground surface; leakage of underground pipelines; and unreasonable stockpiling of industrial solid waste. The relocation of enterprises puts an end to the continual pollution to the environment at a specific site, but the pollution to soil and underground water will continue. On the whole the emission of industrial 'three wastes' (waste gas, waste water and industrial residue) is a direct cause for regional soil pollution. The emission of massive pollutants will finally go into the soil directly or indirectly, pollute the soil surface through diffusion or different means and result in severe soil pollution through long-term accumulation.

7.1.2.3 Danger of soil pollution

After the soil is polluted, its original characteristics will be destroyed and the quality of

¹³ Ministry of Environmental Protection, *Circular on Effective Prevention and Control of Environmental Pollution in Relocation of Enterprises*, Document No. [2004]-47

¹⁴ Ministry of Environmental Protection, *Opinions on Strengthening Soil Pollution Prevention and Control*, Document No. (2008)-48

crops will lower accordingly. Polluted soil in the surface stratum is vulnerable when acted on by wind and water forces. This may result in such ecological environment problems as atmosphere pollution, surface water pollution and ground water pollution.

The quality of agricultural products is an important foundation for food safety. In recent years the problems on quality, sanitation and safety of China's agricultural products have been highlighted. Due to unreasonable use of chemical fertilizers and pesticides in planting and cultivation as well as environmental pollution of origins, the chemical residue and harmful substances in some agricultural products are not acceptable.¹⁵ Currently there are frequent occurrences of events on safety of agricultural products and human health caused by soil pollution, which becomes a key factor in affecting agricultural production, public health and social stability.¹⁶ It's estimated that nationwide, grain polluted by heavy metal is up to 12 million tons every year, with direct economic losses exceeding 20 billion *yuan*.¹⁷

The contaminated soil in cities and industrial sites is a serious threat to human health and ecological environment in China. For example, the petroleum hydrocarbons pollutants in the soil of industrial sites of the petrochemical industry have a big impact on yield and quality of crops; the soil polluted by petroleum may result in changes in other environmental elements; the petroleum hydrocarbons can go into human or animal bodies in such forms as breathing, skin contact or food intake, resulting in cancers, mutagenesis and teratogenesis. When solid waste is piled up in the open area, the pollutants may dissolve, seep, drain and permeate into the ground surface with rainwater after being washed by rain for long, thus polluting groundwater plus rivers and lakes, and further endangering farmland, aquatic products and human health.

Contaminated sites remaining after relocation, shutdown or closedown of industrial enterprises could be located in the city's downtown, and attractive for development of commercial or civil real estate. Though the enterprises have been relocated or shut down, their impact on the environment of the original sites has not been addressed. The pollutants accumulated in the soil and underground water of the original sites will not degrade naturally. If those sites can't be harnessed and restored, the pollutants will go into the human body via underground water or air. Those that live near or on a site have a right to know if their health or well being is or can be affected by past practices or current practices of a site owner/operator.

¹⁵ Circular of The State Council on *Strengthening 'Vegetable basket' Work at the New Stage*, Document No. [2002]-15

¹⁶ *Speech of Shengxian Zhou at the First National Working Meeting on Soil Pollution Prevention and Control*, http://www.zhb.gov.cn/gkml/hbb/qt/200910/t20091023_180126.htm

¹⁷ http://news.xinhuanet.com/environment/2006-07/19/content_4852888.htm

Soil pollution is a key factor in threatening the public health, ecological environment and safety of underground water and food. It has a strong impact on China's social and economic sustainability and on the fulfillment of the objective of building up a well-off society. How to keep a safe and healthy environment for production of agricultural products is not only necessary for protecting resources of agricultural production, producing safe agricultural products, making Chinese agricultural products more competitive and realizing agricultural sustainability, but inevitable for guaranteeing the public health for a harmonious society and promoting people's livelihood.

7.1.3 Development Trend in Soil Environment Protection and Pollution Control Field

The future 5-10 years is a critical period for fulfilling the objective of building a well-off society by 2020. Currently China's soil environment is facing a severe situation. It's estimated that in the future 5-10 years China's population will continue to grow, with rapid development in industrialization, urbanization and agriculture integration. A balance between social and economic development must be struck in order to protect soil. In the future 5-10 years, China's soil environment protection will not face an optimistic situation if this balance is not achieved.

As agricultural development enters a new stage, people's living standard has been improving constantly. China is opening wider and wider to the world. The 'vegetable basket' work is facing new situations and tasks. It's required to control safety of agricultural products to ensure people's health. Keeping a safe and healthy environment for production of agricultural products is critical to making Chinese agricultural products more competitive, achieving agricultural sustainability, guaranteeing the public health, building up a harmonious society and promoting people's livelihood.

With step-by-step implementation of industrial restructuring, a lot of enterprises in petrochemicals, metallurgy, electroplating, printing and dyeing, pesticide and pharmacy will be relocated, closed or shut down. The sites remaining after relocation or closedown of those enterprises will become an important source for land redevelopment of cities. With urbanization, a majority of industrial pollution sites may be redeveloped into housing estates. Guaranteeing a safe living environment for both urban and rural residents is an urgent problem to be solved. There is a huge quantity of industrial residue and domestic refuse from the past in China. Some industrial residues or domestic refuse are located in environmentally-sensitive areas, such as the upper reaches of basins or water source areas, exerting potential risks on the soil, water bodies and human health of the sites.

The existing operations of industries and enterprises need to be inspected and laws en-

forced so that further degradation of Chinese soil does not occur.

7.1.4 Problems Existing in Soil Environment Protection and Pollution Control

China's soil environmental protection and pollution control began in the late 1960s. Through nearly 40 years of research and development, noticeable results have been achieved. Compared with atmospheric and aquatic environment pollution control, however, there are still some problems existing in China's soil environment protection and pollution control.

7.1.4.1 Absence of specific laws and codes for soil environment protection and pollution control

China's soil environmental protection and pollution control legislation needs to be improved. There are such defects as dispersed legislation, subsidiary legislation and a low legislation level. Legislation contents need to be improved. Repetition, conflicts of legislation, excessive legislation that does not go beyond principles, poor operability and absence of basic law systems must be addressed. The existing laws and regulations on soil environment protection and pollution control are fragmented, unsystematic, unfocused, unworkable and not enforced allowing soil to be adversely affected.

7.1.4.2 Weak supervision ability to address soil environment issues and absence of perfect risk management system

At present, China's measures for soil environment supervision and control are incomplete. Knowledge of a site's soil pollution history, the category of soil pollutants (especially organic pollutants), environmental transport behaviours and risk of pollutants is fundamental to proper management. The soil pollution monitoring system is incomplete without an information management system that documents all aspects that affect health, safety and the environment. There is no complete risk evaluation or risk management approach to soil environment management. So far only 9 provinces, autonomous regions and municipalities of the country have carried out supervision of contaminated sites and no relevant work has been conducted yet in the other provinces, autonomous regions and municipalities.

7.1.4.3 Unsound soil environment standard system

The current Standard for Soil Environment Quality (GB 15618-1995) is applicable for soil environment protection management of agricultural land, but there is only a small number of pollutant items covered by the standard; in particular, it lacks standards of some organic pollutants, thus the standard can't meet the need for identification of all kinds of soil pollution in regions and specific sites; and the standard only specifies the national uniform values, which can't fully show differences of regional soil in background and nature.

China's current soil environment standard system lacks the pollution assessment and remediation components. Systematic and complete standards on how to investigate and assess the risk posed by sites to human health and safety are required. Standards and technical codes for site restoration after it is deemed contaminated need to be developed. The existing standards do not meet the need for soil environment assessments and management of the sites, especially carrying out investigations, risk evaluation and pollution restoration of the sites when transforming industrial land into residential and commercial estate. Depending on what land ultimately will be used for has an impact on how its restoration should be addressed.

The current standards for soil monitoring and analysis methods only include monitoring methods for eight kinds of heavy metal and typical pesticides; there are only standard samples for heavy metal pollutants but no standard samples for organic pollutants. The present standards for monitoring and analysis methods for soil environment and standard samples are far from meeting reasonable environmental monitoring needs. In addition, "measurability, quality assurance and definite identification" are critical if affected stakeholders are to have confidence in the system.

7.1.4.4 Weak technical support for restoration of polluted soil

The technologies of soil pollution remediation are not mature yet in China. At present, the costs for soil pollution remediation measures are high with a long purification period. Currently, technologies for polluted soil restoration are not mature yet and most of technologies are still at the stage of laboratory simulation and research, without practical engineering practice. The existing restoration technologies have many problems, so there are no currently available restoration technologies, which are feasible economically, technically sound for different types of polluted soil and acceptable to Chinese conditions. So far, China hasn't established a screening system for restoration technologies and the existing technical support conditions can't meet the need for restoration work of contaminated sites.

7.1.4.5 Absence of funds safeguard for remediation of polluted soil

With full consideration of remediation and control of polluted soil and underground water, there is a huge demand for fund. At present the surveys, evaluation, control and remediation of polluted soil in China are generally funded by relevant governmental departments and land developers, so the fund sources are limited and not guaranteed. Therefore, it's difficult to carry out remediation and control, and the fund problem has become a principal obstacle in redevelopment of many contaminated sites.

7.2 International Experiences and Implications in Soil Environment Protection and Pollution Control for China

7.2.1 Establishment of Policies on Soil Environment Protection

7.2.1.1 Attach importance to measures for soil environment protection

Before the 1970s, Western developed countries had shown little concern on the soil pollution problem. However, the problem began to catch attention with occurrences of all kinds of pollution events. Box 7-1¹⁸ for typical events of soil pollution in the 20th century. There is a huge fund demand for remediation and control of polluted soil. For example, the remediation costs of soil pollution of the Netherlands from 2000 to 2009 amounted €335 million/year, of which the government's investment was €160 million/year. Therefore, the developed countries attach importance to pollution prevention in the soil environment protection and have established complete systems of laws, codes and standards in soil environment protection and pollution control. Based on experience in developed countries in Europe and America, the costs for soil protection, the costs for land sustainability management, and the costs for site restoration increases in a proportion of 1:10:100, so the lowest-cost measure for soil protection is to attach importance to soil protection policies. The general management of soil environment should begin with prevention as well as supervision and remediation of contaminated sites.

Box 7-1 Typical Events of Soil Environment Pollution in the 20th Century

Itai-Itai Disease Event in Toyama Prefecture, Japan: From the beginning of the 20th century, the rice in Toyama Prefecture, Japan didn't grow well in general. In 1931 a weird disease occurred. The symptoms of its patients included pains in joints like waist, arm and leg. At the late stage of the disease, the patients would face softening and atrophy of bones, bending of limbs, deformation of spinal columns and brittle bones. Even coughing would cause fracture of bones. From 1946 to 1960 medical professionals of Japan engaged in general clinic, pathology, epidemiology, animal experiment and analytical chemistry carried out long-term study and found that Itai-Itai Disease was caused by cadmium (Cd) poisoning due to mining wastewater of Kamioka Mining Station in the upper reaches of Jinzu River.

¹⁸ <http://www.people.com.cn/GB/huanbao/259/6899/>

Love Canal Event, USA: Love Canal, CA, USA was out of use as it was dry in the 1940s. In 1942 an American electrochemistry company bought this disused canal as its waste storage, and dumped all kinds of waste up to 8 million tons into the canal within 11 years. After that, a lot of houses and a school were built on it. Since 1977 residents there had suffered from all kinds of weird diseases, such as abortion of pregnant women, death of children, deformity of infants, epilepsy and hemoproctia. Those diseases occurred frequently. In 1987 a black liquid began to seep from the ground there. Through inspection, it contained many poisonous substances, like chloroform, trichlorophenol and methylene bromide, which did huge harm to the human health.

7.2.1.2 Inter-Ministerial cooperation and decision making are crucial in developing effective soil environmental management policies

Defining soil policies are institutionally and legally an extremely complex issue. It relates to many pieces of legislation (e.g., building construction, agriculture, spatial planning, water and waste management) and many different Ministries. Stakeholder support-i.e. involvement of the most relevant Ministries-is an important factor in developing effective soil environmental policies. Setting up a clear institutional structure for the various aspects of soil environmental management, and assigning clear tasks for both public and private parties are essential prerequisites to effectively put these policies into practise. It's an effective measure adopted by developed countries for soil environment protection and pollution control to set up a cross-departmental 'workgroup' to set soil protection goals and formulate laws and regulations. It is an effective measure to set up a cross-departmental 'workgroup' to determine the protection objectives and draw up laws and regulations. Stakeholder support-i.e. involvement of the most relevant Ministries-is an important factor in developing effective soil environmental policies (Box 7-2).

Box 7-2 Cross-departmental Cooperation Is Vital for Making Effective Policies on Soil Environment Management

The soil environment management involves many departments, sectors and fields, and it's necessary to set up a mechanism of cooperation and coordination among departments. It's vital for making policies more enforceable to establish a clearly-defined institutional structure for all aspects of soil environment supervision; and it's an effective measure to set up a cross-departmental "workgroup" to set soil protection goals and formulate laws and regulations. The departments concerned include: environmental protection, land management, building, agriculture, water administration, quality supervision and so on.

Based on the assumption that the contaminated sites issues could be solved in one decade-in the 1980s – the Netherlands failed to muster sufficient inter-Ministerial support. Soil policies were essentially sectorially focused on soil environment only. This led to stagnation in for example spatial planning, building project development and construction of infrastructure. Upon recognition of this situation, soil policies were redefined by the following three Ministries: Ministry of Housing, Spatial Planning and the Environment (lead position); Ministry of Transport, Public Works (i.e. Infrastructure) and Water Management; Ministry of Agriculture, Nature and Food safety.

7.2.1.3 Information disclosure is an important part in establishing soil protection policies

Many developed countries have established polluted soil information databases for the public to inquire. For example, the Superfund Information System in the USA contains more than 10 000 sites and the public can get basic information on a site online in many retrieval forms, like the site's name, number, street, city, county, state, region or postal region. The federal contaminated site directory, set up by the Real Property and Material Policy Division of the Treasury Board Secretariat, has been open to the public since July 2002. There are 6 700 active contaminated sites identified in the directory, and the public can get information on a site, including its location, pollution level, polluting media, pollutant nature, current progress on identifying and clarifying pollution problems, and the quantity of treated liquid and solid media. There are many key word retrieval forms including: typing in the site's name, province or region, population census metropolis, federation electorate, pollutants of the site, the schedule of federal action plans for contaminated sites, and site management plans. This approach has been taken in order to allow all stakeholders to access the available information. It recognizes that depending on your viewpoint, you may be trying to access information in a different way. A scientist may search with different key words than a citizen. Such information can be exported in two forms: table and drawing.

7.2.2 Soil Environment Supervision

7.2.2.1 Soil environment supervision with risk-based methods

At present developed countries generally adopt the modes based on environmental risk assessment and risk management in soil supervision (Box 7-3). For soil quality supervision with risk-based methods, the protected objects are human health, soil ecology and underground water (if possible).

Box 7-3 Adopt the Risk-based Method for Soil Environment Supervision and Give Priority to Treatment of Sites Having the Biggest Risks to Human Health and Environment

Based on experience in developed countries, there is a huge fund demand for remediation and control of polluted soil. For example, there are more than 30 000 contaminated sites in Canada and 294 000-400 000 sites in the USA. It's specified in both Superfund of the USA and Action Plan of Contaminated site of Canada that priority should be given to solving those contaminated site with the highest risks. Generally developed countries adopt the risk-based management mode in accordance with the degree of soil pollution risks to human health and environment: first reduce risks to human health and then risks to ecology and underground water to reduce costs, clean as many contaminated sites as possible and promote local economic and social development.

With methods based on risk management, different soil management policies can be established, such as land sustainability management policies for slightly polluted areas and restoration policies for heavily contaminated sites. An assessment of contaminant risks needs to be considered in the context of current and future land use, and development scenarios (e.g., residential, commercial, industrial, agricultural or recreational use). A detailed site-specific environmental risk assessment may be used to develop strategies that yield acceptable health risks, while achieving low level contamination on-site.

7.2.2.2 Attach importance to participation of interest-related parties in soil environment supervision

The support of interest-related parties (namely participation of the most relevant parties) is a key factor in establishing effective soil environment policies. One of main principles in the contaminated site management flow in the USA is the whole-process participation of communities. The principle of “polluters are responsible for harnessing” for the polluted soil is difficult to be implemented sometimes, and it will be an effective solution that all interest-related parties of polluted soil participate in it together. Figure 7-2 for the relationship among all directly interest-related parties in soil environment supervision.

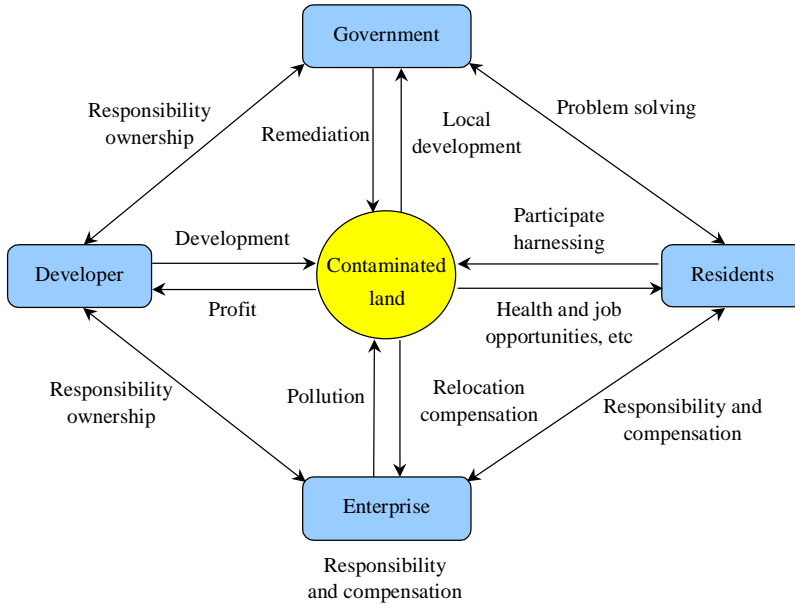


Figure 7-2 The Relationship among All directly Stakeholders

7.2.2.3 Attach importance to soil supervision by local governments

It's shown from experience of Canada that the most effective method is to manage the soil at the local first level, which can make use of capital most effectively. At the same time the diversity of soil and local conditions should be taken into consideration for further optimization of soil environment management costs.

7.2.2.4 Draw up effective financial incentive measures of soil environment supervision

The financial incentive is a determinant in soil environment protection and pollution control as well as a key element for governments at all levels to implement the soil protection strategies. The multi-channel fundraising mode is a determinant in promoting soil control, redevelopment and utilization. Effective financial means include environment taxation, cleaning subsidies, special appropriation, loan guarantee, market licensing and so on. It's shown from experience in developed countries that the challenges caused by soil pollution will not be solved fully unless capital is available and responsible parties are responsible for their behaviours. Box 7-4 for the financial mechanism of Superfund.

Box 7-4 Financial Mechanism of Superfund

The capital sources of Superfund mainly include: the raw material tax on petroleum and 42 kinds of chemical raw materials from 1980; the environment tax collected from the company revenues from 1986; the appropriation from the general finance; the charges collected from companies and individuals responsible for environmental damages relating to disposal of hazardous waste; and others, such as interests and penalties from those companies and individual unwilling to assume relevant environment responsibilities.

In the beginning when Superfund was set up in 1980, its capital sources mainly included the special tax on petroleum and chemical raw materials, plus an appropriation from the general federal finance. The Superfund Amendments and Reauthorization Act of 1986 increased the rate of special taxes for the above petroleum and chemical sectors and also set a new environment tax collected from those companies with an annual revenue not less than US\$2 million, plus an appropriation from the general federal finance. The Omnibus Budget Reconciliation Act of 1990 extended the period of Superfund's taxation and treasury appropriation to 1995, with the same tax rate and the appropriation amount from the general finance. Without new authorization after 1995, the new capital sources of Superfund only included the charges collected from potentially responsible parties and the income from interests and penalties.

7.2.3 Soil Environment Protection Standard System

7.2.3.1 A complete standard system for soil environment protection is a guarantee for implementation of policies

The soil quality standards play a vital role in developing soil environmental protection policies. After drawing up special laws and regulations on soil environment protection, generally developed countries will release relevant enforcement rules and standards in accordance with their respective soil environment problems, thus establishing a complete system of laws, regulations and standards on soil environment protection. In the regulatory framework, most developed countries have set up a complete standard system for soil environment protection in accordance with requirements for soil risk management, land usage and protection objectives of acceptors, including screening, target or restoration values of soil pollutants; meanwhile the system often contains guidelines for standard set values plus documents of technical codes like methods for soil survey, monitoring and pollution screening and evaluation, thus jointly providing technical support for identification, management and harnessing of polluted soil/underground water of the sites.

7.2.3.2 Set standards for soil environment quality with the risk-based method

Since the 1980s, Western developed countries have set standards for soil environment quality in accordance with prior risks (such as human health, safety of agricultural products, ecological system and conservation of resources) and in consideration of different use of land, such as housing, industry, agriculture and nature, regarding the problem of soil and underground water pollution of industrial sites remaining from the industrialization period (Box 7-5). According to the designation situation of guideline values for soil quality in the world currently, it has been an international development trend to set guideline values for soil quality to protect ecology and human health with the evaluation method based on exposure risks by means of dividing different land utilization types and in combination with effects of soil ecotoxicology and exposure risks of human health.

Box 7-5 Set Suitable Standards for Soil Environment Quality

In the 1980s the Netherlands set a general soil quality standard, which was (excessively) strict, without being based on land reuse, thus making a mistake, so that a lot of soil wasn't able to be reused and that the quantity of contaminated sites was huge. It's necessary to set applicable soil quality standards and use funds for control of the most polluted soil for harmonious and sustained development between soil environment protection on one hand and economy and society on the other.

Land use is a complex and sensitive issue. It is therefore recommended to calculate the effects of setting soil quality standards. It took the Netherlands a substantial effort to build up (nation-wide) databases on contaminated soils. At present these databases are used to calculate the socio-economic effects of setting soil quality standards.

Too strict soil quality standards will hamper socio-economic processes. Too lenient soil quality standards will miss the objective of soil protection (and improvement). In Canada and the United States, over the last 30 years, governments have committed considerable time and resources to develop soil quality criteria. These criteria are now used by owners, industry, developers and governments to determine whether a site is contaminated, what activities are allowed on the site and if a site should be remediated and to what standard.

7.2.3.3 Set national and local guiding standards for soil quality

A perfect system for soil environment protection standards is a guarantee for enforcement of policies, and the local governments can formulate local standards stricter than the national one. Since the 1990s, a majority of European and American countries have developed from setting a national uniform standard into setting a series of guiding standards for

soil pollution evaluation and restoration centering soil screening values and harnessing target values in accordance with different regions or sites, different requirements for soil environment quality by different utilization functions and protection objectives, and different objectives of soil pollution harnessing and management. The priority in setting and revising soil environment protection standards has transformed from improving the national uniform mode of ‘universal limit values’ into the mode of ‘one set of rules but multiple guiding values in accordance with local conditions’. Both Canada and USA have established guiding standards for soil quality at the federal/national level. The governments at lower levels (such as provincial-level or state-level) are free to establish guidelines or standards at levels which may be more or less stringent than the national values.

Table 7-1 shows the comparison of measures for soil environment supervision between developed countries and China.

Table 7-1 Comparison of Measures for Soil Environment Supervision between Developed Countries and China

	Developed Countries	China
Legislation	Having special laws and codes for soil environment protection and pollution control, such as Superfund Act and Brownfield Act in the USA, Soil Protection Plan in the Netherlands and Soil Pollution Countermeasures Act in Japan	Having no special laws on soil pollution prevention and control
Supervision	Adopting risk-based management modes	Having not implemented risk-based management modes
Standard system	Having a complete standard system for soil environment protection; both Canada and the USA have established national and local guiding standards for soil quality	The standard system for soil environment protection is incomplete; and the whole country adopts the uniform Standard for Soil Environment Quality
Fund guarantee	Multi-channel fundraising mode	Fund sources are limited and not guaranteed

7.3 Soil Environment Protection Policies Recommendations

7.3.1 Develop and Improve China’s Systems for Laws and Regulations on Soil Environment Protection and Provide Legal Basis for Soil Environment Supervision

Establish a special law of China on soil environment protection and pollution preven-

tion and control that integrates current laws and regulations on soil pollution prevention and control with experience from the international community, foreign countries and Chinese Taiwan. Such a law should effectively coordinate policies, measures, methods, management experience and enforcement activities that have existed in China for many years. Successful policies, measures, methods, management and enforcement experience need to be incorporated into codes of conduct for people in the field of soil pollution prevention and control activities. In establishing this specific law on China's soil environment protection and pollution control, attention should be paid to integration with China's existing laws to avoid contradictions or conflicts.

7.3.1.1 Set up a cross-departmental workgroup

Set up a special cross-departmental workgroup that has political support, to coordinate and draw up laws, codes and relevant systems about China's soil environment protection and pollution control. The workgroup will focus on all soil protection problems in China.

Define supervision management systems for soil environment protection and pollution control. Of them, the most important points include authority setting and division of its functions and powers, especially division of responsibilities among such departments as environmental protection, agriculture, land resources and water resources, Ministry of Finance, Ministry of Defence, and Ministry of Railways. At the same time it's necessary to define basic rights and duties of all parties in soil environment supervision, basic legal principles and systems for soil environment protection, and basic requirements and measures for prevention of soil pollution and restoration or harnessing of polluted soil. In addition, it is necessary to define how to settle disputes about soil pollution prevention and control as well as legal consequences in violation of laws on soil pollution prevention and control.

7.3.1.2 Attach equal importance to soil pollution prevention and harnessing

The fundamental solution for soil pollution is to control the discharge of pollutants with whole-process clean production and recycling of materials. Take comprehensive account of China's current situation and actual needs of soil pollution prevention and control. It's recommended that the legislation of soil pollution prevention and control of China at the present stage should focus on both soil pollution prevention and control.

7.3.2 In Meeting Environmental Supervision and Control Objectives, Great Importance should be Attached to the Soil Pollution Caused by Industrial Activities Apart from that Caused by Agricultural Pollution

The management policies for China's soil environmental problem-solving and restoration must continue to adhere to the overall objectives of improving soil environmental qual-

ity, guaranteeing of the quality of agricultural products and building a good and habitable environment. Comprehensive control efforts, ecological restoration and project demonstrations at typical polluted soil sites must be undertaken. Successful demonstration projects at agricultural and industrial soil contaminated sites will build knowledge for transfer.

7.3.2.1 Strengthen soil environment quality supervision in basic farmland and major agricultural production areas

It's essential to select those regions with good basic conditions, conforming ecological environment and being suitable for producing green and organic food, set up a group of bases of organic and green food and strengthen supervision and management of soil environment, thus ensuring product safety from sources. The environmental protection authority shall work with other departments concerned to work out measures for supervision of soil environment of places of origin of major agricultural products as well as standards for production soil environment safety of products and relevant technical specifications. Also it's necessary to strengthen supervision of pollution sources having an impact on product quality and strictly control the discharge of pollutants. The municipal sludge and bed mud should not be employed on farmland without treatment, thus ensuring safety of agricultural products and ecology. The environmental protection authority should supervise and check the soil environment quality of green and organic food bases on a regular or irregular basis.

It's essential to establish a network of soil environment quality monitoring for places of origin of agricultural products of key cities in combination with the result of the national soil pollution investigation; to exercise supervision and control by classification and division, and give priority to strengthening soil environment quality management of basic farmland and places of origin of major agricultural products, especially bases listed in 'Vegetable Basket' Program; carry out special investigations on environment pollution problems in places of origin of listed in 'Vegetable Basket' Program to get accurate information on the environment pollution status of such places. The Ministry of Agriculture should tighten use of pesticides and fertilizers, and strengthen inspection and quarantine of products listed in 'Vegetable Basket' Program. The Ministry of Environmental Protection should supervise and manage soil environment and pollution sources having an impact on product quality through strengthening supervision-oriented monitoring. The governments at all levels should include funds required by building of soil environment monitoring capacity and monitoring of soil environment into their financial budgets, and put more funds in monitoring.

7.3.2.2 Attach importance to supervision of the high-risk industrial contaminated sites

In order to address problems of industrial soil pollution impacts on human health, it is necessary to attach great importance to high-risk industrial soil pollution management and

control. This requires a concerted effort to intervene and control the following types of industrial land: contaminated sites caused by relocation of industrial enterprises; contaminated sites caused by stockpiling, sites contaminated by treatment and disposal of toxic and harmful waste; contaminated sites of gas stations or underground storage tanks. A comparison of activities responsible for contaminating soil in Europe and America with those that are active in China should be undertaken to ensure that no types of industrial activity escape scrutiny. It's necessary to establish specifications on monitoring and assessment technologies for soil pollution as soon as possible, and to define relevant provisions on field pollution control and restoration. In accordance with different types of industrial pollution fields, it will be necessary to carry out systematic investigations and monitoring of soil at contaminated sites and establish a soil environment monitoring network and database. This database would help to focus soil pollution investigation within key regions. The database could be used to research and develop efficient and fast restoration technologies of polluted soil including physical, chemical and biological combined restoration technologies.

In addition, attention, prevention and control of radioactive pollution in soil are required. Restoration standards or references and study restoration technologies applicable for harnessing radioactive soil are required.

7.3.3 It is Essential to Strengthen Risk-based Soil Environment Management, Drawing on the Mode Generally Adopted by the International Community

7.3.3.1 Draw up different management countermeasures based on risk management methods with the protection targets of human health, soil ecology and groundwater

The risk-based environmental management of polluted soil as a supervision and control mode is generally adopted by the international community. Such a management means has many advantages. A cost benefit approach is used, which is, to a large extent, applicable for China as a developing country. Over the next 5-10 years, it is necessary to establish technical guide rules or documents for field risk evaluation and management using a risk-based management framework. Soil references and standards for risk evaluation of contaminated sites need to be proposed. Risk evaluation models, evaluation criteria and risk management technologies need to be studied and adopted. Acceptable pollutant levels, ecological effects, health hazards and an environmental control index system must be applied in urban and rural areas of China in order to understand how best to protect people and food supply. Effective control technologies to reduce or resolve risk in accordance with risk evaluation need to be specified. Technical guide rules or documents for risk management to protect the human health and the safety of ecological systems need to be developed in such a way that contrac-

tors can implement remediation work. It is necessary to give restoration priority to those contaminated sites with the biggest risks. Low-exposure and low-risk contaminated sites must be given attention through a low cost, high efficiency management approach that protects health/safety.

7.3.3.2 Attach importance to stakeholder partnerships

In the soil environment supervision, it is necessary to ask opinions of all interest-related parties and establish cooperation among relevant departments, among governments at all levels, between public and private sectors, and between affected citizens and others. The link between liability and accountability must be made.

7.3.4 The Means and Measures for Soil Environmental Supervision Require Reform and Innovation. It is Necessary to Promote the Building of a Soil Environment Standard System and to Encourage Provinces and Cities to Set Local Standards for Soil Environment Quality and Restoration of Polluted Soil in the Coming 5-10 Years

7.3.4.1 Establish the soil environment supervision system suitable for China's actual conditions

Both the state and local governments should follow uniform deployment of initiatives by the Ministry of Environmental Protection to include soil environment supervision and management as an important part of environmental protection. The local governments need to be encouraged to research and establish locally-feasible regulations, policies and measures on soil pollution prevention and control in accordance with local conditions. It is necessary to establish China's own soil environment supervision systems based on advanced experience of foreign countries, including the soil environment quality monitoring and evaluation system, the soil pollution accountability system, the soil pollution prevention and control fund system, the polluted soil control system, the soil pollution harnessing and restoration system, and the soil pollution emergency management system.

Both the state and the local government should bring the soil environment quality monitoring under a routine environmental monitoring system, make soil environment monitoring plans, and provide adequate resources to implement the plans. It's necessary to set up and improve the soil environment monitoring network at three levels: national, provincial and county, and carry out research to establish a system for publishing the state of soil environment quality on a regular basis. It also is necessary to strengthen the building of soil environment protection teams and make emergency plans for soil pollution events. Facing the current situation that the soil environment monitoring management has not been brought under the present routine tasks of environmental monitoring, and that the monitoring author-

ities, abilities and systems have not been normalized, it's necessary to further increase and set up special authorities for soil environment monitoring. Existing environmental monitoring stations at county, city and provincial levels will need to be strengthened and added to with the help of the special authorities. The soil environment monitoring field needs to be properly equipped and efficiently integrated to provide results at the county, provincial and national levels.

It's necessary to draw up early warning and response mechanisms and measures based on soil environment risk evaluation, safety evaluation and environmental monitoring information to respond to all kinds of pollution (including accumulated pollution and pollution caused by emergencies or other reasons). Moreover, it's necessary to carry out research that can lead to establishment of a technical support system to guarantee effective early warning and emergency response. The early warning systems for soil environment safety mainly includes: a real-time monitoring information system for the state of pollutant discharge in key pollution sources, an early warning system for emergencies, and an early warning system for soil environmental monitoring and safety evaluation in key areas. It's also necessary to establish criteria that will initiate the early warning system.

It's necessary to strengthen the building of soil environment protection publicity and education teams. Plans, ordinances, rules and regulations for soil environment publicity and education need to be developed. Textbooks for publicity and education of soil environment protection must be written to capture learnings and minimize duplication. Archival repositories for soil environment publicity materials and information network sharing platforms need to be established. Professional teams for scientific research, monitoring and management service of soil environment protection need to be nurtured and supported to ensure those qualified can do their job.

7.3.4.2 Establish a registration system for contaminated sites at the point of property transaction

Establish a registration system for contaminated sites at the point of property transaction, and this would be applied when there is buying or selling or a proposal for a change in land use.

The land seller should identify the current owner of land usage rights, activities / operations on the land (related to causing of any possible contamination), extent of existing contamination, owner's declaration of such contamination or no contamination, and a declaration awareness/acknowledgement recognizing their responsibility/liability for any contamination that may have occurred on this piece of property. The land buyer should identify any contamination on the property and declare the awareness of such contamina-

tion and liability from such contamination that might be transferred to the buyer, and declare the Not-Guilty responsibility with all possible due diligence effort before the property transaction.

7.3.4.3 Improve China's soil environment standard system

China's soil environment protection standard system should include five parts: the standards for soil environment protection of agricultural land, the standards for soil environment protection of sites, the standards for soil environment analysis methods, the soil environment standard samples and the basic standards for soil environment.

The standards for soil environment of agricultural land mainly include the standard for soil environment quality, the technical code for soil environment quality assessment, the technical code for soil environment monitoring and the technical code for soil pollution prevention and control of agricultural land. The standards for soil environment of sites mainly include the technical codes or guidelines about the sites' environmental survey, assessment, restoration and monitoring, mainly involving technical provisions on all links in environmental protection of sites. The standards for soil environment analysis methods mainly include the analysis method standards of various pollutants in the soil, like heavy metal pollutants, volatile pollutants, semi-volatile pollutants and permanent organic pollutants, plus technical specifications for pre-treatment methods of relevant soil pollutant samples. The soil environment standard samples mainly include standard samples of various pollutants in the soil, like heavy metal pollutants, volatile pollutants, semi-volatile pollutants and permanent organic pollutants. The basic standards for soil environment mainly include terminology, definitions, symbols, measurement units and other standards in soil environment protection.

Incorporated into all standards is a requirement of due diligence, liability and accountability in order to ensure those responsible undertake their tasks in a manner that reflects the specified standards.

7.3.4.4 Set the national and local guiding standards for soil quality

The current Standard for Soil Environment Quality emphasis is on a uniform national standard. It should be revised in the coming 5-10 years. It's necessary to adopt risk evaluation methods to set standards for soil environment quality of different regions reflecting different soil characteristics and land utilization types. It's necessary to adjust pollutant items stated in the current Standard for Soil Environment Quality to include other pollutant types (including heavy metal and toxic and harmful organic pollutants). The country should establish soil environment protection standard systems, speed up the revision of the national standard for soil environment quality, draw up and improve relevant monitoring and analysis methods for the soil environment, and implement research to set the soil pollution control

standards. The local governments should be encouraged to research and set local or regional soil environment standards in accordance with local conditions that, at a minimum, meet the national standards but exceed them where required.

Proposals on establishing the soil quality standard:

(1) Suggest methods for China's soil pollution ecology and health risk evaluation and establish relevant laws, codes, technical codes and guide rules as soon as possible.

(2) Carry out studies on pollutants' environmental behaviours, biological availability, ecotoxicology tests and dosage-reaction relations in a systematic way to provide theoretical references for determining the soil standard values.

(3) Develop methods and technologies to establish standards at a national level that reflect China's diversified soil types. All provinces, autonomous regions and municipalities should establish their own regional standards. Revise and improve national soil quality standard systems applicable for different land utilization types. Set local soil quality standards in all provinces, autonomous regions and municipalities.

7.3.5 For Soil Pollution Control and Harnessing, the National Environmental Protection Authority Should Carry Out Assessments on Applicability of Remediation Technology of Polluted Soil Sites Through Implementation of Demonstration Projects and Study to Develop A Financial Capital Mechanism for Addressing Soil Remediation

7.3.5.1 The key areas for soil pollution control and harnessing include lands used for agricultural production, abandoned industrial sites with high pollution and risks, hotspot areas and ecology-sensitive areas. Support should be given to build a group of key demonstration projects of harnessing and restoration

The priority for implementation action should be given to supporting basins and regions with a history of sites harming public health, safety and the habitable environment. Special focus should be given to sites that have contributed to poor quality of agricultural products. In rural areas, the priority should be given to major production bases of grain, agricultural products and export-oriented agricultural products. Restoration of polluted soil and ecological control needs to be in accordance with resolving soil environment problems having an impact on quality of agricultural products or food.

In urban areas, the priority should be given to industrial sites after relocation or closedown of high-pollution and high-risk enterprises (such as pesticide plants, chemical plants, coke-oven plants and landfill of hazardous waste). Comprehensive control and soil restoration of contaminated sites need to be undertaken as a demonstration to show how

public safety and the environment can be protected. In an urban situation, many people can be affected. It's necessary to focus on hotspot areas for demonstration projects. Areas of cancer, areas of endemic diseases and frequently occurring areas of environmental pollution will be a priority. In the coming 5-10 years, it's necessary to establish screening index systems for different restoration technologies with such pollutant targets as heavy metal, petroleum, pesticides and permanent and volatile toxic organic substances. Also, it is necessary to promote the building of a group of national and local key labs for soil pollution prevention and control, or technical centers for soil restoration engineering.

7.3.5.2 The local governments are the principle responsible agents in implementing soil pollution prevention and control projects, and such projects should be mainly funded by the local governments, while the central government's financial fund mainly serves as a guide to encourage the participation of private capital

According to restoration practice of polluted soil sites in different regions at present, the fund raising for restoration is an important bottleneck problem. In the future 5-10 years, it's necessary to find a reasonable mechanism for raising capital for restoration projects. The capital sources should include pollution taxes levied from polluting enterprises, contributions from developers of polluted plots, government grants, funds gathered from responsible parties, penalties from companies and individuals evading their relevant environment responsibilities, funds raised from local communities and residents, public donations, interests of funds.

The projects for prevention and control of soil pollution should be mainly funded by the local governments while the central government's financial fund should mainly serve as a guide to encourage the participation of private capital. The central government should arrange a certain proportion of specific funds from its financial budgets for prevention and control of soil pollution, and ensure that such funds will increase year by year; and also the local governments should arrange a certain amount of funds for prevention and control of soil pollution from their budgets. Besides, the central government should give fund support for local prevention and control of soil pollution, as appropriate.

7.3.6 For Soil Environment Supervision, It is Necessary to Strengthen Technical Support and Make Breakthroughs in Scientific and Technological Obstacles Affecting the Effective Progress of China's Soil Environment Supervision

7.3.6.1 Make lists of pollutants requiring prior control in different regions and different producing areas of agricultural products

Facing the challenge of various kinds of environmental pollution sources and pollutants

affecting agricultural products, the Ministry of Environmental Protection should cooperate with agriculture and health ministries to screen and make lists of pollutants needing control and management. Land used for agricultural production must be tested to ensure pollutants do not enter the food supply. The environmental quality assessment indices for agricultural products should be selected and determined in accordance with the state of pollution sources, characteristics of agricultural production, origin location and status quo of pollution of agricultural products. Relevant standards and evaluation methods should be set to provide guidelines for environment supervision.

7.3.6.2 Establish soil record and information management systems of contaminated sites

Carry out systematic investigations on contaminated sites, especially those industrial contaminated sites currently utilized or abandoned in cities. An audit of pollutant categories in soil and underground water, pollution scope, comparison with background or original plant site data should be undertaken. A soil record and information management review of environmental measures taken for control and remediation should be recorded and compiled for overall government management purposes through a database.

7.3.6.3 Establish screening systems for polluted soil restoration technologies and develop technologies and equipment for polluted soil restoration

Soil restoration technologies for contaminated sites should be developed. Guides need to be prepared for soil restoration technologies at contaminated sites. Policies on technologies and their applicability for soil protection and control must be developed. The building of a group of national key labs for soil pollution prevention and control and technical centers for soil restoration must be developed. National soil analysis and testing methods and standard samples as well as equipment for soil restoration of contaminated sites should be made available for use by the expert teams.

In the future 5-10 years, the priority for restoration and harnessing of polluted soil should be given to implementing demonstration projects. For contaminated sites that are a priority for development, R&D of rapid physical-chemical restoration technologies to improve restoration efficiency and lower the restoration cost need to be pursued. For agricultural soil (including sewage irrigation areas), efforts should be made in developing biological remediation and stabilization technologies. Safe, low-cost and environment-friendly technologies for the purpose of land restoration to safeguard safety of agricultural products and ecology will have to be identified in order for measures to be practical.

7.3.6.4 Establish mechanisms for sharing soil environment data in China

It's necessary to study mechanisms of sharing soil environment data in China based on scientific data sharing management mechanisms in developed countries, including systems

for policies and codes, confidentiality management mechanisms, public sharing mechanisms, organization guarantee of data sharing and so on. The use of environmental due diligence information collected during investment transactions should be explored as a means of building the Country's environmental database.