Strategic thinking on soil protection in China

Zhao Qiguo[A], Luo Yongming[A] and Teng Ying[A]

[A]Institute of Soil Science, Chinese Academy of Sciences, Nanjing, P.R.China, Email qgzhao@issas.ac.cn

Abstract
Research on China's soil protection strategy from state macroscopic and long term perspectives is of great significance for sustainable use and protection of soil resources, improvement of soil environmental quality, and ensuring agricultural production and food safety. Based on analysis of advancement and development trends of soil protection at home and abroad, this paper identifies some shortcomings in soil protection in China and gaps as compared to systems in place in developed countries and raises the key issues in the macro-strategy research on soil resources and the environment. These issues include (1) major problems of current soil protection in China; (2) guiding ideology and theory (namely macro strategy) of soil protection in China, comprising strategic concepts, guidance, objectives, missions and emphasis; (3) countermeasures in the soil protection strategy in China, consisting of management, standards, science and technology, regional soil protection, environmental protection and remediation of major soil types. This paper provides a useful reference for establishing and implementing strategic planning of soil protection in China.

Key Words
Soil, environment, protection, strategic thinking.

With the development of industrialization, urbanization, intensive agriculture and global change, the environmental status of Chinese soils has become more and more severe. Therefore, it is imperative to enhance strategic researches on the protection of soil resources and the environment. Aimed at major problems and demands in soil resources, soil fertility, soil ecology and soil environment, the strategic research on soil protection in China from macroscopic and long-term perspectives will have substantial realistic and far-reaching historic value in sustainable use, protection of soil resources, improvement of soil quality, securing agricultural production, food safety, ecological safety, safety of human residence as well as in the establishment of a well-off and eco-friendly society .

.1Soil problems in China and the urgency of soil protection

1.1Loss of soil resources and its rapid deterioration

China boasts vast expanse of landscapes, complex natural conditions and plentiful soil resources. The Chinese soil resources can be characterized by diversified soil types, huge absolute quantity, and small per capita soil resources. Currently China has two major problems concerning soil resources: namely loss of soil resources and soil deterioration. China has been facing with a number of soil resource problems including water loss and soil erosion, soil fertility reduction, desertification, soil salinization, rocky desertification as well as soil acidification, which has posed serious threats to ecological safety.

1.2 Acceleration of regional soil pollution

Results of recent soil quality survey revealed obvious pedogeochemical abnormity or pollution at watershed or regional level. Cd, Pb and Hg abnormity have been found in the Yangtze River basin, Pearl River basin and coastal areas, Songhua River basin and Liao River basin. High fluorine, high arsenic, and low iodine was found in the Yellow River basin. Soil mercury abnormity was reported in Chinese cities of different size. Preliminary analysis showed that the pedogeochemical abnormities at watershed level are combined results of high natural geochemical background and anthropogenic pollution. In some watershed with heavy metal abnormity or pollution, soil geochemical status deteriorates rapidly.

1.3 Lack of science & technology for soil protection

Although outstanding progress has been made in China concerning soil pollution survey, physical, chemical and biological remediation, gaps still exist between China and developed countries where soil remediation have been commercialized. China starts late in the research of soil pollution control; technology, material and equipment for soil remediation. Therefore, it is time to initiate studies on innovative remediation technologies and to develop technologies, equipments and management system for contaminated farmland, soil around mining area and soil on industrial sites.

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1.4 Weak public awareness and incomplete legislations in soil protection

Public awareness of soil protection is weak with little consciousness and enthusiasm. Government officials do not have adequate knowledge of soil resources, soil quality and soil function and the social value of soils, therefore little was done to raise the awareness of the general public to protect the soil protection. Education concerning soil environment is also inadequate with no specialized authorities or organizations. So far, China has not legislated any law or regulation for soil pollution prevention. Not much research has been done on soil environmental criteria and standards. Until now the soil environmental quality standard is still in revision.

1.5 The urgency of soil and environmental protection

Due to rapid social and economic development and highly intensified human activities in the past 20 years, soil degradation has increased in quantity and expanded, therefore more challenges are to be dealt with in the coming 15 years. The main reasons for soil problems are two fold. On the one hand, the importance of soil protection was not recognized. There is no specialized law, administrative structure, mechanism and supervision system for soil environmental protection. On the other hand, there was lack of investment and research on key scientific, technological, and management problems. And most of all, there is lack of macroscopic thinking of soil and environmental protection strategies.

Therefore, it is vital that a macroscopic strategy for soil environmental protection be made by integration of knowledge, technology and management. It should be based on assessment of current situation of soil environmental protection in China and international experience. The aims of the macroscopic strategy is to establish a harmonious, sustainable soil environmental protection system to improve soil quality, agricultural production, food safety, the environment, ecological safety and human health.

2. Macroscopic strategies of soil protection

2.1 Guiding thoughts and strategic principles

2.1.1 Guiding thoughts

Under the guidance of scientific development, a pedosphere research framework which incorporates soil- water- air- biota -human and a soil management framework which incorporates prevention- control- remediation- supervision should be established with the emphasis on dealing with soil problems at basin, regional levels. The goal is to secure national food safety, the environment, ecological safety and public health as well as construction of a well-off society.

2.1.2 Strategic principles

In the face of apparent or hidden problem of soil degradation and soil pollution at present or in the long run, scientific development should be implemented. The following relationships need to be considered: soil resource protection vs social economic development, maintaining soil fertility vs sustainable agriculture, soil ecology vs biodiversity, soil pollution control vs safe residential environment, wise utilization of soil vs global change, investment for soil protection from central and local governments. Soil utilization and soil protection, soil quantity and soil quality should be considered equally important. The importance of soil pollution prevention should be emphasized. Soils should be protected according to different regions and soil types. Enduring efforts are needed to building soil protection system with Chinese characteristics by progress in science and technology, law enforcement, and increasing public awareness of soil protection.

2.2 Strategic goals

The strategic goals are to maintain soil ecological functions, improve soil environmental quality, secure agricultural production, food safety and human health. It is necessary to ascertain soil quantity and quality, to improve soil fertility and self purification function, to prevent and alleviate soil degradation and soil pollution, to actively push forward innovation in soil science and technological development including theories of pedosphere and research tools, technologies for prevention and remediation of degraded or polluted soils.

To achieve the overall goals, short term, middle-term, and long-term goals are set as follows:

(1) Short-term goals (till 2020): Establish and complete legislation, structure and mechanisms for soil protection, build preliminary national soil protection system, effectively control quantity and quality of soil resources, improve science and technology for soil protection, effectively control the trend of soil pollution and degradation, effectively remediate polluted soils which pose serious threat to food safety, drinking water safety and human health, make progress in protecting soil in ecologically fragile areas and major agricultural zones.

(2) Middle-term goals (till 2030): Further improve the national soil protection system, improve soil research and education level; generally control the trend of regional soil degradation and soil pollution, remediate

polluted soil posing unacceptable risks, achieve better soil environmental quality in China.
(3) Long-term goals (till 2050): Generally alleviate soil pollution and stabilize the trend of soil degradation, largely improve soil ecological functions and environmental quality, improve the national soil protection system and R&D supporting system, and achieve sustainable use of soil resources and eco-environmental protection which fits the social and economical development level.

2.3 Six strategic tasks

2.3.1 Securing and promotion of agricultural production

National soil quantity and quality survey should be conducted periodically in a comprehensive and systematic way to understand the dynamic change of soil quantity and quality and prominent soil environmental problems. A national soil resources and quality information system should be established and soil environmental quality standard should be formulated on scientific basis. Great efforts should be made to strengthen environmental protection in rural areas including protecting soil in major agricultural areas, strictly control the use of chemical fertilizer, pesticides, sewage sludge and agricultural waste. By doing so, improvement of soil fertility and protection of soil environment can be achieved at the same time.

2.3.2 Protection of human health and ecosystem

Effective measures should be taken to prevent pollutants from entering the soil. To prevent soil acidification, air-borne deposition should be strictly controlled and the development of protected agricultural should be carefully controlled. Risk based approach should be used for assessment and management of soil environmental quality. To secure the safety of agricultural products and food, protect the safety of residential areas and human health, integrated measures need to be planned to remediate polluted urban and rural soils progressively.

2.3.3 Mitigation of degraded soil in ecologically fragile areas

To implement soil protection in ecologically fragile areas, it is important to strengthen control of regional soil erosion, sand storm source area and mitigation of degraded soil and control the trend of soil erosion, grassland degradation, desertification, salination, and rock desertification.

2.3.4 Protection of soil in areas with important functions

It is important to protect soils at key ecological conservation areas and nature reserves such as water source zone, flood conditioning & storage area, windproof and dune-fixing area, water and soil conservation area, and habitat of important species so that soil environmental quality is good enough to protect the biota and water body.

2.3.5 Soil environmental research and development

An innovative soil research and development system should be established which integrates fundamental research, environmental standards, and application of high technology. Long lasting soil scientific research and technological development should aim at soil problems at national or regional levels such as formation of soil obstacles, the rules of soil quality evolution, soil quality criteria and standards. Technologies and equipments are needed for soil monitoring, compressive control of soil erosion, grassland degradation, desertification, salination, rock desertification, soil pollution control and remediation, prevention of secondary salination.

2.3.6 Soil environmental management

Soil protection legislation, structure and mechanisms should be established to form a risk based national soil protection system. Soil protection laws, regulations, policies and standards should be enforced at national and local levels. A strict soil protection liability system, economic compensation and investment mechanism, economic and criminal penalty system and executive accountability system should be established. Soil protection supervision authorities as well as soil monitoring network should be established at national and local levels. A market oriented mechanisms should be sought for soil protection. Soil protection education should be strengthened to raise public awareness of soil protection.

2.4 Strategic focuses

2.4.1 Protection of basic farmland soils in different zones

Protection of basic farmland soil, control of dispersed source pollution and protection of rural ecosystem should be strengthened in major agricultural production areas in northeast, north China, southeast, central China, southeast and southwest China. Comprehensive control and ecological conservation measures need to be taken in areas with serious soil erosion such as the loess plateau, arid zones in northwest, sandstorm source zone in north China, hilly Karst areas in southwest, black soils in northeast, and hilly areas in the south. It is necessary to strengthen control of farmland soil degradation (e.g. desertification, salination and rock desertification), ecological restoration and improvement of soil fertility.

2.4.2 Urban and rural soil pollution prevention and remediation

An action plan should be drawn up for soil pollution prevention and remediation in urban, peri-urban and rural areas, based on the principle of prevention first, integration of prevention with control. A staged plan should be made to dispose or clean up polluted soil at industrial sites, especially in economic booming areas, old industrial base, and around large mining areas. Comprehensive measures should be taken to deal with soil pollution around large lakes, river basins and large hydraulic projects.

2.4.3 Soil quantity and quality supervision

A functional division within the government should be responsible for soil quality supervision. A regional soil quantity and quality monitoring network and information share platform should be established. A risk assessment framework and emergency response plan should be established based on Chinese conditions. It is necessary to establish soil standard system, speed up soil pollution prevention and control legislation, launch soil protection advertisement campaign and education to raise public awareness of soil environmental protection.

3. Strategic countermeasures

3.1 Management

Soil protection authorities should be established with clearly defined responsibilities among different governmental departments. Soil protection planning and action plan should be drawn. It is crucial to establish and improve soil protection legislation and enact practical rules for the implemention. The development of soil environmental protection NGOs and active participation of the general public in soil protection should be encouraged and promoted. It is necessary to establish and improve rules for the use of pesticides, fertilizers, sewage sludge and agricultural wastes, to implement rules for soil pollution prevention and remediation, to implement rules for economic and ecological compensation for soil remediation, to develop emergency treatment techniques for soil pollution and to establish a management pattern that integrates protection of soil, water and air quality and the use of soil resources.

3.2 Soil standards

National soil standard for different land use should be derived based on risk assessment. Local soil standard should also be encouraged. A soil protection standards system should be established. Ecotoxicity of soil pollutants should be studied. Soil background values and geochemical baselines should be derived. Methodologies for conducting soil ecological risk assessment, human health risk assessment and environmental risk assessment should be established. Rules for the management of polluted sites and technical specification of risk assessment should be drawn.

3.3 Soil protection research and technological development

It is necessary to strengthen national soil quantity and quality survey, research on the soil quality index and methods for assessing soil quantity and quality change and its impacts, and establish soil monitoring network and information system for protection and management of soil resources. An integrated treatment patterns that incorporates hydraulic engineering, biological engineering and agricultural technologies will be proposed for soil erosion, desertification control. To prevent soil salination, soil irrigation and drainage techniques should be improved. It is necessary to strengthen research on soil pollution diagnosis, and risk assessment as well as soil monitoring equipments and remediation technologies. Deepen research on the impact of global change on soil processes, biodiversity and their ecological functions, establish soil biogeochemical models, and develop technologies for carbon fixation and emission reduction.

3.4 Soil protection in key regions

Soil protection strategies should reflect the difference in natural environment and soil types. China can be divided into six key regions: (1) Economically developed east coastal areas: Strictly control soil resource reduction, implement soil monitoring and risk based soil management in the region; (2) Major grain producing areas in central China: Establish network to monitor soil quantity and quality, improve soil fertility, secure gain production, ecological safety and the environment; (3) Old industrial base in northeast: Soil remediation technology development, mitigation of degraded black soil, integrated sand control measures that incorporate protection, mitigation and use; (4) North China and inner Mongolia: Prevent over-planting and over-stocking, prevent and mitigate soil desertification and grassland degradation, reduce the frequency and intensity of sandstorm; (5)Ecologically fragile areas in southwest: Wise use of water in loess plateau, protect oasis in northwest arid areas, prevent stone desertification in southwest, establish soil monitoring network; (6) Cold alpine zone: Protect natural grassland, natural secondary forest and shrubs, secure soil ecological safety in alpine.