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POLICY RESEARCH REPORT ON ENVIRONMENT AND DEVELOPMENT

ENABLING GOVERNANCE CAPACITY FOR GREEN TRANSFORMATION 2015

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Note on This Volume

2015 was a milestone year for China's environmental protection. Earlier this year, the Chinese government issued two important documents-Opinions on Accelerating Development of Ecological Civilization and Integrated Reform Plan for Promoting Ecological Progressrespectively in April and September.Later in November, the 5th Plenary Session of the 18th CPC Central Committee approved the Proposal for the 13th Five-Year Plan of the National Economic and Social Development. Based on the strategic deployment of what is known in China as the "four comprehensives", the Proposal put forward the guiding concepts, principles, goals, and major initiatives for economic and social development in the next five years. This document contains an independent chapter on green development, which is now considered one of the five core development strategies, outlining the overall plan for promoting ecological civilization and environmental protection.

The three guiding documents are consistentand make clear the concepts, principles, targets and tasks for China's eco-environmental governance over the coming five years, laying out the overall design and roadmap for promoting ecological civilization and green development.

Against this backdrop, the China Council for International Cooperation on Environment and Development (CCICED) held its 2015 Annual General Meeting (AGM) on the theme of "Enabling Governance Capacity for Green Transformation". Six research teams reported to the meeting, namely: "National Governance Capacity for Green Transformation" "Green Finance Reform and Green Transformation" "Rule of Law and Ecological Civilization" "Eco-environmental Risk Management" "Soil Pollution Management", and "Coordinated Actions for Addressing Climate Change and Air Pollution". In addition, council members and experts were able to exchange views during three parallel forums on the themes of "Greening One Belt One Road" "Think Tanks for Green Transition", and "Green Finance and G20". Policy recommendations were finalized, reflecting the opinions of council members and experts.

Mr. Zhang Gaoli, Vice Premier of the State Council, and Chairperson of the CCICED, delivered a keynote speech at the opening ceremony. He pointed out that the Chinese

government has always been supportive of the long term development of the CCICED and hopes that the Council, by making full use of its advantages in terms of a deep talent pool, international vision and strategic thinking, will strive to become a top international think tank in line with the strategic needs of China for ecological civilization construction, and make active contributions to the sustainable development of China and the whole world.

It is generally recognized that 2015 is the beginning year for the implementation of Accelerating Development of Ecological Civilization and Integrated Reform Plan for Promoting Ecological Progress, as well as the final year for the 12th FYP. With the plan for ecological civilization taking shape and environmental governance achieving remarkable progress, a modern multi-governance system on environment is gradually falling into place.

The Policy Research Report of Environment and Development in corporates the CCICED's 2015 policy research findings, 2015 policy recommendations to the Chinese government, and a study of major policy progress on China's environment and development (2014—2015). We trust it will prove useful to decision-makers at all levels, as well as scholars and the general public.

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Chapter 1
Policy Recommendations to the Government of China

The 2015 Annual General Meeting of the China Council for International Cooperation on Environment and Development (CCICED 4th AGM of Phase V) was held from 9 to 11 November 2015 in Beijing with the theme of *Enabling Governance Capacity for Green Transformation*.

2015 is a milestone year to be commended and expected for the world in terms of progress on environment and development. The 2030 Sustainable Development Agenda united the consensus and political commitment of the international community, and provided direction, objectives and approaches for global sustainable development for the next 15 years. International communities have also set high expectations on the outcomes of the upcoming climate change conference in Paris. CCICED members applaud China's significant contribution in environment and development in the aforementioned fora and recognize that it has an important role to play in advancing the international agenda including major initiatives in global sustainable development. The Members have high expectations on the key initiatives and commitments taken by China, including those for South-South cooperation, "One Belt and One Road" initiative, and the AIIB.

2015 is also a symbolic year for environment and development domestically in China. Overall, the green development and environmental protection targets set in the 12th Five-Year Plan are expected to be achieved, or even overachieved. The relationship between economic development and resource consumption is showing a pattern of relative decoupling, and green transformation in China has achieved initial progress. In terms of the path towards becoming an ecological civilization, China has set out an overall work plan and top-level design for institutional reform, with issuance of two guiding documents, *Opinions on Accelerating Ecological Civilization Construction and Integrated Reform Plan for Ecological Civilization*. The recent 5th Plenum of 18th CPC Congress framed the path towards a moderately well-off society during the 13th Five-Year Plan period with five concepts: innovation, coordination, green, opening, and sharing. With the confluence of

high-level commitment and international experience through the CCICED, the coming Five-Years are expected to be critical to establishing green transformation towards an ecological civilization.

CCICED members believe that the 13th Five-Year Plan is a critical period for the success of green transformation which faces multiple difficulties and hard challenges. Becoming a well-off society requires coordination and integrated progress of political, economic, social, cultural and ecological civilization construction, in order to let all people benefit from development and share the outcomes. Currently, eco-environmental quality remains a weak link for achieving a moderately well-off society. Therefore, the 5th Plenum required that China's ecological environmental quality be comprehensively improved by 2020, with emphasis on environmental quality improvement, and that the most stringent environmental protection system be implemented. Such a target implies that China is likely to reach the turning point of environmental quality on the Kuznets curve ahead of the projected schedule. However this achievement will need significant effort and require more resources and stronger governance capacity.

In general, the top-level design and roadmap for ecological civilization and green transformation in China have been developed, and now the key is implementation. Implementation is currently the largest barrier to igniting the first critical steps for green transformation and the modernization of national environment and development governance system and capacity, and has also been a long-term concern of CCICED. Therefore, the theme of this year's AGM is "Enabling Governance Capacity for Green Transformation". To support this theme, CCICED has established targeted task forces, and conducted special policy studies, policy background studies and pilots to illuminate ways to overcome the key challenges to implementation. Knowing that 2016 is the first year of the 13th Five-Year Plan, a critical year of a critical period, CCICED has aligned its findings and output of studies to ensure that the best outcomes can be achieved from the start. Following members' discussion at the 2015 AGM, CCICED has synthesized the key recommendations that will bolster China's great task that lies ahead, and which international communities can also benefit and learn from.

1.1 Recommendation I: Improve national green transformation governance capacity through enhancement of environmental governance capacity

An important pre-condition for improving governance capacity is the overall reform of environmental governance and enhancement of environmental legislation and enforcement. Learning from international experience, it is necessary to move away from "command and control" approach towards integrated, cross-platform, and multi-stakeholder approach. CCICED recommends:

1.1.1 Establish multi-stakeholder governance system

Successful models of national governance involves of three key sectors-government, market, and society. CCICD has identified that a key barrier to transforming the environmental governance capacity in China is the lack of a multi-stakeholder approach. The objective of environmental governance system reform is to establish a multi-stakeholder governance system. During this process, China should pay attention to combination of strong political will with sound scientific analysis, stable top-level design supported by diversified local implementation plans, and clear transformation direction and flexible implementation measures. In addition, it is necessary to establish a sound institutional environment and reasonable incentive system, provide resources matching with responsibilities, improve individual capacity and awareness, so that to ensure full play of roles by government, market and society.

(1) Focus national governance system reform efforts on five areas

First, strengthen environmental legislation and rule of law. Effectively implement the new *Environmental Protection Law and Air Pollution Control Law*, accelerate the revision of water and soil pollution legislations, and strengthen enforcement supervision. Second, improve environmental risk prevention system and promote optimization of spatial layout and industrial structures. Strengthen risk prevention measures including ecological redlining, strategic environmental assessment, environmental standards and dual control system for energy consumption amount and intensity. Third, reform basic institutional system for environmental pollution control to promote environmental quality improvement, with emphasis on establishment of enterprise emission permit system covering all stationary pollution sources and regional coordination mechanism, improvement of environmental market system and establishment of sound evaluation and accountability system. Fourth, establish and improve evaluation and accountability

system. Centralize the responsibility of ecological and environmental quality monitoring as appropriate to establish a unified national real-time environmental monitoring system. Fifth, comprehensively promote information disclosure and encourage public participation. Enhance education on national resource and environmental situation and ecological value to improve public's environmental awareness; promote green consumption revolution; improve environmental information disclosure system and establish Environmental Impact Assessment (EIA) information disclosure mechanism for construction projects; establish and improve internet-based reporting platform and management system.

(2) Develop 2030 roadmap for green transformation governance capacity

Establish an institutional environment and incentive system for green transformation in next 5 years; identify resource demand of government to match responsibilities in next 10 years; guide the formation of green value in the whole society though education and communication in next 15 years, with final objective of significant improvement of capacity of scientific and democratic decision making, environmental judiciary and administrative enforcement, public participation, elimination of environmental externality and innovation. Meanwhile, select certain administrative regions and sectors (such as environmental protection) to pilot green transformation reform to progressively improve governance capacity. Green transformation should be a comprehensive strategic transformation which will draw on international experiences, promote energy transformation, increase resource efficiency and achieve decoupling between energy/resource consumption and economic growth.

(3) Strength government's capacity of scientific decision making and enforcement, and accelerate resource and environment administrative system reform

First, led by State Council, implemented by an independent organization, review the responsibilities and obligations in different departments and governments of different levels. Implement legislative and administrative reforms to realize a sound horizontal and vertical division between rights and obligations and bring into alignment the rights, responsibilities and abilities of departments. Align resources to match with responsibilities. Mainstream environmental issues into decisions of various departments. Second, establish a scientific advisory system, the role of which in decision making is assured by laws and regulations. The members of the committees should take responsibilities for their advice. Improve laws and regulations to clarify the principles of stakeholder identification and their participation rights, ways and procedures; improve the transparency of decision-making process; and minimize the influence from vested interests. Strengthen training of government officials at various levels. Third, integrate ecological environmental

protection and pollution control functions currently scattered among various departments, and strengthen the systematic nature and integrity of environmental protection. Reasonably allocate environmental management responsibilities between central and local governments. Provide adequate administrative and technical support capacity for various levels of governments.

(4) Enhance the market's capacity to promote innovation and internalize environmental externalities

First, establish environmental property right system, reform pricing mechanisms for major resource products to improve resource use efficiency. Second, develop financial and taxation policies to reveal environmental costs in production and consumption. Stimulate markets and social creativity, and foster the marketplace for green industries with healthy competition. Through preferential tax policies facilitate environmental protection markets. Third, promote green government procurement and encourage leading companies to undertake voluntary initiatives on green supply chains and to lead sectoral technical and management upgrading. Fourth, establish ways to address environmental costs through corporate environmental credit system, and meanwhile provide basic information to companies on green financing sources and mechanisms. Fifth, promote cooperation among government, enterprise and research institutes on establishing a green resource and technology-sharing network. Encourage third party engagement in environmental pollution treatment and ecological protection to address fund shortages and to improve effectiveness of treatment and protection.

(5) Build the capacity of social organizations and the public's participation in environmental protection

First, improve laws and regulations to clarify the public's environmental rights and obligations, and clarify channels and procedures for public participation. Second, establish social governance units within environmental protection departments with responsibilities for promoting and enabling greater participation of the public and social organizations through capacity enhancement and facilitating the formation of green values in the whole society. Third, improve the cooperation mechanism between government and social forces in environmental protection, and establish mechanisms for communication and coordination, information sharing and project cooperation between the departments of environmental protection at all levels and social organizations, enterprises and co-operatives engaging in environmental protection. Fourth, strengthen the governmental support for environmental social organizations especially in terms of funding, human resources and information, lower the requirements for registration of environmental NGOs,

and promote orderly participation of NGOs in environmental protection. Fifth, innovate education and communication methods on sustainable consumption and environmental protection. Use internet-based platforms and technologies to promote the public's innovation and entrepreneurship in environmental protection.

(6) Improve green technology R&D and application capacity, and strengthen information capacity of environmental management

First, develop a national green low-carbon development innovation action plan, improve the support capacity of technical innovation to the industrialization of green growth. Second, implement eco-innovation action plans for enterprises and industries focusing on environmental technology innovation. Third, strengthen capacity building on environmental data monitoring, collection, integration and feedback analysis to ensure accuracy, integrity and authenticity of data. Use smart technologies such as big data, internet, internet of things, 3S (remote sensing, GIS and GPS) and cloud computing, etc., to establish a national environmental big data network and enhance data integration, analysis and decision making supporting capacity. Innovate environmental management using big data.

1.1.2 Establish new legislative and enforcement modes in line with ecological civilization

Sound environmental laws and harmonized implementation is another fundamental requirement for achieving ecological civilization construction. The current environmental legislation system has three challenges: First, there are no legislations in many key fields of environmental protection; Second, there are conflicts and inconsistency among many environmental laws which compromise their effectiveness; Third, there are articles in non-environmental laws that block the implementation of environmental laws. The enforcement of environmental laws also faces four challenges: First, current legal instruments lack of governance coordination and enforcement supervision and are ineffective; Second, unclear environmental protection responsibilities among various levels of governments lead to inadequate coordination among departments and regions; Third, inadequate enforcement capacity and resources, and improper administrative interference; Fourth, lack of accountability system and public supervision. To establish new modes of legislation and enforcement, China shall address "gaps" of legislation, "internal conflicts and inconsistency" among many environmental laws, and "external barriers" from non-environmental laws.

(1) Reform the current management system of dangerous chemical which involves multiple departments, develop a D*angerous Chemicals Safety and Environmental Risk Law*

Integrate administrative regulation responsibility for dangerous chemicals among departments of environmental protection, work safety, transport and public security, and establish a unified regulatory system with leading position by environmental department. Establish complete emergency response and pollution handling systems. Clarify the legal responsibilities of producer, user and regulator, and establish an integrated safety and environmental management and accountability system.

(2) Revise the existing *Environmental Impact Assessment Law*, expand its application scope and enhance its independency and scientific nature

Expand EIA scope to cover economic and technical policies and comprehensive plans that have significant environmental impacts. Use spatial land use plan and eco-redlines as major foundation for EIAs for plans, policies and regional development and construction projects. Establish a responsibility system for project owners, EIA consultants and regulatory agencies, and strengthen accountability system for EIA violations.

(3) Develop *Environment Standards Law and Emission Permits Law*

Establish systemic environmental standards, improve scientific supporting system to environmental standards, improve development procedures for standard formulation and enhance legal authority of environmental standards to achieve the objective of environmental quality improvement. Incorporate key indicators of environmental quality standards and emission standards directly into the laws, and develop an Environment Standard Law. Integrate relevant systems of pollution permit, "Three Simultaneousness", pollution emission declaration, total emission control, environmental facility supervision and management of pollution discharge outlet, and develop a Pollution Emission Permit Law. Meanwhile, accelerate the development of Soil *Environmental Protection Law* and other laws for nature reserves, natural resource and environmental property rights, environmental investment, environmental trade and environmental liability.

(4) Develop *Environmental Code*

To address practical problems of overlaps and contradictions of laws, and difficulties of actions by enforcement departments and public.

(5) Establish the legal boundary and attributes of the environment as public goods to address the interference from non-environmental laws

Consider "no deterioration of environment" as a key legal principle to ensure that external laws do no harm to the environment. Especially, ecological civilization and green development concept shall be incorporated into the development Civil Code.

(6) Build efficient mechanisms of environmental regulation, accountability and public participation

First, ensure independent enforcement by environmental departments and other departments with environmental supervision responsibilities, and prevent undue interference of local governments. Second, speed up the development of implementation plans for the provision of "equal responsibilities of party and government leaders, dual responsibilities (both party and government responsibilities) for one position and accountability enforcement", and enhance the implementation mechanisms of environmental laws. Third, give full play to public participation and improve environmental litigation system. Speed up the implementation of environmental public litigation pilots, and ensure transparency of environmental administration. Strengthen the consciousness of all levels of governments to implement environmental laws.

1.2 Recommendation II: Highlight gaps of environmental governance system during 13th Five-Year Plan, and ensure comprehensive improvement of ecological environment quality

To ensure the achievement of overall improvement of ecological environment quality during the 13th Five-Year Plan period, there is a need to identify the weaknesses and gaps of environmental governance, especially regarding environmental risk, soil, short-lived climate pollutants (SLCPs) and non-road mobile sources, and bridge those gaps to achieve the objective of moderately well-off society.

In this regard, CCICED recommends:

1.2.1 Establish sound and effective environmental risk decision-making and management system to guarantee environmental health and ecological security

Currently, China is facing a serious situation in terms of environmental risks. Being incorporated into national decision-making system gradually, environmental risk management in China, however, still features with an "event-driven" management mode. Compared with developed countries, environmental risk management in China needs to fill four major gaps. Firstly, the environmental risk decision making system is incomplete. Secondly, Systematic environmental risk management goals and a national strategy and system for managing environmental risks have not been established. Thirdly, the set

of enabling measures for environmental risk management is incomplete. Fourthly, the environmental risk communication system is incomplete. To address the three types of risks in the future (i.e. sudden accident risk, cumulative threshold event risk, and long-term chronic environmental risk), China shall establish a sound and effective environmental risk decision-making and management system with an objective of ensuring environmental health and ecological security.

1.2.1.1 Establish a risk-based environmental governance system

(1) Establish a high-level national environmental risk board

The Board is: to assess, prioritize environmental risks at national and local levels, set environmental risk management goals and strategy at different levels; to help resolve tradeoffs among multiple risks, and between economic development goals and environmental risk control; and to realize oversee achievement of full implementation of whole-process and priority-based management system for environmental risk by 2025—2030.

(2) Establish an environmental risk assessment and prevention system for macro-strategies

Carry out short-term, middle-term and long-term environmental risk assessments for national macro-strategies such as new-type urbanization, integrated development of the Jing-Jin-Ji area, the "One Belt and One Road" initiative, and the Yangtze River Delta economic zone, to develop preventive risk management strategies and environmental risk prevention and control roadmaps.

(3) Comprehensively promote normalization of environmental risk management

Integrate environmental risk assessment and management into development and implementation of policy, planning and standards at all levels. Promote integration of environmental risk assessment into "Coordinated Multiple Plans" and then identify priority of management areas and risks and develop ecological redlines for environmental risk control.

1.2.1.2 Establish environmental risk management goals and strategy with considerations of different time-scales, regions and risk types

(1) Set environmental risk management targets

Set comprehensive national environmental risk prevention and reduction targets, incorporating risk assessment results, costs and benefits, and public perception. Recommend various provinces and regions to develop differentiated targets and roadmaps based on their actual situation.

(2) Establish a comprehensive environmental risk management strategy

Conduct national and regional risk assessments and ranking exercise to set national and regional priorities. Develop and apply an environmental risk chain-based management approach.

1.2.1.3 Establish enabling measures for environmental risk management

(1) Establish a collaborative multi-department environmental emergency response system with practical emergency response plan as core requirement

Improve the effectiveness of all types of environmental emergency response at all levels. Establish a coordination mechanism with clear responsibilities and information sharing, optimize regional environmental emergency resource allocations.

(2) Clarify, support and enforce the primary responsibility for environmental risk control on the part of enterprises

Industrial enterprises need to implement complete responsibility system for environmental risk and to establish environment health and safety (EHS) management systems in enterprises. Put in place mandatory environmental risk information disclosure in financial statements for listed companies.

(3) Establish and improve a financial system for environmental risk control

Make liability insurance for enterprises mandatory. Create an environmental risk deposit system for high-risk industries. Put in place special funds for contaminated site remediation and environmental health compensation.

(4) Enable environmental risk information integration

Integrate environmental risk information into unified national information platform for eco-environmental monitoring.

1.2.1.4 Establish an environmental risk communication and engagement system

(1) Develop a transparent and effective environmental risk communication system

Achieve sufficient communications among stakeholders including government, public, enterprises, media and NGOs on hot environmental issues of public concerns. Establish mechanisms for risk knowledge transfer to and from the public.

(2) Establish an efficient environmental risk engagement program

Develop and implement community and public engagement programs for dialogue and feedback from affected communities. Integrate stakeholders into the process of policy development and assessment for environmental risk management.

1.2.2 Recognize the value of soil resources, and strengthen soil environment protection

Soil is an indispensable and irreplaceable fundamental resource for national economic and social development. In general, the current situation of soil environment in China is worrying. Some areas are suffering from serious soil pollution, the environmental quality of the arable land is worrying, and there are pressing environmental problems in industrial and mining deserted lands. Soil pollution has become the most prominent issue in environmental protection. China is in its early stage of soil pollution management, with inadequate laws and regulations, incomplete soil environmental standard system and management organizations, insufficient stable funding sources, which pose significant challenges for soil pollution management.

1.2.2.1 Identify soil protection as a basic national policy, and strengthen soil environmental protection policies and supporting measures

First, develop soil environment protection law, and gradually establish a sound soil environmental legal system. Second, establish a most stringent soil protection legal system to prevent soil quality deterioration and generation of new soil contamination. Third, accelerate the establishment of a supporting policy system for soil environment protection to support the implementation of soil environmental protection works. Fourth, identify basic ideas and clear framework for soil environment protection. Focus on clean soil protection and risk control of contaminated soil, with priority of clean farmland protection. Use differentiated measures to address soil pollution problems happening over different time periods. Fifth, strengthen capacity building for soil pollution management and enforcement of soil protection laws.

1.2.2.2 Update concepts of soil protection legislation, change the development of *Soil Pollution Prevention and Control Law to Soil Environmental Protection Law*

Based on current soil situation in China, the primary objective of soil legislation should be the protection of clean soil (over 80% of total national land area). Therefore, it is recommended that China should change its plan to develop a *Soil Pollution Prevention and Control Law to the development of a Soil Environment Protection Law*. The main contents of such this should include: first, protect clean soil, especially clean farmland soil; second, improve current soil environmental quality and prevent deterioration; third, prevent soil pollution from human activities; fourth, control the environmental risks of contaminated land; fifth, treat and remediate contaminated soil; sixth, re-development of contaminated sites. The key focuses should be the protection of clean soil and control of environmental

risks of contaminated soil.

1.2.2.3 Develop and improve a soil environmental standards system, and strengthen soil environmental regulatory capacity

Soil environmental standards system is an important foundation for soil protection and management works. Strengthening or improving soil pollution management requires a set of complete and scientific environmental standards. Follow the principle of considering national context, meeting demand, prioritizing objectives and keeping improvement, China shall establish a soil environmental standard system including soil environmental quality standard for farmland, guideline standard for soil pollution risk screening for construction land, regional soil baseline standard, and technical standards for soil investigation, monitoring, assessment and remediation, as well as basic soil environment standards. Soil environmental standards should include both national and local standards. Solidify the status and role of soil environmental standards in soil environmental legislation.

1.2.2.4 Establish special liability and financial mechanisms to address historical legacy issues of soil contamination and effectively minimize environmental risks of contaminated soil

China should establish a special liability mechanism and funding mechanism to address the legacy issues of soil contamination. First, establish an explicit responsibility system, clarify the responsible bodies for the legacy contaminated sites, and define responsibilities of pollution treatment or remediation. Second, establish special funds to ensure the remediation of historical contaminated sites. Third, organize investigation, assessments and classifications of historical contaminated sites by national and local governments.

1.2.2.5 Improve incentive mechanism and measures for soil environmental protection and establish a multi-stakeholder governance model including government, enterprise and public.

Improve incentive mechanism and measures in the aspects of government guidance, economic incentives and public participation. First, government should develop and disclose redevelopment plans for contaminated sites; clarify the procedures for such redevelopment; implement the policy of "who invests in remediation takes the benefit" and "who remediates the land takes the privilege of redevelopment" to encourage enterprises and social capital engaging in site remediation. Second, encourage the establishment of "Soil Bank" to conserve soil resource. Third, guide soil pollution control works through economic approaches such as incorporating soil resources value into natural resources accounting system. Fourth, establish soil protection fund, and facilitate soil pollution

control through economic approaches such as providing subsidies to organic agriculture. Fifth, improve public participation mechanism, proactively disclose soil pollution information, establish public reporting and complaint channels, and innovate public-enterprise cooperative management model.

1.2.3 Focus on Short-lived Climate Pollutants (SLCPs) and non-road mobile pollution sources, and achieve co-control of air pollution and climate change

Currently, China is facing opportunities and challenges in addressing synergic control of air pollution and climate change. Controlling short-lived climate pollutants will significantly reduce the rate of temperature-rise and other climate change effects, and mitigate air pollution to certain extent. SLCPs emission reduction is closely associated with pollution control of non-traffic mobile pollution sources, however, this relationship has often been ignored in China's current policy frameworks. At present, inadequate attention has been paid to SLCPs and non-road mobile sources. Relevant management system is insufficient to effectively control the pollution, and emission regulations, standards and policies are lagging behind.

1.2.3.1 Develop and improve policies and regulations system for short-lived climate pollutant and non-road mobile pollution sources

Improve the short-lived climate pollution emission standard system, and develop emission thresholds based on best practices technology. Develop emission reduction regulations for new and currently in-use engineering machines, agriculture machines and marine vessels to meet by 2020 the targets of emission standards based on international best practices.

1.2.3.2 Establish and improve emission reduction management system for short-lived climate pollutants and non-road mobile pollution sources.

(1) Clarify the regulatory bodies and responsibilities of relevant departments

Integrate the short-lived climate pollutants control targets into air pollution control and climate change target systems. Identify administration authorities and cooperation departments based on different pollutants. Further clarify the role of enterprises as primary responsible bodies for control of non-road mobile pollution sources.

(2) Establish environmental management model for non-traffic mobile pollution sources with clear responsibility allocation between national and local governments

Develop an environmental compliance management system for new non-road mobile machines at national level including enterprise information disclosure, consistent

production, compliance of in-use machines, environmental recall and environmental labelling etc., and request enterprises to disclose environmental information of their products. Establish environmental management system for existing non-road mobile machines at local level including periodic environmental inspection, random inspection, low emission control zones, upgraded emission control and accelerated phasing-out of non-compliance machines.

(3) Enhance emission compliance management, and innovate enforcement mechanism of emission standards

Establish an emission monitoring and regulatory network for main emission sources of short-lived climate pollutants and major non-road mobile pollution. Develop fuel quality regulation network for non-road mobile sources. Improve environmental regulation for short-lived climate pollutants and non-road mobile pollution sources. Enhance institutional innovation, and carry out policy research on total emission control of short-lived climate pollutants and non-traffic mobile pollution sources, green top-runner initiative, pollution trade and environmental tax. Put forward application to the International Maritime Organization when appropriate to establish ship emission control zones within coastal exclusive economic zones of China where the world's most stringent air pollution control requirements will be enforced.

1.2.3.3 Accelerate the development and implementation of a *National Clean Diesel Engine Action Plan*

In line with the national strategy of Made in China 2025, accelerate development and implementation of a *National Clean Diesel and Diesel Engine Action Plan,* and focus on implementation of special cleaning projects for diesel engines in the key fields of diesel vehicles, engineering machines, agriculture machines and marine vessels. Speed up the installation of particulate matter filters on vehicles and engines as many and as quick as possible. Introduce a compulsory phase-out mechanism for high emission diesel engines, and use acombined method of financial and market-based approaches to encourage early phase-out of old diesel engines. Speed the construction and use of coastal electricity infrastructure to promote clean energy use of ships. Accelerate the adoption of classification standards for diesel, especially focus on significant reduction of sulphur content.

1.2.3.4 Strengthen science and technology innovation and enhance international cooperation on industrial sectoral emission reduction.

Increase investment in independent R & D of best applicable technologies for SLCPs and non-road mobile source pollution control. Establish a unified data accounting system,

develop relevant big data regulation and control decision-making platform, and improve disclosure and sharing mechanism of research and regulation data. China should make full use of current multi-lateral international cooperation mechanisms for SLCPs in its development of emission reduction strategy.

1.3 Recommendation III: Innovate green financing system during the 13th Five-Year Plan to drive and finance China's green transformation

As a new policy instrument, green financing is a driving force to promote green transformation under the "new formal" context, ensure eco-environment security and promote upgrading of green industries in China. It is an innovative financing system for ecological civilization.

Currently, there are five challenges for green finance reform in China. First, the demand for green financing is huge. According to estimates of CCICED task force, in order to achieve the green development objectives and environmental standards developed in 2015, the demand for green financing in China will be at least 123.4 trillion RMB (19.4 trillion USD) for the period of 2014—2030. Second, there is serious shortage of supply of green finance, with a gap of 2.8 trillion RMB (0.44 trillion USD) in 2013. Third, there is a lack of a comprehensive legal system for green finance. The current system has the problems such as weak authority, ineffective operability and incomplete contents. Fourth, there is a lack of national level coordinating mechanism for green finance. Relevant responsibilities are scattered among different government authorities, and green finance system can hardly operate smoothly and coordinately. Fifth, green financing reform in China lacks of a clear strategic roadmap, which results in inadequate coordination, insufficient progress and weak operability, and unrealized potential for facilitating green transformation.

Therefore, it is recommended that:

1.3.1 Implement a Strategic Roadmap for Green Financing Reform

1.3.1.1 Phase I (2016—2020):Initiate green financing reform

Improve the pricing mechanism of resources and environment;innovate financial policies and market tools;launch pilot projects in the national strategic areas, including

Beijing-Tianjin-Hebei coordinated development, Yangtze River Economic Belt, B&R and Free trade pilot areas.

1.3.1.2 Phase II (2021—2025): Deepen green finance reform

Promote capitalization and monetorization of natural resources; expand regional pilots to the national level; shift focus of green financing gradually from environmental pollution control to low carbon development; support innovation in policies, financing platforms and market instruments suitable for cleaner production project demand.

1.3.1.3 Phase III (2026—2030): Complete overall greenization of the entire financial system

Build a green finance culture and value system on the basis of China's eco-civilization construction; promote the greenization of financial institutions; play an important role in global green financial system.

1.3.2 Set priorities for the period of the 13th Five-Year Plan

1.3.2.1 Six breakthrough priorities during the 13th Five-Year Plan

(1) Promot green bonds

Regulatory authirites issue guidance on green bonds, and establish a monitoring and evaluation system for green bonds;

(2) Establish a national green development fund

The fund should consist of fiscal funds from central government, otherfinancial institutions and private investors, with total amount no less than 300 billion RMB. Its operation should follow corporation model, and is subject to marketized and professional management. Fund investment should be mainly equity investments, but should also be given the flexibility to make debt investments, offer mezzanine financing, and provide guarantees.The fund primarily invests in medium- and large-scale, medium- and long-term strategic green projects which meet the standards of national green development and green transformation, as well as green projects that have substantial demonstration effects. The investment will not pursue high returns, but emphasize commercial sustainability. To maximize its ability to efficiently leverage private capital, the sectoral fund and regional fund could be set up based on PPP mode, combined with PPP projects or structured sub-fund mode. Meanwhile, issuing bunds through capital pool. An equity-focused fund can increase the capitals of a project, and attract more capital from private sector.

(3) Speed up the greening of the banking system

Increase the environmental legal liabilities of banks. Establish professional green credits departments within banks.Increase the interest subsidy for green loans, and improve

the interest subsidy mechanism.

In addition, other breakthough fields include:compulsory environmental liability insurance; green PPP financing; carbon trading system and carbon finance.

1.3.2.2 Incorporateecological civilization and green financing into the joint statement of the 2016 G20 Summit

Promote green financing reform experiences in China through the platform of G20, encourage member countries and international financial institutions to develop green finance, and lead the reform and institutional system innovation in greenization of world financial system.

Establish a G20 Green Financing Working Group, with the following tasks: improve the assessment capacity of banks and other institutional investors on green investments; help financial institutions to conduct stress tests on their exposure to high-risk sectors and their preference for green industries; require listed companies and bond issuers to disclose environmental information; support more consistent rules on the definition and classification of green bonds among main financial markets, to facilitate cross-border green investments.

1.3.2.3 Pilot test green finance reforms in one or more strategic economic zones

Conduct pilot in national strategic areas of Jing-Jin-Ji, Yangtze delta, One belt and one road regions etc., guide the flow of finance to local green industries in strategic economic zones. Advance the process of finance reforms at national level through the demonstration of green transformation in these national strategic zones.

1.3.3 Establish enabling conditions for green finance

1.3.3.1 Establish a green finance reform coordinating mechanism at the central level

A green financing coordination mechanism should be established under the direction of the Central Committee's Leadership Group for Deepening Comprehensive Reforms. In addition, the relevant ministries and authorities should also establish new internal structures for the specific purpose of promoting green finance.

1.3.3.2 Optimize the pricing and charging structure for green industries

Green projects must provide competitive returns in order to attract and retain private investors. The rules related to pricing and charging structures applied to green investments should be reviewed to ensure that they allow for financially viable and attractive projects.

1.3.3.3 Enhance the structure of fiscal and tax incentives for green finance

Improve the interest subsidy mechanism for green credit, and establish incentives for green finance related to non-tax revenue. Establish a guarantee system supported by public

financing. Coordinate overall environmental protection fund demands. Increase the use of governmental funds for energy conservation and environmental protection. Enhance the use of tax incentives by implementing additional preferential tax policies for green financial products such as green bonds.

1.3.3.4 Build a bridge between green financial supply and demand systems

Encourage environmental departments to play better roles in promoting green financing reform, improve information communication regarding the demand side needs, and promote two-way transfer of environmental and financial information. Establish a green financing guidance and implementation entity involving the Bank of China, China Banking Regulatory Commission, China Securities Regulatory Commission and China Insurance Regulatory Commission. This entity should coordinate financing and environmental policies, study specific green financing policies and new tools and products, cooperate with environmental departments to implement pilots on financial policies, guidelines, new tools and products, and provide guidance on financial innovation and green financing service.

Chapter 2
Green Goals, Governance Capacity and Innovation -"Mind and Bridge the Gaps"[1]

2.1 Introduction

We are on the cusp of a new, very pragmatic level of environment and development action globally. The new UN 2030 Agenda for Sustainable Development sets out a challenging set of goals and targets.[2] Hopefully there will be a strong outcome at the Paris UNFCC meeting in December. These calls for action are being driven by the emerging green financial sector, leading businesses in fields such as clean technologies and energy innovation, and by the interests and needs of both industrial and developing nations. More than ever before, China is a prominent green development player domestically and internationally. Its commitments include substantial new financial inputs towards South-South Cooperation and China-US commitments on GHG reduction. There are assurances that China's flagship new international initiatives will be green from their start, including the BRIC Bank headquartered in Shanghai, the Asian Infrastructure Investment Bank (AIIB), and the "One Belt One Road" (OBOR) effort to bolster trade and development along the land and sea ancient Silk Road routes.

Above all, China has signaled very clearly by recent domestic policy announcements and actions that it will show great perseverance in shaping new relationships for an Ecological Civilization, with much more emphasis on integrated and coordinated approaches starting with the 13th Five-Year Plan (2016—2020).

Last year CCICED called for better understanding of the "turning points" that could move China away from tipping points such as the air pollution crisis and towards improved environmental and ecological conditions. The major environmental problems now present

1 The Issues Paper is produced for each CCICED Annual General Meeting by the CCICED Chief Advisors, Dr. Arthur Hanson and Prof. Shen Guofang, with inputs from various sources including the Chief Advisor's Group. This is the 14th such document.

2 There are 17 goals and 169 target actions agreed upon by the United Nations General Assembly summit on 25 September 2015. See: *Transforming our world: the 2030 Agenda for Sustainable Development*. https://sustainabledevelopment.un.org/post2015/transformingourworld.

within China have become leadership's key concerns threatening social stability, human health and ultimately the achievement of development goals. Thus it is reasonable at this stage of national development that environmental protection should receive considerably more attention in China than in some other countries.

2.1.1 2015: A "Blockbuster" Year for Environmental Initiatives

Indeed, 2015 has been a "blockbuster" year for environment and development reform within China. The revised Environmental Protection Law became effective on 1 January 2015. An Action Plan on Water Pollution has been initiated and the Air Pollution Act has been strengthened and will become effective in January 2016. Each month there have been advances in environment and development policy and practices, often linked in some fashion with the advice provided by CCICED in past years. Details of these advances are provided in the *2015 Policy Progress* report tabled at this year's CCICED Annual General Meeting (AGM). There is evidence that China's War on Pollution is working, at least with respect to air pollution. And there are many other promising signs of change, not the least of which is the remarkable initiative to bring about regional cooperative planning and management in the Beijing-Tianjin-Hebei region (Jing-Jin-Ji) covering almost 10% of China's population.[1] This will help to create more liveable cities and emphasize regional air pollution control.

Increasingly investment regarding the environment is seen to be compatible with, or part of, the rationale for the New Normal of lower economic growth rate but with higher value added and better efficiency. Environmental matters are now anticipated to be one of the key drivers of China's new, high value economy of the future. The new economy will showcase innovation solutions based on green technology, improved green planning and management across many sectors, and with greater emphasis on the service economy.

The approach towards the process of green development is termed "greenization" by Chinese leaders. The CPC Political Bureau at a meeting chaired by President Xi Jinping on 24 March 2015 introduced a guideline on conservation culture and highlighted greenization of production, the economy and lifestyles-with a focus on lowering resource consumption, boosting green industries and promoting a low-carbon, thrifty lifestyle.[2] The Politburo leaders noted that greenization will contribute to "national soft power" and provide "a new advantage in international competition". This announcement has been

1 Introducing China's Future Megalopolis: TheJing-Jin-Jihttp://blogs.wsj.com/chinarealtime/2014/04/04/chinas-big-ambitions-for-the-jing-jin-ji/.

2 Chinese leaders push for 'greenization'. http://news.xinhuanet.com/english/2015-03/24/c_134094125.htm.

followed up with the release of two major documents providing more detailed direction on reform for ecological civilization, also sometimes referred to as ecological progress.

The first document, released in April 2015, was Opinions of the Central Committee of the Communist Party of China and the State Council on Further Promoting the Development of Ecological Civilization.[1] In September 2015 the CPC and the State Council released an integrated reform plan to provide medium-term policy direction (presumably to about 2030) for constructing China's ecological civilization. This document, which is being provided to all CCICED Members by the CCICED Secretariat, is quite remarkable in its scope and in the magnitude and difficulty of tasks.[2] It proposes transformative changes of eight key systems (see Box 2-1). The framework of ecological civilization reform should be a potent driver since it provides for a longer term and integrated approach. The strategy can take off quickly if it is well embedded within the 13th Five-Year Plan.

Box 2-1 Eight systems to be reformed for China's Ecological Civilization

The September 2015 Ecological Civilization Reform Plan document identifies eight systems in need of reform and strengthening:

- Property rights for natural resource assets;
- Development and protection of territorial space;
- Spatial planning system;
- Regulating total consumption and comprehensive conservation of resources;
- Payment-based resource consumption and compensation for conservation and protection efforts;
- Environmental governance system;
- Market system for environmental governance and ecological preservation; and
- Evaluation system for officials' ecological conservation performance and responsibility for ecological damage.

These eight systems are described primarily in management reform terms rather than institutional terms, since there is much negotiation and work ahead to prepare for the follow-up institutional changes and reforms.

1 Sam Geall. July 2015.Interpreting Ecological Civilization. *Parts 1 (Vision) , 2 (Policy) and 3 (Standards, Mechanisms and Assessment)*. https://www.chinadialogue.net/article/show/single/en/8018-Interpreting-ecological-civilisation-part-one-.

2 Full text of the Integrated Reform Plan for Promoting Ecological Progress is available at:http://english.gov.cn/policies/latest_releases/2015/09/22/content_281475195492066.htm; also see Dimitri de Boer. China's 'Ecological Civilization' Sets China on a Greener Course. https://www.chinadialogue.net/article/show/single/en/8229-OPINION-China-s-Ecological-Civilisation-sets-China-on-a-greener-course.

2.1.2 Performance gaps

Despite the policy progress, plus some hopeful signs of ecological and environmental improvement, important gaps between expectations and performance still exist and, for some matters, are worsening. None could match the immediate drama and overt tragedy of the Tianjin chemical warehouse explosion in August 2015.[1] The cost is high in terms of human loss and economic cost (measured in tens of billions of RMB).Yet the longer-term costs of persistent pollution such as urban air pollution are much higher still.[2] The costs to Chinese society of climate change and poor land use practices such as soil and groundwater pollution are very high and likely will continue to grow. In fact environmental performance gaps are poorly understood and measured. Likely their full impacts are understated.

The capacity to fulfill environment needs is limited by institutional, financial and human resource shortfalls. Innovation efforts, whether technological, managerial or other forms, must be strengthened. In short, it is necessary not only to "mind the gaps" so that progress on environment is even across a wide range of problems, but also to "bridge the gaps" so that China can fully address its green development goals in a fashion that leads to a value-based, transformative ecological civilization. Fortunately, this effort is entirely consistent with the new global aims such as the UN Sustainable Development 2030 goals, and a maximum 2℃ temperature rise.

The path ahead will depend upon a much greater investment on environment and development, with only a fraction of the funding coming directly from central government revenues. Thus innovative financial mechanisms are needed. The rule of law on environmental matters is still relatively untested, and needs some new laws plus considerable reform of existing sectoral laws. Enforcement must be strengthened and attention given to market based laws and regulations that will be of a more enabling nature. This is a decade(s)-long challenge. Overall, there are many shortfalls in governance capacity.

2.1.3 2015 CCICED theme and activities

Enabling Governance Capacity for Green Transformation is the 2015 CCICED

1 China's State Council Probes the TianjinExplosions.http://thediplomat.com/2015/09/chinas-state-council-probes-the-tianjin-explosions/.

2 http://newclimateeconomy.report; Feng Tei and Frank Jotzo. 2014 Reaping the Economic Benefits of Decarbonization for China. https://ccep.crawford.anu.edu.au/sites/default/files/publication/ccep_crawford_anu_edu_au/2014-08/ccep1413.pdf.

AGM theme. Green governance requires an interactive relationship among government, enterprises and civil society (social organizations), with full recognition of responsibilities and approaches of each. Enabling conditions are needed so that all sectors/bodies noted above are able to make their full contribution.

In reality the relationships are still at a formative stage for the most part, with limited precedents for action. Information sharing is relatively limited still, and, as often noted in past CCICED studies, the quality of information remains a limiting factor. The move towards a market-based environmental regulatory approach is far from reality so that incentives are often weak or poorly managed. And in the case of the existing command and control system, enforcement policies are only beginning to be fully functional. Green governance capacity at national and local levels is still limited. Therefore a Task Force (TF) on National Governance Capacity for Green Transformation was tasked with assessing the current situation and recommending improvements. This has turned out to be a very difficult task.

This Task Force has been complemented by two others. The TF on Green Finance Reform and Green Transformation was initiated at precisely the right time, since this issue has received a great deal of attention internationally[1], and that work has spilled over into China[2]. This TF has consolidated existing work and introduced its own ideas in order to provided recommendations that take China's situation and characteristics into account. A TF on Rule of Law for Ecological Civilization will provide its initial recommendations to the 2015 CCICED AGM. However this activity is the first major effort by CCICED to examine legal reform in a comprehensive way. The task is proving to be very complex. The legal work will continue, with a final report of this TF at the 2016 CCICED AGM.

In addition CCICED has carried out three Special Policy Studies (SPS) this year. These more specific topics are all of high significance at the present time: Eco-Environmental Risk Management; Soil Pollution Management; and Coordinated Actions for Addressing Climate Change and Air Pollution. All have provided insight into green governance capacity issues and in particular complement the work on Rule of Law, since they identify specific needs for regulatory strengthening.

From June 8-10, 2015, CCICED convened a meeting in Beijing specifically designed to tap into various sources of international experience relevant to the 13th Five-Year Plan. This meeting brought together a very senior group of Chinese and international

1 UNEP Inquiry Report. October 2015. *The Financial System We Need. Aligning the Financial System with Sustainable Development.* 84 pp.http://web.unep.org/inquiry.

2 See IISD 2015. *Greening China's Financial System*. https://www.iisd.org/publications/greening-chinas-financial-system.

participants, including several CCICED Members. The participants met with CCICED's Chair, Vice Premier Zhang Gaoli.

The topics introduced above are considered in more detail below, along with nine issues of special note.

2.2 Green governance capacity: challenges and progress

2.2.1 Challenges

What makes the green governance challenges in China so complex, worrisome to government, and so difficult to resolve? In Box 2-2 examples are provided where reform is needed or is already underway. Such examples provide a partial answer to the question. Reform involves a full set of governance issues in every case: institutional changes, rule of law, better public supervision of development, and accountability for efficiency and effectiveness-full value for the large sums of public and private expenditure that will be spent on environment and development improvements.

Box 2-2 Examples of on-going environmental governance problems in China

- Magnitude of problems; and slow implementation for Water and Soil Action Plans in the War on Pollution arising from conflicting goals and "turf" wars among ministries.
- Obvious problems with environmental risk planning and management; and lack of coherent national or local systems;
- Corruption in some environmental decisions such as EIA and inadequate oversight function;
- Limited supervisory role of the public, with inconsistent signals from local governments in particular; and ineffective working relationships between enterprises and government on environmental matters; overlapping and unclear mandates of government agencies;
- Divergence in environmental objectives between central and lower levels of government;
- Inadequate levels of staffing, and mismatched skills within some government units; and
- Reliance on administrative measures rather than fully developed Rule of Law.

There are a number of gaps where considerable attention will be needed in coming years. Notably, the gaps are not always about staffing, although it is certainly difficult to believe that the tasks ahead can be fully carried out without additional staffing in institutions such as Ministry of Environmental Protection (MEP). Even if there is a shift

towards use of the market in regulations, and various self-policing efforts, it is essential to build further competencies nationally and at local levels.

What is essential is to recognize that government must work effectively with non-governmental organizations, community and enterprises, plus universities, international bodies, etc., in order to effectively address environmental governance. Much of the effort will have to be directed to creating enabling conditions so that all of the sectors/bodies above are able to make their full contribution.

More generally, capacity gaps are substantial in relation to the following general environmental governance matters:

- Communication;
- Credibility, trust and perceived honesty in environmental transactions;
- Institutional strength and coordination among institutions;
- Self-sustaining green financial mechanisms;
- Knowledge for adaptive planning and management;
- Performance: efficiency and effectiveness, timeliness, comprehensiveness.

There are other items that can be added to this list such as capacity to bring innovative technologies quickly and smoothly to the marketplace; capacity to promote and regulate sustainable consumption; capacity to monitor and control environmental health risks; and, in general carry out integrated regional ecological, natural resource and environmental management. This last problem is of considerable significance when it comes to linked issues such as land-based sources of marine pollution, and planning for urban regions such as Jing-Jin-Ji.

Many of the weaknesses and gaps have their roots in the overall governance system and in the accompanying financial mechanisms and legal framework. Yet, rather than limiting change to patch up existing arrangements, considerable work is needed to identify innovative operational policies and administrative measures that are as much as possible based on transparent and market-based approaches. Such points are often considered most important in China's economic reform, but they equally apply for environment and development concerns.

2.2.2 Progress

The good news is that for many issues, progress is being made, and this is making the outlook for green development quite positive. The examples below are indicative of why we should hope for more rapid progress in the coming Five-Years:

- Enormous investment in War on Pollution;

- Strong emphasis on Green Development, Greenization and Ecological Civilization;
- Assurances that in the 13th Five-Year Plan environment will be given major emphasis and with emerging signs of mid-term strategy;
- Revisions to environmental legislation, with enforcement action strengthened;
- Anticipated peak in coal use, and some indications of possibility for advancement of peak usage dates for other fossil fuels;
- Green development emphasized for China's international cooperation.

What makes the level of action on environmental matters especially significant this year is that they have taken place during a difficult time economically and administratively for China's central government. Challenges posed by the need to address a slowdown in economic growth, stock market fluctuations and bureaucratic slowness in dealing with structural changes have not moved the government away from its focus on environmental improvement.

In reality, arising from moderate economic turbulence and structural adjustment there may be some environmental benefits. The consistent call from leaders for further stimulus of the service economy should reduce energy consumption per unit of GDP. The concern for improved quality of development includes targets related to the environment. Renewed efforts to enhance market-based decision-making can be helpful if they include environmental regulations in the mix. In addition, technology, institutional and management innovation and deepening of economic reform will provide both direct and indirect benefits to environmental management and governance by enhancing efficiency. There also is evidence that the anti-corruption drive is proving to be of value for some aspects of environmental planning and management.

2.3 Bridging the gaps between goals, governance capacity, and innovation

2.3.1 Aspirations and capacity

Given the growing emphasis on green growth and green economy globally, there should be many new possibilities for green innovation that can eclipse the current efforts for Clean Tech and other prominent goals of the past decade. The framework of Ecological Civilization should be a potent driver since it provides for a longer term and integrated approach to unleashing this potential. China can rely on the mutually supportive aspects of a growing and greener domestic consumption market plus increased green international trade opportunities.

China continues to set goals that are intended to solve specific problems, but in the process open new economic and social opportunities for its overall development-the case for low carbon urbanization, circular economy, green chemistry for industrial development, and building environmental cooperation into its new trade and development plans such as OBOR and the AIIB.

These aspirations continue to be pushed at high levels but governance capacity is still a major issue in their actual implementation. Technology innovations may be moved into commercialization quite quickly as was the case for both solar and wind renewable energy. However this innovation has encountered considerable difficulties since the smart grid technology implementation has proceeded more slowly. And institutionally, there has been foot-dragging on the part of the supply chain operators who prefer to deal with more traditional energy suppliers and specifically coal suppliers. Internationally, China has met trade challenges that have hindered sales abroad of its renewable energy equipment. Thus the reality is that while installed capacity of the most innovative renewable energy sources has increased markedly, their actual contribution to green electricity supply may end up being below projected levels, a blow both to pollution reduction and to GHG emission control. This gap may become even larger as the level of installed capacity grows.

Concerning another green initiative-the widespread use of electrical vehicles (EVs)-the plans to replace government fleets with such vehicles and the subsidies provided for private owners will present major challenges. Recharging stations and their networks will require very careful planning to handle demand adequately. Also there are questions related to vehicle life cycle environmental impacts, especially those related to production and disposal of the massive battery packs. Unanticipated consequences of what may be a remarkably disruptive technology and the appropriate regulatory framework undoubtedly will arise. China has the opportunity to address these issues even if they occur at a scale that few other countries are likely to experience, since the government desires a quite rapid changeover for both environmental reasons, and to ensure that China is a leader in the full implementation of this transformative change.

Other examples could be provided, for example, the various eco-compensation programs in providing adequate safeguarding and improvement of ecological services. China now has the largest commitment of such programs in the world. The institutional framework is not adequate to ensure either optimal efficiency or effectiveness. In particular, there is not an adequate linkage of those receiving ecological service benefits (e.g., downstream cities) with those entrusted with safeguarding the benefits (poor upstream farmers). Similar examples bedevil sustainable management practices in nature reserves

throughout China.

Newer programs present particular challenges for example the effort to establish ecological functional zoning and redlining throughout China. This topic was the subject of recent CCICED work and so will not be explored here. Another recent Chinese commitment is to put in place by 2017 a national carbon cap and trade system based on current provincial-level trial efforts. This system may become the largest such national system in the world. The administration will be complex, and potentially open to abuse if not carefully handled at sectoral levels. The point here is that for many of the measures contemplated in China's future environment and development relationship there are weaknesses and gaps in the overall governance system and in the accompanying financial mechanisms and legal framework. Thus important work is needed to identify innovative operational policies and administrative measures that are, as much as possible, based on transparent and market-based approaches.

2.3.2 Governance Capacity Criteria

Governance can be examined through many criteria. In Box 2-3 these criteria are clustered into what might be called a "standard approach" that could be applied to any set of capacity concerns and a "green alternative approach", which covers criteria that are more specific to environment and development. Both lists are indicative rather than complete. A mix drawn from both sides of this box is desirable in order to strengthen green governance capacity in China.

Box 2-3 Standard and green alternative approaches to environmental governance issues

Standard Approach	Green Alternative Approach
Law, regulation & compliance	Development supervision by the people
Institutional size and clarity of mandates	Collaborative planning & management
Leadership ability and commitment	Zero impact development
Skills development	Green taxation
Financing magnitude and distribution efficiency	Sustainable consumption and production
Other incentives	Green investment
Technology fixes and innovations	Integrated and coordinated planning
	Sharing economy

2.3.3 Environmental Governance 2015—2030

A simple theoretical framework for environment and development capacity is shown in Figure 2-1. It draws together international experience as it has played out in various countries in Europe and elsewhere since the 1970s. In early years emphasis was placed on seeking compliance to detailed regulations, often mainly through command and control laws. This approach is necessary to a point but stifles innovation and certainly can have a dampening effect on those who wish to go well beyond what is specified by government, since there is little incentive, but perhaps uncertainty and even punishment in the marketplace for those who might wish to excel.

The next level is recognition that addressing environmental risk management can produce not only direct benefits, but also win support for new ways of approaching environmental problems. Thus, Responsible Care Programs sprung up around the world for businesses, often with a push from insurance and financial sector bodies who refused to deal with environmentally harmful situations. Within government, through proper environmental assessments, risks are reduced on development projects, and investments made more productive.

At another level, there are enabling measures to ensure new, non-polluting technologies, renewable energy and many other innovative solutions help to solve environment and development issues in ways that are good for economy and environment.

China is at a stage where all three levels are in play, although as various explosions at chemical plants have demonstrated this past year, the matter of environmental risk planning and management can be very weak-at least for some industrial operations. Furthermore, building an environmental risk system mainly around acute incidents may continue the trend of inadequate attention to cumulative risks. The ability to innovate with sustainable technologies is far from fully functional. And, the ability to monitor and enforce existing environmental laws and regulations is still relatively weak. Thus the great challenge in coming years is to find the right balance among these three interacting macro-strategies (Figure 2-1).

Presumably over time the value of China's major investment in innovation will pay off handsomely since it may become much easier to successfully bring new products and methods to the marketplace. Hence China's national and local governments, its enterprises and, indeed, Chinese society should prepare to go quite far beyond what today might be perceived as difficult or even impossible to achieve.

Figure 2-1 Capacity levels for environment and development success

Another way to look at governance capacity of a society to address environmental problems at various stages of economic development is through consideration of the Environmental Kuznets Curve (Figure 2-2). This often-maligned (for good reasons) conceptual tool suggests that at a certain level of GDP or other measure of societal wealth there will be much greater demand for environmental quality. Certainly China is at or close to such a state at present. Thus environmental degradation should start to decline, with various turning points reached in the coming 5 to 15 years. It would therefore be fair to examine how quickly acceptable levels of environmental quality could be reached over each of the coming Five-Year periods to 2030 and what environmental governance measures might accelerate the pace, or would the pace be determined largely by level of per capita income? At best this conceptual approach is likely to be quite crude.

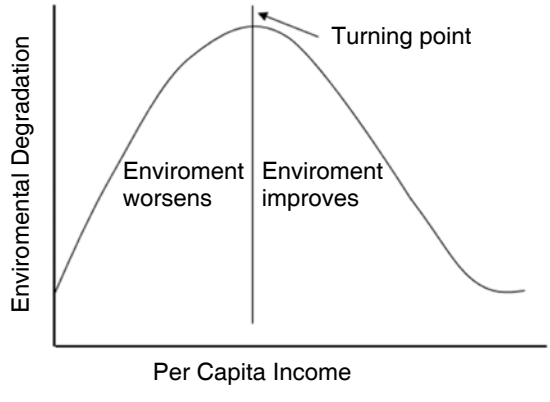

Figure 2-2 Environmental Kuznets Curve

2.4 13th Five-Year Plan Considerations

Most critical over the next Five-Years is how various turning points for environmental improvement can be achieved. This must be done in a credible and enduring way so that people recognize the improvements as real and as contributing to the quality of life. How to fully address the great, still largely unmet need for adequate environmental protection action within all parts of China is a long-term issue. Thus a mid-term strategy is required, certainly from 2015 to 2030, and likely well beyond. Environmental progress made during the 13th Five-Year Plan will be the opening for this longer-term success. The 13th Five-Year Plan is a defining moment in the history of New China. A transition towards a modernized, much richer country; well capable of setting out the future its citizens want. By 2020, the aim is for all parts of the country to be "moderately well-off" economically and in other ways.

The 13th Five-Year Plan will be a time when China's GDP is projected to rise above USD 10,000 per person. The higher level of income will be spread more evenly. Inevitably comparisons will be made with other countries at that same time in their economic development stage. However China will need to do more than achieve such a benchmark since it is already leaving the stage of being a low-cost workshop for the world, especially along in the provinces along its relatively rich east coast. These provinces, some of which are among the most polluted, need an accelerated path to better environmental quality.

The 13th Five-Year Plan offers the opportunity to address the downside of its recent past-a legacy of pollution, over-exploited natural systems, and situations of unsustainable development in both cities and countryside. It will be an opportune time for incremental pressures on the environment to be relieved. Currently, the imbalances between environment and the economy in China are perhaps far worse than those experienced in parts of Europe say in the late 1950s and 1960s. Accelerated environmental action during the 13th Five-Year Plan implementation could take China well above environmental conditions that many other OECD countries experienced at similar points in their economic development during the 20th century industrial age. This is not a prediction, rather it is a hope or anticipation.

At CCICED's June 2015 meeting on 13th Five-Year Plan preparations, participants contributed a wide range of suggestions, including those noted below. The conversations reflected a considerable base of experience covering both international and national experience relevant to China.

2.4.1 Take a coordinated and comprehensive approach

(1) A "whole of government" approach is needed in order to align action towards green development and ecological civilization. Integrate across government departments and agencies; also strengthen vertical linkages on environmental matters, ensuring local government has better means to successfully implement central government objectives. Set clear national objectives for environment and development rather than depend upon individual departments.

(2) Environment must be made a core pillar of development and as a stimulus to China's future growth.

(3) Ensure environmental issues are tightly linked to, and aligned with, overall deepening of reform.

(4) Now is the time to seek complex goal integration so that important development agendas do not collide with each other during their implementation. Rather, they should be complementary and synergistic.

(5) Set "stretched targets" that may be beyond immediate reach, but can take advantage of innovation.

(6) Establish improved cross-regional cooperation on pollution.

(7) Ensure binding targets are set for all pollution action plans. Overall, set clear milestones for 13th Five-Year Plan and demonstrate how these can be of value for initiating longer term action.

(8) Air quality and pollution control should be considered together in order to optimize outcomes in an efficient manner.

2.4.2 Strengthen and rationalize institutional roles

(1) Match fiscal strength to administrative needs and scale of activities, but avoid overinvestment. Work within fiscal capacity to avoid creating an excessive debt burden, especially at local levels where much environmental infrastructure expenditure must take place.

(2) Clarify institutional arrangements for separating protection and exploitation aspects of natural resources and environment issues. This is especially important for water, forests, and for marine and coastal issues. Independent supervision of environment and development should be improved.

2.4.3 Accelerate pace and efficiency of implementation

(1) Focus on implementation effectiveness and efficiency, including zero pollution strategies, great reduction in energy and resource use ("Factor 10" in some instances), a green bottom line for industries, and green market supply chains.

(2) Move more quickly from "pilot project to general practice" and from "practice to habit".

(3) Shift from "learning to leading" in general approach and in various innovation efforts.

2.4.4 Link economy and environment

(1) Build into the 13th Five-Year Plan a new normal model of economics that is respectful of environmental needs. Seek a model that does not trade off either the economy for environment, or environment for economy.

(2) Focus greater attention on jobs and environment potential. Shift tax burden away from labour and onto environmental polluters.

(3) Use greenization as a mechanism for change management.

2.4.5 Enhance natural capital

(1) Consider nature as "green infrastructure", for example coastal wetlands as a frontline defence against storms and for water purification.

(2) Propose better means to recognize and strengthen role of natural capital in development. Ecological redlining is an important element and should be profiled in the plan.

(3) Strengthen integrated ecological civilization indicators such as "life indicators" related to people feeling better off.

(4) Build programs for business, government and the public to understand dependence on their natural capital.

(5) Focus on ecological restoration and natural resources renewal, including biodiversity.

(6) Strengthen eco-environmental accounting in national accounts.

2.4.6 Diversify regulatory approach

(1) Develop regulations that cannot be easily avoided, ignored or overruled.

(2) Enabling legal framework is required in order to encourage citizens and enterprises

towards sustainable practices. Strengthen and expand green procurement by all government-sponsored entities. Supporting the best rather than fighting the worst is a way towards successful transformative change.

(3) Develop market-based approaches to environmental regulation and management, including appropriate mechanisms to address market failure. Recognize the needs of both entrepreneurs (supply) and consumers (demand) in market based regulations and incentives.

(4) Build cap and trade pollution control initiatives in an adaptive fashion since their institutional arrangements and performance may be poorly understood at the start.

(5) Continue to strengthen green taxation initiatives. For example, carbon cap and trade is not mutually exclusive from carbon tax needs. They can be used together.

(6) Extend EIA law and regulations revision to all initiatives, not only construction.

2.4.7 Expand efforts in business, financing and investment

(1) Strengthen role of business, whether in production, finance, construction, tourism, or other fields such as environmental technology, as a partner of government for implementing green development.

(2) Expand use of PPP models (Public Private Partnerships).

(3) Encourage new green products as well as production efficiency and pollution elimination.

(4) Establish a *green investment forum*, a safe place for business and others to formulate advanced approaches for the business community to develop "enlightened self interests" and to uplift their greenization efforts. Could be tied to G20 meeting in 2016.

(5) Engage leading companies in order to change a whole sector.

(6) Focus considerable attention on greenization of SOEs but also how through actions of big companies, SMEs can benefit, for example through assistance on establishing green market supply chains.

(7) Improve procedures for scaling up investments from pilot-level to full implementation; debt financing mechanisms.

(8) Continue move away from high consumption, high pollution industry rather than transfer such effects to other parts of the country.

(9) Should enhance the overall thrust of development towards higher productivity and efficiency across the board. Not sufficient just to get rid of the bad, must also foster the good.

(10) Focus investment more clearly around sustainable green growth opportunities.

(11) Seek investments and standards that will foster genuine green leaps forward, for example CAFE (Corporate Average Fuel Economy) standards leading to breakthrough technology for lighter automobiles.

2.4.8 Improve sectoral action

(1) Focus greenization attention particularly on three key areas: mobility, buildings, and food.

(2) Make agricultural modernization a key contributor through: expanding role of green chemistry, improved processing, incentives for retirement of stranded assets such as some older agro-chemical industry.

(3) Focus greatest attention on newly emerging industries rather than supporting sunset industries.

(4) "Made in China 2025" should have green goals for product quality and manufacturing improvement. Will require extensive commitment to green certification processes.

(5) Some areas for special attention include: water investments, energy efficiency, distributed power, housing, natural gas infrastructure, and parks.

2.4.9 "Going green while going global" and "planetary partnerships"

(1) The BRICS Bank, AIIB and One Belt One Road (OBOR) should have state of the art green strategies.

(2) Seek environmental convergence among partners, for example on circular economy.

(3) Begin to shrink total ecological footprint of China.

(4) Innovation strategies will require greater use of international partnerships, CCS (Carbon Capture and Storage) is an example. In some cases such partnerships could be valuable examples of S-S cooperation, for example in desertification.

(5) Public health and environment deserve to be considered as a higher priority for international cooperation on the part of China and other countries.

(6) Link Ecological Civilization and Planetary Boundaries as a framework for international cooperation.

(7) Consider implications for China of the G7 pledge to complete decarbonization of their economies by the end of the 21st Century.

(8) China should give priority to the 40 to 50 African countries seeking industrialization to foster green industrialization.

During their discussions with Vice Premier Zhang Gaoli on 9 June 2015, participants of the CCICED meeting noted that the opportunities associated with green development eventually will outweigh the challenges faced today. The 13th Five-Year Plan is therefore a pivotal point in the transformative change towards ecological civilization. It is essential to set "stretch targets" with the longer-term in mind. Green development must be seen as an important source of new jobs and the new economy. Governance capacity must be built within business and in the whole of society, not only within government. China is to be applauded for intending to make its new international approaches including the AIIB and OBOR compatible with green development.

The Vice Premier noted that "China will never export pollution to other countries" and that there is every reason to want green investment, with future urban development, for example, to be held to a higher standard. Vice Premier Zhao holds high hopes for China's future environment and development, and for CCICED's continuing contributions to this effort. He affirmed China's strong commitment, domestically and internationally for the 13th Five-Year Plan and beyond, to green development and to low carbon growth -"the right way to achieve national strength and to be accountable to our children's children".

2.5 Nine issues

2.5.1 Equal status in decision-making needs to be given to environment as to economic and social matters

CCICED has discussed this matter at the level of the Premier and Vice Premier, and placed it within our recommendations over the past several years. While generally accepted and with many initiatives now underway or planned, signals are still somewhat ambivalent. As an example, adding the word environment in the Five-Year Plan subtitle (currently the economic and social development plan) would be a very important signal. It is unlikely that this will occur for the 13th Five-Year Plan. However this is not the only change that would be helpful, as the examples below illustrate.

(1) The revised Environmental Protection Law is not a Basic Law and therefore lacks the full weight of some other legislation, by comparison to the fundamental law guiding agriculture, for example.

(2) Inadequate national and local systems of accounts and indicators. While China's central government has considered incorporating additional environment and development indicators in its accounting and decision making, plus downplaying to some extent the

great significance of GDP as a measure of progress and goal attainment, so far green development measurement remains a patchwork quilt rather than a full green system of accounts and indicators.

(3) Impacts of environmental degradation in decision-making and in development monitoring are often seriously underestimated or even remain unknown, and therefore not given full recognition by comparison to social, economic and other development factors. Of particular concern are: environmental impacts on human health, full understanding of problems related to groundwater, soil contamination, trans-boundary impacts, and loss of ecological goods and services. Also for many projects during and after their completion.

(4) Unfunded environmental liabilities (e.g., soil pollution, groundwater depletion and air contamination, legacy mining and industrial sites, and land-based sources of marine pollution) are prevalent throughout China.

2.5.2 A 2015—2030 national environment and development legal reform plan is needed

It will certainly take much more than a decade in China to reach a satisfactory level of legal revision to catch up with the efforts of the EU and some countries such as the USA, Germany and Australia on environment and development rule of law frameworks. Meanwhile environmental lawmaking will continue to evolve globally in response to frameworks for climate change, biodiversity protection, Law of the Sea, trade and environment, and various other aspects of sustainable development where China has an interest and that require domestic law adjustments to be compatible.

While China has made some important strides, it has been a slow process since reform of the whole legal system is involved, including the judicial apparatus that will accompany a proper rule of law approach. Legislative bodies such as the NPC are not well equipped in terms of their budgets and capacity to work at the pace needed for producing a whole reform package. In recent times it has taken periods of several years for laws to be passed. For every reformulated or new law regulations are required to make the law enforceable, and often other laws need to be updated. With the recent emphasis on ecological civilization and on market-based reforms, there will be pressure for additional laws and revisions. It will be helpful to have a full plan to address these legal reform needs from a strategic perspective.

The second part of legal reform is the need for a more independent judiciary, and operating procedures to make the system more accessible to China's citizens. Over the past year or two, progress on this effort has taken place, including the initiation of

environmental courts, with judges specially trained for such needs. As well, the courts are likely to be much more busy as enforcement measures are tightened under the environmental laws now in place.

A third component of legal reform is to provide enabling conditions for many of the emerging technologies and other aspects of modern business development in China. These needs range from environmental issues related to the many new investment and trade agreements being signed by China, the regulatory aspects related to intellectual property rights to the many new environmental technologies, plus the necessary legal frameworks for such technologies to thrive in China and abroad, for example, in the coming revolution of electric automobiles.

Some examples of specific legal issues include the following:

(1) By 2020 could there be a Basic Law on environment and development?

(2) Finding the right balance and complementarity between existing command and control laws and market-based laws and regulations that will stimulate greater participation in green growth and development by enterprises, the financial sector, and others who respond to incentives.

(3) The proposed national cap and trade program for carbon emissions is an example of a new type of environmental solution that will require very carefully prepared legal adjustments, and likely a considerable commitment to monitoring performance, potential fraud, and other matters.

(4) The need for a major effort to harmonize various sectoral laws such as water use with environmental laws; and to harmonize evolving international legal frameworks such as for climate change with national laws and regulations.

(5) It is essential that the primary goal of protecting public interests such as health and safety, and ecological services not be lost during legal reform. This has happened in a number of instances in some other countries, often due to intense lobbying by vested interests.

(6) Environmental law thrived in many OECD countries during the 1970s onward because the courts recognized the standing of environmental groups and their lawyers. Especially in the USA, this became an important, even essential element of the environmental regulatory system. China will need to establish where in the spectrum of rule of law and public participation it should place its efforts on opening its courts for citizens concerned about environmental progress and problems.

2.5.3 Coherent administrative approaches are still lacking for environment and development

It is possible with the new Reform Plan for Ecological Progress that more rapid strides for administrative reform on environment and development can take place. However proceeding to do so in an integrated fashion for the eight systems in Box 2-1 is highly demanding. Especially so, given that there will "pushback" from many existing agencies, all seeking their own strengthening. Administrative reform is not simply consolidating departments and agencies into bigger units, or in establishing a substantial number of new coordinating entities such as leading groups or commissions. The reform requires fundamental effort to ensure that regulating bodies for environmental protection are separated from those tasked with development and exploitation of natural resources. The role of development supervision by local people, especially in areas of sensitive biodiversity and environmental conditions, and where substantial investments in eco-compensation are being made, needs to be strengthened as part of the administrative system. The following examples are among the most critical.

(1) Need resolution of fragmented vertical and horizontal authority for most types of resource and environmental concerns. It is quite possible to pick and choose among available administrative measures to find the most favourable for specific interests.

(2) Separation of environmental protection and exploitation functions needs to be secured in government nationally and locally.

(3) The Ministry of Environmental Protection (MEP) is not well enough positioned or staffed by comparison to environmental protection agencies in other leading countries. This is an important reality that should be addressed urgently so that staffing becomes consistent with level and complexity of responsibilities. If this ministry were to take on the additional responsibilities of green development, the need for a greater range of expertise would be even larger.

(4) Environmental oversight functions (e.g., for performance auditing, EIA and risk management, environmental health and safety) are scattered throughout government, and with limited connections between levels of government. This problem will grow in magnitude as more effort is put into the War on Pollution and new programs for Ecological Civilization, etc.

(5) The current effort to address corruption problems within government and business in China is highly relevant to a system that in the past has relied heavily on administrative measures with a high degree of individual discretion but without full accountability.

It is necessary to tackle corruption issues for any number of reasons and certainly for addressing environmental matters. Environmental risks increase with corrupt practices, EIAs become of less value in decision-making, and public skepticism heightens with resulting social concerns. Sometimes corruption is considered the outcome of "alliances of power and money". Good administrative practices can break such linkages and rebuild confidence in decision processes.

2.5.4 Streamlining of "Greenization" processes

This peculiar term-at least in its translation to English-is meaningful in China, since it opens the concept of green development widely across major sectors and into decision-making at all levels. It is a helpful communications means for leaders, businesses of all sorts, urban and regional planners, and also educators. The problem is that there is no standardized backup as to how greenization processes are to work. Therefore, well-meaning efforts, such as bringing new green measures into play during implementation of the 13th Five-Year Plan, may become very complex and work at cross-purposes, especially among sectors. Streamlining is needed to arrive at conclusions quickly and efficiently. Otherwise green development will not maintain the good reputation that it deserves.

Greenization may be used as an excuse to slow down or stall initiatives unnecessarily. Premier Li Keqiang has noted the following conversation with a mid-level manager in government:

> *"We need to go through environmental assessment, water resources assessment and assessments on energy, work safety, traffic, geology, earthquakes, heritage, thunder, weather," Li quoted the manager as saying. "He told me that it would take at least one or two years."Li said some assessments, including those covering the environment and safety, were necessary, but some local government departments did not have enough professional staff to carry them out swiftly and efficiently. Some authorities ended up outsourcing the tasks to agencies who pocketed money from the deals, he said."Some intermediary agencies wear the hat of the government, hold the whip to the market and collect money from businesses…"*[1]

1 South China Morning Post. 22 April 2015. http://www.scmp.com/news/china/economy/article/1773314/chinas-premier-blasts-delays-created-big-projects-risk.

The feeling is that by prescribing overly elaborate suites of analyses, some civil servants or cadre may be trying to avoid personal accountability by delaying decisions.

At various levels of government and enterprises, there also is a real danger that what should be a serious reform effort can be transformed into public relations "greenwash" or worse. Thus "greenization" should be subject to real scrutiny and made workable, with constant attention to ensure that the outcome truly does add value above and beyond other processes.

Streamlining could involve combining various types of risk assessments, including EIA. Or selecting simpler screening tools rather than unnecessarily applying full-blown analyses. Obviously these choices require rigorous oversight so that approval processes do not turn greenization into a rubber-stamp exercise.

Another approach deserving attention is to apply the principle of subsidiarity to green approval processes. Subsidiarity places the action at the most appropriate level of government, or of governance.[1] This has worked well in many settings, where a consolidated assessment takes place at the most appropriate level based on likely impacts and benefits. So, for example, a mine without major national environmental impacts might be assessed at a provincial or perhaps even a lower level.

2.5.5 Sustainable financial mechanisms for green development

China will be among the largest, if not the largest, country-level investor in environmental improvements during the coming 10 years. When green development, including immense efforts to construct environmental infrastructure and new urban development is added in, the sums become enormous, as will be reported by our TF on Green Finance Reform and Green Transformation. Only a modest portion will come directly from government, perhaps only 20% or 30%. Even that money will come from many sources, including some not fully worked out. Cost sharing with the private sector and SOEs is important, including PPP.

China derives revenues nationally from the improved pricing policies for natural resources, from various environmental fees, and those amounts are likely to increase, although perhaps not at the rate of the recent past. China has not yet set in place property taxes in a fashion that can fuel local development and the running of local government, as happens in many other parts of the world.

1 "Subsidiarity is an organizing principle that matters ought to be handled by the smallest, lowest or least centralized competent authority. Political decisions should be taken at a local level if possible, rather than by a central authority." (Wikipedia). The concept is often exercised in EU governance where the broader concept of "most appropriate level" arises.

Although there are efforts at the national level to identify what might be placed in a green tax system, so far there is no such plan in place. Prospects in the near term for a comprehensive environmental tax system would appear modest. The announcement of a national carbon cap and trade program to start in 2017 may signal an end to the idea for a widely applied carbon tax.

Nevertheless, funding for environmental purposes will continue to rise, perhaps for some problems, spectacularly so. The War on Pollution is targeted in specific ways and appears to be sufficiently funded for air pollution, and likely also for the water pollution priorities. Soil pollution is a puzzle still since no action plan has yet been announced. If experience elsewhere such as in Europe, North America and Japan provides a guideline, soil cleanups in China will be among the most expensive environmental remediation efforts.

There is an expectation that the polluter will pay in China, as elsewhere. There are various mechanisms for this to happen, including special funds linked to mine approvals, etc. However the systems in place are not that mature, and also subject to many factors of ownership and allocation of responsibility, for example in the Bohai Sea oil rig spill earlier in this decade. The general pattern emerging is to set in place reasonable mechanisms for ensuring full financial responsibility lies with those deriving benefits from the use of the environment. This is obviously wise, but the mechanisms to do so require considerable refinement.

Banks and other financial institutions are now required to undertake due diligence so that loans are not made for initiatives causing undue environmental damage. They can do more such as providing concessional rates for green development. They also are important as a source of funding during the commercialization process for novel environmental technologies or other innovation products. Angel investors and other sources of funds from both Chinese and international investors can appear like magic-or not. Joint ventures on a massive scale have helped to modernize industrial bases and put in place advanced power plants. FDI is an important source for many of the environmentally-advanced production facilities operating in China today.

In the near future it is possible that green bonds, a green development bank and various other excellent models for funding green sustainable growth will be well established in China. Some of these sources will also support Chinese efforts internationally, for example through the AIIB. The move towards green financial mechanisms will likely come swiftly and therefore build momentum for green development-as long as the playing field is kept level and open, so that wise investment choices are made. These last conditions will

depend upon freedom from corruption, cronyism, and special interest tampering, especially by local and other vested interest.

Sustainable green growth in particular will require deeper understanding than now exists in order to ensure large sums are not lost on unsuccessful initiatives. Just as there was overinvestment in wind and solar due to failure to take into account demand side considerations, it will be necessary to pace investment in other green development efforts at a rate determined not by the supply side, but on the absorptive capacity and demand. This is particularly important for the massive urbanization effort underway in China.

What is needed is an integrated approach in the assessment of green development financing needs and performance. This capacity does not exist at the present time, either within the supreme auditing system, the individual departments such as the Ministry of Finance and MEP, and perhaps not within the National Development Reform Commission. It is a highly sectorized system, which often becomes part of the problem, as has been the case with the efforts to reform the national power grid and with public transportation systems, where efforts to modernize and to collect realistic levels of user fees have proved difficult.

The financial problems of sustainable green development become particularly acute when it comes to SMEs, the backbone of the Chinese economy. Smaller manufacturing businesses find it very difficult to undertake green upgrades without costly technical assistance and funds to install and maintain pollution control equipment. This is a problem that has so far not advanced much beyond the mechanism of closing down such businesses in favour of larger enterprises, and of advocating a service-based economy with lower pollution levels.

In times to come it should be possible to mobilize community-based funding sources for social organizations and other elements needed for greater public participation in environmental problem solving. In many other countries scattered throughout the world this approach has become highly effective. Whether for cleaning up a stream, or building environmental knowledge bases and safeguarding local environmental treasures, these groups become an essential part of the environmental governance capacity of a city, a province and a nation. China has its own local champions for the environment, and they do require a level of financial support that is at present generally much less than what is found in some neighboring countries.

A great advantage is that China can over time find the funds needed to make its development green and sustainable. However at present it is not at the stage where such funds are being allocated optimally, and therefore the outcomes are less likely to fully

successful. These problems can and should be tackled vigorously during the coming Five-Year Plan.

2.5.6 Integrated green innovation

China will promote Circular Economy, Low Carbon Economy and domestic green consumption in its efforts to build an ecological civilization. China also has invested immensely in S&T education and institution building to support innovation. This is among the most impressive efforts anywhere in the world, but the real test will come during the coming 15 years when the payoff is to materialize. Whether advanced power plants, great boosts to information technology, green cars, or advanced pollution control mechanisms, and better ecosystem management on land, water or sea, there will be a need to deal with whole system problems.

Integrated green innovation requires additional capacity to knit the many individual components of old and new solutions to individual problems into a more effective approach. This is the case for renewable energy options that can contribute, along with use of cleaner coal and greater use of natural gas, to coordinated efforts to reduce air pollution and GHG emissions by control of carbon black and nitrogen compounds from sources such as diesel engines and power plants. Another is the very major problem of substantially reducing non-point source agricultural pollution that affects success in the War on Pollution. A third example is the need to address the growing problems of solid waste accumulation. How can such waste be fully turned into useful resources throughout all parts of China? Is the answer more incinerators on the scale of the one now operating (and expanding in size) in Pudong, Shanghai?

These three examples are only a few among many others requiring integrated green innovation solutions. They are a far cry from earlier Circular Economy and other solutions that served China very well a decade ago, when it transformed recycling worldwide through demand for copper, paper and other commodities.

There are important ways to foster integrated green innovation beyond current efforts. One is to put in place better mechanisms to shorten the time for green innovations to be commercialized. This is essential since integrated green innovation requires all necessary elements to be available when needed. There also is a need for fast-tracking of regulations and approvals so that these do not become obstacles. Of great significance is the regulatory framework for Regional Green Innovation Planning, which currently is experimental and fragmented. A test will be the urban integrated planning for megalopolis areas such as for Jing-Jin-Ji. If successful, the result will be highly beneficial to the War on Pollution,

green public transportation, enhancement of ecological services, and other matters that will improve quality of life throughout this large region.

2.5.7 Data quality & credibility

China continues to suffer from various problems concerning data reliability and also incompatibilities of Chinese and international information. The problems are widespread, certainly not only for environment and development matters. They create credibility issues; and potentially, important decisions may be made based on faulty or incomplete information. Evidence of corruption in data gathering, analysis, and utilization, including "massaging" of information from local levels to higher levels, and in industrial reporting on environmental matters is a further cause for concern. Furthermore, knowledge sharing, while greatly improved, is still subject to many restrictions. A proper "scientific development" approach depends on full data disclosure, transparency & openness concerning methodology.

These problems, unless resolved, will inhibit the success of ecological civilization initiatives and constrain green development efforts. Furthermore, they promote skepticism on the part of the public, meaning a greater chance for a NIMBY reaction, or limitations on public supervision of development.

Given the expansion of academic centres on environmental science, planning and studies in China, with many now operating at provincial or lower levels, there are good capacity development possibilities. Also, environmental monitoring programs are likely to become much more rigorous and valuable sources of up-to-date knowledge. In the coming half-decade, these sources should be brought more closely into decision-making and made more helpful for broadening understanding of environment and development relationships.

What still is in short supply are the capabilities for integrative approaches to the problems highlighted in this Issues Paper. For policy formulation, assessment of progress, and for the adaptive planning and management of major initiatives, such analysis is essential. It requires teamwork consistent with the broad scope of ecological civilization, but also with the practical implementation insights offered by technical specialists, the public and by business interests.

It is often said that environmental agencies need to think of themselves as science-based organizations. They certainly need access to such skills, but also must have the ability to absorb scientific knowledge and further transform it into forms useful for governance. Organizations such as the USEPA and the European Environment Agency (EEA) have become very skilled at doing so. They are models for China.

2.5.8 The need to explore the *sharing economy*

The Sharing Economy-now being highlighted in many countries as a consequence of difficult to govern internet-mediated innovations such as ride-hailing operations Didi Kuaidi, YidaoYongche and Uber-is likely to become an important element of green development. It is anticipated that the concept of creating greater use of assets, whether an apartment, a car, a parking spot in a crowded city, or other underutilized real property, or services is a means to reduce ecological footprint, or planetary resources. The concept is not really new, except perhaps for the role of IT players such as WeChat and Baidu, which provide the connectivity (and sometimes substantial investment in the sharing economy companies) between those with particular needs and those who can supply these needs, often informally and sometimes without exchange of money.

According to Juliet Schor[1], who heads a research network on the sharing economy, such activities fall into four broad categories:

> *"Recirculation of goods, increased utilization of durable assets, exchange of services, and sharing of productive assets…Many [sharing] sites advertise themselves as green and present sharing as a way to reduce carbon footprints. It is a truism among "sharers" that sharing is less resource intensive than the dominant ways of accessing goods and services (e.g., hotels, taxis, shopping malls) because of the assumed reduction in demand for new goods or facilities. The actual environmental impacts of the sites are far more complicated…"*

In a sense the sharing economy concept is close to China's long standing model of political economy that involved sharing of land and other resources via agricultural communes. Even within urban hutongs there is a sense of sharing. The concept might be closely aligned to today's ideals of ecological civilization and green development. Also, for xiaokang, the guiding concept for a moderately well-off society. Another way of thinking about a sharing economy is that it offers ability to do more with less.

Why should sharing economy be profiled on this short list of important issues for China's future?

First, elements of the sharing economy, and the concept itself are under intensive scrutiny throughout the world, including within China. Undoubtedly it will loom larger in

1 Juliet Schor. 2014. *Debating the Sharing Economy*. http://www.greattransition.org/images/GTI_publications/Schor_Debating_the_Sharing_Economy.pdf.

the policy debates of coming years, if for no other reason than the potentially disruptive aspect it may have on existing governance mechanisms for at least some goods and services.

Second, it is not very clear whether the net contribution of a sharing economy to the size of an ecological footprint is positive. As noted by Schor (2014):

> *"The ecological benefits of sharing are often seen as obvious: secondary markets reduce demand for new goods, so footprints go down. Staying in existing homes reduces the demand for new hotels just as tool sharing reduces new tool purchases. However, despite the widespread belief that the sector helps to reduce carbon emissions, there are almost no comprehensive studies of its impact… The ordinary assumptions about ecological impacts are generally about the first, visible shifts made by a consumer-purchasing used products rather than new ones, or staying in a private home rather than a hotel. To assess overall ecological impacts, however, we have to consider ripple effects. What does the seller or the host do with the money earned? She may use the money to buy high-impact products. Does the appearance of a market for used goods lead people to buy more new things that they intend to sell later? If travel becomes less expensive, do people do more of it? All of these effects raise ecological and carbon footprints. There is also the question of impacts at the level of the economy as a whole. The platforms are creating new markets that expand the volume of commerce and boost purchasing power."*

Third, as noted by the Economist[1], "The sharing economy is the latest example of the internet's value to consumers…This emerging model is now big and disruptive enough for regulators and companies to have woken up to it. That is a sign of its immense potential. It is time to start caring about sharing". The term used to describe this form of use is "collaborative consumption".[2]

Fourth, the sharing economy is an important bridge between environment, economy and social development. It provides an alternative approach for achieving sustainable consumption while at the same time developing new models for social networks, including trust-building between total strangers. As noted by Schor, "the uniqueness of this new

1 http://www.economist.com/news/leaders/21573104-internet-everything-hire-rise-sharing-economy.

2 Colin Shek.2014. *No Purchase Necessary*. http://english.ckgsb.edu.cn/sites/default/files/CKGSB201412-Online.pdf.

sharing economy is that it mobilizes technology, markets, and the "wisdom of crowds" to bring strangers together". In this sense, it may expand social capital as well as help the environment.

2.5.9 Taking ecological civilization abroad

The proactive stance of China towards international initiatives during in the past few years has opened unprecedented opportunities to ensure its efforts for a respectful relationship of people and nature can inform the actions of other countries and the international community. Already green guidelines for Chinese enterprises and development initiatives abroad are in place[1], although it is not clear just how well they are operating in practice. At the 2014 APEC leaders meeting held in Tianjin, China a clearinghouse proposal to encourage green market supply chains was agreed upon and efforts are now underway.

New initiatives including the AIIB, BRICS Bank, OBOR and the various bilateral and multilateral trade agreements signed by China require specific operating guidelines on environment. These should be cast in terms of green development where appropriate, and in some instances could be used as the basis for ecological civilization initiatives. Chinese projects and companies operating in countries throughout the world, and particularly those in the countries of the South need to take special care in building local capacity for green development.

Achieving the new UN Sustainable Development 2030 objectives can be helped by China, not only through monies such as the USD 2 billion pledged recently[2] plus loan forgiveness, but also through capacity building and the sharing of experience under mechanisms such as those being pioneered by the UNEP-Chinese Academy of Sciences International Ecosystem Management Partnership (IEMP)[3]. China also has committed RMB 20 Billion in its new fund for South-South climate change cooperation[4]. The sums announced by China at the September 2015 UN Summit on Sustainable Development will be supplemented in various ways, and are intended to meet sustainable development needs of some of the world's poorest nations.

1 Hu Tao. 2013. *A Look at China's New Environmental Guidelines on Overseas Investments*. http://www.wri.org/blog/2013/07/look-chinas-new-environmental-guidelines-overseas-investments.

2 Reuters, 26 September 2015. *China pledges $2 billion to help poor states meet U.N. goals*. http://ca.reuters.com/article/topNews/idCAKCN0RQ0HW20150926?sp=true.

3 http://www.unep-iemp.org.

4 Xinhuanet. 15 October2015. *International Community Lauds China's Climate Fund for South-South Cooperation*. http://news.xinhuanet.com/english/2015-10/15/c_134716775.htm.

These recent Chinese initiatives have been applauded by leaders of many countries and international agencies. They represent new directions for partnerships and significant opportunities for spreading the ecological civilization approach and green development. In a sense they are a challenge to established ways of addressing development assistance. They will draw heavily on China's own experience of poverty reduction, and on the scientific and other ecological and environmental efforts plus technological innovation now going on in China. They also can draw upon joint efforts with international organizations and other countries.

China also has a good track record of "greening" high profile international events taking place within its borders, including the Beijing Summer Olympics and the Shanghai 2010 World Expo. There are new opportunities, starting with the G20 Summit to be held in the fall of 2016 in Hangzhou. It is logical to promote Green Financial Mechanisms as a key element for this meeting. In 2022, the Winter Olympics in Beijing can be another green showcase, hopefully focusing global attention on the advanced innovations for ecological civilization that China is implementing on a large scale.

China has taken on a large agenda that will expand its profile regionally and globally over the coming Five-Year Plan and on into the next decade. It is reasonably prepared in terms of the mutual benefits it would expect to have through enhanced trade and improved relationships. Just as it must seek effective use of funds and Chinese expertise domestically, so also China must understand and act in accordance with the expectations and needs of its partners in other parts of the world. This will not be an easy task, since the countries and regions involved are diverse and in various ecological, social and economic condition.

2.6 Conclusions

2.6.1 Bridging the gaps

The recorded voice and omnipresent signs to "mind the gaps" are familiar to those who use subways and trains in many parts of the world. If we ignore the danger, we stand to lose life or limb. Similarly, for country and planet, if tipping points are reached in ecosystems, or if quality of life degrades, human civilization and planetary boundaries are in trouble. That is the essence of where we are heading today globally and in many countries.

However, "minding the gaps" only makes us more aware of the dangers and provides

some sense of how to avoid the worst. It is building the capacity to fully address the problems that is essential now. Over the coming decade it is unlikely that, either in China or elsewhere, environment and development needs can be fully reconciled. It will take a longer time for that to occur. That is why in this Issues Paper we talk about "*bridging the gaps*". We can expect to change directions, see improvements, and open new opportunities using our best powers of innovation, financing and improved governance during this time frame.

A decade more takes us to the quarter century. By then it should be possible to have firmly established the pathway to an Ecological Civilization in China, and to see the influence this idea may have globally, no matter what the concept may be called outside of China. We must keep sight of the ultimate goals such as those set by the UN Sustainable Development 2030 initiative. And we must recognize the perseverance required for success. If we can successfully bridge the gaps, eventually it will be possible to close the gaps between aspirations and actual results on the ground. On the other hand, if gaps *widen* between goals and performance, more tipping points will occur, making it hard to achieve satisfactory turning points, and adding to the marginal costs of achieving desired changes.

2.6.2 Three important observations

China's 13th Five-Year Plan will be the "Final Sprint" to a "Moderately Well-Off Society by 2020".This is symbolically important since 2021 will be the 100th year anniversary of the founding the Chinese Communist Party. Therefore, considerable emphasis will be given to sustainable growth, jobs, and innovation to achieve this well-off status for all. However unless environmental problems are on track to be solved, the effort cannot be judged to be fully successful. It is for this reason that the 13th Five-Year Plan must be a green plan. It is not enough only to emphasize environment within a single chapter.

China's longer-term environmental protection, green development and ecological progress goals will shift in response to both internal and international pressures.The coming three Five-Year Plans will perhaps be the most important to set the stage for longer-term environmental improvement, including matters related to peak fossil fuel use and peaking of Greenhouse Gas Emissions. There will be a need for 2030, 2050 and perhaps other plans related to China's mature stage of economic, social and environmental development. Visions, targets, and implementation strategies must be adaptive, and designed to take full advantage of emerging technologies and China's changing situation domestically and on the world stage. It is best to move beyond a "comfort zone" at each

stage, since to do otherwise will constrain thinking and action to those technologies, management concepts, and perceptions of need of the day rather than for those of the future.

International Cooperation will play a larger role in China's future environment and development efforts. Greening of trade and investment will play a larger role in China's bilateral, regional and multilateral affairs. North-South green technology and experience sharing (e.g., China-US; China-EU, bilateral country arrangements, international business linkages, think tank cooperation) will increase in complexity and economic significance. South-South climate change and other topics will open new avenues for innovative cooperation. Global environment and development cooperative initiatives will expand via UN agencies, development banks, international environmental organizations, multinational enterprises, scientific organizations and universities.

2.6.3 Using environment and development experience in other sectors

The experience of working through complex multi-stakeholder relationships and other challenges of environment and development problems likely can be applied to other governance issues found in China, locally, nationally, regionally and globally. In this sense, if environment and development is successful in its green transition, other difficult issues such as health system development, job strategies and transition to sustainable growth will benefit from the experience.

Chapter 3
National Governance Capacity for Green Transformation

3.1 Preamble

Green transformation aims to generate inclusive prosperity while maintaining the natural systems that sustain us. Green transformation is more than a new mode of economic growth; it redefines the relationship between environmental protection, economic growth and social progress. In this new paradigm, economic and social development and environmental protection reinforce each other to realize the visions of economic prosperity, social harmony, clear water and green mountains.

Green transformation is not only a process where state interventions correct for negative externalities created by the market, but also a process of avoiding state failures which hamper environmentally benign economic and social development. The greening of the market will require guidelines, support for the development of businesses aiming to protect the environment, and removal of subsidies for industries which harm the environment and society. As key players in the market, enterprises of all sizes should be encouraged to develop green businesses and pursue green technological innovations with supportive framework conditions.

Green transformation encourages public participation, as well as social consensus and trust building. Through engaging in environmental protection, citizens, social organizations, and businesses gain deeper appreciation of public service and its practical significance. Open dialogue, access to reliable information and consensus building processes regarding public values and the goals of green transformation are necessary to build mutual trust among society, economic players and the government, and for shaping a mature social governance system.

The green transformation will require a process of redistributing as well as better integrating various administrative powers and resources. The existing system is highly fragmented, which leads to inefficiencies, redundancies, and at times even counter-productive decisions. A green transformation must be cross-cutting as it affects essentially

all sectors and issue areas: buildings, energy, transport, finance, agriculture, consumption, waste, etc. This means the green transformation will involve many governmental departments at all levels of government. It is imperative to optimize the distribution of power and resources both horizontally and vertically.

The requirements for strategic planning, policy making and enforcement, and monitoring and supervision for the green transformation are different from those for traditional development. The green transformation will be knowledge-intensive. Officials at all levels of the bureaucracy will have to be schooled in ecological civilization and green transformation objectives and implementation procedures and transform their value systems to embrace these aims. Routine administrative decision making is insufficient for guaranteeing effective policy making and enforcement. Bureaucrats have to be equipped with systematic knowledge on how to integrate environmental protection, human health, and social progress objectives into economic decision making and to advance the green transformation by integrating macro-level green development strategies into micro-level policies and measures.

Green transformation requires complementarity in the roles played by government, market and civil society in addressing market and government failures. Such cooperation will enable government, businesses, and citizens to reach their full potential. Under a governance system for the green transformation, economic growth, technical and social progress, and the professionalization of the bureaucracy must advance simultaneously.

3.2 Necessity and challenges of green transformation

3.2.1 Green transformation

Green transformation aims to maintain the sustainability of natural ecosystems while creating an inclusive prosperity. It encompasses similar concepts like the green economy, circular economy, and low carbon economy. Green economy stresses the improvement of resource efficiency; circular economy focuses on the dematerialization of material inputs (e.g. reducing, reusing and recycling waste); low carbon economy aims at the rapid improvement of energy efficiency and the deployment of renewable energy. The concept of green transformation is broader and more inclusive, going beyond the economic sphere to include the economy, society, environment, and resource use.

Decoupling economic growth from the use of natural resources is a necessary condition, key indicator and main driver of the green transformation. Two key indicators

are resource decoupling and impact decoupling. Resource decoupling means reducing the use of resources per unit of economic activity by raising resource productivity; impact decoupling means raising economic output while reducing negative environmental impacts. Relative decoupling occurs when economic growth is greater than the growth rate of resource use or environmental impact. Absolute decoupling means an absolute reduction in resource use regardless of economic growth.

3.2.2 Necessity of green transformation

China's rapid economic development has placed tremendous pressures on the environment. The carrying capacity of many ecological systems has been exceeded. Air, water, and soil pollution have reached critical levels resulting in major economic losses. The public is increasingly concerned about the health impacts of environmental pollution and expects better environmental quality.

In the face of the economic slowdown, China will need to find a means to ensure macroeconomic stability and promote sustainable economic development while improving environmental quality, protecting the natural heritage, and respecting ecological red lines. China will have to promote economic restructuring away from investments in heavy industry towards research and development in green business fields and energy restructuring. It will need to coordinate the development of urban and rural areas, deal with severe environmental pollution problems and environmental degradation, and cope with new and more complex environmental pollution issues, like climate change, biodiversity loss, persistent organic pollutants, and loss of resources.

The traditional mode of pushing economic growth at the expense of the environment is not sustainable and is no longer feasible under the "new normal". Green transformation is the inevitable choice for a paradigm shift to a new type of social and economic progress and to opening a new era of development. China needs major adjustments to its energy and industrial structures to realize the green transformation. Doing so will support efforts to maintain better economic growth, improve environmental sustainability, and promote a socially inclusive and balanced environment.

3.2.3 Challenges for green transformation

Green transformation is an enormous undertaking which is confronted by many challenges. First and foremost, China has an unbalanced economic structure and is trapped in economic path dependencies. Although great progress has been made in readjusting China's industrial system, its many resource-intensive and energy-intensive industries

still account for a big share of the economy making change towards a green economy challenging. Although China is the world's second largest economy, the quality and efficiency of economic growth is not high because of inefficient resource allocation, a low input-output rate, regional economic disparity, and weak market innovation capacity.

Second, green technological and management innovations and applications are important endogenous drivers of green growth for traditional industries as well as new green industries, but China's green technology R&D investment is inadequate. There is a large gap with developed countries in terms of innovation in the areas of clean production, alternative energy sources, and environmental protection. For instance, in the wind energy industry, most of the high-end components are imported, and R&D and human resource capacities are fairly weak.

Third, governance institutions were designed at a time when the green transformation was not yet a priority. The monetary and fiscal policy systems do not promote green growth, and there is not an effective resource pricing mechanism. Existing policies and measures are scattered in departments dealing with sectoral development, reform, finance, environmental protection, forestry, and water conservation. Policies often overlap and sometimes even purse conflicting objectives. There is no overall coordination mechanism to assure that green transformation and ecological civilization objectives are given sufficient priority. In addition, strong institutional constraints exist and incentives are lacking. Under the evaluation and promotion system, local government officials focus on the pursuit of short-term goals rather than on green development strategies and policies set by the central government. Standards for assessing progress towards improved environmental quality, green transformation of industry, and broader ecological civilization objectives at different levels of government have not been set.

Fourth, green transformation requires the complementary participation of all societal actors: government, market players, and society. Green transformation is knowledge-intensive, yet the ability of the executive branch of government to make and enforce evidence-based policies is relatively weak. Government officials have not been trained in green transformation thinking and often lack adequate tools and resources to turn policies into practice. In terms of the market, there are few market signals or mechanisms in place to encourage green innovation. The pricing system and subsidies often support traditional, resource-intensive and polluting industries rather than more sustainable, green industries. Citizens and social organizations' ability and willingness to participate in the green transformation is growing, but the full potential of their contributions have yet to be realized. Enhancing capacity in a cost-efficient manner means mobilizing the potentials

that exist in the market and in society to partner with the government in structural and market reform for an ecological civilization.

3.3 Governance capacity: concept and framework

3.3.1 The concept of national governance capacity

A green transformation will need new ideas about governance, systemic reform of the national governance system and strengthening of governance capacity. President Xi Jinping explained his understanding of the national governance system and governance capacity in an article in *Qiushi*:

> *"China's national governance system can be understood as a full set of closely linked and coordinated national systems through which the country is governed under the leadership of the Party. It consists of institutions, mechanisms, laws, and regulations with regard to economy, politics, culture, society, ecological progress, and Party building. China's national governance capacity refers to our capacity to administer various social affairs through the application of national systems. This includes promoting reform, development, and stability, handling domestic affairs, foreign affairs, and national defense, and governing the Party, the state, and the armed forces. A country's national governance system and governance capacity complement one another to form an organic whole. We say this because a sound governance system is essential for the improvement of governance capacity, while the improvement of governance capacity is a necessary precondition for fully exerting the effectiveness of a governance system".*[1]

When discussing national governance capacity for green transformation, not only should the individual roles of the government, market and society be considered, but also the establishment of a long-term institutional system in which these three dimensions will be in close coordination and mutually supportive. In this way the governance system can provide a sound environment for effective policy implementation. The institutional system can act as a supporting framework and policies can serve as instruments for the continuous

1 Xi Jinping, Aligning Our Thinking with the Guiding Principles of the Third Plenary Session of the Eighteenth CPC Central Committee, *Qiushi*, January 2014.

promotion of market, societal and governmental functions.

The Task Force's discussions about green transformation of national governance capacity have focused on these three dimensions. For the Task Force, national governance capacity includes the abilities of the government to build institutions, the executive branch of government to make and enforce rules, the market to internalize externalities, and the public and social organizations to participate in environmental protection.

In 2014, the Task Force, "*Institutional Innovation for Environmental Protection in the Context of Ecological Civilization*" of the China Council for International Cooperation on Environment and Development produced a detailed study of the environmental protection system. With this as background, the policy recommendations of this Task Force focus mainly on governance capacity, the promotion of governance capacity, and the reform of the governance system. While drafting policy recommendations, this Task Force gave full consideration to how to enhance national governance capacity to better promote the effectiveness of institutional reform for ecological civilization as called for in the *Integrated Reform Plan for Promoting Ecological Progress*.

3.3.2 The framework for improving national governance capacity

National governance capacity is often evaluated in terms of results, such as, the ability to collect taxes. Since the major objective of this Task Force is to put forward policy recommendations which can increase national governance capacity for green transformation, the governance capacities of the government, market, and society are explored and practical recommendations for enhancing national governance capacity are proposed.

Key factors which can influence the roles of government, market, and society in the green transformation are: a good institutional environment; a reasonable incentive system; adequate resources (human, financial, material, technological, informational, etc.) which correspond to responsibilities; and, the capabilities and environmental awareness of stakeholders (public officials, enterprises, the public, and organizations). Goals to be achieved by 2020 and for the following two Five-Year periods through 2030 linked to these four factors are proposed (Figure 3-1).

Establishing a good institutional environment and a reasonable incentive system through the reform of institutional mechanisms, laws and regulations can lead to results in implementation in the near future (2020). In the context of ecological civilization construction, China is rapidly advancing related institution building. The *Integrated Reform Plan for Promoting Ecological Progress* proposed reform goals to achieve by

2020. These goals are also addressed by the institutional environmental construction proposed by this Task Force.

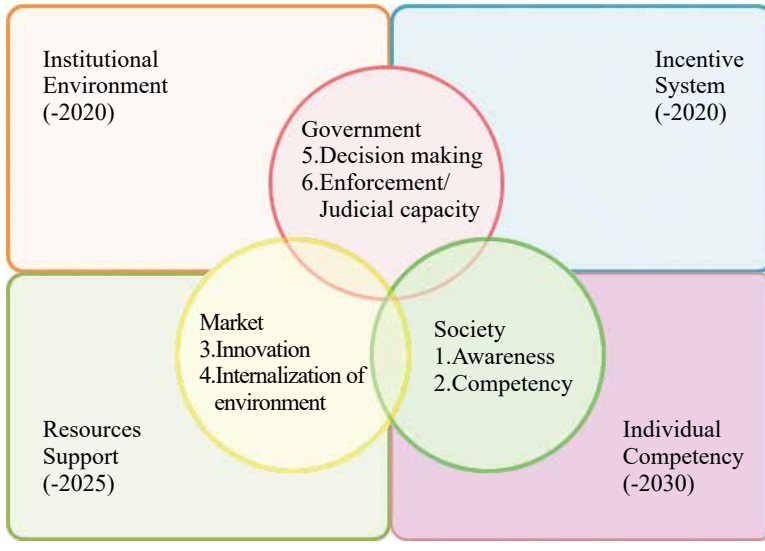

Figure 3-1 Framework for improving national governance capacity for green transformation

It will take time to match resource needs with the responsibilities especially of the executive branch of government related to policy enforcement. First, identifying social management needs which are already undergoing dynamic changes as a result of the implementation of policies "to streamline administration and delegate power to lower levels" will be a complex task. Second, determining the resource requirements of public agencies in relation to their functions, institutions, and staff size will also be a complex undertaking. Finally, realizing a steady adjustment in the power, responsibilities, and resources of different agencies will be a gradual and time-consuming process. It can be expected that reallocating resources for the green transformation will achieve certain results by 2025.

Developing an appreciation of the concept and values of green development in all of society will be a long-term undertaking. It will require persistent education, training, and guidance throughout the entire educational system. Enhancing the capacities of the government officials and social organizations will require continuous training and learning. Improvements in individuals' abilities and environmental consciousness for green transformation will be a long-term process but results can be expected by 2030.

3.4 Deficiencies in national governance capacity

In the national governance system, the roles of the government, market and society are dynamic and changing. In the era of the planned economy, the government played an absolute and dominant role. During the transformation to a market economy, the market began to play a more and more important role in national governance. With the enhancement of public participation and awareness, citizens and social organizations are playing a more important role in national governance than ever. One of the principles of reform called for in the *Integrated Reform Plan for Promoting Ecological Progress* was defined as "adhering to the correct direction of reform, perfecting market mechanisms, giving a better play to the leading and supervisory functions of the government, bringing the initiative and self-restraint of enterprises into play and giving free rein to participation and supervisory roles of social organizations and the public". In this chapter, we will further discuss the status quo and capability challenges for green transformation governance.

3.4.1 The capacity of the state to make policies

The United Nations Conference on the Human Environment held in 1972 brought impetus to the start of China's contemporary environmental protection. At the Second National Environmental Protection Conference held in 1983, environmental protection policy was listed as one of the fundamental national policies of China. Afterwards, the central government enacted the *Environmental Protection Law, Water Pollution Prevention and Control Law and the Air Pollution Prevention and Control Law* and issued a series of policy documents, including *Action Plan on Prevention and Control of Air Pollution, Action Plan on Prevention and Control of Water Pollution and the Opinions on Accelerating the Ecological Civilization Construction*. In addition, China signed a number of international environmental conventions. The central government also issued related administrative rules and regulations, such as the *Regulation on Environmental Impact Assessment of Planning and the Regulations of the People's Republic of China on Nature Reserves*. The competent authorities formulated nearly 200 department regulations and normative documents as well as a number of national environmental standards. In this way, China established an institutional system for pollution control and environmental protection guided by national framework policies; relying on laws, rules and regulations, standards and administrative orders; and laying an institutional foundation for green transformation.

Though China has made continuous efforts at perfecting its institutional system, the government is still notably weak in terms of its policy-making capabilities. There are several specific weaknesses existing in relation to policy makers, policy texts and policy execution:

3.4.1.1 Deficient professional knowledge and lack of information hinder scientific decision-making

Sound and scientific decision-making for green transformation involves sophisticated professional knowledge of environmental science and engineering, economics and public administration. Any public policy regarding green transformation must be based on the analysis of modern environmental science and engineering, economic cost-benefit analysis and regulatory impact assessments. Unscientific and random decision-making not only causes immense waste of public resources but also causes more environmental problems. China must solve the conflicts between economic development and environmental protection and promote green transformation of economic and social development in a scientific manner. The Chinese government's legislation and decision-making for the green transformation must also be based on comprehensive scientific analysis.

Legislation by departments has long been the case in China and is an inertia in the current system. Specialty laws such as those on environmental protection are generally drafted first by the relevant governing ministry, submitted to the Legal Office of the State Council for review and circulated in other related ministries for comment. Once a bill is reviewed and approved in principle by the State Council, it will be submitted to the National People's Congress (NPC). Bills are reviewed by the relevant committee of the NPC and technically reviewed by the Commission of Legislative Affairs, Standing Committee of the NPC before being submitted to the NPC and its Standing Committee for voting. Members of the NPC and its Standing Committee, are primarily promoted from departments and local governments, who generally lack knowledge relevant for the green transformation. Of the 32 members of the NPC Environment Protection and Resource Conservation Committee, very few have a professional background or work experience in environmental protection. For this reason, it is difficult for them to voice any professional opinion on green transformation questions.

In the existing legislative and decision-making systems, though scientists are personally engaged in consultation, there is no mechanism for a comprehensive responsible expert committee to convey professional and collective opinions based on in-depth systematic analysis of related major decisions and legislation. As a result, legislation becomes the conveyor belt of the interests of government departments rather than the

reflection of comprehensive and scientific analysis.

Meanwhile, incomplete data collection and sharing result in deficiencies in obtaining the kind of comprehensive information needed for institutional improvement and policy-making. The ecological environmental monitoring network is incomplete in terms of its scope and coverage. There are inconsistencies in construction planning, standards and specifications and information distribution. There is a low level of IT application and information sharing, and the connection between monitoring and supervision is loose. There is room for further improvement in the quality of monitoring data. It is becoming clear that this system is failing to meet the demands of ecological civilization construction and compromises the scientific basis and authoritativeness of the monitoring system and public trust in the government. Moreover, some local governments, driven by economic growth, tend to conceal relevant information, which also compromises the abilities and awareness of decision makers in evidence-based decision-making.

3.4.1.2 Principle-based regulations do not guarantee the orderly participation of multiple stakeholders

Pluralistic participation entails being open to the public about the strategies to be used in implementation, and allowing the public to raise questions, to be involved in discussions and to make suggestions in decision making processes, thereby ultimately influencing outcomes. There are a lot of references to pluralism in Chinese laws and regulations. For example, as specified in Article 5 of the *Environmental Protection Law*: "Activities concerning environmental protection shall adhere to the following principles: according priority to protection, emphasis on prevention, integrated governance, public participation and liability assumption of damages". As specified in Article 14, relevant departments of the State Council and the governments of provinces, autonomous regions and municipalities directly under the Central government should fully take environmental impacts into consideration when formulating economic and technical policies and solicit the views of stakeholders and experts. These are basic provisions of the *Environmental Protection Law* in relation to stakeholder participation.

In addition, the *Environmental Impact Assessment Law* and the *Air Pollution Prevention Law* share the same principles. Nevertheless, although the principles in existing laws and regulations are sufficient, details are inadequate. The system lacks a means to secure pluralistic participation and specific rules on participation in the preparation of regulations. Furthermore, over use of vague words, like "should" and "encouraging" decreases the authority and efficiency of relevant legal provisions. For example, public participation in construction programs are held mainly by construction units; associates or

supporters of the construction units tend to participate in the so-called verification meetings and hearings. There is a lack of specific methods and procedures, so that the significance of such hearing and meetings are greatly reduced.

3.4.2 The capacity of the government to enforce policies

Starting in the 1970s, China gradually established a top-down natural resources and ecological environmental protection management system. There are ten departments with functions related to protecting resources and ecological and environmental systems, including development and reform, environment protection, land resources, agriculture, water resources, housing and urban-rural development, transport, industry and information technology, forestry, and ocean departments. After several adjustments, gradually the system for management of natural resources and the ecological environment is moving towards a system of uniform supervision and management, differentiated responsibility and horizontal coordination. This system plays an important role in the implementation of strategies governing China's natural resource use and ecological environmental protection, but there are shortcomings in relation to the following aspects:

3.4.2.1 The current horizontal and vertical institutional arrangement for environmental protection restricts the roles the environmental administrative agencies can play

Green transformation is a systematic project, requiring cooperation and coordination among a number of administrative departments engaged in environmental protection as well as at the central and local levels. As explicitly stipulated in the *Environmental Protection Law of the People's Republic of China* Article 13, "The content of environmental planning should include ecological protection and pollution prevention goals, tasks, safeguard measures, and there should be a convergence in the main functional areas of planning, land use planning and urban and rural areas planning". However, administrative fragmentation, and functional overlaps result in a situation in which the formulation and implementation of environmental protection plans, laws and regulations fails to penetrate into other relevant departments. As a result, the environmental protection system is not currently capable of adequately fulfilling its responsibility for promoting ecological protection and green production and life.

Among the 53 main ecological environmental functions at the national level, 21 are in the Ministry of Environmental Protection, while 32 are dispersed in nine other departments. Of the 21 functions for which the Ministry of Environmental Protection bears the main

responsibility, almost half overlap with responsibilities found in other departments.[1] Although local environmental protection departments are nominally subordinate to the Ministry of Environmental Protection, they are in fact guided and controlled by their local governments. Under this system, local environmental protection departments inevitably compete for the same budgetary resources with other peer governmental departments. Due to the primacy placed on economic development by local governmental officials, the environmental supervision of enterprises is seldom considered. Therefore, local environmental protection departments fail to get the resources necessary for environmental protection, leading to problems with environmental regulatory enforcements.

Within environmental protection departments, the resources of law enforcement agencies do not match their responsibilities, resulting in fatigue and frustration among law enforcement personnel.

And compared with administrative punishment measures, the effect of criminal law on environmental protection enforcement in China is still limited and will be so for a long time. In cases of alleged environmental criminal activity, the filing requirements and standards in the *Code of Criminal Procedure*, lack practical operability affecting the detection and filing of suspected environment criminal cases.

3.4.2.2 Inadequate consideration of environmental performance in the promotion system affects the attention governmental officials give to environmental protection

Currently, political incentive systems for ecological civilization and environmental protection are driven by negative incentives. There is much less use of positive incentives. The accountability system for officials is maturing, but accountability is often still based on negative incentives or disciplinary measures for those failing to strictly implement the corresponding strategy. In the performance indicators used in the appraisal of cadres, beneficial indicators for cadres that positively perform the functions of environmental protection are lacking. The lack of positive incentives directly ties into the limited movement and promotion opportunities for officials.[2] Although the central government is putting emphasis on environmental indicators in the cadre appraisal system, it is difficult to completely change the conflict between environmental indicators and other mandatory economic development indicators in a short period of time. Local cadres tend to resist or employ flexible strategies rather than implementing the central policy of ecological

1 Wu Shunze. Eight Challenges for Environmental Protection during the "13th Five-Year Plan" Period [J]. *China Environment News*, 2015: 9-25.

2 Kostka G. Environmental protection bureau leadership at the provincial level in China: examining diverging career backgrounds and appointment patterns [J]. *Journal of Environmental Policy & Planning*, 2013, 15(1): 41-63.

environmental protection efficiently and loyally.

3.4.2.3 Regulatory power does not match with resources granted to regulatory agencies at all levels

Environmental monitoring is a precondition to environment regulations, environmental risk prevention and the green transformation. Prior to 2003, the State Environmental Protection Agency was responsible for environmental monitoring and assuring that pollution standards were met. However, with the significant expansion of the scale of national industrial production, even though the concentration of pollutants released by specific industries may have met standards, total ambient pollution discharges were often very high resulting in serious degradation of environmental quality. Since 2003, the State Environmental Protection Administration (now, Ministry of Environmental Protection) requires local environmental protection departments to calculate total allowable emission levels for air and water within respective jurisdictions and then based on this to adjust permissible discharge levels for each pollution source.

Because of limited resources, the environmental protection departments usually focus their attention on large-scale pollution sources; however, although their total pollution discharges may be very large, most SMEs, and especially those in rural areas, tend not to be monitored. In addition, the fixed investments for constructing environmental monitoring stations falls on the environmental protection departments while operating costs are borne by the local government. This is a heavy burden for economically less-developed areas. Especially after the promulgation of new air quality standards in 2012, existing monitoring equipment is inadequate to fulfill monitoring requirements. A major challenge in constructing the national air environmental quality monitoring network will be finding ways to assure there are sufficient resources.

3.4.2.4 The competencies and awareness of civil servants related to green transformation need to be improved

The green transformation is a knowledge-intensive undertaking; policies to promote the green transformation touch on many fields, including green investment, green trade, green consumption, green fiscal policy, green taxes, green finances, green industrial policy, and policies for greening the economy, as well as other policies to guide the social and environment fields.[1] This will require that civil servants have relevant knowledge to pursue this green transformation. In addition, the green transformation puts expectations and

1 Yu Hai.World and China under New Trend of Green Transformation, People's Forum Academic Front, 2015(1): 53-63.

constraints on civil servants,[1] including in terms of improving service quality, improving work efficiency, reducing administrative costs and eliminating office waste. Accordingly, the cognitive skills and attitudes and the education and business skills for the green transformation of civil servants needs to be improved.

3.4.3 The capacity of the market to internalize externalities

Although the effort of the whole society is required for the green transformation, enterprises will be crucial to the green transformation. The discussion of the governance capacity of the green transformation is actually a discussion of the capacities of enterprises, the main actors in the market, to green their businesses. The basic goal of participants in the market is to obtain economic benefits. Unless there is a benefit or a regulatory requirement, the market participant will not invest in green innovation or reduce environmental pollution. Therefore, government and industry associations have to create an institutional environment that will be conducive to promoting green innovation and internalizing environmental externalities. In other words, companies' green transformation will require their own efforts as well as positive action on the part of the government in terms of providing a favorable market environment for green businesses, and through establishing various incentives and constraints on business behavior, including fiscal and taxation policies and standards. China still has many deficiencies in these areas:

3.4.3.1 Price reform of important resources is still lagging behind; the government's economic incentive policies for the green transformation of enterprises through finance, taxation, standard setting, and the like are not without flaw

The government intervenes in the setting of prices for coal, oil, natural gas and other key resources, so prices do not reflect the scarcity of resources, resulting in excessive consumption of resources and their exhaustive exploitation. Resource taxes are low and do not reflect the costs of resource destruction and environmental governance. The ecological damage caused by resource extraction and use cannot be sufficiently compensated, resulting in environmental destruction.

There is a lack of existing measures available to the government to use to provide economic incentives to enterprises, such as financial and taxation policies or standards. The government should improve its approaches to and efficiency in providing financial support to R&D and the promotion of green technology applications. The standards of some major sectors are still inadequate. The progress in developing platforms for the cooperation

1 Hu Yuemin, Liu Jiaku. Green Development Transformation: Literature Search and Theoretical Analysis, Modern Economic Research, 2013(6): 33-42.

among government, enterprises, universities and research institutes on innovation and for the promotion of green technology and business models is slow.

Green supply chain standards and the green standard certification are imperfect and inconsistent, leading to high implementation costs for green supply chains. While multinational enterprises are leading in the development of green standards, the degree of participation in green procurement, marketing, production and other aspects of the standard setting process by government agencies, industry associations, enterprise unions and middle and SMEs is quite low. Due to insufficient cooperation, there is a lack of uniformity in the green standard certification systems established by different industries and leading companies.

3.4.3.2 Enterprises have difficulty in translating reputation in environmental protection into real economic benefits. The market for environmental industry is still not mature, so the market fails to play a decisive role in the allocation of resources or to provide positive incentives for green development by enterprises

The existence of a green consumer market is a prerequisite for enterprises to become engaged in the production and provision of green products. The Chinese green consumer market is still lagging behind, a system is required to promote the development of green market and raise awareness of green products and their consumption needs to be increased. The tax and subsidy policies which could contribute to green consumption are imperfect, and a price system mechanism to promote green consumption has not been established. In addition, the corresponding marketing and distribution systems have not been formed, which makes it difficult to translate the reputation, trust and other social capital firms may have in the field of environmental protection into real economic benefits.

There is shortage of government capacity to create a market environment that is open, fair and conducive to new emerging industries. There is still some direct governmental interference in micro-level economic activities. In some fields, enterprises of different ownership types are treated unequally. Problems of administrative monopolies are still prominent, and there are still institutional barriers facing enterprises (especially those in the private sector) wishing to access some key fields. There are problems of local protectionism, and a unified nationwide market has yet to be formed. The current market regulatory approaches are not compatible with the demands of new economic models and new industries.

3.4.3.3 The governmental capacity for supporting green innovation and green practice is inadequate

In the past few years, a diversified network platform was established by the

government, industry associations and enterprises and a green standard certification and enterprise environmental information database was established, expanding the avenues for participation in the governance for a green transformation by various market actors. For example, the first comprehensive service platform for the marketization of green supply chain management of China (Tianjin Green Supply Chain Service Center), established by American Sustainability Consortium, China Environmental United Certification Center Co., Ltd. and Tianjin Government, promoted the localized application of the American green supply chain management system.

However, the resource integration of the green platform is quite weak. The green technology platform, green supply chain centers and enterprise environmental information platforms are dispersed; the links between the various types of network platforms, the sharing among them and their openness is inadequate, which limits the integration and sharing of green resources, technology, products and supply chain management services. There is limited enthusiasm or willingness of enterprises to proactively participate and thus, corporate environmental information is not comprehensive, but rather imprecise and opaque.

3.4.3.4 Many small-and medium-sized enterprises (SMEs) do not participate in the green supply chain system. The concept of green development is not well understood, nor is the idea of a green supply chain well appreciated. The overall sense of social responsibility for the environment is inadequate

The understanding of green transformation governance is lagging in many enterprises, especially heavily polluting industries. There is a certain misperception in these enterprises' understanding of green technology and green supply chain, and appreciation of corporate social responsibility for environmental protection is weak. For example, the Zijin Mining Industry Co., Ltd.'s problematic understanding of the green development concept resulted in its indifference towards environmental protection, and this resulted in many serious environmental pollution events.

The green supply chain has been strictly implemented in some fields. Under the impetus of multinational companies like IKEA, Wal-Mart, Epson, Apple Inc., and other representative enterprises in the automobile, electronics, and chemical industries, green supply chains have been strictly implemented and enforced. The supply chain governance model has matured. There is now joint participation by government departments, buyers, and consumers, and the system now functions well. For example, as required by the Ministry of Industry and Information Technology, Huawei established a three-way cycle sharing model with China Mobile and Chinapack Jingli Company. In 2011, the total

delivery quantity of green packaging of Huawei reached 47,600 pieces, which reduced the demand for forest wood by about 5,300 cubic meters. Carbon dioxide emission reductions amounted to 13,000 tons. The green package application ratio for major devices reached 79%, and the resource recovery rate reached 85.8%. Under the promotion of multinational companies, since 2005, representative domestic enterprises like Baosteel, Skyworth, SGM, etc., have started to promote green supply chains.

However, the ability of SMEs to participate in the green supply chain is low. Many SMEs face restrictions like financial constraints, inter-firm trust, technical knowledge, environmental standards and the tax system, and as a result, they do not participate in green supply chains. For example, the *China Green Supply Chain Survey Report* issued jointly by GXS and the Global Supply Chain Council in 2010 indicated that 36% of the respondents thought that the biggest obstacle for the implementation of the green supply chain management was the high cost.

3.4.4 The capacity of the civil society to participate in green transformation

In 1994, the State Council issued *China's Agenda 21 - White Paper for Population, Environment and Development of China in the 21st Century*, stating that "to achieve the sustainable development goal, we must rely on the support and participation of the public and social organizations, including workers, farmers, women, the youth, technology and education fields". This was also the first time that the government of China defined a path and policies for public participation in environmental protection in a programmatic document. Since then, great progress has been made in laws, regulations and policies for social organizations, but there are still many challenges facing the public and social organizations in terms of their participation in environmental protection. Social governance capacity is still weak, which mainly is reflected in the following ways:

3.4.4.1 There is still a shortage of laws and regulations facilitating the participation of the public in environmental protection; the overall political environment for the development of social organizations related to environmental protection needs to be improved. The rights and responsibilities of the public to the environment require clarification

In order to promote public and environmental social organization participation in environmental protection, the government issued a series of policies. For example, in 1996, the State Bureau of Environmental Protection, the Propaganda Department of CCCPC, and the State Education Commission issued the *Outline of National Actions on Environmental*

Publicity and Education; in 2006, to promote and legislate public participation in environmental impact assessment activities, the State Environmental Protection Agency established the *Interim Measures on Public Participation in Environmental Impact Assessment*; in 2011, the Ministry of Environmental Protection issued the *Guidelines on Cultivation and Guiding Orderly Development of Environmental NGOs*; in 2014, the Ministry of Environmental Protection issued the *Guidance on Promoting Public Participation in Environmental Protection, Opinions on Strengthening Work of Environmental Information Disclosure and Media Guidance* and the "*Breathe Together & Work Together" Citizen Code of Conduct*; and in 2015, to strengthen the degree of participation by the public, the Ministry of Environmental Protection issued the *Measures for Public Participation in Environmental Protection*.

Still, although there are many laws and regulations associated with the participation of the public in environmental protection, these laws and regulations are fragmented, their legal force is low, and they are weak in terms of their ability to constrain behaviors. The existing laws and regulations lack a clear definition on rights and obligations of the public to participate in environmental protection. Environmental law enforcement, moreover, is often not practiced. The *Guidelines on Cultivation and Guiding Orderly Development of Environmental NGOs* issued by the Ministry of Environmental Protection has not been well implemented since it was issued. Its legal hierarchy is low and its constraining force is limited. Moreover, there is no special institution, personnel nor budget in local environmental protection departments to implement the policy.

In addition, environmental social organizations still face some bottlenecks in relation to registration, fund-raising qualifications, environmental information acquisition, channels for institutionalized participation in environmental protection, etc., and the cultivation and supervision policies of environmental social organizations still needs to be further improved.

3.4.4.2 The public and social organizations lack necessary information for participating in environmental protection; and the environmental departments lack budget for full-time staff to perform the work involved in supporting public and social organization participation

Environmental information is the basis for public and social organization participation in environmental protection. However, information related to environmental protection is scattered because of the absence of a unified information disclosure platform. The participation of the public and the social organization is restricted. According to the provisions of the recently issued Measures for the Disclosure of Environmental

Information by Enterprises and Public Institutions, enterprises and institutions shall conform to the principles of both mandatory disclosure and voluntary disclosure. This "voluntarily encouraged" policy-oriented legislation method does not specify the obligations of polluting enterprises to disclose environmental information, nor does it specify the legal sanctions for enterprises violating the disclosure obligation, nor does it set measures to encourage enterprises to actively provide relevant information. Under these circumstances, it is very difficult for the public to obtain environmental information about enterprises.

To promote public participation and improve social governance capacity, the Propaganda and Education Department of the Ministry of Environmental Protection strengthened the basic responsibility to "centralize the environmental protection business training for social public participation, and promote public and social organization participation in environmental protection".[1] This means that the government will have a special functional department that is responsible for governing social work for environmental protection. In addition, the Ministry of Environmental Protection has set up the Publicity and Education Centre which is a "technical support unit that conducts publicity and education as well as capacity training for various industries," engages in environmental publicity and training projects, drives the local environmental protection propaganda and education centre network to jointly improve environmental awareness of various social industries, and promotes public participation in environmental protection. The environmental protection departments of various regions also established corresponding institutions. Though the Ministry of Environmental Protection has specified the Propaganda and Education Department to be responsible for public participation, there is no special office responsible for relevant work. The Propaganda and Education Department is still mainly involved in traditional environmental protection publicity and education work. The effort put into promoting public and social organization participation in environmental protection is relatively limited. In addition, local environmental departments lack special personnel and budget for supporting public and the social organization participation.

3.4.4.3 The public still lacks the knowledge and skills required for participating in environmental protection. Environmental protection social organizations still face such problems as small size, inadequate funds, and lack of skilled individuals

Environmental protection departments, the media and relevant departments at all levels have been engaged to a certain extent in publicity and education for environmental

1 See the website of Ministry of Environmental Protection: http: //xjs. mep. gov. cn/.

protection and green culture in schools, communities and enterprises to advocate green civilization, and in this way were heightening environmental awareness among the public. Currently, the Chinese public is environmentally aware but often does not take relevant actions. Research shows that whereas only 36% of the respondents in China agreed to develop a green GDP in 1998, that rate increased to 80% in 2008. In 1998, 56.7% of the public felt that environmental pollution was "quite severe" or "very severe". In 2008, that rate increased to 76.4%. However, although the public's environmental awareness has strengthened, some research shows that the public still rarely takes environmental protection actions, and does not adopt environmental protection behaviors. Only 26% of the public claim that they "often take environmental protection and energy saving behaviors". While 62.6% of the public occasionally attend environmental protection related activities, up to 30% of the public say they have never attended any such activities.

Although the nation has invested enormous manpower and materials in promotion and education for environmental protection, and citizens are increasingly more environmentally aware, the public still has insufficient knowledge about environmental science and lacks environmental protection skills. According to the research of Shanghai Jiaotong University in 2015, only 43.2% of respondents claim that they understand $PM_{2.5}$, more or less the same rate as two years earlier.[1] In another study, 66.3%, 56.9%, 45.5%, 41.4%, and 27.8% of the interviewees heard of "trash classification", "white pollution", "the three wastes (waste air, waste water, and waste solid) in environmental pollution", "greenhouse gases", and "biodiversity", respectively. This reflects that the level of environmental knowledge is quite low, as is the public's skills and abilities in engaging in environmental protection.

China started late and has a poor basis for social environmental organizations. The first environmental social organization, China Society of Environmental Sciences, was established in 1978. To date, the number of environmental social organizations in China is less than 8,000 in total, and the number of persons joining in social environmental organizations was less than 0.06 in 10,000. In addition, most social environmental organizations are small with poor expertise and capacity. According to research conducted in 2013, 22% of the social environmental organizations in China have no full-time staff, 59% have 1 to 9 full-time staff, and only 2.6% have more than 35 full-time staff.[2] Besides the small scale of personnel, environmental social organizations in China suffer from

1 SJTU Center for Public Opinion Research, Research on Environmental Awareness of Chinese Urban Residents in 2015. http: //www.aiweibang. com/yuedu/40875259. html.

2 Deng Guosheng, Zhao Rui, Zhao Ying. Research Report on Status of Social Environmental Organizations in China, NGO Research Institute, School of Public Policy and Management, Tsinghua University, 2013.

inadequate funding. According to a survey, 14.5% of the organizations do not have any revenue, 50% of the organizations have an annual revenue of 500,000 Chinese RMB and above, and only 8.6% of the organizations have a revenue of 10 million Chinese RMB and above. According to a survey conducted by the All-China Environment Federation, only 55.2% of the environmental social organizations have their own offices, 55.2% of the environmental social organizations have a website, and 76.8% of the environmental social organizations have designated email addresses. In terms of international experiences and trends, social enterprises and energy-related cooperatives as distinct from social environmental organizations are also playing an increasingly significant role and making continuous innovations in green transformation. However, social enterprises, energy and organic agriculture cooperatives in China are in an early stage of development. Their social vitality has yet to be awakened.

3.5 Policy recommendations

To achieve the goals of green transformation, China needs to reengineer its national governance system and improve its national governance capacity. In *the Integrated Reform Plan for Promoting Ecological Progress*, China lays out the institutional reforms needed to realize green transformation. Green transformation requires the involvement of the whole society and there is a high degree of consensus of the whole society on the necessity of green transformation, which makes national governance capacity building for green transformation an ideal experimental field for a comprehensive reform on improving overall national governance capacity. National governance capacity is critical in building institutions and making the institutions work. Significant capacity enhancement is required by government, the market, and the civil society in green transformation as follows:

3.5.1 Enhance state capacity to make policies

Overall objective: Enhance state capacity for making policies in a scientific and democratic way by using scientific analysis to inform policy making and enabling stakeholders to participate in the policy making process and in forging consensus.

3.5.1.1 The government should establish a guaranteed legal rights to, and ways for pluralistic participation in the formulation of laws, regulations and policies

Change is required to current arrangements where policies and planning are mainly proposed and even made by administrative agencies. Key decisions which may incur

a significant potential impact on the environment should be jointly made by the higher level comprehensive organization, including inputs from the department of environmental protection, expert advisory and social groups. This is to be done to eliminate department interest-based policy-making and to avoid new conflicts erupting with other policies where departments design and decide their main policy areas and plans by themselves. The rights to, and ways for participation should be institutionalized.

In making laws, regulations and policies for a green transformation, the responsibilities of various committees and the mechanisms governing their establishment and abolition need to be clarified. The Federal Advisory Committee Act of the United States highlights good practice. Opportunities to enable public participation need to be embedded into key legislative instruments and policy development relating to the green transformation and need to be mandatory. Information disclosure is a basic premise for broad participation in the green transformation and should be guaranteed. Opportunities for stakeholder and broader public input need to be broadened by the state and include mechanisms to provide feedback.

3.5.1.2 The State Council should set regulations to promote evidence-based policy making, and enhance the transparency of policy making to improve decision quality

Green transformation is an enormous undertaking. Institution building and policy making for green transformation needs to be evidence-based. The Task Force recommends that the transparency of policy making be enhanced and the procedures for justifying policies be improved. To promote public participation in policy making, there are multiple approaches which can be adopted, including but not limited to: a) openly soliciting policy issues from the public, b) selecting public representatives via internet, c) communicating with the public through emails, d) making public the policy making process through live broadcast, and e) conducting on-the-spot dialogue.

Making transparent how the government makes policies on green transformation and allowing for extensive democratic participation can build a pattern of “open policy making”. The principle of sustainable development should underpin key economic, social and departmental policies as well as policies on technical innovation, and evaluation and adjustment processes. Strengthening cost-effectiveness analyses tied to policy making can prevent excessive gaps between policy goals and outcomes.

3.5.1.3 Train policy makers on how to make evidence-based policies, innovate ways to train and educate individuals to be qualified to support the legislature on green transformation issues

First, a mechanism should be set up to improve training relevant to the green

transformation. Consideration could be given to establishing legislative training agencies jointly run by the National People's Congress (NPC) and academic institutions specialized in legal sciences and which can offer courses on the state of knowledge, potential and methods of green transformation and develop systematic and thorough conventional training programs.

Second, means for recruiting skilled individuals should be improved. It is proposed this include an increase to the number of staff supporting NPC legislative efforts as this is urgently needed for the green transformation of society.

Third, a means for enhancing the sharing of information and exchange among relevant actors should be developed which can stimulate communication between the legislators of the NPC, administrative organs, judicial agencies, law firms, institutions of higher learning and scientific research institutions on experiences related to the country's governance capacity for the green transformation.

Fourth, a high quality talent cultivation system should be established. It is recommended that this include programs for training of legislative talent in institutions of higher learning, the accelerated establishment of high-caliber policy and law and other related disciplines in universities and colleges and permitting qualified institutions of higher learning to award master's and doctoral degrees in policy and legal science.

Fifth, corresponding supporting mechanisms should be established. A series of measures should be provided to help guarantee that NPC representatives and legislators can perform their duties, for instance, by increasing their basic material benefits and improving their working conditions.

3.5.2 Enhance governmental capacity to enforce policies

Overall objective: Enhance the capacity of the executive branch of government to implement policies and the judiciary to adjudicate.

3.5.2.1 Establish the legal foundations for green transformation

First, it is advised that the CPC Central Committee and the State Council formulate a "Guidance for Expediting Green Development" at the state level; make comprehensive plans for low-carbon and circular-economy development; implement a uniform and comprehensive system and policy incentives for green development under the framework of ecological civilization construction; pinpoint the obligations and responsibilities of the government, the enterprises and other parties concerned, underscore the leading role of the government in green transformation and development; and establish comprehensive coordination mechanisms at the state level for green development.

Second, the *Circular Economy Promotion Law* should be amended in accordance with new domestic and international trends in circular-economy development and taking into account the implementation challenges of the present law. Conservation, recycling and the comprehensive utilization of resources should be effectively promoted. It is also recommended to set efficiency and total resource consumption targets, steadily boost the efficiency of resource utilization, build a circular society, explore institutional arrangements to control total resource consumption, step up the formulation of supportive regulations and standards for the circular economy, and develop a comprehensive set of legal and regulatory policies and standards.

Third, a *Law to Tackle Climate Change for Low-Carbon Development* should be drawn up. To achieve the overall objective of peaking carbon emissions by 2030 or earlier if possible, it is strongly advised to formulate an institutional system focusing on total carbon emission control and emission permits, establish and improve systems for climate change mitigation and adaptation; define the responsibilities of all parties for carbon emission reductions and make explicit laws and regulations for the calculation and monitoring of carbon emissions, allocation of carbon emission reduction targets, carbon assets management and carbon emissions trading, the incentive mechanisms for low-carbon development and consumption, as well as public participation and international cooperation.

Fourth, a carbon tax should be considered during the drafting of the *Environmental Protection Tax Law*. It is strongly advised to deepen tax reform, promote a fiscally neutral green taxation structure and expedite the consultation process tied to the drafting of the *Environmental Protection Tax Law.* The principle of "taxation by law" as stipulated by law should be followed and the NPC should legislate on the collection of environmental taxes. This is a good use of legislative resources. Considering the complexity of establishing the carbon market and the shortage of effective market measures for carbon emission reductions, it is recommended that consideration be given to adding a carbon tax under the *Tax Law for Environmental Protection*. The carbon tax could at first apply a low tax rate during its initial startup stage, adopting differential tax rates for different industries and then with time make gradual adjustment according to developments.

Fifth, reinforce implementation and inspection systems, increase the costs of violating the law and practically safeguard the fairness and dignity of the law. It is appropriate to make reasonable use of judicial resources to promote green transformation and green development, and to enhance the position of regulatory authorities and their capacity to enforce laws. This should include making information accessible to the public and making

transparent the implementation of laws while enhancing public participation mechanisms to encourage people to abide by the law rather than relying solely on enforcement efforts. Laws should however be strictly enforced and violators should be brought to justice.

3.5.2.2 Strengthen the coordination between departments responsible for different national policies

First, conduct a systematic evaluation of departmental policies, macroeconomic policies, and environmental protection policies from the perspective of the sustainable development of the state. This should be done to minimize policy inconsistency, enhance policy conformity and give full scope to the functions of policy tools.

Second, create, optimize and develop the current environmental policy system, modify and remedy the shortcomings of present policies, devote positive efforts to researching, developing, formulating and supplementing new policy means for environmental protection, especially the making and issuing of relevant environmental policies focused on consumption and encouraging and guiding green and sustainable consumption by eliminating or lessening the conflicts of current policy measures.

Third, present laws and regulations shall be systematically rationalized and evaluated, the conflicts between different laws and between laws and regulations should be addressed to enhance complementarities. Coordination between laws and regulations should be improved to lower the costs, boost the efficiency, and improve the quality of the legal system. The adaptability of laws should be encouraged.

Fourth, inappropriate articles of law should be amended and the articles of law concerning guiding principles should be further elaborated and supplemented for the purpose of reinforcing the operability and enforceability of laws. Laws or articles of laws relating to sustainable development shall be added or supplemented in an effort to clear the gaps between laws or between laws and regulations and boost the completeness and interconnectivity of the legal system.

3.5.2.3 Implement legislative and administrative reforms to realize a sound horizontal and vertical division between rights and obligations and bring into alignment the rights, responsibilities and abilities of departments

First, establish a comprehensive coordination mechanism for green development and an Interdepartmental Leading Group for Green Transformation and Green Development. Transform the currently fragmented, independent, and closed decision-making system. Attach priorities to constructing and improving the division of labor among departments, trans-departmental coordination, and comprehensive decision making on environment and development.

Second, switch from top-down management to a combined top-down and bottom-up management approach or alternatively integrate an interactive top-down and bottom-up management approach. There are various constraints to the promotion of green transformation resulting from local development and socio-economic and environmental conditions. Local exploratory approaches are of vital significance and need to be popularized through experiences accumulated in local pilot units. It is advised to change the dominant management patterns employed by governmental departments, encourage exchange platforms and cooperation mechanisms for mutual learning, and allow for monitoring by the government, enterprises and the public.

Third, it is strongly recommended that the functions of the government for green transformation be adjusted when the government opens the opportunity window. One department should be assigned the responsibility to make overall plans and policies and having supervisory functions tied to the green transformation. It should focus on linking the energy structure transition, energy conservation and carbon emission reductions, circular-economy development, and other related issues in all social and economic development processes. Meanwhile, an International Development Agency needs to be founded. It is quite important to establish an independent International Development Agency to share the experiences from development and to take on the responsibility of a great power. The agency can unify the aid functions of different governmental departments and develop a plan for foreign aid for development, and improve the implementation of the "Going-out" strategy and the "One Belt and One Road" initiative for green development.

Fourth, reform the present environmental protection management system, rationalize the relationship between the central government and the local authorities and solve inter-district environmental problems. The dispersed functions of water conservation, environmental protection, housing and construction as well as land and resources relating to pollution control should be consolidated in one ministry, which should be in charge of pollution control and environmental regulation. It should have branch offices in local areas and basin regions which will be authorized to supervise and handle regional and basin wide environmental problems which cut across administrative regions. This Leading Ministry with its branch offices would then vertically control the environmental departments that are below the level of provinces, municipalities directly under the central government and autonomous regions. Environmental protection agencies below the county level would be dissolved.

3.5.2.4 The government should add the fulfillment of duties for green transformation to the various appraisal systems for officials

It is strongly recommended to speed up the implementation of the *Methods of Investigating of Responsibility and Accountability of Leaders of CPC and Governments for Eco-environment Damages* to take into account the lifelong responsibilities of party leaders and government executives for eco-environmental damages and to establish a green governance system based on "dual responsibility", namely the responsibilities of both the party leaders and government executives concerned.

First, it is advised that the State Council department in charge of eco-environmental protection and resource management formulate detailed work rules regarding responsibilities for eco-environmental damages in line with the *Methods of Investigating of Responsibility and Accountability of Leaders of CPC and Governments for Eco-environment Damages* and practical experiences of local areas. It is also highly recommended to implement procedures for investigating the responsibilities of related departments, and establish systems to investigate responsibilities for eco-environmental damages in a scientific, fair and transparent way.

Second, based on the principle of equal responsibility of both party leaders and government executives, it is generally advised to connect the implementation of the *Methods of Investigating of Responsibility and Accountability of Leaders of CPC and Governments for Eco-environment Damages*, the newly released *Regulations on Inspection Teams of the Communist Party of China*, the plans for auditing of outgoing leading officials' natural resources/assets accountability, the *Scheme for Environmental Protection and Supervision* and the communication and accountability systems for environmental protection in order to support institutional innovation.

Third, it is advised to select some prominent problems and serious cases arising in eco-civilization construction and environmental protection to pilot investigations for responsibility for eco-environmental damages at different levels, for different targets and of different types, and based on accumulated experiences to further improve the *Methods of Investigating of Responsibility and Accountability of Leaders of CPC and Governments for Eco-environment Damages*.

Fourth, it is advised to establish an eco-environmental damage liability investigation system, which gives full scope to the functions of the judiciary, provides a role for social organizations, and takes into the scope of investigation prominent problems discovered in investigations of related cases, as well as those identified by the public or stipulated in the *Methods of Investigating of Responsibility and Accountability of Leaders of CPC and*

Governments for Eco-environment Damages.

Fifth, it is advised to integrate the essence and regulations of t*he Methods of Investigating of Responsibility and Accountability of Leaders of CPC and Governments for Eco-environment Damages* into the amendments of the *Atmospheric Pollution Prevention Law* and of the *Water Pollution Prevention Law*. Provisions shall be incorporated into specific laws and regulations first, then the amendment of the *Environmental Protection Law* and other laws can be implemented to upgrade the party's policies.

3.5.2.5 Training should be provided to public servants on knowledge relevant to green transformation

Set up courses on green transformation, eco-civilization construction, environmental protection and sustainable development and in the policies of the central government in the party schools and administrative colleges; enhance the interpretative and cognitive abilities and related training of policy implementers at all levels; strengthen professional knowledge training for employees of the environmental courts and cultivate a group of professionally skilled and competent employees to work in legal services; invite environmentalists to participate in judicial adjudication on environmental problems as jurors or expert witnesses; and take the views of experts as evidence to confirm the facts of cases.

3.5.3 Enhance market's capacity to internalize environmental externalities

Overall objective: Enterprises are the key players in green transformation. It is imperative to have incentive-compatible institutions and policies to provide signals to incentivize enterprises to engage in green businesses while gaining profits.

3.5.3.1 Improve the property rights system on natural resources

First, establish a property rights system for environmental assets. Environmental standards shall be established and an ecological red line must be set. The environmental carrying capacity for economic development should be determined and corresponding property rights specified. The purpose of this is to maximize the economic benefits of economic development.

Second, establish nationally an economic system for exercising this environmental carrying capacity ownership on behalf of the whole people; a "National Environmental Asset Operation Corporation" can be considered to contract the environmental carrying capacity as an economic asset. This Corporation could allocate limited environmental carrying capacity for economic activities in such a way as to maximize economic benefits.

Third, establish an environmental asset property rights exchange market in order to

enable the market mechanism to play a decisive role in allocating economic resources and enable the limited resource of environmental carrying capacity to be transferred to the production field where higher benefits can be obtained through the market. These ideas can be tested in local regions or basins.

3.5.3.2 Promote economic utilization of resources through reform of the price mechanism for important resources; use fiscal taxation policies to make explicit the environmental costs of production and consumption; and create a healthy competitive market for environmental protection industries

Price reform of important resources such as coal, oil and gas should be accelerated. Correct price signals are required for the market to effectively allocate resources. Only under the guidance of correct price signals and taking externalities into account will enterprises be motivated to utilize resources more efficiently and energy efficiency management services and other energy-saving environmental protection industries have more chance to develop. This will require first deregulating the prices of important resources and then establishing a pricing system, which is mainly determined by the relation between market supply and demand. Second it will be necessary to regulate and improve the taxing of resources so that they fully reflect resource scarcities. This can be done through determination of tax rates, which internalize environmental externalities, and in this way set a more reasonable price relationship between resources. Third it will be important to establish progressive water prices, electricity prices and gas prices and to promote resource savings.

Implement measures to encourage an increase in resource utilization efficiency. Tax reductions, allowances and other preferential treatments could be made available to any economic activity that recycles resources. The government could enact laws and regulations and relevant polices to define incentives or provide credits to those purchasing and using energy-saving and water saving materials, products, and equipment and facilities which are friendly to the environment. The government may enact laws, regulations and policies to support the development of clean energy, and energy-saving industries, including setting up funds to support R&E of clean technologies, risk investment funds, a platform for the promotion of new energy-saving and environmental protection technologies. The government could establish and improve the eco-environmental damage compensation system, the eco-compensation system and other important systems.

To realize the green transformation, enterprises must be encouraged to improve their productivity and move towards a system of orderly competition. For this, intellectual property protection, protection of the legal rights of various ownership models from

infringement, and the fair treatment of various market participants are needed. Second, anti-monopoly and anti-unfair competition laws and regulations, increased monitoring, investigation and prosecution, the breaking up of various monopolies and strengthening of government regulations on natural monopolies are needed. Third various regulations and practices hindering national market unification must be removed and local protectionism must be broken and national market unification must be accelerated. Fourth the administration must be streamlined at the same time that there is more decentralization. Reform of government functions should be accelerated, and various administrative approval behaviors strictly regulated in order to establish the rights of government while substantially reducing the government's intervention in micro-economic activities. Furthermore, attention should be paid to improving routine supervisory capabilities; strengthening monitoring through strengthening supervisory teams in the fields of environmental protection, consumer protection, and intellectual property right protections; and utilizing information channels to improve supervisory capabilities.

3.5.3.3 An environmental credit system for enterprises should be established which accounts for capital costs and environmental costs in the same system, and at the same time basic information for implementing green financing needs to be provided

Develop a differentiated pricing system for basic resources that would provide environmental credit to market actors who eliminate environmental externalities. For instance, Nantong city has raised the wastewater treatment rate for "Red" and "Black" enterprises. Recently, the Notice on *Improving Differentiated Water Price Policy* was jointly issued by the Pricing Bureau, the Environmental Protection Bureau and Finance Bureau of Nantong. Since 2009, Nantong has implemented a differentiated water price system, i.e. an additional 0.3 RMB/m^3 and 0.5 RMB/m^3 for wastewater treatment fee for "Red" and "Black" enterprises. In July 2014, Nantong government decided to further increase the wastewater water treatment fee for "Red" and "Black" enterprises, that is, the fee for 82 "Red" enterprises was increased from 0.3 RMB/m^3 to 0.6 RMB/m^3, and from 0.5 RMB/m^3 to 1.00 RMB/m^3 for 28 "Black" enterprises. The new standard was put into effect on August 1, 2014. Tariffs collected through this type of water pricing system are collected through water supply entities and submitted to a governmental fiscal account which is to be for designated use. The differentiated price for "red" and "black" enterprises can be lowered to a normal price only if firms can improve their environmental credit up to the standard of "yellow" or better in a following year's evaluation.

3.5.3.4 Incentivize leading companies to transform and green their supply chains

Incentivize leading companies to transform and green their supply chains. Financial

institutions may be encouraged to provide green financial services, giving financing support to the implementation of green supply chains. The government, enterprises and public institutions may jointly make contributions to set up a "Green Supply Chain Development Fund", help create voluntary projects for green supply chains and accelerate the promotion of green supply chains in key sectors. The government may cooperate with WWF and other non-governmental organizations (NGOs), research institutes, and internationally known enterprises in key sectors and industries to conduct training related to laws, knowledge and skills tied to the green transformation and enterprises' governance capacity and develop projects for best practices in green supply chains. The government could consider to support and promote the setting up a "green supply chain promotion center" and provide general services including certification, green supply chain planning and design, operation and management as well as energy performance contracting and platform operations.

3.5.3.5 Incentivize enterprises to carry out green technology application and innovation

The government shall actively utilize multiple means to provide economic incentives for enterprise R&D and green technology applications. For this, a first step is to study approaches to governmental management which may be more adaptable to the innovation requirements of the green-oriented business model to really inspire enterprises drive to innovate. Second is to make full use of government purchasing power. The range and proportion of green products purchased should be steadily enlarged. Ways to standardize government green purchasing should be actively explored and energy management contracting and other energy-saving services should be employed. Third is to regulate financial funds so that they will embody green considerations. Various funds, including a financial incentive fund for energy savings and technical retrofitting and a special fund for closing down outdated production facilities, should be explored and established in order to improve the service efficiency of financial funds. The multi-level financial subsidy system, including investment subsidies, output subsidies, and consumer subsidies, should be perfected. Fourth, standards should be strengthened, popularized and implemented.

3.5.3.6 Government, enterprises, and research institutes should jointly establish a network for sharing green information and technologies

The government, enterprises, research institutes and universities could work together to build a network for sharing green resources and technology. Relevant governmental authorities could take the lead to work with relevant institutes both at home and abroad and industry leaders to set up a public network platform for sharing green resources and

technologies. The platform can create a catalogue of green technologies, green products, green services and green supply chains and push forward the work of improving green standard certification and environmental information data thereby reducing the cost for obtaining appropriate green information, resources and technology. Using the experiences of Australia and Germany in green development as reference, local governments, research institutes and enterprises can be supported to work together to create a green industry alliance and SME network to speed up the sharing and cooperation of appropriate green resources and technology.

3.5.4 Enhance civil society's capacity to participate in green transformation

Overall objective: Build public trust in the green transformation process by ensuring and enabling societal participation as a key driver of green transformation. Improve capacity of public and social organizations to participate in environmental protection.

3.5.4.1 Change the name of the Department of Education and Communications under the Ministry of Environmental Protection to the Department of Education, Communications, and Public Participation

The Task Force suggests changing the name of the Department of Education and Communications under the Ministry of Environmental Protection to the Department of Education, Communications and Public Participation, highlighting its functional responsibility in general planning and encouraging the participation of the public and social organizations. The Department of Education, Communications and Public Participation is advised to set up a Public Participation Office, which may designate special personnel and allocate budget to carry out work related to public and social organizations' participation. Meanwhile, the Education and Communications Center under the Ministry of Environmental Protection may change its name to the Education, Communications and Public Participation Center, highlighting its responsibility to organize the public's and social organizations' participation, so as to improve the execution of policies related to public participation.

3.5.4.2 The coordination between governmental departments and social organizations should be strengthened

Mechanisms for communication and coordination, information sharing and project cooperation between the departments of environmental protection at all levels and social organizations, mass organizations, social undertakings and co-operatives engaging in environmental protection should be established. The level of public and social organization

participation can be improved by enhancing such mechanisms and integrating social resources.

3.5.4.3 Governmental support for environmental social organizations should be enhanced, especially in terms of funding, skilled individuals, and information

Enhance governmental support for social organizations engaging in environmental protection. The main problems faced by Chinese social organizations engaging in environmental protection at present include shortages of funds and qualified personnel, insufficient information and data, difficulties in registration, and insufficient innovation. Therefore, the government may strengthen financial support to social organizations engaging in environmental protection by means of purchasing their services, funding their projects and providing preferential tax policies. The shortage of qualified individuals specialized in environmental protection can be solved by training and encouraging college graduates to be innovative or to start businesses in the field. The ability of social organizations to take part in environmental monitoring can be improved through environmental protection information disclosure. Local environmental protection departments shall be encouraged to serve as the responsible authority for social organizations engaged in environmental protection or such social organizations should be allowed to register directly, with a reduced threshold for registration. Improve the transparency and social trustworthiness of social organizations through government regulation, third-party assessment, self-discipline and media supervision. All in all, greater development space shall be given to the social organizations engaged in environmental protection while making improvements in their supervision and administration.

Actively guide other social organizations and mass organizations to take part in environmental protection. As of 2014, there are more than 600,000 social organizations registered in civil affairs departments in China. The Women's Federation, the Communist Youth League and other networks can be found throughout the country. The government could actively guide such other social organizations and mass organizations which do not have an explicit environmental protection focus to carry out environmental protection activities, and enhance the efforts to train or praise those proactively taking part in the green transformation. Moreover, the government may take foreign experience as a reference and vigorously develop social enterprises and co-operatives in the sector of environmental protection, giving full play to social forces.

3.5.4.4 Encourage the public to take part in monitoring and reporting environmental protection data via modern communication technology

Encourage the public to use modern information technology and reduce the

restrictions for the public to participate in the green transformation. One reason not so many Chinese take part in environmental protection is that there are few channels to do so, making it difficult for them to be engaged. The experiences learnt from public participation in Bottrop, Germany and that learnt from the application of the IPE's pollution map APP in China show that building a platform for public participation and encouraging the public to use mobile internet technology can greatly reduce the restriction for public participation and inspire public engagement in environmental supervision. Such participation can enhance the public's understanding of environmental information, urge them to take proper measures, and help monitor whether the government and enterprises are fulfilling their responsibilities.

So long as the information is made public and the restriction for participation is reduced, Chinese will be enthusiastic about taking part in environmental protection activities. Since the IPE's APP is simple to use and environmental protection is closely bound up with everyone's daily life, the public has become fully mobilized behind environmental supervision. Since its release in 2014, there has been a sharp increase from 50,000 to 3,000,000 users of the pollution map. This shows that once the public is given the power to participate, their initiatives for environmental protection will be enhanced remarkably.

3.5.4.5 Innovative education and communication strategies should be developed to promote green consumption and environmental protection

The government can actively instruct the public to change their behavior patterns, by advocating green living and unleashing the potential of green demand as a stimulus for green industry. There should be innovative improvements made to how environmental protection is publicized. Great efforts have been made in publicity and education for environmental protection in China, and initial results have been achieved. Still, although the public now pays more attention to environmental issues and environmental value, they still lack sufficient knowledge and skills about environmental protection. The government needs to continuously update its approach to publicity and education. In this regard, foreign experiences can be used as reference. Public private partnerships (PPPs) and social impact bonds (also known as "pay-for-success"), can improve the results of publicity and education and practically enhance the public's knowledge and skills about environmental protection.

Motivate environmental protection behaviors of the public. A challenge with public participation for the green transformation is when there is environmental awareness but this does not carry over into environmental protection behaviors. Here too, domestic and

foreign experiences can be taken as a reference. Great efforts should be made to support the development of community-based environmental protection volunteer organizations, green consumption co-operatives and green associations. The power of organizations can be used to cultivate the public to develop voluntary and sustainable environmental protection behavior and make green living and green consumption a habit, culture and societal fashion.

3.5.5 Policies critical to the capacity of government, market and society

Recommendations on policies which are conductive to the enhancement of the governance capacity of the government, market and civil society.

3.5.5.1 Promote information collection, integration, usage, and disclosure

Integrate, optimize, and strengthen existing information collection and monitoring systems related to the economy, environment and energy, and give a rational definition to the rights and mechanisms of information management and usage through legislation. Make information serve scientific research and evidence-based decision-making. Environmental information disclosure should be greatly promoted, including the status of pollution and its impact on human health. To disclose such information may incur mass outcry in the short-term, but in the long run, it helps to eliminate information asymmetry, increase environmental awareness, and reduce the obstacles for green transformation.

The existing environmental monitoring polices and standards are formulated based on geological locations and environmental mediums. However, it is essential to understand the relationships between environment, health risks and environmental standards. The Ministry of Environmental Protection may consider interpreting environmental quality in relation to its health effects, developing activity guides and other approaches that are easy for the public to comprehend.

The disclosure of environmental information can have potentially negative effects on polluters, which makes it difficult for the public to obtain environmental information, or even harder especially when the polluter is very powerful in lobbying at the local level and local governments turn a blind eye to pollution. In accordance with the requirements of Chinese laws concerning disclosure of environmental information, the Ministry of Environmental Protection may consider setting up a Pollutant Release and Transfer Register (PRTR) system to reinforce its capacity to rate the environmental behavior of industries that cause pollution, to use it to enhance enforcement based on the rating results determined via interactive communication technology, and improve the effectiveness of

environmental protection enforcement.

Environmental performance has been included in the assessment system of local government officials. The Ministry of Environmental Protection may consider providing the local government with the capacity to diagnose environmental problems and evaluate local environmental behavior. The Ministry may use such information to develop interactive tools, through which the citizens can supervise the environmental behavior of local governments. This would enhance the accountability system of the government.

3.5.5.2 Enable green innovation in green technology, management, and culture

First, the national innovation system needs to be reoriented and redefined, so as to green the existing dominant technology system, in particular using technology clusters that have extensive driving and penetrating effect and can play a key role in green development once technology breakthroughs are made. Second, financial inputs and policy support for the R&D of green technology should be steadily enhanced. Credit loans, tax policies and allowances can be used to encourage and attract enterprises to invest in R&D and promote green technologies and products, and to strengthen their effort to introduce innovations on green technologies and equipment, and to make technical transformations for energy saving, water saving and material saving. Third, a government procurement system promoting independent innovation in green technology shall be implemented, giving priority to purchasing domestic hi-tech equipment and products with proprietary intellectual property rights. Fourth, social forces shall be mobilized to join government and industry in investing in green technology R&D. Fifth, the reform of scientific and technological systems should be promoted to enhance cooperation between the governments, enterprises, R&D institutes, intermediaries and society. Publicity, education and training shall be enhanced to improve the awareness of governmental departments, enterprises and the public about the green transformation and to lay a good social foundation for the development of green technology. Sixth, the coordination between green policy and innovation policy should be strengthened in order to create a policy environment in favor of green technology innovation and give full play to the incentive effects of green policy on green technology innovation.

Cultural innovation involves developing useful and discarding useless traditional values. An important principle in coordinating the relation between human and nature is changing human's attitudes and behaviors about nature, so as to form an environmentally-friendly production mode and consumption pattern guided by scientific outlooks on development. *Our Common Future* points out that human survival and well-being could depend on whether there is success in elevating sustainable development to a global ethic.

The ethic of sustainable development requires high cultural and moral standards from the people. People must come to understand the long-term impact of their behavior on nature and the survival and development of human society. They must be made aware of their solemn responsibility to society and future generations and be willing to sacrifice some short-term interests for the long-term interests of society. We should eliminate excessive consumption, the showing-off of wealth, the paying of too much attention to material interests and the sacrificing of the environment for profit, and adopt instead a pattern of moderate, green and sustainable consumption, so as to build up an ecological and green civilization.

3.6 Acknowledgements

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Chapter 4
Green Finance Reform and Green Transformation

4.1 The five major challenges facing green financial reform

4.1.1 Greening the financial system: a cornerstone of China's green transformation

Green finance refers to an innovative financial system that supports the construction of an ecological civilization. China is in the process of implementing its strategy to achieve its eco-civilization construction goals. Financial system reform that stimulates green investment patterns is a critical and necessary pillar to supporting China's eco-civilization goals. Green financial reform includes innovations in institutions, policies, financial markets, and technologies to encourage and incentivize private capital to invest into the green industrial chains, resource efficiency, and environmental protection. Green finance stimulates economic growth, supports low carbon development, and promotes green urbanization to deliver a cleaner environment and higher quality of life.

Green finance is the driver of new areas of economic growth and key to achieving China's green transformation. The "New Normal" in China refers to a "great transformation period" as the Chinese economy shifts from its traditional model of resource-intensive growth to a new model. Developing green industry sectors and promoting the transformation of traditional industry will help drive China's transformation, and offers a valuable new source of economic growth during the "13th Five-Year Plan" period. Green finance plays an important role in enabling the upgrade of China's industrial base and moving the country from being a resource-intensive and pollution-intensive economy to one based on technological innovation.

Green finance offers a vehicle for China to incorporate "green" approaches into its international engagement and enhance its international reputation. China's financial system has its own characteristics, and has the opportunity to play a leading role in promoting green financial development and green economic transformation in developing countries

through the "Belt and Road" initiative, the Asia Infrastructure Investment Bank (AIIB), Silk Road Fund, and the G20. Helping other countries pursue a path of green growth will bring positive recognition that will enhance China's international reputation.

4.1.2 China's strategic framework for green financial reform

China's green transformation will help enhance long-term national competitiveness, foster new sources of economic growth, safeguard resource security, and improve environmental quality. This transformation is part of constructing an eco-civilization and building a moderately prosperous society. However, realizing these goals will require substantial new investments that surpass the resources available from public funds, and can only be achieved by leveraging the financial system to attract private investors. The ultimate objective of green financial reform is to "green" the entire financial system to mobilize substantial new flows of private capital away from "brown" investments and into green investments.

Figure 4-1 shows the framework of green financial reform in China as containing four parts: the national development strategy and goals, the green finance supply system, the demand system, and enabling (or "driving") conditions. The four elements constitute a holistic, inter-related system and changes in one part will lead to changes in the other parts.

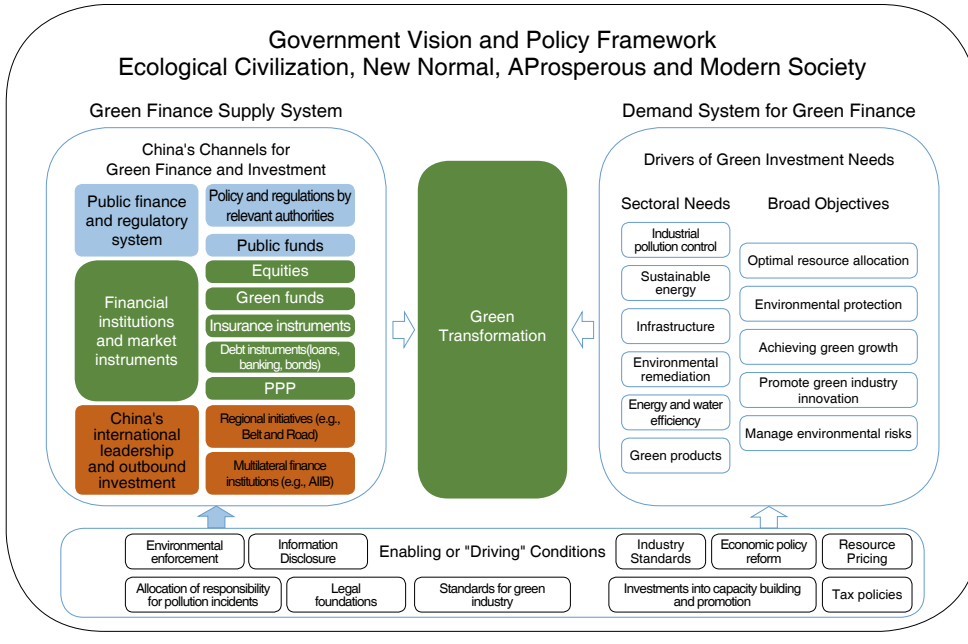

Figure 4-1 Strategic Framework of Green Financial Reform in China

The government's vision for development and environment sets the overall framework, but the enabling (or "driving") conditions at the bottom of the chart are the keys for converting investment "needs" (on the right side of the chart) into actual demand. In designing a greener financial system it is important to remember that this is no substitute for sound environmental policies that will shift investment demand away from environmentally damaging activities and towards sustainable activities. These include the entire set of policies that shift incentives towards environmentally sustainable behavior. The diagram lists a number of enabling conditions, but the key starting points are: a) the establishment and enforcement of standards relating to environmental protection; and b) setting the proper pricing for resources. Without the right market signals, companies and other actors will not be motivated to seek financing to invest into environmental protection, which will increase the burden on public finance. Other factors such as capacity-building, technology standards, and information disclosure play important supporting roles in structuring supply and demand, but have a much more limited impact without strong regulations and enforcement.

The supply system of green finance spans banking, equity markets, bond markets, hybrid approaches through investment funds and PPP, and insurance. There are a range of options available to policy-makers that can help stimulate market actors to better recognize the environmental risks around investments or to help create incentives to support the investment case for green investments. Public funds play a critical role where the investment case remains too weak to attract private actors. However, subsidies must be deployed smartly to ensure that limited public funds can leverage their multiples in private capital. They can also both stimulate investments that will remediate existing pollution, and also stimulate investments that reduce the pollution generation and resource consumption baselines, thereby lowering future investment requirements.

The UNEP *Inquiry into the Design of Sustainable Financial System* has identified five essential elements in aligning the financial system to sustainable investment: a) enhancing market practice; b) harnessing the public balance sheet; c) directing finance through policy; d) transforming culture; and e) upgrading governance. The CCICED Task Force has benefited greatly from the work of the Inquiry in the course of its research. The Task Force's recommendations are consistent with themes and directions identified by the Inquiry, and are grounded in the current context of China.

China's green transformation has evolved from the twin requirements of: a) achieving emissions reductions to help avoid a global climate change crisis; and b) the country's need to reconcile environmental quality and economic growth in the face of China's massive

industrialization and urbanization. While the objective of green financial reform is to green the entire financial system, the interim steps along this pathway must be tied to the stages of the strategy for China's green transformation. A strong alignment will ensure that the Task Force's recommendations remain practical and feasible to implement and are closely linked with China's broader economic development strategy.

4.1.3 Five major challenges in planning China's green financial reform

4.1.3.1 Challenge 1: The scale of Chinese green financing demand is large, and needs further definition in order to determine the right policy choices

The starting point for developing the right policy recommendations is to first understand the nature of China's green investment needs in terms of the targets of the investment and the amount of finance required. Choices in policies will both influence the development of green finance and also shape the nature of future demand for green investment.

This task force has undertaken to fill that gap with detailed estimates of investment needs for 2014—2020 and 2021—2030 by combining analysis of current policies and standards, forecasts of future policies, and information on China's current environmental conditions, which is detailed in section 4.2.

4.1.3.2 Challenge 2: The flow of finance in China does not focus on green investment opportunities, resulting in a substantial shortage of supply of green finance

There is currently an enormous need for green finance in China, and there are large pools of capital within China. In addition, there is a strong interest amongst financial institutions to capitalize in the investment opportunities accompanying China's green transformation. However, due to the imperfect institutional system that supports green finance reform, the huge demand for green financing in China fails to effectively capitalize on the strong willingness of financial institutions on green investment. As a result, the majority of existing finance in China flows to traditional investments, and there is insufficient flow of finance to green investments.

According to the calculations by the task force, investments amounting to 2.7 trillion RMB would have been necessary in 2013 to have halted further environmental degradation, in contrast to the 0.9 trillion RMB that was actually spent from both public and private sources.

There are various reasons to explain such a huge capital gap. First, there has been the lack of effective demand amongst users of environmental finance. Environmental

policies and instruments need to provide sufficient incentive to motivate enterprises and other economic actors to pursue investment. Financial institutions will not pursue green investments if they do not experience client demand or if they are unfamiliar with the specific types of projects.

Second, there are shortcomings in the sharing and transmission of information between the supply side and demand side. Even with the introduction of environmental laws or standards, it will only translate into actual deployment of finance if investors have access to sufficient information to understand the impacts of these changes. Which industries will be affected by the rules? What are the specific characteristics and attributes of the industries and their new investment needs? What are the risks and revenue models underpinning projects?

Recognizing these challenges, the task force has developed proposals for systemic and institutional changes to build bridges between supply and demand systems.

China has a diverse financial system ranging from traditional commercial bank credit and bond finance to listed equity financing, insurance, various PPP arrangements, carbon finance, etc. Even though these different sectors hold substantial capital, given the dominance of the banking sector, the greening of the financial system can most effectively start from the banking sector and then extend to other parts.

4.1.3.3 Challenge 3: Green finance development lacks comprehensive legal foundation

Green finance reform can only be effectively implemented if a comprehensive legal foundation has been established. For instance, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in the United States establishes banks' responsibility for cleanup of polluted sites. The liability of a bank in relation to its borrowers is precisely determined in a manner that is not yet the case in China.

In the 1990's, China began to advance the legal structure for green finance. The Peoples' Bank of China (PBOC) released the *Circular on Issues Concerning Implementing Credit Policy and Enhancing Environmental Protection* in 1995, which required financial institutions at different levels to take environmental protection and pollution prevention as one of the key factors in reviewing loan applications. In 2001, the Chinese Securities Regulatory Commission (CSRC) issued the *Guidelines on Information Disclosure by Public-offering Companies*, requiring issuers to explain risks to investment projects caused by environmental factors, including risks related to changes in environmental policies. In 2001, eight government agencies, including the SETC and the PBOC, jointly released the *Opinions on Accelerating the Development of Environmental Protection Industries*.

The agencies identified the development of environmental protection industries as one of the industrial policies of China, and stated that the PBOC and commercial banks should support industries and products with high technology content, high added value, low energy consumption, and low pollution. In 2007, the State Environmental Protection Administration (SEPA), PBOC, and the Chinese Banking Regulatory Commission (CBRC) jointly released an *Opinion on Implementing Environmental Protection Policies and Regulations to Avoid Credit Risks*. The Opinion emphasized that a clean environmental compliance record should be a precondition for issuing loans to companies.

In February 2012, the CBRC released the *Green Credit Guidelines*, which defined the direction and priorities for green credit in China. The guidelines stipulated that industries which are regulated by the state or bear major environmental or social risks shall implement differential and dynamic credit granting policies to manage risk exposure. In January 2015, CBRC and the National Development and Reform Commission (NDRC) unveiled the *Energy Efficiency Credit Guidelines* to encourage and direct financial institutions in the banking industry to develop energy efficiency-related financial products and services, to effectively manage risks related to this business, to support industrial restructuring and technology upgrading, to promote energy saving and emissions reduction, and to advance green development.

These regulations give impetus to the development of green finance in China. However, despite these numerous efforts, a number of problems still exist today, such as incomplete legislation, ineffective operational structures, etc. For instance, the *Energy Efficiency Credit Guidelines* released by CBRC and NDRC focus on encouraging financial institutions to fulfill their responsibilities on environmental protection, yet they lack clear penalties and a mechanism for targeting violators. The absence of legal foundations is regarded as one of the major barriers to promoting green finance reform. Therefore, the Task Force gives policy recommendations on establishing and improving the legal foundations for green financial reform.

4.1.3.4 Challenge 4: A coordinating mechanism is urgently needed at the central level to guide the development of green finance

At present, one of the barriers to promoting green finance reform is the absence of a coordinating mechanism at the national level. The development of green financial reform requires the collaboration of numerous different departments. The Task Force has outlined a Strategic Framework (Figure 4-1) containing four parts. However, these four parts all pertain to the domain of different government authorities and will best serve the national strategy for green transformation if the parts are developed jointly and

in coordination. For example, the demand for green finance is affected by not only the Ministry of Environmental Protection, but also the Ministry of Agriculture, the Ministry of Water Resources, the Department of Forestry, the Ministry of Industry and Information Technology and the Ministry of Commerce. As China's financial system continues to evolve and diversify, the supply of green finance is driven by the traditional "one bank and three commissions" (PBOC, CBRC, CSRC, and CIRC) as well as other agencies such as the NDRC, the Ministry of Finance, and multilateral financial institutions such as AIIB. Under the present situation, China lacks a coordinating mechanism at the level of the central government, which makes it difficult to guide the four parts of the green financial system to function in a coordinated way. Hence, the task force puts forward the policy recommendations to address this gap.

4.1.3.5 Challenge 5: Green finance reform in China lacks clear strategic route map

Green finance reform is a comprehensive process that will build a green financial and market system in stages. At present, green finance reform in China lacks a clear strategic road map. As a result, green finance reform is handicapped with inadequate coordination and operation. For this reason, the Task Force proposes a strategic road map for green finance reform and priority areas that will enable breakthroughs in the near-term.

4.2 Demand for green finance

The supply and demand of green finance is built on the foundation of a range of policies and enabling conditions such as laws, standards, resource pricing, regulatory enforcement, and others. Government policies play an active role in shaping the market and influencing private investment decisions by individuals, households, small and medium size businesses, large corporations, and other economic actors. Policies that generate higher costs for polluting activities will naturally increase the amount of private investment in greener production and consumption. As private investment increases, there will be less need for government-led interventions to subsidize green investment.

Although the investment requirements for remediating past or existing pollution can be relatively clearly defined, the nature of future demand for green finance and investment will partially depend on government decisions on policy. In addition, some of the most significant drivers of green investment, such as urbanization, climate change, transformation of production systems, and the interaction between infrastructure sectors, have mutual influence upon each other, making long-term predictions challenging.

China currently is facing a choice between two paths for investment. China can continue to follow today's development pattern or China can pursue a "greener" development path, which will bring additional medium to long-term social and economic benefits. Thus, green investments should not be viewed solely in terms of the visible short-term investment costs. If all costs and benefits are considered, the actual cost of "greener" path may be lower over time than continuing the current development pattern. International experience demonstrates that the benefits of more efficient use of capital and the elimination of the need for the investments necessary for resource-intensive development and to clean up pollution can balance the added upfront costs of "greener" development paths. The high costs of air pollution alone suggest large benefits for China from cleaner development pathways.

4.2.1 Research scope and analysis

We have undertaken a quantitative analysis to illuminate current and future demand for green finance.

Drawing upon the published plans and goals of various government agencies, the project team divided demand for green finance into three main categories of investment:

(1) those requiring principally private sector investment;

(2) those likely have both public and private investment; and

(3) those unlikely to be commercially viable.

Estimates were developed for six sectors: sustainable energy; infrastructure (including environmental protection infrastructure); environmental remediation; industrial pollution control; energy and water efficiency; and green products. These six sectors have been divided into 16 sub-sectors (Table 4-1). A number of other important sectors exist but not be included here, such as ecosystem protection, climate adaptation, and green consumption.

We have estimated the financial demand under low, middle, and high scenarios for the period of 2014 to 2020.

(1) The low scenario is based on the green development goals as of 2013, the level of environmental protection as of 2013, and levels of investment at that time. However, this level of investment may not be sufficient to achieve the green development goals;

(2) The middle scenario is based on the investment need to achieve the environmental standards of 2013 combined with the investment needs for the green development goals as updated in 2015;

(3) The high scenario is based on the environmental standards set in 2015 combined

with the green development goals as set in 2015.

Table 4-1 Demand for Green Finance in China (2014—2020)

(Unit = billion RMB)

Source	Category	Sub-category	Low	Medium	High
Private Funds	Sustainable Energy	Renewable and Clean Energy (electricity generation)	3,230	4,580	5,540
		Biomass Energy (non-electricity generation)	190	360	360
	Industrial Pollution Control	Industrial Wastewater	330	670	990
		Industrial Air Pollution	80	490	840
		Industrial Solid Waste	10	720	960
	Environmental Remediation	Industrial Land	3,200	4,200	5,200
Private Funds and Public Funds	Other Infrastructure, including for Environmental Protection	Municipal Water Supply	720	1,530	1,530
		MunicipalWastewater Treatment	170	900	1,440
		Municipal Rail Transportation	3,850	4,550	4,550
		Municipal Solid Waste Treatment	130	360	650
	Energy and Resource Efficiency	Energy Efficiency	800	1,350	1,350
		Water Efficiency	300	1,200	1,200
	Green Products	Green Buildings	530	1,320	1,320
		Electric Vehicle	220	650	650
Public Funds	Environmental Remediation	Agricultural Land	400	600	1,200
		Groundwater	400	800	2,100
Total			14,560	24,280	29,880

4.2.2 Matching demand with supply tools

In addition to our quantitative analysis of financing demands, we also considered the nature of the instruments that could be used to raise and channel investment. The different types of demand for green finance need to be supported by the appropriate policies and tools.

Many of the technologies for sustainable energy are relatively mature and established and demonstrably contribute to reducing air pollution. However, they require substantial upfront investments and a long return period. Therefore, they are best suited to the use of financial instruments and policies such as loans, emissions trading, and green bonds.

Environmental remediation requires very large investments over time, and typically

offers two different types of investment profiles. One type is to provide substantial public benefit or service, such as remediation of farm land and groundwater, where the costs of clean up exceed the financial returns over the life of the project. For this type of project, government funding and PPP is likely to be the most suitable financial instrument. The other type refers to industrial or commercial land that requires remediation. These types of projects typically have significant commercial return potential once the land is returned to a usable state, especially in areas with rapid economic growth or in development zones. The financing needs of this type of commercially viable projects can be met through loans and investment funds.

The financing needs for infrastructure are also quite large and such infrastructure usually provides a public service. The use of PPP can engage the private sector and the use of green bonds can tap capital markets. Private capital is most easily engaged where the use of the infrastructure service can be measured, (e.g. through user fees for services that generate revenue streams). Infrastructure that has lower use or is more difficult to price will rely more heavily on public funds.

Industrial pollution control investments should follow the principle of "polluter pays" and draw upon private investment. Enterprises may choose to draw upon a range of different forms of financing to support their investments into pollution control.

Energy and water resource efficiency rely on technology improvements and may be characterized by significant upfront investments that are recouped over time. Green bonds and loans are well-suited as financing tools for improvements. Investment funds may be well-suited for concentrating both public and private capital to support the development and commercialization of advanced technologies or practices such as in the industrial or agriculture sectors or in buildings. Low-interest credit lines can also overcome barriers to stimulate private investment.

Green buildings and electric vehicles can be supported through green bonds and loans.

As can be seen, no single solution fits every type of demand. Needs and projects will be funded in different ways suited to their particular characteristics. In general, the government should start by using relative price changes (via subsidies or adjusting taxes) to make private investment (via bank credit and green bonds) attractive. This should be possible in sectors such as construction and in energy investments. In remediation, this is more difficult, which is why government funding may be more important in that field.

4.2.3 Long-Term Projections

Targets for environmental protection and green development up to 2020 have been

defined in current national and sectoral plans. However, beyond 2020, the lack of clarity around a number of key variables, including future standards and goals, the level and quantity of investment, and future development plans and policies makes it difficult to provide reliable estimates for 2030. Estimates for the period of 2021—2030 (Table 4-2) carry a substantially higher degree of uncertainty and potential for change than the estimates for 2014—2020.

Table 4-2 Demand for Green Finance in China (2021—2030)

(Unit = billion RMB)

Source	Category	Sub-category	Low	Medium	High
Private Funds	Sustainable Energy	Renewable and Clean Energy (electricity generation)	7,370	9,320	12,820
		Biomass Energy (non-electricity generation)	910	940	2,640
	Industrial Pollution Control	Industrial Wastewater	370	630	1,010
		Industrial Air Pollution	120	110	160
		Industrial Solid Waste	290	780	1,340
	Environmental Remediation	Industrial Land	3,400	15,040	18,800
Private Funds and Public Funds	Other Infrastructure, including for Environmental Protection	Municipal Water Supply	880	1,870	3,970
		MunicipalWastewater Treatment	1,430	1,100	12,860
		Municipal Rail Transportation	730	1,250	7,950
		Municipal Solid Waste Treatment	670	640	650
	Energy and Resource Efficiency	Energy Efficiency	320	410	1,150
		Water Efficiency	1,800	3,100	12,400
Public Funds	Environmental Remediation	Agricultural Land	3,600	5,400	10,800
		Groundwater	4,600	7,200	8,900
Total			26.490	47,790	95,450

4.3 Architecture of a green financial market: institutions, rules and instruments

With the emergence of the “New Normal”, China will benefit significantly by speeding the establishment of a greener finance system. In recent years, China has made substantial efforts to guide the development of Green Credit policy, including establishing

a statistical system for green credit and emphasizing the importance of restricting access to credit for highly polluting and energy-intensive sectors. China has also initiated work in other arenas, including piloting carbon trading, and piloting environmental liability insurance in some localities. However, these efforts are just a first step towards establishing a green financial system. In addition, they face limits to their impact because they are disparate initiatives and not yet integrated into a systematic policy framework that is coordinated with economic development policies.

At present, China's economic structure is undergoing massive transformation and adjustment. This is both a challenge and an opportunity for China's green industries. China can benefit from successful international experiences, and strive to construct a more comprehensive and effective green finance system encapsulating the following five components: a) banking & credit; b) capital markets; c) insurance; d) PPP and environmental protection funds; and e) carbon markets. Given the very urgent need for green finance, such a system should leverage a range of tools to mobilize public finance and private capital and to incentivize investments to shift from "brown" to "green" .

4.3.1 The Banking System

For a considerable period of time into the future, the main source of finance for green investment will continue to be green credit. According to statistics from the China Banking Regulatory Commission (CBRC), green credit accounted for approximately 9% of the total loan balance, and approximately 6% of total bank assets at the end of 2013. Currently, annual total credit growth is approximately 10 trillion RMB per year. If ten percent of this growth (i.e., 1 trillion RMB) were to be green credit, then it would still only satisfy approximately one fourth of the annual green investment needs. The Task Force hopes that the annual growth of green credit could, on average, account for 20% of the annual credit growth over the next Five-Years allowing the volume to reach 2 trillion RMB.

The Task Force recommends that green credit should be promoted during the Thirteenth Five-Year Program period by: a) greening the banking system through the institutionalization of environmental business within existing commercial banks; b) enhancing the role of interest subsidies in leveraging green credit; and c) clarifying the environmental liabilities of banks. These three aspects are elaborated below.

4.3.1.1 Towards establishing a green banking system

Since 2007, the government has been promoting the Green Credit policy to encourage commercial banks to invest in green industries. However, the actual implementation is such that the development of green credit has been impeded in many ways.

Commercial banks face the dual constraints of their business model and their technical capabilities. Within their business model, there exists a mismatch between the short-term nature of the funding sources used by commercial banks and the relatively long duration of green projects. The incentives provided by government policies are limited, and the penalties imposed on investments that cause pollution do not create enough risks to deter banks from lending to such projects.

In terms of "technical capabilities", commercial banks typically lack staff who understand green technologies and are familiar with the business models underlying green projects. As such, banks have difficulty evaluating green projects and managing such loans and customers.

The Task Force recommends several specific steps to green existing banks: a) specialized green credit departments should be set up within banks; b) banks should be ranked based on their green performance to recognize those with a high percentage of green loans and mature environmental risk control procedures and methodologies; and c) banks should be encouraged to establish internal green credit objectives and performance incentives; and d) Banks should also be encouraged to conduct stress tests assessing the potential impacts of environmental standards becoming more stringent or changes to resources prices in the future.

Banks should also be encouraged to conduct quantitative analysis of the environmental costs of projects. The analysis can be used as a basis to explore and establish internal environmental cost methodologies which can be integrated into banks' credit risk pricing systems. This would allow banks to reduce the internal cost of green loans and increase the internal cost of loans by projects with higher environmental risk profiles. A public Project Environmental Cost and Benefit Evaluation System should be established in order to rapidly enhance the capabilities of the entire financial sector (including banks) to identify and evaluate green projects. It is useful to note that the development banks of some countries-such as KFW of Germany-have set up Green Finance Departments which focus on investing in green projects and helping with building the capacity of private banks and enterprises. It is also useful to note that the Industrial Bank in China has set up an Environmental Finance Department in order to enable specialized management of green finance. Since this department was established, the non-performing assets of the bank have been effectively controlled (with an NPL ratio of 0.2% only) and return on capital has been more than 20%.

4.3.1.2 Strengthening interest subsidies for green loans

Subsidizing interest is an effective means of using a relatively small amount of

fiscal funding to leverage private capital at a ratio of more than ten times. In recent years, China has been strengthening support for energy conservation and environmental protection, and has promulgated dozens of policies to increase fiscal expenditure for that purpose. However, most of the support takes the form of direct subsidy, whereas interest subsidies are relatively less common. At the national level, most of the funding from the central government's earmarked budget for environmental protection is used as direct grant, subsidy or award, but not typically for subsidizing loan interest. Some local governments have identified loan interest subsidies as a way of spending earmarked funds for environmental protection, and some local governments have even emphasized that all fiscal support to key pollution mitigation projects should in principle come in the form of loan interest subsidies. However, the number of regions where interest subsidies have actually been adopted is limited, and some local governments have even withdrawn their support for the approach.

Compared with direct subsidy, interest subsidies can enable a modest amount of funding to achieve bigger social benefits, and guide more private capital to invest in environmental protection. At the same time, an interest subsidy mechanism can transfer the responsibility of project identification and selection from the government to more specialized commercial banks and other economic entities, thereby alleviating administrative and supervisory burden on government finance departments.

The German Government entrusts its national development bank-KFW-to provide loan interest subsidies for environmental and energy conservation projects, which has produced good results. In order to ensure the effectiveness of its interest subsidy program, KFW has put in place a series of concrete measures, some of which are listed below. First, the objective of the program is to contribute to the realization of the national strategy for improving environmental quality and promoting energy efficiency. Second, in order to make sure that projects comply with stipulated standards and to reduce project risks, the bank provides expert consulting services for the parties receiving its investment. Third, for energy efficiency projects, interest subsidies can only be obtained after the investment has been made. Fourth, the bank supports bundled products for energy efficiency projects. Fifth, the bank encourages the application of innovative technologies or practices. Sixth, the bank pays close attention to the demonstration impact of public goods with a view to raising the public's environmental awareness.

Based on our analysis, there are several reasons for the lack of use of interest subsidies by special environmental protection funds. First, the finance authorities of the government do not fully recognize the lever effect of interest subsidies in mobilizing private capital.

As a consequence, the amount of fiscal resources allocated for interest subsidization is very limited. Second, financial authorities have limited staff and technical capabilities for evaluating projects. This prevents them from expanding the use of interest subsidies. Third, the application documentation requirements are overly-stringent. For example, for projects that contain pollution treatment facilities, the policy is that interest subsidies apply to loans obtained for purpose of constructing the pollution treatment facilities only, and not to loans obtained for the purpose of constructing the main manufacturing facilities. In practice, it is difficult to distinguish between these two "types" of loans, making it impossible for project owners to present verification documents from banks. Fourth, restrictions on the rate and duration of subsidies are overly stringent. Fifth, subsidies typically apply to the interest payment within a certain duration. The amount of funding involved is usually small, and the application time frame is relatively tight. This increases the relative cost of preparing the required documentation. As a result, only a small proportion of projects have applied for subsidies.

The Task Force proposes the following specific recommendations to establish a highly effective interest subsidy mechanism. First, the use of interest subsidies should be promoted in fiscal spending on energy conservation and environmental protection, and the scale of funding for interest subsidies should be expanded. Second, the subsidization rate should be increased. Currently, the subsidization rate typically cannot be higher than the PBOC's benchmark interest rate or banks' loan interest rate; in some cases, the upper limit is set to be the actual interest rate of the same year, and cannot be higher than 3%. It is recommended that green loans enjoy full interest subsidization based on the actual interest rate. Third, the subsidy duration should be set differently. Currently, the duration of interest subsidization through central fiscal funding is typically no more than three years and even less under some circumstances. This has seriously constrained the use of this instrument. It is recommended that the "three-year maximum duration" requirement be lifted based on the actual characteristics of green loans. Fourth, by drawing on the experience of KFW in Germany, China could pilot the practice of entrusting commercial banks to manage interest subsidies programs for green loans.

4.3.1.3 Environmental liabilities of banks

China's current legislation on environmental protection and financial services falls short of stipulating the environmental legal liabilities of commercial banks. In order to pursue a high return on capital or due to pressure from local governments, some commercial banks have invested in highly polluting industries (such as iron & steel, cement and chemicals), which are contributors to environmental damage. Therefore,

commercial banks should be held partially accountable for environmental degradation, and the law should clearly define the legal liabilities of commercial banks for the environmental consequences of their investments.

In developed countries in North America and Europe, commercial banks may face prosecution if they invest in polluting projects and have caused environmental damage as a result. In recent years, some developing countries, such as South Africa and Brazil, have introduced legislation on the environmental liabilities of commercial banks. Such legal stipulations serve as a strong influence on the lending behaviors of commercial banks and motivate them to incorporate due diligence on the environmental consequences and associated risks of prospective deals.

As commercial entities, banks are geared to pursue profits and control risks. In addition, they should also ideally seek to allocate resources towards the projects that have minimal environmental risks or actually demonstrate outstanding environmental performance. If commercial banks are regulated in such a way that they are obliged to consider the potential environmental impacts of their transactions, it would be possible to guide the flow of financial resources into projects that comply with the principle of sustainable development. If this were to be achieved, commercial banks could become key players in the pursuit of sustainable development.

We have the following specific recommendations regarding clarifying the environmental liabilities of banks. First, *Commercial Banking Law* should be revised to clearly stipulate the legal obligation of commercial banks to evaluate and monitor the environmental impacts of the projects in which they invest. The environmental legal liabilities of a commercial bank should be defined in such terms as liability attribution, form of liability, extent of liability, etc. Environmental law enforcement authorities, NGOs and individuals should be granted the right to sue commercial banks. Second, based on the revised *Commercial Banking Law*, the CBRC, the PBOC and environmental authorities should formulate specific rules to: a) clarify the requirements and specific procedures required for due diligence and risk management by commercial banks on environmental risks; b) define conditions for waiving liability; and c) clarify the upper limit of joint legal liabilities that commercial banks shall bear in circumstances where they fail to undertake due diligence.

4.3.2 Capital markets

Capital markets are comprised of equity markets and debt markets. This section addresses both aspects of the financial system.

4.3.2.1 Green stock markets

(1) Current status of China's green stock market

China's green equity market has developed along three lines to date. First, listed companies are required to disclose information about environmental risks and sustainable development, which helps promote the environmental awareness of these companies and their investors. Second, green securities indices have been launched to offer the market opportunities for investment. Third, some green investment funds have been developed to meet the capital demand from environmental protection and energy conservation industries.

(2) International experience

In 2002, Johannesburg Stock Exchange in South Africa started to require all listed companies to publish sustainability reports. The *King III Code of Corporate Governance* launched in 2009 states that a company's annual financial report should include environmental and social information, which should be reviewed by an independent auditor. In order to promote the long-term competitiveness of the companies within its jurisdiction, the European Union issued *Directive 2013/34/EU* and *Directive 2014/95/EU* requiring that companies above a certain size should disclose environment, social responsibility and governance information in their annual reporting.

Internationally, dozens of sustainability indexes have been launched such as the Dow Jones Sustainability Index, FTSE Good World Social Index, MSCI ESG Index, etc. Among them, Dow Jones Sustainability Index has the longest history and has widespread influence. In addition, there are specialized indexes in clean energy and clean technologies, such as the Wilder Hill Clean Energy Index (ECO), CTIUS, the NASDAQ Clean Edge Green Energy Index, and the S&P Global Clean Energy Index.

(3) Policy recommendations on improving China's green stock market

First, green securities should be incorporated into China's *Securities Law* and *Corporate Law*, and the environmental information disclosure (EID) system for listed companies should be improved. Specifically, the *Securities Law* and the *Corporate Law* should include a requirement for listed companies and bond issuing companies to disclose environmental information to lay a foundation for green securities. Strengthening the EID system will be important for: a) pushing companies to fulfill their social responsibilities; b) protecting the interest of investors in the securities market; and c) preventing environmental risks. The China Securities Regulatory Commission (CSRC) should further strengthen EID requirements and the verification responsibilities of intermediary institutions.

Second, cooperation in the enforcement of EID disclosure requirements should

be strengthened. The securities regulatory bodies, self-regulated organizations, and environmental authorities should strengthen the exchange of environmental information disclosed by companies. Oversight regarding the quality of EID by listed companies or debt issuing companies should be further strengthened, including the materiality, timeliness, reliability, and comparability of EID. Existing supervisory and administrative means and measures should be fully utilized to identify and penalize violations of EID regulations, so as to ensure EID by listed companies and bond issuing companies is sufficiently open and transparent.

Third, green investment should be systematically encouraged, so as to motivate influential institutional investors to introduce environmental criteria into their investment decision making. Increased investor attention to environmental disclosures will motivate investee companies to improve their performance and their information disclosure. Initiatives should also be launched to educate investors on green securities and the use of environmental information.

Fourth, an environmental performance evaluation (EPE) system should be established for listed companies. Research needs to be carried out on an EPE indicator system for listed companies by drawing on international experience. A cross-section of energy-intensive and/or heavily polluting industries could be selected to pilot EPE.

Fifth, a fast track should be established for the IPOs of green enterprises. Stock exchanges should increase their support for the direct financing of green enterprises. The quality and efficiency of verification services for securities offerings should be enhanced, so as to gradually shorten the waiting period for green enterprises.

Two specific recommendations are as follows: First, the IPO verification and filing procedures for green enterprises should be simplified, and restrictions regarding the amount and ratio of fund raising-for the purpose of replenishing liquid capital or repaying bank loans-should be relaxed as appropriate. Specific definitions could be developed for "green enterprises" to determine eligibility for the fast track. Specific policies could be developed by drawing on China's past experience in creating fast track mechanisms. For example, enterprises from the affected regions of the Great Wenchuan Earthquake were provided with a fast track and a similar process was also established for enterprises from western regions such as Tibet and Xinjiang after 2012. Green enterprises should have priority during the IPO verification process, and their IPOs should be distributed in a balanced way between the Shanghai Stock Exchange and the Shenzhen Stock Exchange.

Second, given the ongoing suspension of IPO approval, it is difficult for green enterprises to raise funds in the near term through an IPO on the main board. It is therefore

recommended that the National Equities Exchange and Quotations (NEEQ) adopt measures to encourage green enterprises to seek listings. In the future, if "board transfer" is piloted for enterprises listed on the NEEQ, appropriate preferential policies could be considered for green enterprises.

4.3.2.2 Green bond market

(1) The importance of a green bond market to China

In 2014, bond financing accounted for nearly 20% of total investment. This ratio is expected to reach 30% in the future. However, so far, green investment almost entirely relies on green loans. Assuming that the ratio between bond financing and total investment applies in equal proportion to the green financing market in the future, then the green bond market could grow to provide 20%~30% of China's total green investment. The bond market would then become the second largest channel for green financing. Green bond financing is particularly suitable for medium and long-term green projects with stable cash flow (such as railway, light rail, renewable energy power generation, urban wastewater treatment, and green buildings, etc.), and such projects are expected to account for more than 30% of all green projects. Therefore, a more developed green bond market will significantly boost China's capacity for green investing.

The green bond market has special significance in two ways. First, it will enhance the capacity of banks to provide medium and long-term green financing. A great many energy conservation and environmental protection projects need medium and long-term financing. However, most of the liabilities of China's commercial banks are short-term, which constrains the banks' ability to be proactive and take risks in providing financing for medium and long-term projects. Bonds could become a source of long-term, stable funding for medium and long-term projects. This will effectively solve the problem of the mismatch of the durations between banks' assets and their liabilities.

Second, it will make financing less difficult and less costly for green enterprises. Bond issuance reduces intermediary costs for banks, so the financing cost is lower than the cost of loans. Since it is difficult for green enterprises to obtain long-term loans from banks, they typically have to borrow new loans in order to repay old loans on a continual basis. This increases the risk of capital chain rupture. An enterprise can avoid such risks by directly issuing a long-term green bond. In addition, some enterprises might not qualify as issuing body because their financial position does not meet the requirements of the market. However, they might have certain projects that have sufficient cash flow to seek financing on the bond market in the form of "green project financing bills".

(2) International experience with green bonds

International standards regarding the requirements of a green bond emphasize three aspects. First, there is very strict requirement that money is invested in green projects. Second, the issuing enterprise should have very clear procedures to supervise the flow of funding. Third, the issuing enterprise needs to prepare regular reports for investors on the flow of funding.

Ever since the World Bank put forward its first Green Bond in 2007—2008 and the European Investment Bank put forward the Climate Awareness Bond, the green bond market has been developing rapidly. In 2014, the total green bond issuance exceeded 35 billion dollars, which was more than triple the amounts from 2013. Although the green bond market size is still very small, accounting for only less than 1% of the US bond market, it is predicted by the Climate Bond Initiative (CBI) that green bond issuance will reach 100 billion dollars in 2015.[1] As of June 2014, among the green bonds issued by the World Bank, 25% were for sustainable transportation, 23% for energy efficiency, 19% for renewable energy, 11% for water treatment, and 22% for other sectors.

At the beginning, green bond issuance was mainly dominated by multilateral development banks. Starting from 2014, new forms and new issuers have appeared. Enterprises, provincial-level (state) governments and issuers from emerging markets have begun issuing green bonds. In 2013, the market share of corporate green bonds was very small. However, in 2014, corporate green bonds became a main driver of market growth and accounted for more than 30% of total market issuance. The share of municipal green bonds in the market has increased to 13% following the issuance by Ontario, Canada and eleven states in the US in the second half of 2014. Issuers from emerging markets are also starting to enter into the green bond market. In 2014, the first green bond issuer from emerging markets launched in Johannesburg, South Africa that was followed by the Yes Bank announcing the first issuance of a green bond in India.

Due to a relatively small probability of green bonds becoming non-performing assets, large asset management firms are very active in the market. Large asset managers have become the biggest holders of green bonds issued by the World Bank. In the future, insurance companies are likely to become the biggest holders of green project bonds.

(3) Recommendations on developing a green bond market in China

First, regulators should provide guidance on green bonds to support market development. The PBOC could take the lead in providing guidance on green financial bonds issued by banks for inter-bank investors and green corporate credit bonds issued by

1 Statistics from Securities Information and Financial Market Association (SIFMA) shows that, in 2014, the total amount of bonds issued was 5.8 trillion dollars.

non-bank institutions. On that basis, the CSRC could provide guidance on green bonds for Exchange investors, and the NDRC could subsequently provide a supporting statement and guidance regarding green bonds by SOEs. Such guidance by the regulatory bodies should focus on clarifying the following aspects regarding green bonds: a) basic principles for green bonds; b) review and approval procedures; c) regulatory responsibilities; d) reporting on the use of funds; e) overall disclosure requirements; and f) performance evaluation expectations. The guidance should also provide policies to support green bonds, such as: a) simplifying review and approval procedures; b) allowing adequate flexibility for the use of funds: c) allowing financial innovation; and d) opening the market to international investors.

Second, green bonds should be defined and classified. In order to establish authoritative standards, the work could be guided by the Professional Committee on Green Finance under China Society for Finance and Banking.

Third, the income from the interest of green bonds purchased by enterprises and institutional investors should be fully exempt from corporate income tax.

Fourth, interest subsidies and policies to enhance creditworthiness can be used to support green bonds. Local governments should be encouraged to allocate dedicated budgets to subsidize-partially or fully-the interest of loans borrowed by enterprises for the green projects supported by green bonds. Local governments should also adopt measures to enhance the credit profiles (such as guarantee measures) of green projects supported by green bonds. Such measures have been used successfully in the past to support SME and S&T enterprises.

Fifth, a monitoring and evaluation system should be established. Third-party evaluation institutions with technical capabilities should be cultivated to: a) certify green bonds before their issuance; and b) evaluate the use of funds and the benefits of green bonds after their issuance. The capabilities of bond rating institutions, institutional investors, and analysts from securities firms to analyze and evaluate green bonds should be enhanced.

4.3.3 The Insurance Market

4.3.3.1 Need for and feasibility of compulsory environmental liability insurance (CELI)

In recent years, China has seen a dramatically increasing number of environmental pollution incidents. They not only pose enormous threat to property and public health, but also affect social stability. Moreover, the enterprises that cause such accidents or incidents

may become bankrupt or have to shut down for failing to compensate for the damages that they have caused.

Based on an analysis of nearly 700 environmental pollution accidents in China between 1952 and 2010, we discover the following characteristics: a) the number of accidents has been increasing, albeit with fluctuations. b) Accidents occurred most often in the following industries: chemical materials and chemicals production, road and water transport, metallurgy, mining, and petroleum & natural gas extraction. Among them, the chemical materials and chemicals production industry accounted for 66% of all accidents. c) Accidents occurred most often in economically advanced regions. The five provinces that had the greatest number of accidents were: Jiangsu, Shandong, Guangdong, Hunan and Liaoning. Four out of these five provinces are ranked in the top ten across the nation in terms of GDP.

This suggests a positive correlation between the frequency of environmental pollution accidents in China and the level of economic development. The industries with high frequencies of pollution accidents are important pillars of Chinese economy. In order to achieve the objectives of controlling pollution accidents while still supporting high-risk industries, it is recommended that CELI be introduced. CELI is an effective economic instrument to alleviate environmental risks and help economic entities and high-risk industries avoid causing environmental damage. Its basic function is to provide "relief" to affected parties and the high-risk enterprises. If implemented properly, CELI should help enterprises prevent and manage environmental risks, which will also enable the economy to grow steadily with less risk of disruption due to environmental incidents.

Chinese laws and regulations regarding environmental liabilities are becoming increasingly stringent, and enterprises' awareness of environmental risks is growing. The regions with the highest levels of environmental risks are economically advanced, and the enterprises in these regions have relatively strong financial capacity. These factors provide a solid basis for the implementation of CELI.

4.3.3.2 Problems identified during the piloting of CELI in China

In 2007, the State Environmental Protection Administration (predecessor of MEP) and China Insurance Regulatory Commission (CIRC) jointly issued *Guiding Comments on Environmental Pollution Liability Insurance* to promote the piloting of environmental liability insurance. Twelve provinces (including Hebei) participated in the piloting. The participating enterprises or industries mainly included: a) enterprises involved in the production, sale, storage, transportation and use of hazardous chemicals; b) the petrochemical industry; and c) the hazardous waste disposal industry. However, only a

small number of enterprises participated in the pilot. On 21st January 2013, the MEP and the CIRC launched a new round of piloting by jointly promulgated *Guiding Comments on the Piloting of Compulsory Environmental Liability Insurance*. The types of enterprises included in the piloting were: a) enterprises related to heavy metals; b) enterprises that are required to join due to local regulations; c) enterprises with high environmental risks, such as those in the petroleum and national gas extraction industry, the petro-chemical industry and the chemical engineering industry; d) enterprises engaged in the production, storage, use, sale or transportation of hazardous chemicals; e) enterprises engaged in the generation, collection, storage, transportation, utilization or disposal of hazardous wastes; and f) enterprises emitting dioxin. However, the post-2013 piloting program has also not succeeded in securing strong participation from neither insurance companies nor enterprises. The main reasons are as follows:

First, the existing laws and regulations lack clear statements regarding compensation liabilities for damage caused by environmental pollution. "Polluters pay" is a theoretical principle only. In practice, there is a lack of a legal basis to pursue the civil or criminal liabilities of those who cause environmental pollution accidents. The responsible parties are supposed to be punished by administrative means, but the scope of administrative punishment as authorized by the law is limited.

Second, there is a lack of legal basis for CELI. As mentioned earlier, MEP and CIRC jointly promulgated *Guiding Comments on the Piloting of Compulsory Environmental Liability Insurance* in 2013, but it is only a guidance document and not a legal basis to require enterprises to be insured. *The Environmental Law of the People's Republic of China* (revised in 2014 and taking effect on 1st January 2015) contains an article that says "the state encourages environmental pollution liability insurance"; however, "encourage" is different from "require".

Third, due to a lack of participation by enterprises in the piloting, the insurance companies did not have a sufficient amount of insurance requests. This made it difficult for insurance companies to estimate the probability of accidents. Therefore, insurance companies were concerned that they might misjudge the level of risk transferred from the polluting enterprises to them. Consequently, they are unwilling to provide insurance, and even if they do in some cases, they tightly restrict the scope of insurance.

4.3.3.3 International experience on CELI

A study of the evolution and models of environmental liability insurance in developed countries shows that all countries adopted a step-by-step approach to introducing CELI. These countries exhibited the following two common features in promoting environmental

liability insurance.

First, many countries have shown the tendency to promote CELI in order to alleviate polluters' burden regarding economic compensation, fully protect the legal rights of the victims and safeguard social fairness and justice. For example, the United States requires certain enterprises under specific circumstances to seek insurance and has linked environmental liability insurance with financial guarantees.

Second, the insuring institutions have a tendency to provide joint insurance. Insurance companies actively explore a "joint approach" in which multiple insurers form an "environmental liability insurance consortium" to jointly shoulder risks. In 1990, a joint insurance group consisting of 76 insurance companies was established in Italy. In France, some foreign insurance companies and some domestic insurance companies formed a "pollution reinsurance joint group". In Finland, a number of insurance companies jointly established a consortium called the Environmental Insurance Center.

4.3.3.4 Recommended policies and pathways for implementing CELI

First, legislation could be piloted initially at the sub-provincial level, and then scaled up to the provincial level or even the entire country. A number of sub-provincial-level regions or municipalities could be selected in provinces such as Jiangsu, Shandong, Guangdong, Hunan, and Liaoning where environmental risks are high. Based on the lessons learned, CELI can then be scaled up to the provincial level or even the national level.

Second, lists should be compiled to define who will be required to participate in CELI. The main role of the government should be to implement a thorough investigation regarding the need for and feasibility of such lists. Environmental risks that can be handled by the market itself should not be included in the CELI catalogues.

Third, CELI is a type of policy-directed insurance, therefore fiscal subsidy policies or preferential tax policies should be developed in order to promote the healthy development of CELI.

Fourth, a national-level environmental liability insurance institution or information sharing platform should be established. Currently, the amount of environmental liability insurance provided by a single insurer is very small, making it difficult to model the probability of an environmental accident and the appropriate premium levels. China could consider: a) establishing a specialized national environmental insurance corporation; or b) establishing a national-level joint environmental liability insurance group by drawing on international experience.

4.3.4 Project financing through public-private-partnership (PPP)

4.3.4.1 PPP and project financing

The concept of PPP was first proposed by the Chancellor of Exchequer of Great Britain in 1992 as a solution for upgrading the UK's infrastructure and resolving the shortage of public funding, the lack of effectiveness of public institutions, and the low efficiency of public spending. The Chinese version of "PPP Model" was first put forward in a draft the government budget approved by the 2nd session of the 12th National People's Congress in March 2014. The government and private investors form a cooperative relationship across the "entire process" of delivering public goods or services. The model is based on the granting concessions, sharing benefits, and sharing risks. It aims to enhance the quality of public goods and services as well as the efficiency with which they are delivered. PPP accomplishes these goals by introducing market competition, incentive and constraint mechanisms, and taking advantage of the respective strengths of the government and the private sector.

China's PPP model relies on project finance under which a project obtains non-recourse or limited-recourse funding or loans by using the project's assets, expected income, or equity as collateral. During project financing, the main guarantee of loan repayment is tied to the financial strength of the project itself. It is a highly technical way of financing, and is mainly used for large-scale projects (such as natural gas, coal, petroleum, transportation, electricity and public utilities, etc.) which require enormous amounts of funding, carry high levels of investment risk, have difficulty obtaining finance through traditional methods, and are expected to have stable cash flow once the project is successfully started. The key features of PPP include: a) forming a project company for the project; b) using the expected income from the project to repay debts; and c) the lending banks have limited or no recourse.

The PPP model used by the Chinese Government is a deepening of the practice of promoting the role of private parties in the provision of public services and is based on projects. For example, the PPP Project Pool established by the NDRC covers many areas such as water conservation facilities, transportation facilities, municipal facilities, public services, etc. In all these areas, there is a serious shortfall in public services. All these projects are large-scale, and a Special Purpose Vehicle (SPV) must be set up for each project. The government and private investors jointly fund the SPV so that they manage the project together via this company. However, in some cases, the government does not have to join the SPV.

Regardless of whether the government is a part of the SPV or not, it is a requirement

that a PPP project must have an SPV and that any concessions and fiscal funding will be awarded to the SPV. As a result, PPPs in China must utilize project financing as a funding vehicle. As an entirely new project company, a SPV will not have three years of sufficiently strong financial statements, nor will it have sufficient collateral to secure other types of financing. Moreover, an SPV's own funding may be no more than 30% of the project investment. Therefore, the remaining funding needed by the project must be obtained by using the project's assets, expected future income, and equities as collateral.

There are five reasons why adopting PPP to promote the role of private parties in providing public services at a large scale is suited to China's current needs. First, fiscal resources are limited. Private parties can bring additional capital into public service projects, which will help make up for the shortage of fiscal resources. Some of the public service projects that formerly lacked funding have now been implemented through PPP. Second, risks will be shared by between the government and private parties and a strategic alliance reduces investment risks for each. Third, participation by private parties can enhance project management efficiency and funding utilization rate, shorten project construction duration, and reduce project costs. Fourth, competition among the private parties participating in the project will contribute to the reduction of project costs and improve investment efficiency. Fifth, the government retains a certain level of decision-making power and control over the project, which is conducive to achieving the public service objectives.

However, the shortcomings of project financing through PPP should also be noted: a) The cost of financing is high. b) The duration of financing/investment is long-typically 20—30 years. c) Contract documents are numerous and complex. d) Negotiation is time-consuming, and the front-end cost is high. Given these shortcomings, project financing through PPP is usually suitable for large-scale public service projects. If medium or small-scale public service projects need to adopt this approach, special design may be needed to bundle multiple such projects into a large one.

4.3.4.2 Applying the PPP model to environmental projects

(1) PPP model for individual environmental projects

The PPP model for individual environmental projects came into being as private parties were allowed to undertake infrastructure projects. The earliest projects of this type were urban wastewater treatment plants (WWTP). They were typically large projects requiring investments at the level of hundreds of million RMB or even several billion RMB.

In 2002, the Ministry of Construction (i.e. predecessor of Ministry of Housing and

Urban and Rural Development) promulgated *Comments on Accelerating the Privatization of Municipal Utilities*, which instituted concessions-based operations of municipal utilities. After that, the Ministry of Construction promulgated: a) *Administrative Rules Regarding Concessions-based Operation of Municipal Utilities*; b) *Comments on Promoting the Supervision and Administration of Municipal Utilities*; and c) *Template for Concessions Contracts*, which made specific arrangements regarding concessions and laid a basis for the application of PPP in this field.

Currently, environmental infrastructure projects (such as WWTP and power generation by waste incineration) typically adopt the PPP project financing approach. With increased financial support from both the central government and local governments at various levels, and with the introduction of the PPP project financing approach, urban environmental infrastructure construction has been greatly increased. The number of urban WWTPs increased from 537 in 2002 to 3,340 in 2013, and wastewater treatment rate increased from 40.0% in 2002 to 87.3% in 2013. Garbage treatment rate increased from 54.2% in 2002 to 84.8% in 2013. In large and medium-sized cities, all wastewater and garbage are treated.

(2) PPP model for regional environmental programs

The "PPP model for regional environmental program" is an innovative form of PPP. It takes the treatment of an entire river basin or eco-city as one large program and, on that basis, constructs a PPP agreement. It is different from the "PPP model for single projects" discussed above in that it deals with a package of projects. Within the package, projects are classified as "low-return projects", "medium-return projects," or "high-return projects" based on expected levels of return on investment. The projects are from many industries that are inter-linked or complementary with one another within the project region. Low and medium-return projects can be bundled together with high-return projects, so that the industrial chain is consolidated to reduce investment risks and to increase the overall return of project bundles. One such example is the PPP model for the treatment of the Botanical Garden Section (Nakao River) in the upper reaches of Zhupai River, Nanning Municipality. This program, which has a total investment of 1 billion RMB, contains a number of projects-including water course treatment, water course sewage interception, water course ecology, wastewater treatment, and IT monitoring, etc. In terms of investment, this is a relatively small program for the comprehensive management of a river basin. A similar yet bigger PPP program is the comprehensive treatment of Zhupi River Basin whose planned investment in the first phase alone is 3 billion RMB. Another example is the PPP program for the comprehensive treatment of the water environment of Boyang Lake catchment,

whose total investment is 12.5 billion RMB.

The advantage of using the PPP model for a regional environmental program is that the various projects from different industries can be designed in such a way that they are linked. This creates a compelling driver for all-round innovation in terms of technology collaboration, business models, and building financing platforms, thereby greatly reducing the cost of environmental treatment. However, the investment required for such a program is usually extremely large, and the duration of implementation is very long (typically 20-30 years). Therefore, a program financing platform is essential for raising funds from various channels and to reduce financial costs.

Typically, for such a regional environmental PPP program, a Program Fund should be established. The Fund should have the same characteristics as a generic PPP model: a) it is based on a program and is centered on contracts; b) it attracts investment by way of granting concessions; and c) it integrates the processes of financing, construction and operation. The assets and expected future income of the program serve as the basis for financing the Fund. The Fund regards the environmental protection activities of an entire region or river basin as a large program, which contains various sub-level environmental projects including some medium and low-return ones. Key attributes of the Program include: a) the injection of fiscal funding; b) the granting of concessions and related contracts management; and c) overall design to make sub-level projects form industrial chains. Through these attributes, the overall return of the entire program can be increased to a level that is sufficient to attract private capital and achieve the intended environmental objectives.

Certain special mechanisms could be adopted to increase the attractiveness of a Fund to private capital. For example, insurance companies are risk-averse and typically do not invest directly in projects. However, if the Fund could adopt a Limited Partnership structure, then insurance companies could become Priority Partners. Under such an arrangement, the insurance companies would have priority for capital recovery and benefit distribution, but will receive fewer or even no excess earnings. This will reduce investment risks for insurance companies. An opposite example is private equity funds that are willing to take higher risk for higher return. They can become a separate class of partners who will be entitled to participating in the distribution of the remaining earnings after the Priority Partners have claimed their principal and shares of profits.

In sum, a Fund could be designed to accommodate the varying risk appetites and return expectations of different types of investors. Such mechanisms will help attract financial resources from a diverse set of channels, including banks credit, insurance funds,

private equity funds, bonds and even pension funds. This will not only absorb private capital to the greatest extent possible, but also effectively reduce financing cost.

4.3.4.3 Policy recommendations on promoting PPP for environmental projects

First, there should be a mechanism to make sure that the required government payments and operation subsidies for environmental PPP projects are incorporated into the fiscal budgets of the government. For general environmental PPP projects, the required government payments and operation subsidies should be incorporated into the annual fiscal budgets of the relevant public agencies, and proper arrangements should be made to make sure that they are classified and delivered. For key environmental PPP projects, a longer-term budget guarantee system should be established. Namely, the required government payments and operation subsidies should be incorporated into the mid-term fiscal planning of the jurisdiction in question, so that they will be considered at a higher level. On that basis, a multi-year budget balancing and dynamic adjustment mechanism should be established.

Second, it is recommended that, for "regional environmental PPP programs", the government participate in the SPV as a shareholder by investing. A regional environmental PPP program involves the transfer of management rights from the government to the SPV. The government can only continue to exercise control over these rights if it participates in the SPV. Otherwise, there is a greater risk of the SPV over-emphasizing investment returns at the expense of the PPPs environmental protection and public service objectives. Moreover, regional environmental PPP programs represent an innovative form of the PPP model, and the relevant rules-in terms of financing, construction and operation-need continuous improvement. A regional environmental PPP program is a package of many sub-level projects.

However, the pricing or fee collection mechanisms for the services delivered by some of these projects are not yet fully in effect. As a result, a regional environmental PPP program may not have cash flows that are as clear as those of an ordinary PPP project. If the government invested into the SPV as a shareholder, it will not only increase the SPV's own funding and the program's credit rating, but will also be conducive to the program's obtaining bank loans, issuing bonds, and organizing a Program Fund (as discussed earlier and will be discussed again below).

Third, regional Environmental PPP Program Fund structures should be introduced and supported. Only with the existence of such a Fund structure (serving as a financing platform) can investors be grouped according to their different risk preferences. This will help maximize the use of available funding, optimize portfolios, and reduce financing costs.

Fourth, an innovative green financing system based on Environmental PPP Program Funds could be established.In order to promote the development of project financing, international experience could be drawn upon to establish new types of standards for: a) the assessment of loan and investment risks based on expected earnings from projects; and b) risk assessment and credit evaluation and approval for innovative projects. Moreover, innovation in environmental financial services should be encouraged. Support should be given to revenue pledge financing based on the revenues from pollution discharge rights, fees collection, government purchase agreement, and concessions contracts. In particular, revenue pledge financing should be explored for wastewater treatment projects.

Fifth, pricing and fee collection mechanisms for public environmental services should be improved. Private parties will only be willing to enter into projects related to environmental services if there is a reasonable rate of return. The basis for guaranteeing the return of these projects is to establish effective pricing and fee collection mechanisms for public environmental services. For example, the willingness of private parties to participate in integrated river basin treatment depends on whether there are appropriate pricing and fee collection mechanisms for environmental resources, natural capital, and economic resources.

4.3.5 National green development fund

4.3.5.1 Green investment funds as a source of finance

As part of supporting the implementation of China's ecological civilization goals, the 13th Five-Year Plan highlights the importance of green finance and calls for the establishment of a Green Development Fund. China's green industries face a number of bottlenecks to their development that can be addressed through green finance reform. Green industries will need increase in size and scale as well as undergo consolidation in order to become capable of innovating new technologies and competing internationally. However, interest subsidies and other public subsidies cannot deliver the level of finance needed to support such an upgrading of the sector. Bank loans have been the primary source of green financing in China, but not all companies can access bank financing. Therefore, a fund is needed that can leverage private capital to make equity investments to enable the transformation of green industries.

4.3.5.2 The benefits of establishing a market-oriented green fund

A Green Development Fund should be established on a market-oriented, commercial basis for several reasons. First, an equity-focused fund can fill gaps in the marketplace

that cannot be readily addressed through interest subsidies or other financing instruments. Many companies in green industry sectors lack a deep capital base, which impairs their ability to scale their business and innovate new technologies. This is particularly a problem for early stage companies, SMES, and companies that operate in asset-heavy industries. Weak capitalization also creates a barrier to accessing bank financing since projects and companies can only obtain bank financing once they have reached a certain level of financial stability and capitalization. Government subsidy programs can provide support that enables companies to remain solvent in the marketplace, but they can't provide the capital necessary to grow or enhance competitiveness. As a result, green industries run the risk of becoming a burden on public finances and surviving at the margins of the market through continued subsidies rather than becoming new drivers of economic growth. An equity-oriented development fund could provide capital to enable companies, to make the leap in scale necessary for sustained growth.

Second, a market-oriented green development fund could efficiently pool capital from public and private investors with differing risk appetites. A fund would also have flexibility to launch sectoral or regional funds on a limited partnership basis to optimize the deployment of its capital. This would allow for the use of differentiated return mechanisms that can optimize its ability to attract private capital.

A green development fund could potentially deliver a higher degree of effectiveness than public grants. Green investment projects are highly specialized and technical in nature. Establishing standards that span the full spectrum of green industries to guide reviews of subsidy applications and fairly disburse public funds is complex. The process requires staff with specialized skills in finance and environment, which can be difficult to source and retain in a public sector organization. A commercially-oriented green development fund would apply market discipline and standards to select investments, yet, as a publicly-sponsored entity, it could also take public benefits into account. This balancing of public interest with market discipline can result in increased administrative efficiency and improved decision-making. In addition, a Fund provides a more efficient means of using limited government resources than direct grants due to its ability to leverage private capital. Operating independently of annual budgeting cycles also eliminates uncertainties for investee companies who otherwise might be concerned that unforeseen budget changes might disrupt their investment plans.

4.3.5.3 Recommendations

(1) Parameters for a Green Development Fund

The Task Force recommends the establishment of a National Green Investment Fund

to support the development of green industries. The fund should operate on a commercial basis with professional management applying a market-oriented approach to medium-to-long term investments into large-scale projects. It should primarily make equity investments, but should also be given the flexibility to make debt investments, offer mezzanine financing, and provide guarantees. Investment priorities should include sectors that can support a green and low carbon economy such as: resource efficiency, renewable energy, industrial pollution control, and advanced vehicle technologies. The purpose of the Fund should not be profit maximization, but rather to provide public benefits while still remaining commercially sustainable. In order to maximize its ability to efficiently leverage private capital, the Fund would have the option of establishing sectoral funds or regionally-focused funds that could be structured as joint investments with domestic and foreign partners. At the project level, the Fund could utilize debt instruments (e.g., bank loans, issuance of bonds) to increase the capital available.

The Fund should be designed with strong governance mechanisms to ensure that it maintains efficient operations focused on clear investment goals. The fund should establish performance targets, including both financial and environmental criteria. The Fund management evaluation and compensation criteria should be clearly defined, and regular audits conducted by independent third parties. Annual reporting, would highlight the commercial basis for the Fund, and strengthen the Fund's ability to attract different types of investors.

(2) The scale and capitalization of the fund

In light of the estimates presented in Chapter 4.5, the Task Force recommends to initially set the target for capitalization of the Green Investment Fund to reach 300 billion RMB over time with the option of raising further private capital as needed. The primary sources of the capital for the fund could include: fiscal funds from the central government, development finance, and other interested financial institutions and private investors.

4.3.6 The carbon market

4.3.6.1 Current status of China's carbon market

China has been piloting carbon emission rights trading in seven locations (including Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, and Shenzhen). The pilot phase covers the three years of 2013—2015, during which the seven pilot provinces/municipalities successively kicked off carbon trading. In 2013, China's carbon market became the second largest in the world following the European Union Emissions Trading System.

According to the plans of the NDRC, the period of 2014—2016 is the Preparatory

Phase for establishing a national carbon market. During this phase, the design and construction of the market will be completed, relevant laws and regulations developed, the human resources lined up, work mechanisms further improved, and fundamental capabilities put in place. The years of 2017—2020 will be the phase for launching and continually improving the market. During this phase, the market's development will be monitored, rules will be refined, and the market is expected to develop steadily. The years beyond 2020 will be the Stabilizing and Deepening Phase during which market coverage will be expanded, the types of traded products will be increased, and international links will be explored.

From a long-term perspective, the objective of a national carbon market is to transform China's scattered and experimental regional markets into a single compulsory national market. The integration process will move in stages and will unifying the following aspects: a) registration and filing platform; b) monitoring, reporting and verification (MRV) rules; c) rules relating to the distribution of allowances; d) convention implementation rules; e) qualification requirements; and f) supervision and administration.

4.3.6.2 Existing problems with China's carbon trading

Many shortcomings have been observed in China's current carbon market. In all the pilot markets, liquidity is low, trading volume is small, and traded carbon prices have been trending downward. These shortcomings indicate that a problem exists in linking the allowances generation mechanism to GDP growth objectives. Compared with the alternative approach of having a fixed total amount of emission allowances, the current mechanism requires more intervention by the government. Moreover, there is a lack of penalty mechanisms for exceeding carbon emission limits. Absent a solid legal basis, the penalty measures are not strong enough to substantively change behavior. From a long-term perspective, this needs to be changed.

Given the fact that Chinese Government has set clear post-2020 objectives for Nationally Determined Contributions, the development of China's carbon market should be accelerated. The question of whether China is able to reduce mitigation cost is contingent, partially, on how healthy the carbon market will become. Compared with other ways of mitigation, a healthy and successful carbon market will enable China to realize the climate change mitigation expectations of the international community at a relatively low cost, thereby reducing the chances of constraining China's economic development and could offer a boost.

International experience has shown that a carbon trading market requires the participation of financial institutions and intermediary institutions, which help increase

trading volume. Auction is the most effective way of distributing allowances, and can help improve liquidity. Providing allowances free of charge can reduce political resistance, but should be gradually phased out as a method of distribution. The overall mitigation objective and the amount of allowances should be set at a reasonable level in order to prevent carbon prices from being too low. Regulatory bodies should not intervene in the carbon market excessively, but should allow the market to adjust automatically.

International experience also shows that energy efficiency and renewable energy development objectives can co-exist with and complement a carbon trading program. A carbon market or a carbon pricing mechanism alone is incapable of overcoming all market failures or barriers related to energy conservation and carbon mitigation.

4.3.6.3 Recommendations on the carbon market

(1) A unified carbon market should be established step-by-step

China should develop its carbon trading system incrementally by planning in a unified manner, implementing step-by-step, and scaling up level-by-level. The first step is to develop a voluntary carbon trading market. After the institutional barriers and technical difficulties have been gradually overcome, the market can then be transformed into a mandatory one based on a national cap on total emissions. To establish such a mandatory carbon trading market, the following fundamental measures need to be taken in advance.

First, legal foundations for the national carbon emission rights trading market should be established to enable the transition from the current interim system. The development of *Regulations on the Administration of Carbon Emission Rights Trading* should be accelerated. There should be legal and institutional stipulations regarding such issues as: a) the industries participating in carbon mitigation; b) the compulsory nature of a carbon mitigation target; and c) the tradability of carbon products.

Second, a national cap on carbon emission rights should be set, and plans for distributing allowances should be developed. Initially, carbon allowances could be distributed for free; then, the proportion of allowances that are auctioned should be increased in stages to reach a point where all allowances are distributed by auction.

Third, the monitoring system and penalty mechanism for the national carbon trading market should be improved. Carbon accounting and reporting standards should be developed for key industries and enterprises. The regulatory bodies should develop clear and unified rules regarding carbon monitoring procedures and carbon emissions calculation methodologies. The Carbon Trading Registration and Filing System should be improved. An information disclosure system for carbon emissions should be established so as to boost the motivation of participating parties. Relevant penalty measures must be imposed

on the parties that do not fulfill mitigation obligations.

(2) Financial institutions should be encouraged to provide innovative financial products

First, financial institutions should be encouraged to develop the range of services related to asset management, debts, intermediation services, and direct financing necessary to service the many parties in the carbon market. For this purpose, they may need to make changes to their institutions, facilities, staffing, and mechanisms.

① In terms of credit financing: Enterprises should be allowed to use emission rights reduction as collateral to obtain financing. Measures should be taken to first meet the financing needs of the enterprises that have made a commitment to comply with mitigation targets. Special loans could be provided for mitigation technology retrofitting or projects to upgrade facilities.

② In terms of intermediary business: Financial institutions should be encouraged to provide account convenience, R&D support, and intermediary services for emission rights trading. The development of civil institutions, intermediaries and third-party institutions capable of certifying mitigation technologies should be actively encouraged.

③ In terms of direct financing: Eligible environmental enterprises or projects should be supported to issue debt financing instruments such as corporate bonds, corporate debts, short-term financing bills, mid-term notes, and asset-backed paper. Preferential measures should be taken to encourage private equity funds, venture capital, social donation funds and international aid funds to invest in environmental protection and resource conservation.

Second, with the maturing of the carbon trading market, derivative products such as carbon swaps, carbon futures, carbon options, and carbon assets securitization products can be developed. Such derivative products can not only provide hedges for carbon trading participants, but also are important for promoting the innovation of financial products and the diversification of financial markets.

4.4 Promoting the development of green finance through public finance

4.4.1 Public finance has a key role to play in promoting green finance in China

4.4.1.1 Public financial policies can guide and promote the development of green finance

Public financial policy is an important tool for promoting the development of green

finance, including through the national budget, taxation policy, national debt, and fiscal subsidies. The national budget represents the government's overall plan for financial revenues and expenditures at both the central and local levels. In China, budgets for local government are organized at different levels, including: provinces, cities with sub-districts, cities without sub-districts, and counties. The budget of the central government is comprised of the budgets of the individual ministries and commissions at the central level, the revenue turned over to central government by local governments, and transfers from the central government to local governments through tax rebates and subsidies. The national budget system usually covers the general public budget, the budget of governmental management funds, the budget of state-owned capital management, the social insurance fund budget, etc. The public finance system and associated policies can be used as powerful levers to guide the development of green finance.

The elements of the general public budget related to green finance include expenditures on energy conservation and environment protection, agriculture, forestry and water conservation, financial expenses, and the tax and non-tax revenue related to these areas. In the budget of the governmental management fund, there are five categories related to green finance, including subsidies for supplemental renewable energy power tariff, the ship oil pollution compensation fund, and others. There are four categories related to green finance within the state-owned capital operation budget, including expenditures on agriculture, forestry and water conservation, and expenditures on transportation.

Within funds managed by the central government, there are seven items related to energy saving and environmental protection, including the renewable energy development fund, ship oil pollution compensation fund, the fund for the disposal of waste electronic and electric equipment, and forest restoration fees. With the exception of the fund for renewable energy development, the budget utilization of governmental funds for energy saving and environment protection is fairly low and, in the case of the forest restoration fee, decreasing year-over-year.

The nontax revenues which contain revenues related to green finance are those from administrative and institutional fees, such as supervision fees for securities, futures industry, insurance industry, and banking industry. Currently, China waives supervision fees for: securities investment funds and bonds; industry supervision fees for policy banks, commercial banks, and departments related to agriculture, farmers and rural areas; insurance institution supervision fees; and business supervision fees for agricultural insurance, family planning insurance, medical insurance, and critical illness insurance. As green finance develops in the future, financial institutions should also enjoy exemptions

from fees related to their green credit, securities, and insurance businesses.

Within the tax system, the largest number of clauses related to green taxes are found within the value-added tax, consumption taxes, corporate income tax, resource taxes, vehicle and vessel taxes, and vehicle purchase tax. Corporate income tax has the most significant potential impact on green finance, accounting for about 20 percent of total tax revenues in China. At present, the corporate income tax rate in China is 25 percent. However, institutional investors' interest income does not receive any preferential tax treatment. Therefore, introducing income tax exemptions for green bond investors could make a substantial contribution to the development of the green bond market.

National bonds are issued by the central government to raise money mainly for military expenditure, balancing financial revenue and expenditure, and funding construction projects, which can include promoting the construction of green infrastructure. In recent years, the Chinese government has sought to strengthen its support for energy saving and environment protection and has introduced a range of subsidy and expenditure policies. In total, the government has promoted 13 fiscal subsidy policies, including the central environmental protection special fund, fund for prevention and control of heavy metals pollution, and subsidies for supplemental renewable energy resource power tariffs.

4.4.1.2 The role that financial policy has played in the development of green finance

China has unveiled a number of interest subsidy policies related to green credit. According to the results of performance evaluations, the "central environmental protection fund" and the "heavy pollution prevention and control fund" both have proven effective in delivering results in pollution reduction, improving risk prevention, and providing solutions to critical problems in local areas.

Public investment in energy conservation and environment protection has greatly advanced the development of green finance. The Ministry of Finance set up the "central environmental protection fund" in 2004. Later, the central government successively established other special funds, including the Fund for Major Pollutant Emission Reduction and Prevention and the Heavy Metals Pollution Control Fund. During the 11th Five-Year Plan period, funds dedicated by the Central Government for environmental protection rose to 74.633 billion RMB.

In 2006, the "211 environment protection" program was established within the budget, marking the first time that environmental protection was a specific accounting item in governmental budget expenditures. During the 12th Five-Year Plan period, expenditures on conservation and environmental protection reached 1.29 trillion RMB. The total amount of investment into environmental protection during the 12th Five-Year Plan period amounted

to 3.4 trillion RMB or 1.5% of China's GDP.

Since 2006, the NDRC has released a series of policies on power prices related to desulfurizing, denitrification, and dust reduction. At present, the supplemental desulfurization power tariff is 0.015 RMB/KWH; denitrification power tariff 0.01RMB; and dust reduction power tariff is 0.02RMB. These tariffs have played a significant role in encouraging coal-fired power plants to install pollution control equipment and reduce pollutant emissions.

4.4.2 Challenges in using public finance to catalyze green finance development in China

4.4.2.1 The scale of fiscal support to the environmental sector is limited in relation to the challenges

While total investment into environmental protection reached 3.4 trillion RMB (equivalent to 1.41% of GDP) during the period of the 12th Five-Year Plan, the level of investment was insufficient to meet the overall investment need. In response to the worsening environment, China has launched the National Air Pollution Control Action Plan and the Water Pollution Control Action Plan, and it plans to launch a Soil Pollution Control Action Plan. However, these plans will require substantial amounts of investment with the estimated needs for the Air Action Plan alone expected to reach 1.7 trillion RMB over five years. The investment gap facing China remains quite large. In addition, the results achieved from environmental investments to date are not sufficient in scale given the amount of funds invested. Previous performance evaluations have found shortcomings in the use and management of funds set aside for environmental protection.

Amongst the allocations by the governmental management fund, the utilization within energy conservation and environmental protection funds has room for improvement. With the exception of the renewable energy development fund, the budget utilization rate of national environmental government funds is relatively low. This is partially because strict qualifying and implementation conditions and inflexible mechanisms result in many projects failing to qualify. As a consequence, the funds do not have enough projects to invest into and their budget utilization rate is low.

4.4.2.2 China could support green finance by enhancing its fiscal stimulus policies

Currently, China has not yet extended preferential tax policies to the green finance sector. For example, the tax incentives under the corporate income tax do not include benefits for institutional investors on their interest income from green investments. Once China completes its transition from a business tax to value-added taxation, the government

could consider preferential value-added tax treatment for green finance.

Currently, there are not any tax preferential policies available for non-tax revenue related to green finance. Such non-tax revenue mainly comes from administrative and institutional fees including supervision fees for securities, future industry, insurance industry, and banking industry. In 2015, Ministry of Finance and the National Development Reform Commission (NDRC) have not announced any substantive preferential policies on tax deductions or exemptions for financial institutions offering green bond, credit, or insurance services, nor have they announced reductions or exemptions from regulation or supervision fees.

The mechanism for interest subsidies needs to be improved further. Currently, public finance places limited emphasis on interest subsidies for green loans. The rules and procedures relating to subsidy periods, subsidy standards, and application processes could be improved. Local governments currently make limited use of interest subsidies and financial authorities have no mechanism for delegating the management of interest subsidies for green credit to professional agencies (such as banks or their green credit divisions). Meanwhile, there are not sufficient dedicated funds at the local level to cover interest subsidies for green loans.

4.4.2.3 The role of financial leverage could be improved

Government's national expenditures on environmental protection have remained too low and demonstrated a tendency to focus on near-term urgencies rather than long-term investments. From 2011—2014, 1.3 trillion RMB were invested under the 211 budget allocation with progressively larger sums year-over-year. The 211 budget line includes energy conservation, pollution, and eco-construction investments. During this period, pollution prevention and control accounted for approximately one-third of the expenditures, which is a sum equivalent to less than 1% of all government spending. Earmarked environmental funds are small and disparate, which limits their ability to develop synergies and scale impacts.

Fiscal support for market mechanisms needs to increase. Currently, public funding plays the leading role in green finance in China, but public resources on their own are not enough. It is essential to mobilize private capital and strengthen market-oriented approaches such as the use of PPP and carbon markets. For certain types of projects, such as ecological protection or primary research on low carbon technologies, it is possible allocate public funds. However, for projects with commercial value, the government should use mechanisms that leverage private capital. The government needs to evolve its approach and increasingly seek a large impact through small expenditures.

Special funding for environmental protection within public budgets needs to adjust its approach to be more systematic and performance-based. The methods currently applied do not sufficiently link allocation processes to performance and effectiveness, and therefore do not create the right incentives for guiding the use of funds by regions.

4.4.3 Recommendations for strengthening the role of public finance in green finance development

4.4.3.1 Increasing the scale of funding and diversifying channels

Work should be done to establish a National Environmental Protection Fund and diversify the financing channels to resolve underinvestment in environmental protection. Finance from the central government should be used to mobilize private capital through the use of low-interest or interest-free loans as well as loan guarantees. Low-interest and interest-free credit and financing guarantees should be used to support the contracting of third-parties for pollution control (rather than the original polluter) and the procurement of environmental services. Banks and venture capital firms should also enjoy risk subsidies and revenue compensation for their environmental investment as a means to achieve multi-party participation and increase investment.

Dedicated environmental funds should be further integrated and managed much more closely on the basis of performance. The results of performance monitoring should be incorporated into decisions on fund allocations. For those pollution control projects, environmental special funds could deliver support by substituting rewards for subsidies and investments, requiring construction before providing subsidies, and requiring construction before awarding investment. Steps should be taken to clarify the division of authority between the central government and local governments and establish reasonable levels of environmental investment. Realistic estimations for expenditures in the 211 Special Protection budgets are needed.

The use of governmental management fund for energy conservation and environmental protection shall be expanded. Efforts should be made to relax the requirements of projects to qualify for subsidies and simplify the approval procedures. Further, the use of various governmental funds for environmental protection should be designed to mobilize sufficient private capital to close the funding gap.

4.4.3.2 Expanding fiscal incentives to contribute to green finance

Green finance should enjoy preferential tax treatment. Institutional investors buying green bonds should receive partial exemptions from corporate income tax on their interest income. Policy banks should be encouraged to give more support to environmental

protection and green finance. Once business tax is replaced by Value Added Tax (VAT), institutions involved in green finance should receive preferential tax treatment under the new system.

The government should establish a new company or fund specifically focused on collaborating with private sector financial institutions to provide credit guarantees for green loans and provide credit risk compensation to providers of risk guarantees. Preferential tax measures can be instituted to reduce the operating costs of institutions providing credit guarantees for green finance.

The interest subsidy mechanism for green credit should be further improved. Work should be done to increase the scale of funds available for interest subsidies, raise the subsidy rate, and either extend or abolish the ongoing three-year duration for interest subsidies.Efforts should be made to compile a list of projects that qualify for interest rate subsidies and simplify the approval procedures for the projects. In addition, China should benefit from international practice and authorize commercial banks to manage the interest subsidy system for green loans.

Nontax revenue incentives should be adopted to support green finance. Financial institutions offering green bond services, commercial banks offering green credit products, insurance providers offering green insurance products should all be given preferential treatment or exemption from supervision fees.

4.4.3.3 Strengthening support for public-private partnerships

The approach to operating national special environmental protection funds should be improved. The application of public funds to catalyze the use of PPP or third-party remediation should be encouraged when implementing comprehensive remediation, river remediation, and heavy metals pollution remediation to resolve challenges faced by local governments in securing both financing and suitable technical expertise for projects.

Government should encourage public-private partnerships, including further collaboration between the public and private sector on sewage and garbage disposal as well as other projects. Efforts shall be made to improve the government subsidy and compensation mechanisms for the construction and operation of environmental pollution control facilities. In addition, a risk compensation mechanism for private investment should be established, and performance assessments should be implemented on environmental protection projects involving collaboration between the government and private investors.

4.4.3.4 Implementing a performance monitoring and evaluation system

Implement a reasonable and scientifically sound system for monitoring and evaluating performance. The evaluations can be conducted by qualified third-party organizations.

In addition, strengthen reporting on public finance for green finance, such as the role of public bonds in furthering energy conservation and environmental protection. In addition, public oversight and participation should be strengthened to guarantee efficiency in the use of public funds.

4.5 The role of green finance in China's opening-up strategy

China's leadership of green finance within China also needs to be shown with regard to its investment overseas. This would make a very positive impact on the quality of investment in many countries. This part highlights the importance of deploying international best practices and promoting green growth while pursuing investment opportunities.

4.5.1 The growth of chinese overseas investments and China's leadership role

By the end of 2014, China's outward foreign direct investment (OFDI) stock in non-financial sectors reached 3.97 trillion RMB-23 times what it was in year 2000. The average annual growth rate during this period was about 25%.[1] At the same time, China's foreign aid has been increasing every year.[2] It is predicted that in 2015, China's OFDI will exceed incoming foreign direct investment, which would be a milestone in the country's "Going Global" strategy and make China a net exporter of capital.[3] With the rapid increase in China's overseas investments, environmental and social risks related to Chinese enterprises overseas have also increased.

Currently, China's largest overseas industrial investments are in the mining, and oil and gas industries. In Africa and Oceania, where natural resources are rich, these two industries accounted for 26% and 61% of China's OFDI respectively.[4] These industries, and others such as the construction of large-scale infrastructure, present significant risks to the environment and local people. These types of investments often entail risks associated with, for example, increased soil, water and air pollution, the degradation of natural

1 http://fec.mofcom.gov.cn/article/tjzl/jwtz/201501/1853462_1.html?COLLCC=2716141095&.

2 China's Foreign Aid and Government-Sponsored Investment: Activities, Scale, Content, Destinations, and Implications. http://www.rand.org/pubs/research_reports/RR118.html.

3 http://www.mofcom.gov.cn/article/tongjiziliao/v/201501/20150100880913.shtml.

4 《2014 年度中国对外直接投资统计公报》。

resources, and the resettling of communities.

Over the next 15 years, the global economy will need to invest about $90 trillion in infrastructure assets.[1] The Global Commission on the Economy and Climate has shown that it does not cost more to invest in low carbon, low polluting activities than in traditional high polluting infrastructure, and there are additional economic benefits such as the reduced health impacts of air pollution, less vulnerability to volatile fuel prices, etc.[2]

China has the opportunity to demonstrate how financial institutions can shift overseas lending and investment towards environmentally beneficial sectors. It is spearheading two new financial institutions-the Asian Infrastructure Investment Bank (AIIB) and the New Development Bank (NDB)-as well as the Belt and Road Initiative. China's leadership in green finance can set a new standard for investing.

4.5.2 International experience with environmental and social risk management

Foreign investment can lead to a number of environmental and social risks; however, these risks can be mitigated if properly identified in advance. These lessons can be divided into different types of risk that financiers and relevant other stakeholders have encountered.

In developing environmental and social risk management systems, the financial institutions led by China can benefit from studying international experiences. Numerous public and private actors have embraced systems to reduce the potential negative impacts of their lending and investments. The World Bank Group, Asian Development Bank, African Development Bank, and Inter-American Development Bank, for example, all have environmental and social safeguard policies and performance standards. The importance of this issue is also recognized in other emerging economies as well. For example, the Central Bank of Nigeria has adopted sustainable banking principles requiring risk management due diligence by financial institutions operating in sensitive sectors.[3] The Central Bank of Indonesia has also adopted Green Banking Guidelines. The principles aim to balance economic opportunity with environmental and social costs. In 2011, Brazil's central bank instructed banks to monitor environmental risks as part of

1 Estimates drawn from the *Better Growth, Better Climate* report of the Global Commission on the Economy and Climate (September 2014).

2 Marshal Brown, Yongsung Kim and Mattia Romani (2015) "Green Infrastructure: definition and needs" GGGI-G24. . These figures also include around $100 billion per year of adaptation investments to make infrastructure more climate resilient. They do not take account of the potential to save up to $300 billion capital investment per year from more compact cities, as estimated by the Global Commission.

3 http://www.cenbank.org/out/2012/ccd/circular-nsbp.pdf.

implementation of Basel III's Internal Review for Capital Adequacy. Last year, the central bank added a requirement that all banks establish environmental and social (E&S) risk management systems. In addition, a number of financial institutions from developing countries, including the Development Bank of Latin America (CAF) and the Indian National Bank for Agriculture and Rural Development (Nabard) have implemented their own environmental and social risk management systems.

The International Finance Corporation (IFC)'s Performance Standards on Social and Environmental Sustainability provide one good example of strong safeguards. A number of private financial institutions have committed to following the Equator Principles, which are modeled after IFC's Standards.[1] These consist of a set of policy commitments related to key environmental and social areas of concern, including the resettlement of people, the degradation of environmentally sensitive areas, or the release of pollutants. They also emphasize the importance of stakeholder consultation, particularly with vulnerable groups in the communities affected by the project.

Early interventions provide long-term benefits. Studies have shown repeatedly that engaging proactively with local communities affected by investments, and protecting the ecosystems on which they rely, can reduce long-term costs for investors. In some situations, conflicts between communities and foreign investment have led to protests, violence, and even deaths. These conflicts have not only affected projects operations, but also resulted in significant financial losses and damaged the image of the investor countries. One specific example is the China National Petroleum Corporation, which experienced some of the potential costs of improper environmental management when it paid $400 million to settle a dispute with the Chad government over environmental degradation resulting from its activities.[2]

Early engagement with stakeholders can greatly improve the chances that an investment will be successful in the long-term. There is much evidence that shows that companies that succeeded in gaining community support for an investment documented significant financial savings.[3]

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1 The Equator Principles are voluntary E&S risk management guidelines officially adopted by 80 private and public sector financial institutions in 35 countries. The Equator Principles, based on the IFC Performance Standards, is a risk management framework that provide a minimum due diligence standard to support responsible decision-making. They apply to all industry sectors and a variety of financial products.

2 http://www.bbc.com/news/world-africa-23697269.

3 http://www.wri.org/sites/default/files/pdf/breaking_ground_engaging_communities.pdf.

4.5.3 Policy recommendations for China in the opening-up strategy

To help China smoothly implement its new financial initiatives and its "Going Global" strategy, the Task Force offers the following recommendations:

First, systematically integrate principles of sustainability into collaboration with countries receiving finance from the AIIB, NDB and the Silk Road Fund. China will benefit from actively championing environmental and social protections in its engagement with the countries in which it invests. Embracing opportunities for green investment and managing environmental and social risks in host countries will help China achieve the vision of promoting host countries' sustainable development and regional interconnection.

Second, require financial institutions to establish and implement a standard for environmental and social risk management. To ensure competitiveness, these standards should be consistent with or better than the practices of international financial institutions. One step in this direction would be to strengthen the Green Credit Guidelines and make them mandatory for overseas investments. These standards should: a) Commit financial institutions to only provide finance to operations that can show that they implement certain environmental and social safeguards. b) Ensure effective stakeholder engagement at both the project and institutional level. This requires financial institutions to adopt information disclosure policies, grievance mechanisms and/or other methods for engagement with the public. c) Be accompanied by effective management systems with adequate staffing and appropriate incentive structures to ensure that the standards are effectively upheld.

Third, require financial institutions to set green investment targets and reduce their support for polluting industries. Chinese financial institutions can support green growth by setting country-specific targets and magnifying the contribution of finance to green transformation. Chinese financial institutions should develop green infrastructure investment strategies and reduce investments in fossil-fuel energy projects.

Fourth, establish Ombudsman to handle grievances and requests for information from the public. The ombudsman can be an independent organization or departments in the ministries responsible for supervising overseas investment. This will help with stakeholder engagement and communication, and will allow people from China and host countries to request information and express concerns.

Fifth, integrate ecological civilization principles in cross border trade and investment. Chinese institutions should take into account sustainable development and the welfare of local communities when conducting trade and overseas investment, and help host countries

avoid the old model of "pollute first treat later" which can create an impression that China seeks to export pollution to other countries.

4.5.4 China's leading role as chair of the G20

China will be the host country of the G20 Summit in 2016 and is showing great leadership by establishing a G20 Green Finance Study Group. This can play a critical role in promoting green finance among government, international organizations, financial institutions, and civil society. We suggest that the G20 Green Finance Study Group investigate the following aspects: a) How to build the capacity of banks and other institutional investors to assess green investments; b) The viability of requiring financial institutions to conduct stress tests on their exposure to high-risk sectors and their preference for green industries; c) The possibility of requiring listed companies and bond issuers to disclose environmental information, in order to enable capital markets to more easily allocate resources to green industries; d) The value of major financial markets establishing consistent rules on the definition and classification of green bonds, to facilitate cross-border green investments.

China's upcoming hosting of the G20 presidency offers an opportunity to provide international leadership. As demonstrated through the work of the UNEP Inquiry, green finance has emerged as an area of much interest and experimentation around the world. With its early efforts towards greening its financial system, China has already stepped forward to support the establishment of new sources of financing through, for example, the AIIB and the Silk Road Fund. China has practical experience to share and the opportunity to bring leadership to the global community in this critical area of global financial reform of institutions and incentives. Using the G20 as a platform, China has the opportunity to help springboard green finance from an emerging concept to a common international practice.

4.6 Policy recommendations on promoting green financial reform in China

The policy recommendations of the Task Force on promoting the green financial reform in China are presented in this chapter. These recommendations address various aspects of the legal, institutional, and policy foundations needed to support the greening of the financial system and a sustained flow of resources to green investment needs.

4.6.1 Establish a coordinating mechanism at the national level

The building of a green financial system is a process that requires collaboration across a range of actors. A strategic approach to reform requires consideration of four elements: the overall national development strategy, the scale and composition of green finance investment needs, the supply of green finance, and the environmental policy context that will convert need into demand and encourage new supply. However, these elements are influenced by multiple different departments within government, and driving successful reform will require broad-based collaboration across public agencies involved in finance, environment, economic planning, natural resource management, etc. Therefore, green finance reform requires innovation not only in policies and regulations, but also in institutional arrangements and organizational structures.

The Task Force recommends the establishment of a coordinating function at the level of the central government. The function could be established under the direction of the Central Committee's Leadership Group for Deepening Comprehensive Reforms. In addition, the relevant ministries and authorities should also establish new internal structures for the specific purpose of promoting green finance. The establishment of these new structures will enable more effective division of labor, coordination, and collaboration to achieve practical results.

4.6.2 Implement measures to create a sustained supply of green finance

4.6.2.1 Establishing and improving the legal foundations

The implementation of green financial reform relies on having a solid foundation of laws and regulations that establish rights, obligations, and incentives that drive behavior change. The Task Force specifically recommends the following: a) Develop and implement more stringent and effective environmental laws, regulations, and standards. Environmental laws supported by strict enforcement are the prerequisite for generating real demand for green finance and generating growth opportunities for green industry. The current lack enforcement can allow polluting enterprises to obtain unfair competitive advantages by exporting the cost of their pollution, and can reduce the effectiveness of efforts to create demand for green finance. b) Incorporate environmental liability into financial laws and regulations. Lenders and other investors should bear appropriate liability for the environmental hazards associated with their investments. Clarifying the cost of and responsibility for environmental damage will raise awareness of the risks associated

with financing energy-intensive and/or pollution-intensive industries. As institutions recognize greater risks, they will be motivated to implement due diligence and re-balance their portfolios appropriately. c) Implement mandatory disclosure of environmental information. Investors need standardized environmental information to identify, understand and determine the risks and opportunities of investments or projects. The Task Force recommends that the Securities Law and the Company Law incorporate provisions requiring listed companies and bond issuers to disclose environmental information. These provisions should include an article requiring companies listed in China or other venues approved by the State Council and companies whose bonds are traded publicly to periodically disclose environmental performance information. In addition, companies should be required to immediately report major environmental incidents to the securities regulatory bodies and the stock exchanges as well as make public disclosures to interested parties.

4.6.2.2 Rationalize the pricing and charging mechanisms for green industry

In order attract capital on a sustained basis, green projects must deliver financial returns that meet investors' expectations. Incentives and policy supports such as interest subsidies, tax deductions or exemptions, and guarantees can increase returns and enhance a project's creditworthiness, but the government's financial resources are limited. Rationalizing the pricing and charging rates incorporated into projects represents a more sustainable and effective approach to ensuring that projects generate attractive returns. Many green investment projects involve public goods to some degree and their ability to attract needed private investment revolves heavily around decisions on pricing and charge rates.

With the promotion of PPP by the Chinese government, the very large green projects in many investment fields originally driven by governmental funds, such as watershed management and eco-city governance, have been opened to private investors. Such large green projects often involve investment amounting to tens of billions RMB, and contain numerous components in industry, agriculture, urban development, and other fields. Reasonable pricing and charging mechanisms are a must for China to attract and sustain a flow of private capital for green projects favorable to natural resources and environment.

4.6.2.3 Fiscal and tax policies can be enhanced to support green finance

The Task Force has six recommendations on enhancing fiscal and tax policies aimed at effective use of government funds. Given the limited nature of public resources, the cost-effectiveness of specific measures must be central. Funds must be allocated in a manner that generates the maximum leverage for green finance. a) Improve the interest subsidy

mechanism for green credit, and establish incentives for green finance related to non-tax revenue. b) Establish a guarantee system supported by public financing. c) Enhance the efficiency of the use of funds dedicated to environmental protection through two steps. First, consolidate overall demand for environmental protection funds. Second, integrate and standardize special funds for environmental protection, and establish dedicated environmental protection funds within the central government budget. d) Increase the use of governmental funds for energy conservation and environmental protection. e) Enhance the use of tax incentives by implementing additional preferential tax policies for green financial products such as green bonds.

4.6.2.4 Build a bridge between supply and demand for green finance

Environmental laws, regulations and standards create both risks and business opportunities for financial institutions. Which industries will be affected by these environmental laws, regulations and standards and what will be the impacts on specific industry sectors? To which environmental risks and opportunities will financial institutions be directly exposed? What risk management systems and risk management tools need to be developed to deal with these risks? Where will these changes drive new investment and create demand for finance? Most financial institutions have limited internal expertise on the environment and therefore often lack answers to these questions.

China must build bridges to strengthen the engagement between the environmental sector and the financial industry. The financial sector needs to better understand the financing characteristics, risk profiles, and business models underpinning green projects in order to find the business opportunities in China's green transformation. The development of international green finance has followed a process of integration between the finance industry and the environmental sector. For example, the United Nations Environment Program-Finance Initiative (UNEP-FI) has created a team of both environmental and financial experts; the World Bank employs a large number of environmental experts to work alongside its investment officers to develop tools and standards to guide its investments, including the International Finance Corporation's Performance Standards; the world's leading banks, such as Citibank, Deutsche Bank, and Standard Chartered, have established environmental risk and environmental markets departments to support their business units; the US Environmental Protection Agency supports a network of external Environmental Finance Centers that provide advice related to financing environmental projects.

Given the need to establish bridges between the professional realms of environment and finance, the Task Force recommends:

First, Environmental protection authorities can improve the dissemination of information to the financial sector by establishing specialized teams and resources. The initiatives, laws, regulations, policies, and standards of environmental protection authorities, such as the recently promulgated Air Pollution Prevention and Control Action Plan, the Water Pollution Prevention and Control Action Plan, as well as the Soil Pollution Prevention and Control Action Plan to be promulgated, play an important role in converting potential investments needs into actual market demand for green finance. Environmental protection authorities must disseminate environmental information to financial regulatory authorities and financial institutions, so as to allow financial regulatory authorities to develop appropriate policies and measures to guide financial institutions towards green investment.

From international experience, environmental protection departments can play a role primarily in the following four areas. First, they promote environmental information disclosure jointly with financial regulatory authorities. For example, the United States Environmental Protection Agency (USEPA) and UK Department for Environment, Food & Rural Affairs (DEFRA) issued regulations requiring companies to submit greenhouse gas emission reports in 2009 and 2013, respectively. Second, they establish various environmental protection funds to support the implementation of environmental protection actions. For example, USEPA and Department of the Environment in Australia have established various funds, such as water pollution prevention and control funds and soil restoration funds. Third, they support external research on innovative green financing. For example, the USEPA as well as DEFRA have supported research on green finance. Finally, they provide green programs and projects with technical support and training on green finance. For example, USEPA has established the Environmental Finance Center Grant Program to fund nine universities to play the above role.

Second, the "One Bank and Three Commissions" can establish green finance guidance and implementation institutions. The "One Bank and Three Commissions" can play an important role in using environmental information to create policies that catalyze innovation in green financial service.

The Task Force recommends that the One Bank and Three Commissions set up green finance guidance and implementation institutions to undertake the following functions: a) enhance coordination between financial policies and environmental policies; b) research green financial policies, tools, and products by drawing upon information on green investment needs provided by environmental protection departments; c) cooperate with other government agencies with green financial demands to launch and popularize pilot

projects involving new policies, guidelines, tools, or products; and d) guide financial institutions in implementing green investment activities.

Third, China can support well-known research institutions to build technical support teams for green finance. To better connect green financial supply and demand, China could benefit from a team of professionals with rich knowledge in both finance and environment. These professionals could help environmental protection departments and financial departments convert environmental information into useful financial insights and develop green financial policies and tools in response to green financing demand. China is recommended to support its academic institutions to lead the building of technical support teams for green finance and can review the previously cited international examples.

4.6.2.5 Build the infrastructure for green financial development

Greening the financial system requires developing the tools, service infrastructure, and internal capacities to enable financial institutions to assess environmental risk and innovate their offerings. This includes developing the technical resources to support financial institutions such as environmental risk assessment criteria and procedures, databases to support green finance decision-making, green rating systems, and investment networks. In addition, the professionals working within the finance sector need access to training and capacity building resources in order for them to participate in developing the market.

4.6.3 Seven breakthrough priorities during the 13th Five-Year plan

The Task Force has identified seven priority fields for breakthroughs based on our analysis of financing needs and the Overall Plan for the Reform of Eco-Civilization System issued by the State Council on 21 September 2015. The Task Force recommendations include some fields already proposed within the Overall Plan for the Reform of Eco-Civilization System (such as green credit, green bonds, green securities and green insurance), but also proposes some additional fields. The Task Force recommends:

4.6.3.1 To launch a National Green Development Fund

The importance of green finance has been formally recognized within the 13th Five-Year Plan coupled with a recommendation to establish a National Green Development Fund. Green industries will need increase in size and scale as well as undergo consolidation to become capable of innovating new technologies and improve their international competitiveness. However, public subsidies on their own cannot deliver the level of finance needed to support such an upgrading of the sector. Further, bank loans have been the primary source of green financing in China, but not all companies can access bank financing. A national fund could provide a valuable link in the financial system by

providing equity that can be leveraged to enable access to other financing channels such as bank loans and provide support investments into industry upgrading.

The Task Force recommends establishing a National Green Development Fund with a focus on medium-to-long term equity financing for large-scale projects. The Fund could be established with a goal of reaching 300 billion RMB over time using a combination of various public funds, development funds, and investments from other major financial institutions and companies. Operating with a market orientation under professional management, the purpose of the Fund should not be profit maximization, but rather to operate on a commercially sustainable basis while also delivering public benefits. The Fund also could have the option of developing specialized sector funds as well as funds targeted at specific regions such the strategic economic development zones identified by the government (e.g., Jing-Jin-Ji/Tianjin-Beijing-Hebei area).

4.6.3.2 To develop green bonds

China will see significant development of its direct financing market, especially the bond market, in the next 15 years. The main funds supplied in the bond market are stable, mid-long-term funds and available at a reasonable financing cost. The Task Force recommends: a) to issue guidelines for green bonds by the regulatory authorities; b) to define and classify green bonds; c) to consider provide tax exemptions for the interest from green bonds; d) to support the development of green bonds with modest interest subsidies and credit enhancement policies; e) to build an environmental performance tracking and evaluation system for green bonds.

4.6.3.3 To build the central and local green banking systems

China's financial system is dominated by loan financing, and thus the banking industry plays a decisive role in China's financial system. The main source of green investment funds will remain loans for quite a long period to come. The Task Force offers the following recommendations. a) establish specialized green credit and banking functions within existing banks; b) increase the interest subsidy for green loans, and improve the interest subsidy mechanism; c) increase the environmental legal liabilities of banks; and d) embark on a major program within commercial backs to build capacity to assess environmental risks and opportunities.

4.6.3.4 To implement compulsory environmental liability insurance

The frequency of environmental accidents in recent years, especially the recent Tianjin blast, demonstrate the importance of introducing compulsory environmental liability insurance. The Task Force recommends: a) to develop the regulations for trial implementation at the local level (prefecture-level cities) first and then expand to the

provincial and national level; b) to develop the list of entities subject to mandatory environmental liability insurance; c) to explore financial subsidy and preferential tax policies to support mandatory environmental liability insurance; and d) to set up a unified national organization to underwrite environmental pollution liability insurance or to set up an information sharing platform.

4.6.3.5 To develop green PPP Project financing

It has become increasingly difficult for the government to continue shouldering the responsibility for supplying many environmental public goods in the face of environmental pressures. Thus there is an urgent need to increase the participation of private funds into the supply of such public goods. The active participation of public finance can help the PPP model resolve the barriers to attracting private investors created by the comparatively low return and credit profile of investments in the field of environmental services. A PPP project financing platform can facilitate diversified financing for large-scale green projects from multiple sources, such as fiscal funds, loans, bonds, and private equity funds, and reduces financing costs.

The Task Force recommends: a) to include government payments and operating subsidies involved in environmental protection PPP project financing in the fiscal budget, so as to form a budget guarantee mechanism; b) that the government considers engaging in the operations of SPV companies through equity investment when financing regional environmental protection PPPs; c) to promote and support the operations of regional environmental protection PPP project funds; d) to build a green financial innovation system with the support of PPP environmental protection funds; e) to establish and improve the structure of tax incentive policies for PPP; f) to improve the pricing and charging mechanisms for public services in the environmental protection field.

4.6.3.6 To establish a green channel in the IPO process

The environmental protection industry is an asset-heavy industry to some extent, and technical innovation is more likely to be successful in large-scale enterprises. Both the National Development and Reform Commission and Ministry of Environmental Protection have introduced policies to encourage the establishment and development of large-scale environmental protection enterprises. For example, the Ministry of Environmental Protection has introduced 12th Five-Year Plan for Environmental Service Industry. The plan calls for consolidation of the environmental protection industry and fostering the emergence large environmental protection enterprises. The Ministry of Finance, the National Development and Reform Commission, the Ministry of Industry and Information Technology, and the Ministry of Environmental Protection jointly issued the

Implementation Plan for the System of Environmental Protection Leaders in 2015, calling for the active cultivation of large-scale environmental protection enterprises. Securing financing through public listing on stock market is a step in the path to grow into large-scale enterprises.

The Task Force recommends to simplify the IPO review or filing procedures for companies that meet the definition of green enterprises. Restrictions on the amount and proportion of the raised funds eligible for use as working funds of green enterprises or for repaying bank loans should be eased. Policy makers may refer to the special policies for enterprises planning to be listed within the affected region after Wenchuan Earthquake and within the Western Region, including Xinjiang and Tibet, after 2012. Similarly, priority should be given to green enterprises in the IPO review process, and allow them to list on the Shanghai Stock Exchange or the Shenzhen Stock Exchange.

IPOs have temporarily been suspended, so it is not possible for green enterprises to be listed on the main board in the near term. Therefore, it is suggested that National Equities Exchange and Quotations undertakes measures to encourage green enterprises to be listed on its platform for equity transfer. Policy makers may also develop preferential policies for green enterprises if they decide to participate in pilot projects for qualified enterprises to transfer to another board.

4.6.3.7 To establish a carbon trading system and promote carbon finance

The Chinese Government has recently announced its plan to create a national cap-and trade system by 2017. By so doing China can demonstrate how to reduce emissions at lowest costs. China's bold decision will influence many other countries. To be successful it will necessary to encourage financial institutions to develop innovative carbon financial products: a) to allow financial institutions to accept carbon emission permits and emission reductions as collaterals, so as to raise the credit line granted to environmental protection enterprises; b) to allow financial institutions to start loan business for technical transformation projects and equipment upgrading projects in the field of energy conservation and emission reduction; c) to encourage financial institutions to provide convenient accounts, R&D support and intermediary services for green enterprises involved in carbon emission trading; d) to actively promote the development of non-government institutions, intermediary institutions, and third party institutions qualified for emission reduction technology certification; e) with regard to direct financing, to support qualified environmental protection enterprises or projects to issue enterprise bonds, corporate bonds, short-term financing bills, medium-term notes, asset-backed notes and other debt financing instruments.

4.6.4 Greening China's overseas investment

As noted in Chapter 5, China's growing role in international investment offers a remarkable opportunity to influence the sustainability of investment internationally. The Task Force therefore recommends:

4.6.4.1 To include green finance in the agenda of 2016 Summit of the G20

China will be hosting the G20 Summit in 2016 and is showing great leadership by establishing a G20 Green Finance Study Group. The Task Force suggests that G20 Green Finance Study Group investigate the following aspects: a) how to build the capacity of banks and other institutional investors to assess green investments; b) the viability of requiring financial institutions to conduct stress tests on their exposure to high-risk sectors and their preference for green industries; c) the possibility of requiring listed companies and bond issuers to disclose environmental information in order to enable capital markets to more easily allocate resources to green industries; d) the value of major financial markets establishing consistent rules on the definition and classification of green bonds, to facilitate cross-border green investments.

4.6.4.2 To adhere to the principles of green finance in China's overseas investment

a) integrate principles of sustainability into collaboration with countries receiving finance from the AIIB, NDB and the Silk Road Fund; b) require financial institutions to establish and implement a standard for environmental and social risk management; c) require financial institutions to set green investment targets and reduce their support for polluting industries; d) establish Ombudsman to handle grievances and requests for information from the public; e) Integrate ecological civilization principles in cross border trade and investment.

4.6.5 Strategic roadmap for green financial reform

Establish and implement a road map for green finance reform.

Chinese scholars generally estimate that China will require 15 years to complete its green transformation and evolve into a middle income country. The Task Force recommends to develop a road map for the coming 15 years based on three phases: the launch of green finance reform from 2016—2020; the deepening of green finance reform from 2021—2025; and completion of the greening of China's financial system from 2026—2030.

(1) Phase 1: the launch of green finance reform (2016—2020)

Establishing a strong foundation for green foundation is critical to enabling China to

deal with its needs for pollution control and developing a low carbon energy infrastructure. The priorities in the launch phase will involve four areas. First, China must further enhance its mechanism for pricing natural and environmental resources. Second, the report outlines six breakthrough areas related to banks, bonds, funds, insurance, and other areas which should be the focus of revising policies and developing tools. Reforms in these areas can not only help address pollution control needs, but will also serve as investments into improving China's resource efficiency to lower the complexities and costs of pollution control in future phases of development. Third, China should initiate pilot programs for green finance with the Strategic Economic Development Zones identified by the government, such as Beijing Tianjin Cooperative Development Plan, Yangtze River Economic Area,the Belt and Road regions, free trade zones, etc. These pilot programs should support the participation of international organizations and generally work to promote the concept of green finance. Fourth, it is important to lay the legal foundations for green finance, including implementing suitable environmental policies and standards.

(2) Phase 2: deepening green finance reform (2021—2025)

Over the course of the first phase, China will make significant progress in remediating environmental pollution and establishing the foundation for low carbon development and broad-based deployment of cleaner production technologies. The second phase will build directly on these achievements through further reforms and expansion of efforts from Phase One. Pricing reforms will pave the way for introducing markets and associated financial mechanisms for ecological services. Successful regional piloting programs can be expanded to cover a wider region. Environmental pollution remediation will have achieved key milestones freeing further financing resources to speed the pace of low carbon development. The introduction of further policy innovations, financing platforms, and market tools will further accelerate the development of cleaner production projects and technologies.

(3) Phase 3: completion of green finance reform

The final phase will see the completion of the embedding of green finance throughout the financial system. This will include develop a culture and set of values within the financial system that emphasizes the establishment of an ecological civilization. China will remain engaged in a leading role in the international green finance community supporting its promotion and development.

Chapter 5
Task Force on the Rule of Law and Ecological Civilization

5.1 Improving environmental legislation to promote ecological progress

5.1.1 Existing laws and their major problems

In the 30 years since the reform and opening up, China has revised and promulgated many basic laws, including the Constitution, the General Principles of the Civil Law, the Real Rights Law, the Tort Liability Law, and the Criminal Law. These have created legal norms relating to use of resources and environmental protection.

The Tort Liability Law provides for tort liability for environmental pollution and damage. The Criminal Law has a myriad of fundamental provisions so as to guarantee natural resources ownership, protection of the ecological environment and reasonable use of resources.

Three laws providing for the transition of industries, green energy and spatial planning have been enacted, namely, the Law on Promoting Clean Production, the Law on Promoting Circular Economy, and the Urban and Rural Planning Law. They provide a legal foundation for speeding up economic growth transition and proper land planning.

Ten laws regarding resources utilization and management have also been enacted, including the Land Management Law, the Mineral Resources Law, the Law on the Administration of the Use of Sea Areas, the Coal Industry Law, the Energy Conservation Law, the Renewable Energy Law, the Forest Law, the Water Law, the Grassland Law and the Fisheries Law, Environmental Protection Law, the Marine Environment Protection Law, the Law on the Prevention and Control of Water Pollution, the Law on the Prevention and Control of Air Pollution, the Law on the Prevention and Control of Environmental Pollution by Solid Waste, the Law on the Prevention and Control of Environmental noise Pollution, the Law on the Prevention and Control of Radioactive Pollution, the Environmental Impact Assessment Law, the Law on the Protection of Wildlife, the Water

and Soil Conservation Law, the Law on the Prevention and Control of Desertification, and the Island Protection Law.

These laws form a comparatively complete legal system for environmental protection in China with multi-layered laws, regulations and specifications (national laws, administrative regulations and local regulations).

However, the current system has some problems that need to be rectified to promote ecological civilization progress. There are three in particular.

5.1.1.1 "Gaps" in environmental legislation

There are gaps in some key areas and weaknesses in the design of some legislation. Emphasis is placed on administrative regulatory measures such as planning, assessment and approval while neglecting market-based mechanisms, public involvement, monitoring and supervision of the approval process, and post-approval implementation.

With China's growing economy and accumulating ecological issues, damage caused by soil pollution and harmful and toxic chemicals to human health and the environment has become increasingly serious. However, the current regulation of soil pollution and harmful and toxic chemical substances is weak.

Regulatory responsibilities among different authorities overlap. There are no effective regulatory mechanisms, no rigorous risk prevention or control measures, and there is no independent regulatory institution. Environmental and social risks have reached a point where they can no longer be ignored.

Legislation is urgently needed to regulate and tightly control soil pollution and harmful and toxic chemicals. Though necessary administrative regulations and supplementary technical norms in the areas of nuclear safety, biodiversity protection and natural reserve management are already in place, they are at a low level and they are fragmented. Special laws are needed to unify regulation.

BOX 5-1 Regulation of hazardous materials in the U.S.

U.S. regulation of the storage and discharge of hazardous or toxic substances emphasizes planning, emergency response, transparency, and public supervision.In the wake of the 1984 Union Carbide accident in Bhopal, India, American citizens called for stronger regulation of hazardous materials.

In 1986, Congress passed the Emergency Planning and Community Right-to-Know Act (EPCRA). EPCRA required U.S. states to create state emergency response commissions (SERCs)

and local communities to establish local emergency planning committees (LEPCs). LEPCs are required to create emergency response plans. Companies are in turn required to provide to SERCs, LEPCs and local fire departments annual reports regarding the identities, locations and amounts of hazardous chemicals on-site.

Perhaps the greatest innovation of the EPCRA was the creation of the Toxics Release Inventory (TRI), which required certain facilities to provide annual reports to EPA regarding emissions of up to 600 or more toxic chemicals. TRI information was made available to the public through a national computerized database.

The U.S. Congress created the TRI in the belief that open information about toxic chemical releases would raise public awareness and provide the public with the tools to bring pressure to bear on companies to reduce use and emissions of toxic chemicals. In the first year after the TRI was implemented, reported emissions declined by 39 percent according to one study, and emissions have declined in nearly every subsequent year.

A subsequent program, the EPA Risk Management Program, required emitting facilities to prepare Risk Management Plans with:

A history of accidental releases occurring during the previous Five-Years;

A summary of the facility's accidental release prevention program;

An offsite consequence analysis, which is an analytical determination of the potential impacts to the environment and the public in a hypothetical worst case accident scenario and alternative accident scenarios;

A summary of the facility's emergency response plan.

Congress also authorized the U.S. Chemical Safety and Hazard Investigation Board, an independent board established to investigate the causes of major chemical accidents.

BOX 5-2 Management of chemicals by the european union

The European Union (EU) early considered the need to establish a balance between ensuring the free marketing and trade of chemical products on the one hand and protecting human health and the environment against the risks from chemicals on the other

One of the main challenges was to overcome the gap that numerous chemicals are put on the market or used by industry, for which not enough knowledge about the risks for humans or the environment exists. To overcome this problem, the EU set up a European Chemical Agency (ECHA) with a staff of some 600 people and the task to manage chemicals.

Chemical substances, on their own, in preparations or in articles must not be placed on the EU market until they have been registered with ECHA. Any request for registration must be accompanied by detailed information on the chemical, and in particular, a safety report following a safety assessment of the chemical. According to the quantity to be marketed, the risk of the

chemical and other conditions, testing proposals must also be made. The responsibility to provide data on a chemical substance is thus deliberately placed on the economic operator.

ECHA must evaluate all substances. It may ask for further information and for further tests to be carried out. Substances found to be of very high concern-these are in particular substances that are carcinogenic, mutagenic, toxic for reproduction, bio accumulative, persistent or toxic for reproduction-must be authorised by the EU and supplementary information on the substance is required.

Normally, an authorisation is given for a certain use of the substance. Substances of concern for humans or the environment may be restricted in use, after detailed scientific and socio-economic consultations.

All these provisions are detailed in the REACH-Regulation (Regulation 1907/2006) as well as in numerous delegated and implementing Acts. The provisions apply all over the EU, i.e. to some 500 million people.

Active substances used in biocidal products are also subject to an assessment and evaluation of ECHA and then authorised by the European Commission. Active substances contained in pesticides as well as genetically modified organisms undergo a detailed scientific examination of the European Food Safety Authority (EFSA), before they may be authorised and then used within the EU.

Member States, manufacturers, importers, and traders who disagree with decisions by ECHA or the European Commission, may appeal to a court against the decision. Individual persons and environmental organisations only have limited access to courts to have a chemical or a substance banned or restricted in use.

In order to prevent major industrial accidents caused by chemicals, the EU has binding directive 2012/18 similar to the US model described in BOX 5-1.

Legislation for resource use and environmental protection lag behind the reform of the Chinese market-oriented economy. There are major weaknesses in legislative design. The position between the government and the market is unclear; administrative instruments and measures are favored over market-based mechanisms and public participation and supervision; resource use mostly relies on the administrative approval of projects and administrative targets.

The administrative control system plays a prominent role and rules and measures such as financing, tax, price, credit, trade and the like are still relatively piecemeal and barely regulate the use of resources and the environment. The legal framework governing the ownership and management of natural resources and the environment is also lacking.

There is no clear-cut distinction between the government's public management function in the field of natural resources and its function to operate natural resources

markets. Major resources management authorities regulate the market while participating as agents of resources and property. Measures adopted in the planned economy still govern resource utilization.

Legal provisions concerning public environmental rights and interests are commonly inoperable. Substantive and procedural requirements for information disclosure and public participation are still limited, with few channels available for public participation so social oversight is hardly ever put into practice.

Oversight and post-approval implementation is lacking. Most laws and rules lack necessary procedures for implementation. This affects the operability and effectiveness of important legal tools such as environmental standards, environmental impact assessment and permits for resource use and environmental protection.

The existing requirements are expressed in terms that are too general, containing only principles. Necessary legal norms and procedures have not been established for the effective implementation of environmental standards, environmental impact assessment and permits. This leads to extremely wide and unclear discretion in the hands of regulatory authorities in implementation and enforcement.

Some necessary legal norms and supplementary provisions are absent for new approaches, including ecological redlines, ecological compensation, ownership of natural resources, asset management, administrative oversight on natural resources, planning main functional zones, spatial planning and use control, environmental damage liability and compensation.

5.1.1.2 "Gaps" in other important laws

Philosophies, principles and mechanisms consistent with ecological progress and sustainable development are not yet integrated into civil law, commercial law, economical law and administrative law. An integrated legal system that takes account of the ownership of natural resources and the environment, as well as civil liability for environmental damage, has yet to be established. This greatly diminishes environment protection.

For example, the precautionary principle is not reflected in the civil law. A party to a contract may be prevented from taking early prevention measures to control risks caused by hazardous waste. The principle of sustainable use of natural resources is also missing. There is nothing to prevent someone from causing a severe threat to ecological safety or human existence when using soil or water resources.

The civil law does not create environmental rights to protect common environmental interests. There are no measures to protect the public need for clean soil and water, fresh air and a beautiful environment.

In other countries, there are many cases in which judges consider the violation of an environmental right as the infringement of a human right, and provide civil remedies for the victims. However, in China, there is no such remedy for victims.

China's *Property Law* also fails to account for the environment and natural resources and does not recognize environmental rights. The public nature of the environment means that it cannot be "directly possessed for exclusive use" by anyone. Air, rivers, oceans, forest and grassland, as components of the environment, cannot be an object of real rights. This makes it difficult to protect the environment under the *Property Law*.

Without an explicit obligation to protect the environment and to prevent and reduce pollution and ecological damage, it is difficult to guide the use of resources rationally and effectively. The *Property Law* imposes insufficient requirements on types of usufruct and on exercising rights.

There are also many problems with the tort liability system where provisions are scattered and inconsistent. The provisions on environmental tort responsibility are scattered in the *General Provisions of the Civil Law*, the *Tort Liability Law*, the *Environmental Protection Law,* the *Civil Litigation Law*, as well as in special laws relating to environmental protection such as the *Law on the Prevention and Control of Air Pollution* and the *Law on the Prevention and Control of Water Pollution*. They are often expressed in very general terms and conflict with each other.

In current environmental tort cases, it is common to see victims demand that polluters reduce pollution to below the required standard and to install and operate environmental facilities in compliance with the requirements of environmental authorities. However, there are no detailed provisions on the forms, approaches and procedures to prevent a breach of the pollution laws from occurring. Polluters are only held responsible after the harm has occurred. Inadequate compensation mechanisms often result in little compensation even for significant impacts and severe implications.

It is hard for victims to obtain relief. Complex environmental tort cases pose insurmountable problems, for example, disputes may go beyond one administrative jurisdiction, or may be long-term with unknown causes and difficulty in identifying the person responsible.

5.1.1.3 Institutional frictions

Overlapping regulatory responsibilities between government departments have resulted in fragmented, overlapping and inconsistent laws.

The legal tools to protect ecological systems are artificially separated by various regulatory departments. For example, in the case of water conservation, there is an array of

substantially similar conservation systems. Thus, there are systems for the prevention and control of water pollution artificially divided into water functional areas or zones. There is also overall basin planning and water resources conservation planning, with a variety of water indices such as a water assimilative capacity index, a water environmental capacity index and a total water index.

A complete natural and ecological system is regulated by different departments by a variety of laws and regulations, isolating species protection from habitat conservation, animals from plants, and terrestrial from aquatic species.

It is also common for management systems to be isolated and fragmented inside departments. For example, the management of environmental data and information in the Ministry of Environmental Protection contains five sets of data and information systems including environmental monitoring, environmental statistics, pollutant discharge reporting and appraisal, pollutant emission reduction and pollution source census. Gathering, processing, reporting, reviewing and final generation of each set of data and information are also carried out by different departments or bureaus. Overlap and inconsistency is conspicuous among data channels.

There are duplicate requirements and systems between the *Environmental Protection Law* and each separate sectoral law for pollution prevention. The use of legal tools involving planning, standards, monitoring, assessment, information, permits, oversight and inspection is fragmented and segregated.

Duplications lead to overlapping management imposing unnecessary administrative burden on departments and organizations. For example, there are a string of systems for construction projects, such as flood resistance evaluation, soil and land conservation assessment, water and energy saving evaluation. This forces the project owner to conduct a number of technological verification repeatedly, and these are subjected to endless review and approval of administrative authorities. In fact, all of these could and should be included in a single assessment system.

The following boxes show some good practices in other countries in environmental impact assessment, permitting and use of standards.

BOX 5-3 Strategic environmental assessment in the European Union

Projects that significantly affect the environment require an Environmental Impact Assessment (EIA). European and German Law also provide for a Strategic Environmental Assessment (SEA) for plans and programs (e.g. regional, landscape, spatial and local planning or sectorial planning (e.g. waste management plans)).

The SEA aims to assess the environmental impacts of a plan or a program at an upstream level, in other words at a very early stage. The key elements are the same as those for the EIA: screening and scoping of the plan, submission of all relevant documents by the planning institution/authority (EIS), involving other affected public authorities, public participation, a summarizing presentation about environmental impacts, evaluation, consideration within the decision making process and publishing of the results.

The two-step-approach-SEA followed by an EIA-allows an assessment of alternative actions/ measures at an early stage which is more effective than at the project level, where alternatives e.g. for compensation for nature interventions or the location of an industrial project often do not exist. Furthermore it allows public participation at a stage where concrete decisions are not yet taken. Finally the Environmental Impact Assessment has to take into account the results of the Strategic Environmental Assessment so that a doubling of environmental assessments can be avoided.

BOX 5-4 Permits and EIA

In international jurisdictions, an environmental impact assessment process (EIA) is applied to large infrastructure and industrial projects as early as possible in the development of the project. The project must not commence until the EIA has been assessed by the relevant authority.

The purpose of an environmental impact assessment is to identify and describe the direct and indirect impacts a project may have on people, animals, plants, land, water, air, climate, landscape and cultural environment and on the management of materials, raw materials and energy, land, water and the physical environment in general.

The EIA process is closely linked to the permitting process. An application for a permit must contain an environmental impact statement (EIS) setting out in full the information that emerged during the EIA process. The permitting authority must consider this before granting a permit and setting the permit conditions.

Examples of the kinds of matters that must be addressed in the EIS include:

(1) An analysis of any feasible alternatives to the carrying out of the project having regard to its objectives, including the consequences of not carrying out the project;

(2) A detailed description of those aspects of the environment that are likely to be significantly affected;

(3) A full description of the measures proposed to mitigate any adverse effects of the project on the environment; and the reasons justifying the carrying out of the project infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development.

Full public consultation is required during the EIA process. For example, the full EIS must be released to the public for comment and those comments must be taken into account when considering whether a permit should be granted. It is not uncommon for projects to be modified as a result of the public consultation process.

The permitting authority must refuse a permit application if an EIA is not adequate. Permitting decisions can be challenged in the court on the grounds that the EIA has not been adequately carried out.

EIAs are carried out by private consultants engaged by the applicant. While there is some public concern that the consultants are not independent, there are safeguards. Firstly, the EIA must satisfy staff of the relevant authority who are competent to assess its adequacy, secondly there is public consultation of the full EIA and finally there is judicial supervision of compliance with legal requirements.

The permitting authority must refuse a permit application if an EIS is not adequate. Permitting decisions can be challenged in the court on the grounds that the EIS has not been adequately prepared.

EISs are prepared by private consultants engaged by the applicant. While there is some public concern that the consultants are not independent, there are safeguards. Firstly, the EIS must satisfy agency staff of the relevant authority who are competent to assess its adequacy, secondly there is public consultation of the full EIS and finally there is judicial supervision of compliance with legal requirements.

BOX 5-5 Integrated environmental permits-standards using BAT and BREF

The objective of integrated environmental permitting is to establish legally binding environmental requirements for fixed sources of emissions (factories and other large point sources) in a transparent and predictable manner in order to protect human health and environment.

The requirements resolve conflicts between private economic interests in conducting activities that adversely impact on the environment on the one hand and the public interest in ensuring that the environment is protected on the other.

Integrated environmental permitting is an approach that has long been used in Sweden and Australia and in recent years it has also been used in the EU. The requirements are imposed by state or municipal authorities through a permitting process that results in conditions often expressed as maximum allowable emissions of pollutants to air and water, and as limitations of other environmental aspects such as waste and noise (Emission Limit Values, ELVs).

The main advantage of the approach is that it provides for an integrated assessment of the various impacts of a project. This results in better environmental outcomes than if impacts are assessed separately with separate permits for air, water, noise and waste. Industry and the community also welcome the integrated approach because it means a "one stop shop" resulting in one clear and consistent set of operating rules.

BAT (Best Available Techniques) is an important decision-making criterion for the formulation of conditions. The basic philosophy is to limit the pollution as much as technically possible, environmentally justified and economically feasible.

The EU has developed specific BAT identification documents for various industry sectors (BAT Reference Documents, BREFs). In these often voluminous documents, BAT is described by means of emission limit values (ELV) within a range that allows taking account of local conditions. However, there is no simple rule of thumb for applying BAT in each case. An informed judgment by the permitting authority is always a part of the permitting process.

It should be noted though that any deviation of the decision from the BREFs must be properly justified.

In the Swedish Code there are general rules of consideration, which a permitting authority has to consider before granting a permit and setting the conditions (as described in BOX 5-7 on the Swedish Code)

For businesses of a certain type, there are also pre-determined emissions limits that they must comply with.

BOX 5-6 Periodic review of permits in New South Wales

In New South Wales, Australia, the law requires the EPA to review permits (called environment protection licenses) at least every 5 years. In addition, the permit conditions can be strengthened at any other time if necessary to protect the environment.

It is very rare for the EPA to shut down a facility. If an older facility is not able to achieve the environmental performance of new facilities, the EPA negotiates a pollution reduction program with the license holder requiring steps to be taken over a specified period to bring its performance up to the new standard.

This may be achieved by phasing in new technology or adopting improved production processes. The steps in the pollution reduction program are attached as requirements in the license and it is a criminal offence not to comply.

5.1.2 Recommendations for filling the gaps and creating a unified legal framework

5.1.2.1 Short-term recommendations

(1) Reform the current fragmented system for managing hazardous chemicals

Firstly, reform the current multi-department management system (including safety, environment protection, transport and public security) by integrating the supervisory functions and establishing a unified independent system to prevent and control environmental and safety risks.

Secondly, establish a unified legal system for identifying dangerous chemical substances and for risk evaluation drawing on the experience in foreign jurisdictions.

Thirdly, revise and improve current administrative requirements to establish a complete system for reporting and registration of new chemical substances and a system for the market entry of chemicals.

Fourthly, clarify fundamental requirements and measures to restrain (for example, by contents limits) or to eliminate high-risk chemical substances contained in varieties of products, based on actual demand.

Fifthly, in line with process requirements "from the cradle to grave", clarify risk management requirements for toxic and hazardous chemical substances and products throughout their entire life span from R&D, production, use, consumption, import and export, transport, storage, abandonment and final disposal.

Sixthly, build an overall emergency response system for accident emergency and environmental pollution handling.

Finally, develop a comprehensive liability system for safety and environmental protection by clearly imposing legal liabilities on producers, consumers and regulators.

(2) Strengthen and streamline EIA for plans and projects

Firstly, expand the scope of EIA to major economic and technological policies and comprehensive economic plans that are likely to have significant impacts on the environment, (planning EIA) by strengthening EIA-related laws.

Secondly, improve substantive and procedural requirements for planning EIAs and project EIAs. Require the following important considerations to be taken into account for both planning EIA and project EIAs: Key functional zone planning approved by the State Council, major land use planning and ecological redlines. Plans and construction projects that fail to satisfy these requirements should not be approved.

Thirdly, strengthen the role of EIA by providing for integrated environmental

assessment, gradually bringing EIA for the use of resources and ecological protection into the current EIA system, and reduce overlapping administration and duplicated assessment required by different authorities.

Fourthly, improve EIA preparation and approval procedures; further improve the procedures for stakeholders consultations while enhancing professional EIA technical review; and strengthen the role of EIA in balancing the interests of the various parties involved.

Fifthly, enhance the supervision and regulation system for third-party assessment of the EIA by combining industry self-regulation with oversight from administrative authorities and the community thereby improving the independence and scientific quality of the EIA.

Finally, create a liability system where owners, the third-party experts who prepare EIAs and regulatory agencies are held to account and intensify efforts to pursue EIA violations.

5.1.2.2 Medium-term recommendations

(1) Strengthen permitting and integrate with EIA

Firstly, elevate the legal status of discharge permits and make it clear that no discharge is allowed without a permit.

Secondly, make the permit comprehensive so that it regulates all forms of pollution-water, air, solid pollutants (except those conditions specially permitted by other laws).

Thirdly, clearly identify responsibilities of environmental agencies at all levels in relation to the permitting process and in particular, the responsibility to monitor and enforce the conditions of the permit. Establish effective institutional arrangements for inspection, supervision and enforcement at the national and local levels.

Fourthly, streamline and implement various legal tools and integrate them into the permitting process, including environmental standards, environmental monitoring, EIA, “three-simultaneity”, pollutant registration, total amount control (emission cap program), end-of-pipe installation and other environmental management tools. Integrate them into the permit as much as possible.

Fifthly, create procedures for permit applications and for issuing permits and for relevant supervision, such as regular reporting and on-site inspection.

Finally, integrate existing liability-related provisions to create set a complete liability system.

(2) Strengthen environmental standards

Firstly, make clear that environmental quality and emission standards are mandatory

legal norms; require that national environmental quality and emission standards be prepared by environmental protection departments and approved by the State Council.

Secondly, establish standards using the best available technology or best reliable and feasible technology (BAT or BREF), and determine emission standards and total amount emission control based on BAT.

Thirdly, reform existing technical assessment and review when setting environmental quality and emission standards to clarify that these standards should be prepared by environmental authorities, and evaluated and reviewed by independent professional technical agencies. Expand public participation based on the legislative procedures to ensure full public review by all stakeholders.

Fourthly, build complete environmental quality and emission standards at the national, regional and local levels, and integrate the total amount target into emission standards; set up regional emission standards across administrative jurisdictions.

Finally, implement environmental standards in an integrated manner with other legal tools to create an effective environmental standard implementation system.

(3) Reforms concerning natural reserves and natural resources

Firstly, reform the existing overlapping management system by various agencies of natural reserves, scenic attractions, geological parks, forest parks and other kinds of conservation areas; establish a unified classification system; integrate laws, administrative regulations and technical specifications to create a relatively complete and unified system.

Secondly, establish the ownership of natural resources, and the rights to use natural resources, improve regulations on property right transactions. Develop laws and supporting regulations to reform the asset management system of state-owned non-profit natural resources to gradually develop an administrative and institutional system for natural capital delegation, management and auditing.

5.1.2.3 Long-term recommendations

(1) "Green" other laws to promote ecological progress

Firstly, the Constitution and other laws should recognize and protect the environment as a public resource.

Secondly, the promotion of ecological civilization progress should be integrated into the civil code. It should not merely be confined to creating traditional property rights but also reflect humanistic and ecological considerations, for example when creating property rights, and tort liability.

The precautionary principle and sustainable use should be promoted and environmental rights recognized and guaranteed by law.

Tort liability provisions should be improved by creating liability for ecological damage, for example, for water and soil losses, the permanent destruction of agricultural production conditions and the devastation of living conditions.

Establish a social aid mechanism for environment-related tort liability by extending the scope of environmental liability insurance. Businesses should have absolute responsibility for environment-related tort liability with insurers bearing the second layer of responsibility. However, for massive tort liability cases, damage compensation, for example nuclear accidents, a mechanism of last-line compensation by the states required.

(2) Develop an environmental code for China

There is merit in codifying environmental laws to harmonize them and ensure a coordinated and consistent approach avoiding gaps and inconsistencies. However, this is an enormous task and needs to be approached in a stepwise process, starting with clarifying the relationship between the Environmental Protection Law and other pollution prevention and control laws and also reducing repetition.

Two options for codification have been considered. The most ambitious is to codify both pollution prevention laws and resource protection laws. The second option is to codify just the pollution prevention laws. This is a more manageable task and would have the benefit of providing a code with Chinese characteristics suited to the administrative system at China's current stage. The code could enrich, strengthen and integrate environmental management systems and drastically cut repetitive terms and conditions facilitating implementation.

It is recommended that further study be conducted into the process for developing of an environmental code for China.

BOX 5-7 Swedish Environmental Code

The overall purpose of the Swedish Environmental Code is to promote sustainable development to assure a healthy and sound environment for present and future generations. It replaced 16 former Acts and took ten years to develop.

The Code was first introduced in 1999 to harmonize environmental legislation, ensuring a consistent approach and avoiding gaps and inconsistencies.

It applies in principle to all human activities that may harm the environment or human health and must be applied in such a way as to ensure that:

- Human health and the environment are protected against damage and nuisance, whether caused by pollutants or other impacts;

- Valuable natural and cultural enviroments are protected and preserred.
- Biological diversity is preserved;
- The use of land, water and the physical environment in general is such as to secure a long term good management in ecological, social, cultural and economic terms; and
- Reuse and recycling, as well as other management of materials, raw materials and energy are encouraged with a view to establishing and maintaining natural cycles.

Important overarching principles, policies and goals are laid down in the Code and must be followed by agencies and the Court when applying it. For example, when considering a permit application and imposing conditions on any permit approval,

the relevant agency must consider the following principles, policies and goals:

(1) Polluters pay principle;

(2) Precautionary principle;

(3) Prevention principle;

(4) Burden of proof;

(5) Best available techniques;

(6) The location of activities;

(7) Reuse and recycling;

(8) Cost-benefit balancing.

General provisions in the Code promote the principle of sustainable development. Examples include provisions concerning :

(1) The management of land and water areas;

(2) Protection of nature;

(3) Protections of animal and plant species.

The principle of sustainable development in the first section of the Code must be applied when the Government or agencies under the Government make rules and regulations based on the Code.

The Code also contains special provisions relating to particular activities including:

(1) Environmentally hazardous activities and health protection;

(2) Activities that cause environmental damage;

(3) Water operations;

(4) Chemical products and biotechnical organisms;

(5) Waste and producer responsibility.

The Code also contains also a great number of procedural rules.

5.1.3 Recommendations to improve the quality of legislation

5.1.3.1 Build an institutional mechanism to ensure Party rule making is consistent with national laws

Set up an institutional mechanism to ensure Party regulations are in line with

national laws in the formulation process. This would meet the strategic requirements for modernizing the national governance system set forth in the 4th Plenary Session of the 18th Central Committee of the CPC.

Use the revision of the Law on Prevention and Control of Water as a trial.

5.1.3.2 Build an institutional mechanism for the legislative drafting process to avoid departmental conflict of interests

Departmental conflicts of interest heavily restrain environmental legislation in China. To ensure this does not happen, it is essential to set up an institutional mechanism in accordance with the decision of the 4th Plenary Session of the 18th Central Committee of CPC.

Firstly, the formulation or modification of laws should be decided by the NPC according to its inspection, enforcement or surveys; or initiated by the State Council when submitting a proposal to the NPC or its Standing Committee for deliberation. Various ministries, commissions and bureaus should be able to provide comments before the decision of the State Council.

Secondly, if any new or amending law is required to be enacted by the NPC or its Standing Committee, the text must only be drafted by the NPC Standing Committee's special committee or a designated working committee. It should not be entrusted to the Office of Legislative Affairs of the State Council, nor to ministries, commissions and bureau for drafting. This is to ensure the fairness and integrity in the environmental law drafting process.

Once a draft is prepared, the special committee or a related working committee that drafts the text of NPC may call for comments and recommendations of the Legislative Affairs Office of the State Council as well as those of ministries, commissions and bureau.

5.1.3.3 Improve environmental legislation by providing the whole package

Laws containing only general principles make environmental laws inoperable by leaving too much discretion to the government agencies that implement and enforce the laws.

It is recommended that wherever possible, laws should not be too general and lacking in detail.It is imperative to give a complete package of provisions when promulgating laws. It's also necessary to anticipate possible implementation problems in advance and deal with them. If it is impossible to lay down all the provisions, deadlines for the creation of supplementary norms and standards should be provided.

5.1.3.4 Further strengthen information disclosure and public participation

Insufficient information disclosure and low public participation has become a

great impediment constraining social forces to rise as a third pole of the environmental management system. Accordingly, in the modification or formulation of environmental laws and regulations in the next stage, it is essential to expand and provide detailed provisions on information disclosure and public participation Further development is required of the *Regulations on Environmental Information Disclosure and Public Participation*.

5.1.3.5 Integrate the multi-planning process

Integrate "multi-planning-in-one" and make plans that accord with Chinese realities and with the requirements for national governance strategy. Environmental plans, economic and social development plans, urban and rural construction plans, overall land use plans should combine into one blueprint, making environmental protection a binding factor in a real sense.

"Multi-planning-in-one" is in line with the requirement for Chinese environmental management and is an important means of avoiding the waste of precious resources. Therefore, it should be firmly put into practice. Currently, China is carrying out "multi-regulations-in-one", in counties and cities. Hainan Province has launched its trial program as a provincial trial zone. In 2016, China should summarize this experience to extend the trial programs.

It is important to learn from the EU by reconstructing a system of environment policies and regulations, and enhancing the status of environmental plans and standards in the legal system. China can define and achieve its environmental goals by planning and by developing appropriate environmental standards, laws and regulations to meet economic development needs while addressing China's current environmental challenges.

5.2 Implementation and enforcement-achieving the aims of the legislation

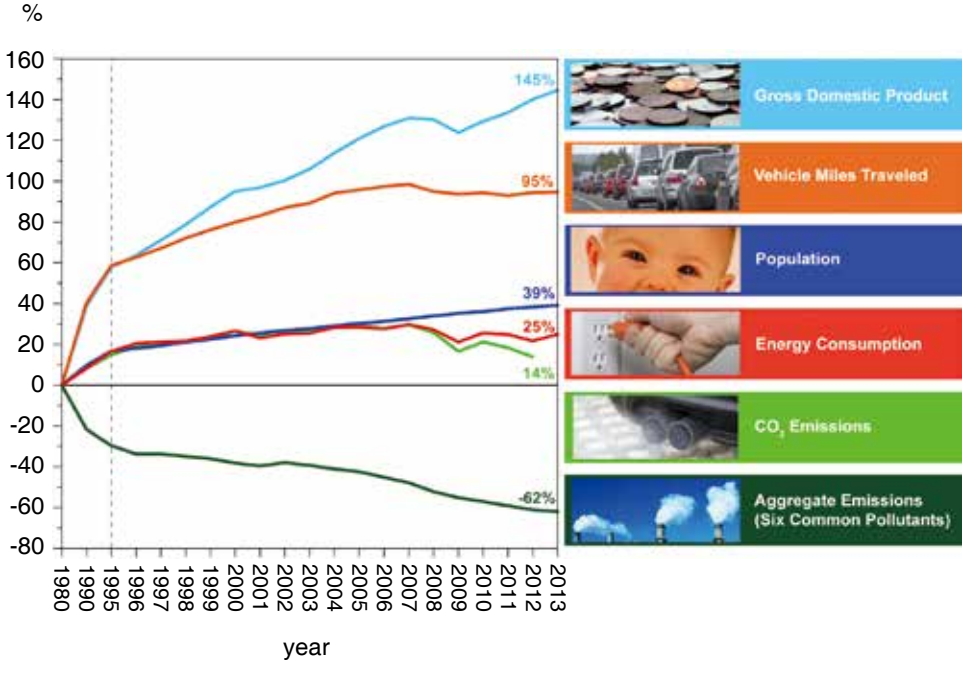
5.2.1 Implementation and enforcement problems in China

The implementation of the new Environmental Protection Law marks a new era for environmental protection in China. There have been achievements such as significant improvements in urban air quality and a rapid growth in the number of enforcement cases.

However, continuing environmental problems, especially air, soil and water pollution reflect extensive economic development for decades combined with lax law enforcement.

BOX 5-8 Persuading public that environmental protection compatible with economic growth

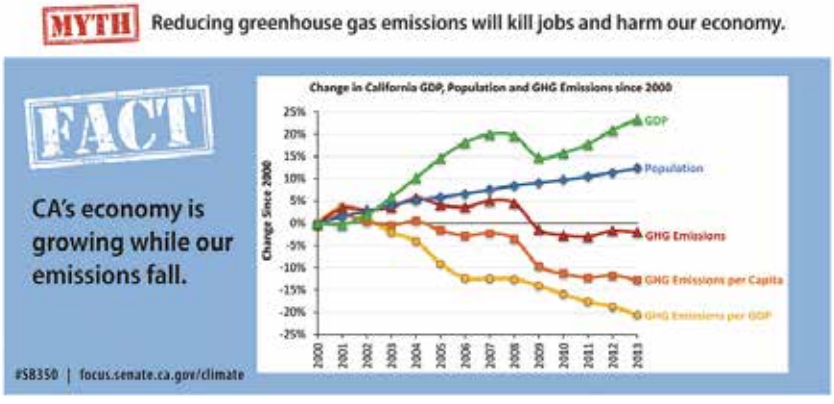
Debates over environmental regulation in China still too often treat environmental protection as incompatible with economic growth. This box uses examples from the United States to highlight the importance of persuading the public not only that growth and environment are not incompatible, but that environmental regulation can actually be a driver of growth. American regulators (both federal and state) regularly emphasize the net benefits of environmental regulation in terms of economic growth, health, and other metrics. For example, the U.S. EPA regularly highlights the fact that substantial reductions (–62%) in criteria air pollutants (SO_2, NO_2, ozone, CO, PM, lead) have been achieved even as GDP has increased by 145%, vehicle miles traveled have nearly doubled, and population as well as energy consumption have increased.



US Air Quality Improvements (1980—2013)

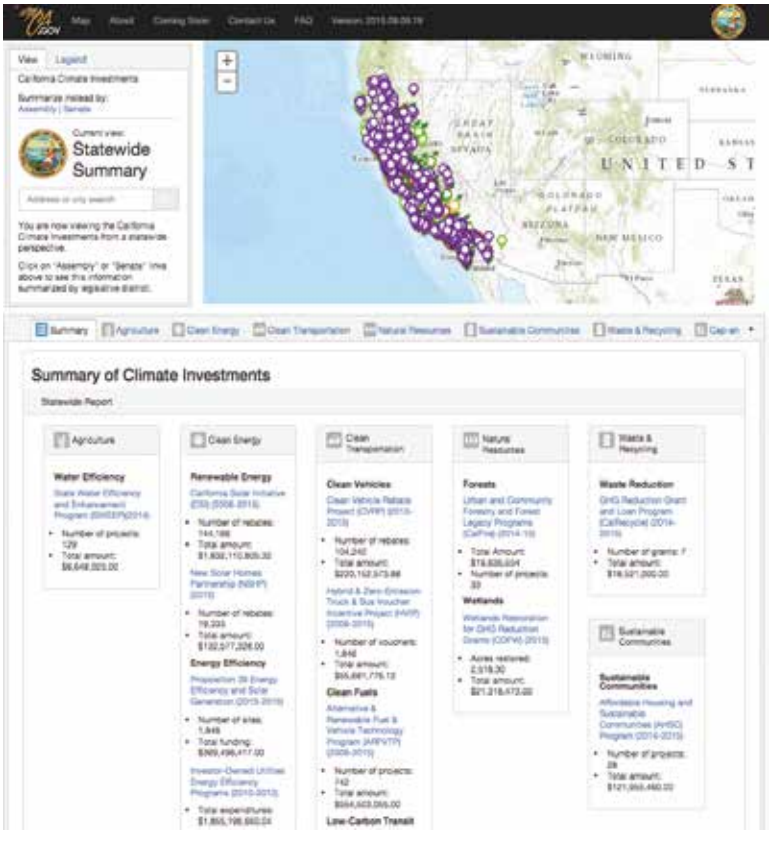
http://www.epa.gov/airtrends/aqtrends.html

California EPA uses similar statistics to illustrate that greenhouse gas emissions regulation is compatible with economic growth.



http://focus.senate.ca.gov/climate/sb350-facts

California has also created an online map highlighting the numerous investments associated with climate change regulation.The point is to remind the public that environmental regulation can generate economic growth.



The Chinese government is now promoting a similar message. Green development and economic transformation are the keys to a cleaner, healthier, and more prosperous future in China. Government officials, environmental regulators, NGOs, and concerned citizens in China need to strengthen their ability to highlight these benefits of environmental regulation to counter the still prevalent idea that environmental regulation presents an either-or choice between growth or the environment.

Problems caused by the laws themselves:

(1) Environmental protection law is a lower-level law and weak in playing its coordination role

A basic law is a higher-level law. A prerequisite for a law to become a basic law in China is that the law is adopted by the NPC. However, the new Environmental Protection Law is adopted by the NPC Standing Committee, so it does not have the status of a basic law of China.

The new Environmental Protection Law is a comprehensive and foundational law intended to reach every aspect of environmental protection including the ecological red line system, the protection of natural ecological regions, ecological restoration, security, compensation and the protection of agricultural ecological systems.

However, because it is not a higher-level law when compared with laws such as the Agricultural law, the Forest law, the Grassland Law, and the Water Law, its authority is weakened. Until this issue is addressed the Environment Protection Law will continue to lack authority and will be unable to play its coordination role.

(2) Poor connection between laws and weak coordination between systems

Pollution prevention laws and natural resources laws are only weakly connected and this has not been addressed by the new Environmental Protection Law. There is overlap and conflict with specific laws and systems relating to natural resources. One example is conflicting requirements for monitoring.

Low linkages between laws inevitably leads to ineffective coordination between legal systems and administrative departments, increasing the risk of environmental accidents.

Take the recent Tianjin Port Explosion as an example. The lack of clear division of administrative powers and responsibilities between the work safety department and the environmental protection department prior to the accident resulted in great risks to the port area.

A production safety emergency drill was held in the port area on July 20, shortly

before the accident, but it did not have the desired effect. Poor communications between the environmental protection department, the work safety department and the fire department after the accident led to inadequate emergency measures and inaccurate information about dangerous goods such as cyanide. This seriously endangered the health and safety of the local residents.

(3) Laws and regulations strong in principle, but aspirational rather than effective

The environmental laws and regulations are often criticized for their low operability and the lack of supporting laws and regulations. An environmental law that cannot be implemented effectively exists in name only.

The new Environmental Protection Law has gone some way to addressing this issue and the Ministry of Environmental Protection has introduced a number of legal tools including performance review, ecological redlines, ecological compensation, public interest litigation, and stricter penalties. Furthermore, a number of supporting regulations have been made, for example, regulations providing for daily penalties, halting production and the disclosure of information by enterprises and public institutions.

However, there are still gaps. For example, there are no provisions for objective assessment or for time limits for the establishment of standards, rules, policies, and plans by the competent administrative departments and local governments. Supervision responsibilities remain unclear.

In addition, China does not have any evaluation mechanism or indicator system for measuring the effectiveness of implementation and enforcement, of the law. Local governments and competent administrative departments should be urged to enforce the law strictly by giving them scores based on the effectiveness of implementation and enforcement.

BOX 5-9 Compliance and enforcement performance measurement

Many OECD countries have developed and used performance measurement indicators to measure the performance of environmental enforcement authorities since early 1990s. An OECD 2010 report analyzing the experience of ten OECD countries in the design and implementation of quantitative indicators indicated that four categories of indicators are widely used over the years: a) inputs indicators (e.g., time, staff, funding, materials, equipment, and other resources); b) outputs indicators (e.g., the number of inspections performed, the number of compliance promotion activities and the number of enforcement actions); c) intermediate outcomes indicators (e.g., improved environmental management and reduced environmental impact); and d) final outcomes indicators (e.g., improved ambient water or air quality and reduced soil contamination, etc.).

Traditionally, compliance and enforcement performance has been evaluated by inputs and outputs indicators. In recent years, many environmental enforcement authorities realize that input and output indicators alone do not reflect the effectiveness of various enforcement activities. Therefore, more meaningful outcome-based measurement indicators have been developed to focus on the improvements in environmental conditions or behaviors of the regulated community. Generally speaking, six types outcome-based performance measurement indicators are often used:

(1) Compliance rates;

(2) Measures of recidivism and duration of non-compliance;

(3) Pollution release indicators;

(4) Indicators of improved environmental management practices and reduced risk;

(5) Measures of effectiveness of individual compliance assurance instruments; and

(6) Environmental quality (final outcome) indicators.

OECD countries experiences show there are three approaches in designing outcome-based indicators of compliance and enforcement:

(1) Performance assessment focused on the effectiveness of compliance assurance instruments across regulations and environmental problems (e.g., USEPA measures the improved behavior of the regulated community, inspections and enforcement actions as well as ensuing pollution reductions).

(2) Performance assessment focused on specific environmental problems reflecting the competent authority's strategic priorities (e.g., UK, Denmark and Ireland use this approach to track high-risk industrial incidents, emissions of priority pollutants, etc.).

(3) Multi-tier performance assessment focused on pollutant-specific results of regulatory actions at the lower level and on the overall programme effectiveness at the higher level (e.g., Environment Canada looks first at reductions of individual regulated pollutants as a result of compliance and then aggregates them into a composite measure characterizing the environmental impact of these reductions).

From the scope of the indicators, the experiences from around the world show four types of compliance and enforcement measurement indicators:

(1) Comprehensive National Indicators to assess the overall effectiveness and improve management of the national environmental agency's compliance and enforcement programme. For example, the USEPA's national ECE indicators. For more information see http://www.epa.gov/compliance/planning/reuslts/index.html.

(2) Comprehensive Sub-National Indicators to assess the overall effectiveness and improve management of the compliance and enforcement programme of a regional or district office of the national environmental agency, a state or provincial agency, or a local municipal agency.

(3) Focused National Indicators to assess the effectiveness and improve management of a focused national initiative to address a specific noncompliance pattern or environmental risk. For example, Environment Canada's focused national ECE indicators. For more information, see http://www.ec.gc.ca.

(4) Focused Sub-National Indicators to assess the effectiveness and improve management of a focused initiative to address a specific non-compliance patter or environmental risk at the regional, provincial/state, or local/municipal agency, use focused sub-national indicators.

However, there are some major challenges for developing and using compliance outcome indicators, including resources limitation for data collection and treatment, complexity of scope definition, difficulty of designing statistically-valid indicators, uncertainty in linking outputs with outcomes, and low comparability of indictor, etc.

It is not possible to identify a "best practice" approach or a set of "flawless" indicators. The design of the measurement indicators ultimately depends on their purpose and suitability for joint analysis with the enforcement authority's resource (input) and activity (output) indicators.

Sources:

① OECD Environment Working Paper No. 18 (by Eugene Mazur), Outcome Performance Measures of Environmental Compliance Assurance (2010), available at: http://www.oecd-ilibrary.org/environment/outcome-performance-measures-of-environmental-compliance-assurance_5kmd9j75cf44-en.

② INECE, The Performance Measurement Guidance for Compliance and Enforcement Practitioners, Second Edition (2008), available at: http://inece.org//indicators/guidance.pdf.

(4) Problems in legal tools design and lack of shared governance

In the current environmental legal system, environmental control mechanisms predominate over market mechanisms.

Rules for public participation are mainly established in pollution prevention and control laws and regulations, and rarely seen in other environmental legislation.

With increasing public environmental awareness today, the design philosophy of the environmental legal system should be broadened from just regulating acts and punishing

illegal acts of enterprises and citizens to also include guiding and supporting enterprises and citizens to comply with the law consciously.

BOX 5-10 Compliance and enforcement- best regulatory practice

The role of a modern regulatory agency is to enforce the law when necessary, but also to inform and educate, provide support, monitor compliance, and encourage higher performance.

Range of tools for compliance

International experience has shown that the most cost effective way to achieve compliance is through education and support, backed up by strong enforcement.

There are many drivers of non-compliance and these include a lack of knowledge or understanding of the rules, unclear or contradictory rules, a low likelihood that a breach will be detected, a low likelihood that sanctions will be imposed or sanctions that are too low to act as a deterrent.

These drivers are addressed by a combination of positive motivators and incentives for compliance, (education and support, clear coherent rules, public acknowledgment of good performers), and by effective deterrents for those who break the law (a suite of escalating sanctions).

When setting policy and drafting regulations, the Hampton Review of effective regulation in the United Kingdom recommended that they should be written in consultation with stakeholders so that they are easily understood, easily implemented and easily enforced.

Explicit consideration should also be given to how they can be enforced using existing systems and data to minimize the administrative burden imposed. The agency also needs to provide education and support.

Exercise of discretion-accountability

Regulatory agencies exercise discretion in compliance and enforcement as a matter of course- at the managerial level in the allocation of resources and at the field level in choosing how to respond. This is often unacknowledged and not understood.

The modern regulator explains to the community how it will prioritize its focus and target its resources. It also explains the strategies it will apply when dealing with regulated facilities so its actions and responses are predictable and consistent. It reports to the community annually on its performance and achievements.

Risk-based approach and performance measurement

In determining priorities, modern regulators adopt a risk-based approach devoting resources to areas where they will make the biggest difference and manage the biggest risks.

The UK Environmental Agency is considered an exemplar in risk-based regulatory practice with the transparent disclosure of its risk-based targeting, licensing and inspection approaches through the Operator Pollution and Risk Appraisal system (OPRA).

EPA Victoria has recently adopted a similar risk based approach in Australia after an extensive review of regulatory best practice.

Implementing recommendations of the review, the agency has published a new Compliance and Enforcement Policy explaining its methods and priorities for ensuring compliance and using its compliance and enforcement powers. This approach is standard practice for regulators today.

It has also published an annual Compliance Plan informing the community of the EPA's planned and proactive compliance activities for the year ahead. These are divided into strategic compliance activities, compliance maintenance activities and pollution response. Each category requires a different approach to risk assessment, resource allocation and problem solving.

The agency reports to the public annually on its performance in achieving the objectives of is Compliance Plan. The public is also able to read about the outcomes of EPA's compliance and enforcement activities by following it on social media and on its website.

Sources

Hampton Report March 2005. www.hm-treasury.gov.uk/ media/AAF/00/bud05hampton_641. pdf.

Environment Agency UK website www.environment-agency.gov.uk.

http://www.epa.vic.gov.au/our-work/compliance-and-enforcement/ce-review.

(5) Parts of the legal system are out of date and incomplete

Pollution discharge fees are too low and fail to reflect regional differences. The system for licensing pollution discharges has not been effectively implemented for a long time. Pollutant discharge standards are out of date and do not match the standards required for environmental quality and public health. There are not enough industrial and regional pollutant discharge standards.

The environmental impact assessment system does not cover all decisions and policies that can have a significant impact on the environment. Wrong environmental decisions and policies will inevitably lead to serious environmental consequences, greater than that of general environmental pollution behavior and environmental accidents.

The environmental legal system needs to adjust to the current environmental pollution problems in China. In the past, the main focus has been on prevention and control of point source pollution. However, our environmental problems have evolved from point source pollution to non-point source pollution crossing multiple administrative regions and watersheds and affecting multiple provinces and municipalities. So it is necessary to adjust the current system and make it more suitable for the problems of today.

(6) Poor coordination in planning without full consideration of environmental protection

Environmental planning should be considered together with economic and social development planning, urban and rural construction planning, and overall planning for land use.

Resource use should not go beyond environmental bearing capacity. Environmental planning by many local governments should be integrated with economic and social development planning, urban and rural construction planning, and overall planning for land use. Otherwise, each department acts only in its own interests and the environment becomes the victim of struggling interest groups and regionalism.

5.2.2 Law enforcement problems

5.2.2.1 Barriers to effective implementation and enforcement

Roles and responsibilities of all levels of government in the implementation and enforcement of environmental legislation are unclear. There are conflicts between regional administration and vertical administrations in China.

Conflicts between resource departments and environment protection departments make coordination of their functions difficult and hinder overall planning for environmental and natural resource protection. This damages the government's credibility, for example, through inconsistent announcements and data.

In addition, staffing, staff authority and funding of local environmental protection departments are in the hands of local governments with the potential for improper influence by local governments in compliance and enforcement.

Under the Environmental Protection Law, local governments are responsible for environmental quality. However, apart from the evaluation mechanism, the relevant laws fail to guide and assist local governments to fulfill their responsibilities. The environmental protection departments always become the target of criticism for poor regulation.

5.2.2.2 Party committee not responsible or accountable for illegal intervention in environmental protection

Enterprises are responsible for environmental pollution incidents and regional haze pollution incidents. The government is responsible for supervising these enterprises. However, the governments are led by party committees. These committees should assume leadership responsibility for environmental protection and receive party discipline punishment and policy discipline punishment for weak supervision.

In practice, it is difficult to make the officials from party committees accountable for

environmental accidents because they are usually not involved in day-to-day regulation over specific affairs.

The vast majority punished for environmental events and accidents are government officials. Nationwide, it is hard to find a standing committee member of party committee in charge of environmental protection. The objective of the struggle of a government deputy head in charge of environmental protection is to become a standing committee member and avoid responsibility for environmental regulation.

Deputy heads of governments in charge of environmental protection are usually low ranking and requests for resources for environmental protection do not receive the attention they deserve.

5.2.2.3 Lack of trans-regional coordination and unclear division of responsibilities

There are three major environmental problems in China: atmosphere pollution, watershed pollution, and soil pollution. Solving them requires trans-regional coordination.

Take watershed pollution prevention and control in China as an example. The river water has the characteristics of trans-regional and even trans-national flow, but the watershed pollution prevention and control are carried out based on administrative jurisdictions. This results in unbalanced rights and obligations and unfair results. The downstream region suffers from pollution discharged by the upstream region while the downstream region can be a "free rider" of pollution control carried out by the upstream region. This threatens social stability in river basin regions.

The current regulatory system for watershed pollution does not provide for joint prevention and control authorities, except for the important rivers and lakes. The lack of a coordination authority ultimately affects the interests of residents in these regions.

5.2.2.4 Departmental protectionism causes weak cooperation in law enforcement

The complexity and particularity of environmental problems distinguishes environmental law enforcement from general law enforcement. In daily practice, it is necessary for an environmental protection department to cooperate with other departments or peers in other regions, to ensure the job is well done. Experience has shown that environmental problems cannot be solved by the efforts of a single local environmental protection department or a single local government.

The predicament of law enforcement is largely caused by conflicts of interest between government departments. Some environmental issues come within the jurisdiction of both the environmental protection department and other departments, while others don't come within any department's jurisdiction. This has become the biggest obstacle to the implementation of environmental laws and regulations.

A government department inevitably interprets provisions of a declarative or vague nature in its own interests, either "passing the buck" or seeking to further its own primary objectives.

Local governments and departments need to cooperate with each other in law enforcement to deal with regional or watershed environmental problems. However, they are only likely to take the initiative to solve an environmental problem through collaborative law enforcement when the case is extremely serious.

5.2.3 Attitude to environmental law enforcement

5.2.3.1 Local governments require pressure from the central government to carry out local environmental law enforcement

The new *Environmental Protection Law* has been in force for more than eight months. It has resulted in stricter and more pragmatic environmental law enforcement and greater public awareness and participation in environmental protection.

In the first half of 2015, under great pressure of the central government, the environmental protection department inspected more than 620,000 enterprises/times nation-wide, ordered 15,839 enterprises to suspend production and 9,325 enterprises to shut down business, collected daily penalty of more than 230 million RMB, handled 1,814 cases involving seizure or detainment of property, transferred 782 administrative detention cases to the public security organs, and transferred 740 alleged pollution crime cases to the procuratorial organs.

The Ministry of Environmental Protection suspended the review and approval of all proposed new projects within 5 cities with prominent emission reduction problems, ordered 37 enterprises to complete rectification within specified time limits under public supervision, and required thermal power enterprises that failed desulfurization facility inspections to make additional payment for pollutant discharges amounting to 510 million RMB.

Provinces and municipalities directly under the central government can be divided into three levels in term of their environmental quality and enforcement attitude.

The first level has good environmental quality and local governments take the initiative to enforce environmental laws and regulations. The second level is where the environmental quality is just so-so and the local governments fulfill their duties in accordance with the law but in a manner that may be described as "in the middle of active and passive law enforcement". The third level is where environmental quality is poor and the local governments often have to be urged by the central government through inspection

and supervision to improve law enforcement capability.

Currently, the provinces at the third level are economically developed regions where it is harder for environmental laws and regulations to be implemented. The driving force for implementation in these regions is mainly the pressure from higher levels of governments and the central government. For example, from February to June 2015, the environmental protection departments questioned the principal leaders of Cangzhou, Wuxi, and Linyi on the issues of environmental quality, environmental law enforcement, people's livelihood, and economic development.

It is clear that enforcement across China has not yet reached the state of active enforcement everywhere, and monitoring and supervision by the central government is still required to a large extent.

Economic downward pressure has increased especially since June this year, making employment growth the main goal of local governments. According to local environmental protection departments, local governments have become more reluctant to carry out enforcement.

5.2.3.2 Local selective law enforcement and campaign-style law enforcement are common

In order to improve administrative efficiency, Chinese environmental laws and regulations give environmental protection departments certain discretion in administration. However, the departments often use this discretion to take a weak approach to enforcement. They tend to enforce selectively where it is easiest to do so and do not take a broader, fairer and more strategic approach. Other difficulties causing this weak approach to enforcement include problems of geographic location and the concerns of a superior authority.

At present, local environmental protection departments prefer to crack down on violations by launching campaigns to achieve rapid improvement of regional environmental quality. The so-called campaign-style law enforcement mainly refers to the well-organized and targeted large-scale law enforcement or joint law enforcement through the centralization of manpower and material resources by the environmental protection departments.

However, in the absence of a strategic enforcement framework, campaign-style law enforcement only curbs violations in the short term, resulting in the endless loop of "violation-punishment-violation-punishment".

5.2.3.3 Improper local administrative interventions in environmental protection are common

The environmental protection departments often don't dare to enforce the law because of the intervention of the local governments and party committees. Environmental protection departments are then criticized by both sides. The public is dissatisfied if they don't enforce the law and local governments and party committees are dissatisfied if they do.

Strict law enforcement is seen as affecting local employment and revenue growth, thereby affecting the performance evaluation and political future of officials. In spite of the independence of environmental protection departments in law enforcement, the appointment of environmental officials is still under the control of local party committees and governments.

5.2.4 Supervision of law enforcement

5.2.4.1 Inadequate legislative guarantee for social supervision and inadequate People's Congress supervision

The new Environmental Protection Law provides a legal basis for public participation and supervision in environmental law enforcement. However, the provisions are of a declarative nature and are soft in creating implementation responsibilities It is far from effective in relation to public participation and supervision. To achieve the intent of the legislation, civil society groups must have the right of supervision by law.

The new Environmental Protection Law provides the environmental protection departments with powerful law enforcement measures, such as administrative detention and blame-taking resignation. However, the number of environment law violators sentenced to administrative detention after the implementation of the new Environmental Protection Law can be counted on two hands. None have been forced to resign.

This reflects poor enforcement rather than an absence of violators. The People's Congress supervision and public supervision are not effective. At present, the People's Congress tends to use reports as the main method of supervision, it has yet to make inquiries or to held officials accountable for their violations.

The environmental situation is grim and the public can do almost nothing. Social groups feel powerless particularly about regional and watershed environmental pollution problems, reflecting the weakness of social supervision. They have to vent their discontents through network platforms, such as Weibo and WeChat, triggering social conflicts.

In addition, some for-profit media agencies and opinion leaders forge or tamper with

environmental information for their own interests, such as increasing clicks to attract attention. They kidnap public opinion by exaggerating environmental problems causing panic and mass incidents. This results in the misdirection of enforcement activities.

5.2.4.2 Low level of information disclosure and public participation

Public participation has always been important in environmental law enforcement and its low level has been widely criticized in China. The new Environmental Protection Law has a whole chapter of provisions to increase information disclosure and public participation. Public participation is widely regarded as an essential element of policy making at the top level and of law enforcement at the grassroots level.

However in Hebei Province, public participation is mainly passive participation in the form of information acceptance. Active participation is mainly reflected in reporting and supervision of unlawful acts and law-enforcing acts. Judicial review mainly takes the form of civil public interest litigation. Public participation remains at a low level and has not become an important part of environmental decision-making and law enforcement.

The Tianjin Port Explosion in 2015 provides one example. According to laws, the safe distance between a hazardous chemical warehouse and surrounding buildings is 1,000 meters. However, more than 5,600 households were found living within a radius of 1,000 meters from the burst point after the accident. The real estate developers claimed they had not received any notice saying the nearby general logistics warehouse would be reconstructed into a hazardous chemical warehouse. The opinions of nearby residents had not been sought on environmental issues. It appears that the parties concerned in the establishment of the hazardous chemical warehouse failed to fulfill their legal obligations for information disclosure and environmental impact assessment.

BOX 5-11 Information, participation and access to justice

Successful implementation and enforcement of environmental law is the duty of public authorities. The European Union and especially Germany have developed legal instruments for access to information, participation and judicial review building public and government confidence in effective implementation and enforcement.

Based on the Aarhus Convention (Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters), which came into force 2001, the European Union and their member states adopted several legal acts which:

(1) Oblige public authorities to provide access to environmental information for private individuals without having the duty to claim an infringement of interest or right (passive information) and

(2) Oblige authorities, other public offices in the parties' sphere of influence, and international organizations to publish documents with environmental impacts (active information).

(3) Give the right for the civil society (private persons) to participate in approval procedure with the aim of permitting large-scale projects with environmental impacts.

(4) Provide access to justice for individuals with an infringed interest or right and non-governmental organizations to control the approvals of large-scale projects.

Free access to all relevant accurate data, and actively publishing that data, has enabled civil society to monitor public authorities and their enforcement practices. The produced transparency has improved decision-making and promoted not only trust in the authorities' actions but also acceptance of its decisions.

Legal remedies are provided because without them, there would be a risk that the first (access to information) and second pillar (participation) of the Convention would peter out with no effect, and other environmental requirements would not be monitored.

NGOs

In order to avoid improper use of the right of access to information, participation and access to justice, the German law requires NGOs to apply for governmental recognition. The German Environmental Appeals Act provides a list of requirements. An association must be recognized if it:

(1) Predominantly promotes the objectives of environmental protection according to it by law

(2) Has corresponding activities

(3) Existed for a minimum period of three years

(4) Guarantees proper performance of its functions

(5) Pursues public benefit purposes

(6) Allow any person who supports the objectives to become a full right member of the association with an exemption for umbrella organization.

The recognition is issued by the Federal Agency for Nature Conservation.

Upstream bureaucratic supervision

In Germany, the task of monitoring agency compliance and enforcement actions is not simply left to individuals and NGOs. Supervision of public authorities at the local level is also carried out by public authorities at the regional or state level (upstream-supervision).

Conclusion

The lessons learnt by the European and German implementation experiences are: There will be no effective enforcement, acceptance and trust without transparency, participation and judicial review of public authorities' decision–making processes and enforcement. Upstream bureaucratic supervision is also important.

5.2.4.3 Lack of accountability for failure to implement environmental laws

Though the new Environmental Protection Law makes several innovations such as imposing a responsibility system, an evaluation system and a blame-taking resignation system, it is still doubtful how well these systems will work to serve the public interest.

Under the blame-taking resignation system, principals must take the blame and resign, but there is no system for investigating and discovering that a principal should be blamed. In addition, the leading party and government cadres who take the blame and resign then go to other work places with a corresponding rank after consideration is given to factors such as their general performances, qualifications, specialties, etc. Consequently, many officials who violate the discipline have nothing to fear.

The public cannot take any action under the Environmental Protection Law if a local government fails to hold the personnel concerned accountable in accordance with the law or fails to take tough administrative punishment measures, such as daily penalty and administrative detention.

5.2.4.4 Narrow scope of Public Interest Litigation

Public interest litigation is regarded as the most important measure in the recent amendments to the Environmental Protection Law.

On July 1st, 2015, the Standing Committee of the National People's Congress authorized the Supreme People's Procuratorate to carry out administrative or civil public interest litigation pilot work. Thirteen provinces, autonomous regions and direct-controlled municipalities are the pilot areas, including Beijing, Inner Mongolia, Jilin, Jiangsu, Anhui, Fujian, Shandong, Hubei, Guangdong, Guizhou, Yunnan, Shaanxi and Gansu, have been nominated as pilot areas.

However, the law only provides for civil public interest litigation, and not administrative public interest litigation. Administrative public interest litigation supervises the government to protect the public interest according to law and has an important role in perfecting the environmental legal system in China. It is difficult for the community to gather the evidence and file a suit to safeguard their own legal rights and interests.

5.2.5 Weak law enforcement capacity

5.2.5.1 Improper institutional structure (inverted pyramid structure) unable to meet enforcement needs

Problems exist in the institutional arrangements of environmental protection departments. It is difficult for implementation of the new Environmental Protection Law to "go to the grassroots units". On the whole, the environmental protection departments in the

central and provincial levels have relatively stronger capacity, with relatively prominent professionalization and more senior research talents; while those in the municipal and county levels have less.

The enforcement capacity of the environmental protection departments takes the structure of an inverted pyramid, with strong capacity in the central and provincial levels but weak capacity at the municipal, county and township levels. Some county-level environmental protection bureaus have only one or two staff to maintain their daily enforcement, and some rural towns even have no enforcement at all. These grassroots units are also required to provide guidance to a vast number of enterprises.

The goals of the Environmental Protection Law cannot be achieved because of this lack of capacity and resources at the lower levels.

5.2.5.2 Uneven professional capacity

Environmental laws are developed by high-level personnel in China and implementation of the laws requires personnel with relevant expertise. Enforcement is complicated and difficult work. Laws are general and abstract and must be applied to circumstances that are numerous and diverse. Officials must be able to understand the law and choose how to enforce it in the particular circumstances.

Moreover, with China's environmental protection legislation becoming more and more professional, the requirements for the professionalization of environmental protection departments increases, especially for the staff in charge of grassroots environmental law enforcement.

However, many environmental law enforcement officials lack knowledge of the laws and are untrained. Indeed, many districts and counties employ contract workers or temporary workers who are always of lower educational levels and lack the capacity for general law enforcement.

This lack of professionalization in environmental protection departments at county and township levels results in poor implementation and enforcement.

BOX 5-12 Environmental agencies in other jurisdictions

USEPA

The USEPA is a national agency employing 18,000 permanent staff with an annual budget from Congress of US $8 billion. It serves a population of 320 million covering an area similar in size to China.

More than half of its full time staff is professionally trained-for example, engineers, scientists and environmental protection and education specialists. Other groups include legal, public affairs, and financial and information technologists.

The agency regulates 800,000 facilities nationwide.

One of the agency's seven key themes is "embracing the EPA as a high performing organization". Staff are hired, trained and supported to enhance their performance in all areas, including in compliance and enforcement.

NSW EPA

The NSW EPA is an Australian agency at the State level employing 450 permanent staff, with a current annual budget from the State government of AUD$158 million. It serves a population of 7.5 million covering 10% of Australia. The agency directly regulates 2000 facilities across the State.

Staff have similar professional qualifications to staff of the USEPA. Core capabilities for which the agency provides on-going training include incident management, gathering evidence and conducting investigations, policy development, leadership and management.

National network to support regulatory staff

The Australasian Environmental Law Enforcement and Regulators Network (AELERT) is a collective of environmental regulators from all levels of government across Australia and New Zealand.It provides a platform for environmental regulators to connect and collaborate in their work and is modeled on the International Network for Environmental Enforcement and Compliance (INECE).

Member officers connect through AELERT to exchange resources, knowledge and experience about environmental regulatory practice and work together to drive continuous improvement and new approaches to the "regulatory craft".

For example, it provides a Professional Development and Training Program coordinating and delivering a suite of accredited and non-accredited courses that are open to environmental regulatory practitioners.

Accredited courses are delivered by Registered Training Organizations to a standard set by the Australian Skills Quality Authority (ASQA) established by the National Vocational Education and Training Regulatory Act 2011. These courses are designed to assess competency against a range of skills and knowledge relating to the area of study. AELERT offers these courses in Government & Environmental Regulation, Environmental Auditing as well as in Investigations.

5.2.5.3 Weak financial and technical support

With the causes of environmental problems becoming more complex and the environmental protection laws needing to become more professional, the requirements for funds, technology and information to support implementation and enforcement are becoming higher and higher.

At present, China's fiscal allocation for environmental protection within its financial budget is smaller than that of other fields. Moreover, as a result of inadequate financial support, environmental protection departments, especially those in the grassroots units, inevitably choose the path of "profit-driven law enforcement".

Environmental administrative law enforcement is different from general administrative law enforcement activities and requires a lot of technical support for environmental monitoring. For example, technology is required to determine whether the discharged pollutants exceed the standards and whether the components of pollutants have changed.

On a daily basis, law enforcement officers face the problem of being unable to investigate illegal acts because of a lack of technical support.

5.2.6 Recommendations for improving environmental enforcement effectiveness

The following recommendations are to ensure the effective implementation of the Environmental Protection Law and other environmental protection laws

5.2.6.1 Improve the environmental regulatory system and environmental monitoring system

(1) Optimize the environmental management system, combine centralized regulation and decentralized regulation, and integrate law enforcement and supervision

Firstly, establish a uniform Environmental Administrative Organization Law to create a clear division about the rights and liabilities of competent environmental administrative departments as well as other relevant departments.

Clarify the differences between unified monitoring and separate responsibility under the Environmental Protection Law.

Give comprehensive coordination and unified management authority to the environmental protection departments to avoid the occurrence of buck passing arising from unclear rights and liabilities.

If possible, follow the ideas of super-ministry system reform to establish a super-ministry of environmental protection responsible for unified guidance, coordination, and supervision of environmental protection activities.

Secondly, optimize the division of duty for environmental regulation between central and local governments. It is necessary to re-evaluate the effectiveness of the current system of simplifying administrative procedures and delegating powers to lower levels according to the principle of "combining central-level supervision and local-level regulation and integrating higher-level assessment and lower-level accountability".

Launch a new round of environmental governance reform, delegate administrative licensing and regulatory power to lower levels, and give intermediary organizations a role in providing technical services. Take back supervisory and assessment power from lower levels.

Apply the principle of "accountability of party committee and government", so as to ensure the local party committees and governments maintain a positive attitude to environmental regulation and fulfill their regulatory duties. This work could be started in the early stage of the 13th Five-Year plan.

Thirdly, build a high-level environmental management coordinating body for the current problems, especially for watershed and cross-regional pollution problems.

For example, set up a national environmental protection committee, locating the general office in the Ministry of Environmental Protection, set up a watershed environmental protection coordination body within each watershed, and set up a coordination body within each key area for atmospheric pollution prevention and control. This work may be started in the early stage of the 13th Five-Year plan.

(2) Improve accountability and supervision of party committees and governments at all levels for environment protection

There are two reasons for making the party committee and the government accountable in the field of environmental protection. Firstly, the progress of environmental protection requires the joint efforts of local party committee and local government. Secondly, in environmental management activities the local government is often held accountable for environmental pollution or accidents while the local party committee keeps out of it.

Generally speaking, major local decisions are made at the standing committee meeting or government work meeting. This means that the local party committee takes part in local environmental decision-making and so should also be responsible for the consequence of the decision-making.

The concept of "two responsibilities for one post" should be applied in the field of environmental protection because the protection of the environment is not just the responsibility of environmental protection departments alone, but also requires the

cooperation of other departments. If an investment promotion department only cares about the economic benefits of an enterprise to an area and ignores the possible environmental damage it may cause, there will never be an improvement in the environment no matter how strictly the local environmental protection department enforces the laws.

To implement the system of "accountability of party committee and government, two responsibilities for one post, and accountability of delinquent officials", the Ministry of Environmental Protection should work with the Organization Department of the CPC Central Committee and the Central Commission for Discipline Inspection (Ministry of Supervision) to formulate the procedural rules for questioning, accountability and rectification from September 2015 onwards, in accordance with the Measures for the Accountability of Party and Government Leaders for Damages to Ecological Environment (for Trial Implementation) issued by the General Office of the CPC Central Committee and the General Office of the State Council.

The procedural rules should provide for who will start the process of questioning a local party secretary, who shall cooperate, who shall investigate and collect evidence, and who shall impose punishment.

In addition, the National People's Congress and its standing committee should work for the relevant reforms, formulate the measures for the implementation of supervision and accountability for the environmental protection activities by local People's Congress and its standing committee at all levels, and require local People's Congresses and their standing committees to supervise and call the parties concerned to account for environmental problems in accordance with such measures.

5.2.6.2 Independent administrative law enforcement in accordance with law, without improper interference of local governments

The independent exercise of powers by environmental protection departments according to the law has always been a key to improving the environmental management system and strengthening environmental law enforcement. Much attention has been paid to the abuse of power by these departments and to the their capture by political power.

For example, the Water Pollution Prevention and Control Law promulgated in 2008 gave the environmental protection department power to order violators to dismantle illegally built drain outlets. However, the environmental protection departments have seldom exercised this power and it exists in name only. How to solve this problem? The answer is to emphasize the independence of the environmental protection departments.

The first recommendation is to strengthen the leadership responsibility of governments, especially local governments. Require that "the local people's governments at or above the

county level must assume the leadership responsibility for environmental law enforcement and regulation within their respective administrative areas" as specified in the Circular of the General Office of the State Council on Strengthening Environmental Regulation and Law Enforcement, letting the government be the backer of the environmental protection department, and thereby getting the environmental protection department out of its current predicament.

The second recommendation is to establish and improve the mechanisms for specifying government authority and responsibilities. In accordance with the requirements of the Decision of the CPC Central Committee on Major Issues pertaining to Comprehensively Promoting the Rule of Law adopted at the fourth plenary session of the eighteenth CPC Central Committee, clarify the responsibilities and authority of the environmental protection department and related departments to ensure that the government carries out all its statutory functions and duties in accordance with the law. This work may be started at the end of 2015.

5.2.6.3 Strengthen and promote environmental legal responsibility, enhance public participation and supervision

(1) Establish and improve the tenure accountability system

The recent Circular of the State Council General Office on Strengthening Environmental Regulation and Enforcement proposed a life-long investigation system for liabilities for eco-environmental damage. This system needs to be perfected.

The purpose of the system is to address the situation where directors and staff of environmental protection departments do not carry any responsibility for failures to enforce the law after transfer or retirement.

The new Environmental Protection Law gives environmental departments powerful teeth in the form of daily penalties and administrative detention. Up until now, the system has focused only on administrative punishments. It needs to be extended to examine the use of the powerful new tools provided by the new law.

(2) Improve civil public interest litigation, establish administrative public interest litigation, and give play to public supervision

China has launched various attempts at environmental public interest litigation. The following recommendations are based on experience gained from these attempts.

Firstly, improve the system of the procuratorate filing requests for public interest litigation. There is an irresistible trend for the procuratorate itself, as the organ of legal supervision, to file public interest litigation in place of the social organization. There are differences between the procedures of litigation filed by the procuratorate and social

organizations.

To improve efficiency, set up two procedures for the procuratorial organs filing environmental administrative public interest litigation. One should be for suspected illegal acts involving administrative organs. Under this procedure, the procuratorate should be able to make recommendations asking the administrative organ for rectification within a specified time. If the administrative organs think that they've done nothing wrong or refuse to rectify, then it will enter into the second procedure automatically.

According to the intra-Party regulations, before initiating environmental administrative public interest litigation, the procuratorial organs should submit the evidence for the case to the local Party committee at the same level for discussion. If the standing committee of the local Party committee coordinates successfully and the administrative organ corrects its mistakes in time, the procuratorate will not file the case. Otherwise it will. This method recognizes the organic connection and coordination between the intra-Party regulations of environmental protection and national legislation to reduce political risks.

Secondly, loosen the restrictions on social organizations filing public interest litigation. The social organizations willing and able to file environmental public interest litigation are really limited. This undermines the whole system. The qualifications allowing social organizations to take part in environmental civil public interest litigation needs to be broadened to make it easier for environmental protection organizations to file litigation. For example, reduce the time limits for specialized environmental protection public interest activities and reduce the requirements for registration. It is recommended that registration according to law anywhere in the country should be enough.

The third recommendation is to establish a system of environmental administrative public interest litigation allowing individuals and organizations to file these cases during 2025—2030 after the completion of economic and social transition. This is a medium-term goal.

5.2.6.4 Strengthen capacity for implementation and enforcement

Implementation and enforcement of environmental laws requires adequate staff with capacity to do the job, adequate financial resources and the support of the public. It is necessary to build talented teams, use special funds, conduct publicity and mass education, and to introduce and develop advanced technology to guarantee effective implementation and law enforcement.

(1) Set up the entry qualifications for law enforcement personnel, and strengthen training of law enforcement personnel

Implementation and enforcement is carried out by people, many of whom work at the

grassroots level. If they are unqualified to do the work assigned to them, the goals of the legislation will not be achieved. The quality of environmental administrative enforcement officials directly determines the efficacy of environmental laws and regulations. Consistent with the provisions of the Circular of the State Council General Office on Strengthening Environmental Regulation and Enforcement, this reports makes the following training recommendations.

Firstly, establish the entry threshold for environmental law enforcement and regulation personnel in terms of profession, education background, qualifications and record of service, laying a foundation for the building of a qualified environmental law enforcement and regulation team.

Secondly, there should be a strong emphasis on the training of enforcement officials at the grass roots level. They are the front line of environmental administrative enforcement. Only by improving the quality of grassroots enforcement officials can we make the fundamental improvement required for effective implementation and enforcement of China's environmental laws.

Thirdly, there should be training of all the current environmental enforcement officials. Only after being tested and meeting the standards for a position, should they be able to undertake the functions of that position.

(2) Reinforce public education

Publicity and mass education are important ways to lead the public to take part in environmental law enforcement. It will reinforce the authority of environmental laws, improve public awareness of the need for environmental protection, and gain public support for the work of environmental protection departments

The decision of the Fourth Plenary Session of the 18th Central Committee of the Communist Party of China (CPC), clearly resolved to "perfect the publicity and mass education mechanism of law popularization" and to "bring law-related education into the contents of constructing spiritual civilization, launch mass law-related cultural activities, perfect the public interest law popularization system of media, and strengthen the utilization of new media and new technology in law popularization to improve its effectiveness".

Therefore, publicity and mass education about environment protection must continue to be reinforced, thereby promoting and increasing meaningful and orderly public participation.

(3) Standardize environmental law enforcement and monitoring equipment

The standardization of monitoring equipment would help the environmental protection

departments to regulate a great number of enterprises with limited manpower.

The Circular of the General Office of the State Council on Strengthening Environmental Regulation and Law Enforcement recognizes, for example, for the need for equipment for investigation and evidence collection, and the need to ensure the availability of vehicles for grass-roots regulation and enforcement. More than 80% of the environmental monitoring agencies are required to be equipped with and use portable handheld terminals for the standardization of law enforcement activities by the end of 2017.

The Circular also requires technical monitoring to be strengthened, for example, automatic monitoring, satellite remote sensing, and unmanned aerial vehicles as well as improving the mechanism to ensure adequate funding by including the funds for regulation and enforcement into the financial budget. The Circular establishes a timetable for the popularization of advanced monitoring technologies among the environmental monitoring agencies, showing China's firm resolution of stepping up efforts to promote the application of advanced monitoring technologies.

As a practical example of what can be achieved, Shaoxing started the preparation and establishment of the automatic pollution source monitoring system in 2007, and it has invested 70 million RMB for environmental monitoring capacity building as of 2011. The system has covered 80% of wastewater discharge enterprises in Shaoxing city. It monitors the waste water discharge situation of the city effectively, and masters the regular patterns of waste water discharge from pollution sources by comparing the enterprise waste water discharge data from different seasons and times, providing an important basis for the rational use of resources for law enforcement.

(4) Standardize the use of special funds for environmental protection

As environmental protection becomes more and more important and complex, the funds required also increases. Special funds are essential. The environmental protection special fund is a major initiative. This report makes the following recommendations for perfection of the environmental protection special funds.

Firstly, perfect supervision and accountability for the funds. Separate construction from management to avoid the situation where the one department is both the "chess player" and the "rule maker".

Secondly, introduce performance audits of the use of environmental funds, evaluating both the expenditure of the funds as well as the performance of environmental protection departments and their staff.

Thirdly, establish detailed procedures for the use of funds to ensure due process and supervision.

5.3 Acknowledgments

Our gratitude first goes to China Council for International Cooperation on Environment and Development (CCICED) for establishing and supporting the research project “Rule of law and ecological civilization construction” which provides a platform for Chinese and foreign experts to discuss and communicate with each other. We also want to extend special thanks to CCICED chief foreign adviser Dr. Hanson and supporting expert panel member Dr. Konate for their advice in project implementation, and to the Secretariat and International Support Office of CCICED for their organization and coordination.

The task force of “Rule of law and ecological civilization construction” also receives the support and assistance from environmental law experts at China University of Political science and Law, Renmin University of China and Peking University, and our sincere gratitude also goes to them.

Chapter 6
Eco-environment Risk Management

6.1 Current status and future prospects of environmental risks in China

6.1.1 Definition of environmental risk

6.1.1.1 Concept of environmental risk

Environmental risk refers to the combination of the probability and consequence of adverse environmental outcomes from an event or activity which is induced by natural causes or human activities. It is determined by assessment of the probability of the event or activity occurring, the exposure of environmental receptors to the sources of risk, and the severity of the consequence or loss. It can be expressed as:

Environmental risk = extent of losses due to the event/activity × probability of it occurring

According to this definition, an event or activity can be defined as an environmental risk if it has a probability to cause environmental damage, no matter what the causes of the event or activity (natural or human). The losses include not only physical effects but also their social valuation.

6.1.1.2 Environmental risk system and environmental risk chain

In the reality of environmental risk management, the concept of environmental risk is often more in line with the common cognitions of stakeholders and with environmental risk management practices than the above formula. The environmental risk system is a complex entity which comprises environmental risk sources, environmental risk receptors, and control mechanisms (Figure 6-1).

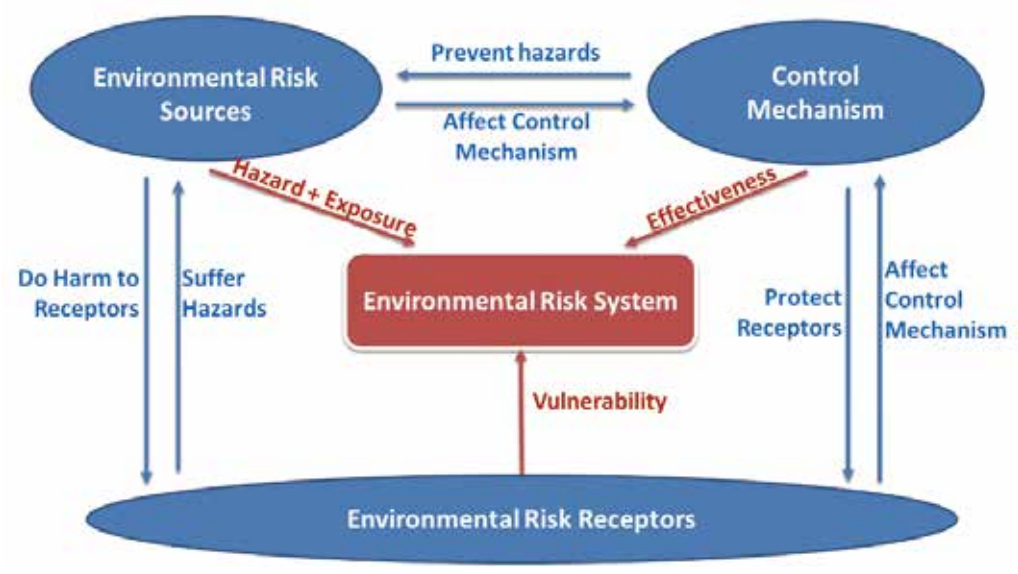


Figure 6-1 Environmental risk system

Environmental risk sources: the sources of possible environmental hazards include the precursors of environmental risk events or activities. Risk sources can be the production, transportation, utilization, and storage of flammable and explosive materials or toxic chemicals and hazardous materials, treatment of the "three wastes" (waste water, waste gas, and solid waste), as well as long-existing polluted media such as emissions yielding chronic air pollution and soil and groundwater pollution at contaminated sites. Note that safety accidents inside industrial facilities,such as chemical explosions, may not automatically pose hazards to the external environment outside the facility, but the probabilities for environmental impacts do exist.

Environmental risk receptors: entities such as humans, ecosystems, and socioeconomic structures that will suffer from risk consequences.

Environmental risk control mechanisms: Policies, measures, technologies and practices to reduce environmental risks. These include environmental risk source controls at industrial facilities, management mechanisms and practices at facilities, and the management of transport networks. Control mechanisms can be classed as primary or secondary. Primary mechanisms refer to control systems to avoid risk factors (such as energy and pollutants) being released from risk sources. The failure of primary control mechanisms includes the release of energy and pollutants in connection with natural disasters, and mechanical and human failures. Secondary control mechanisms refer to the

systems for controlling the transport of released risk factors (e.g., blocking and reducing pollutants to avoid them entering into environmental media), and measures for reducing the exposure posed to receptors (e.g., evacuation of potentially exposed people). For environmental risks induced by natural disasters, secondary control mechanisms are more important for alleviating environmental damage.

Environmental risk events or activities can involve all components of the environmental risk system and they comprise the basic processes that constitute the environmental risk chain (Figure 6-2).

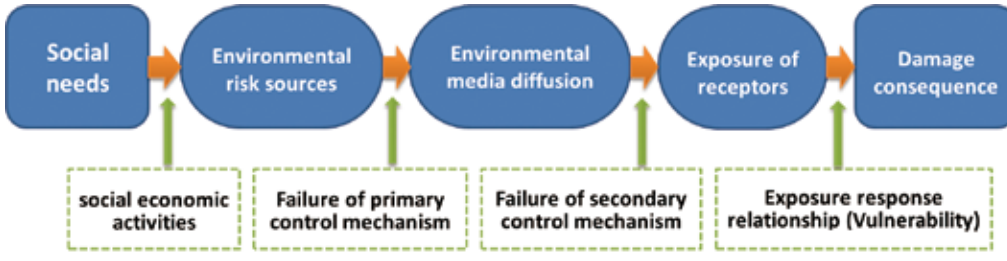


Figure 6-2 Environmental risk chain

In the whole process from social needs to risk damage, causes of environmental risks and their hazards may exist in any node of the risk chain. The purpose of environmental risk management is, first of all, to reduce the probabilities of environmental risk events happening. The purpose is also to reduce the damage if a risk event does happen at any node of the environmental risk chain. Damage can be minimized through laws, regulations, policy, and technical measures. These steps help reduce the environmental risks facing society and help secure regional and human health, environmental quality, and the functioning and integrity of ecosystems.

6.1.1.3 Determination of categories and scope of environmental risks

Based on the environmental risk chain, the characteristics of the process from environmental risk sources to damage are different for different types of risks. Since there is no unified risk classification system in China, for the purposes of this report three categories of environmental risk have been defined along the spectrum from chronic to acute consequences (Figure 6-3):

Detailed descriptions of three categories of environmental risks are shown in Annex 6-1.

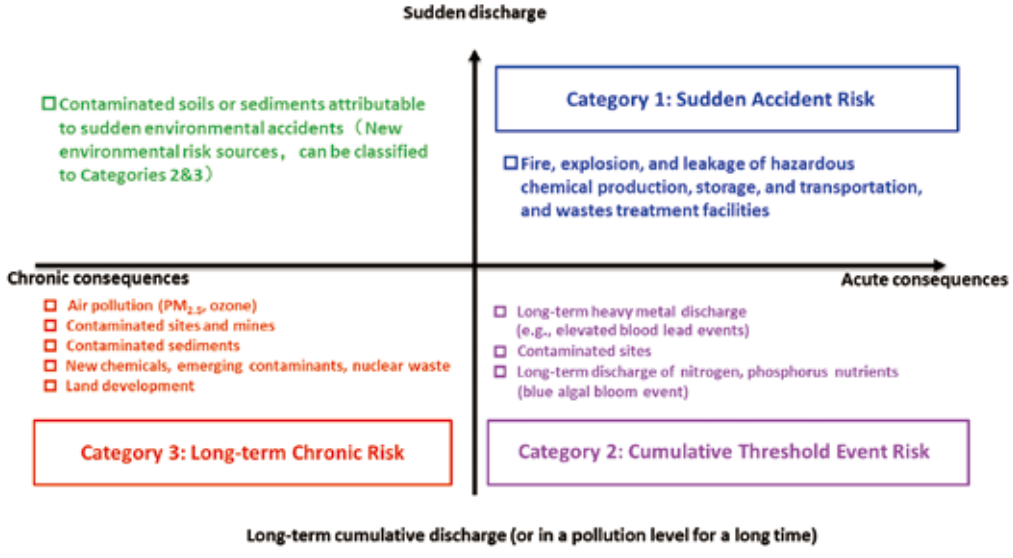


Figure 6-3 Categories of environmental risks

6.1.2 Current status of environmental risks in china

6.1.2.1 Spatial and temporal characteristics of environmental risks in China

(1) Accidental environmental pollution incidents

A recent study[1] analysed accidental environmental incidents occurring during 1993—2014 on the basis of data provided in the *China Environmental Statistical Yearbook*, and as well collected 1,065 detailed case studies during 2000—2010 through the *Safety and Environment Journal*, and from internet and media reports. These records include the first two categories of risk: accidental environmental events and activities where a threshold is reached. Since the data do not distinguish between Categories 1 and 2, we analysed the spatiotemporal characteristics of all these incidents considered together. As for Category 3 risks, this study provides analysis based on existing results from other researches.

The frequency of environmental pollution incidents has fluctuated with a declining trend (Figure 6-4). This is attributable to improvements in environmental risk management driven by environmental risk events. Environmental pollution incidents happened often during the early 1990s, with 2,500 to 3,000 cases. From 1994 to 2000 they fluctuated at high levels and then decreased and, after 2005, stabilized at around 500 per year. Little decrease has occurred in recent years.

1 Bi, J et. al., 2012. Research report of China's 863 project of "Research on Integrated Technology System of Major Environmental Pollution Accident Emergency Response", with data updated to 2014. Unpublished.

Serious environmental accidents continue to happen, however, such as the Dalian oil pipeline explosion in 2010 and the Tianjin explosion in 2015. These show that accidental pollution event risks in China are still prominent. Although missing reports and concealment of pollution incidents produce some uncertainties in the data, the figures still reflect the overall trend of environmental pollution incident risks in China.

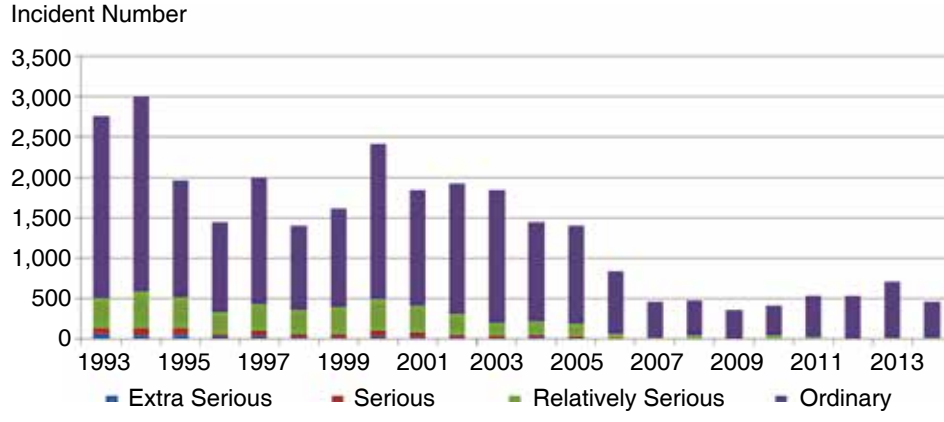


Figure 6-4 Environmental Pollution Incidents in China (1993—2014)[1]

Unsurprisingly, the spatial distribution of environmental accidents is broadly consistent with the spatial distribution of major risk sources. Various types of pollution incidents happen where there are major risk sources. The areas with dense risk sources have more frequent pollution incidents, especially in eastern coastal regions and Hunan and Sichuan. Areas with fewer risk sources have fewer incidents, such as the northwest and northeast regions. Guangxi province has fewer major risk sources but it has a high frequency of incidents, an anomaly due to low environmental management capacity and a large industrial infrastructure. Other studies of spatial distribution of accidents reach broadly similar conclusions[2, 3].

This study also analysed sectoral risk sources (Figure 6-5) based on a survey of 1,065 environmental pollution cases during 2000—2010.The results are broadly consistent with the literature cited above. Clearly, serious sector structural environmental risks exist in

1 Statistics on extra serious, serious, relatively serious, and ordinary pollution events in *the China Environmental Statistical Yearbook*.

2 He-Da, Zhang and Xiao-Ping Zheng. "Characteristics of hazardous chemical accidents in China: A statistical investigation", *Journal of Loss Prevention in the Process Industries*, 25, (2012), pp. 686-693.

3 Li, Yang, et al. "Statistical analysis of sudden chemical leakage accidents reported in China between 2006 and 2011". *Environ Sci Pollut Res 21*, (2014), pp.5547-5553.

China. The order of the twelve sectors with most pollution incidents in China is: chemical raw material and products, water production and supply, road transportation, waterway transportation, paper making and paper products, ferrous/non-ferrous metal mining, ferrous/non-ferrous metal smelting/processing, petroleum processing/coking/nuclear fuel processing, power/heat generation and supply, agricultural products/food processing, textile manufacture and petroleum/natural gas exploration.

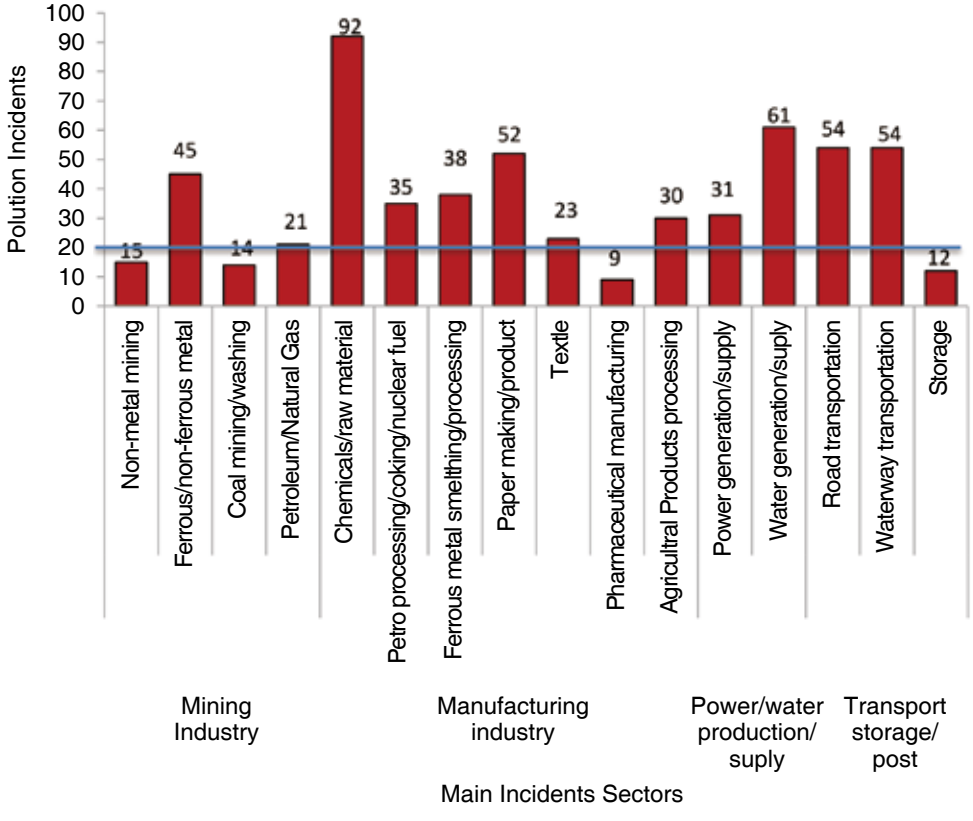


Figure 6-5 Sectoral Distribution of Main Incidents[1]

The study also looked at accidental environmental risks that are due to industrial layout. Many chemical production enterprises are located in densely populated areas, either on or near important water sources, rivers, lakes, wetlands, and ecological protection areas. These enterprises can become major environmental risks.

Results of the *Inspection of Environmental Risks and Chemicals in Key Sectors and Enterprises*, conducted by MEP in 2009, show that among 46,000 key sector and chemical

1 Bi, J et. al., 2012. Research report of China's 863 project of "Research on Integrated Technology System of Major Environmental Pollution Accident Emergency Response". Unpublished.

enterprises, 12.2% are located within 1kilometre of drinking water and ecological function protection areas; 10.1% are within 1kilometre of densely populated residential areas; and 72% are along key rivers and basins such as the Yangtze, Yellow, and Pearl rivers, and Taihu Lake near Shanghai.

According to the *Report of Environmental Exposure Related Activity Patterns Research of Chinese Population* conducted by the Chinese Academy of Environmental Science, about 110 million people live within 1 kilometre of seven major polluting enterprises, and 140 million live within 50 metres of main roads. This report also examined the main causes for accidental environmental pollution incidents.

A recent study[1] of 1605 incidents divides the reasons for primary control mechanism failure into human factors and external factors such as equipment and weather conditions. Human factors are the main reason for incidents, accounting for 50% to 70%. Equipment failure such as wear, corrosion, aging, or extended use contributes to 10% to 20%. Poor institutional systems account for about 30%, with a rising trend.

Human factors can be divided into five types: violation of the law, non-compliance of operation, operational error, inadequate management, and weak capacity. Violation of the law accounts for 38.8% of total incidents and is the major reason. In adequate management contributes to 36.2%. Other surveys of the causes of China's accidental pollution incidents point to similar causes, although the percentages differ among these studies[2].

Finally, this study looked at the current status of *China's emergency response to environmental incidents*. It selected 50 cases from *Typical Environmental Accidents Cases (Part I)* (MEP Emergency Response Lead Group Office, 2011) to analyse the main reasons for the ineffectiveness of responses. The results (Annex 6-2) show that China's response capacity is weak. It lacks effective emergency response plans and scientific support, leading to improper response measures and poor control of environmental effects.

(2) Long-term and chronic environmental risks in China

In addition to the above-mentioned types of environmental risks, there is a third type that has existed for a long time in China, but has been neglected because its effects are not

1 Bi, J et. al., 2012. Research report of China's 863 project of "Research on Integrated Technology System of Major Environmental Pollution Accident Emergency Response". Unpublished.

2 He, Guizhen et al., Why small and medium chemical companies continue to pose severe environmental risks in rural China. *Environmental Pollution*, 185, (2014), pp.158-167.
Li, Yang et al., Statistical analysis of sudden chemical leakage accidents reported in China between 2006 and 2011. Environ Sci Pollut Res 21, (2014), pp.5547-5553.
Zhang, He-Da and Xiao-Ping Zheng, Characteristics of hazardous chemical accidents in China: A statistical investigation. *Journal of Loss Prevention in the Process Industries*, 25, 686-693.
Zhang, He-Da and Wei Liu, Causes of hazardous chemical accidents in China. *Journal of Industrial Safety and Environmental Protection*, 11, (2012), pp.10-11.

sudden and acute. These are long-term or chronic environmental risks, and they include: soil contamination risk, health risk from accumulated air pollution, health and ecological risk from new emerging pollutants, and risk from regional development and large-scale infrastructure development on ecosystems.

① Soil pollution

With increasing industrialization and urbanization, large areas of China's lands are gradually becoming contaminated, bringing significant environmental and health risks. The World Bank report *Current Status of Contaminated Site Remediation and Redevelopment* (2010) indicates that land contamination has become an increasingly serious environmental pollution problem in China. MEP and the Ministry of Land and Resources conducted the first national soil pollution investigation. The results show that the overall condition of soil pollution is problematic. Over 16.1% of the investigation sites exceed the soil quality standard. The degraded soil quality of cultivated land is worrying. Soil pollution problems in abandoned industrial and mining lands are prominent.

Soil quality is influenced by many factors. Soil pollution in China results from the long-term accumulation of economic and social development pressures. Industrial, mining, and agricultural activities and high natural background values are the major reasons for soil pollution in China. The pollution of cultivated soil can pose serious threats to agricultural product safety. The redevelopment of industrial and mining legacy contaminated sites may pose long-term and chronic health risks to the public, especially where there are heavy metals and persistent organic pollutants (POPs) present. For example, analysis of soil heavy-metal health risks from 62 mining areas in 19 provinces[1] shows that most of the areas have a carcinogenic risk[2] of between 1×10^{-4} and 1×10^{-5}, with a certain proportion of mining areas having a carcinogenic risk over 1×10^{-4}. Clearly, heavy-metal contamination in mining areas poses fairly high carcinogenic as well as non-carcinogenic risks to human health.

Although some practices in polluted soil management and remediation have been introduced, over all the number of contaminated sites remains unclear, and development of relevant laws and regulations still lags. A soil risk management system adapted to the China's situation has not yet been put in place.

1 Li, Z. et al., A review of soil heavy metal pollution from mines in China: pollution and health risk assessment. *Science of the total environment*,468, (2014), pp.843-853.

2 Based on risk assessment methodology defined in the Technical Guidelines for Risk Assessment for Contaminated Sites (HJ25.3-2014, MEP). The acceptable level for carcinogenic risk of a single pollutant is defined 1×10^{-6}.

② Air pollution

In recent years, fine particulate matter ($PM_{2.5}$) air pollution has become a prominent environmental issue in China. Numerous epidemiological studies around the world have demonstrated that $PM_{2.5}$ is associated with negative health effects. The 2010 study by the Global Burden of Disease (GBD) showed that outdoor exposure to $PM_{2.5}$ was the fourth most serious mortality factor in China and was associated with 1.23 million deaths per year. The study calculated an average annual risk of dying from this cause when living in China of approximately 10^{-3} (Figure 6-6).

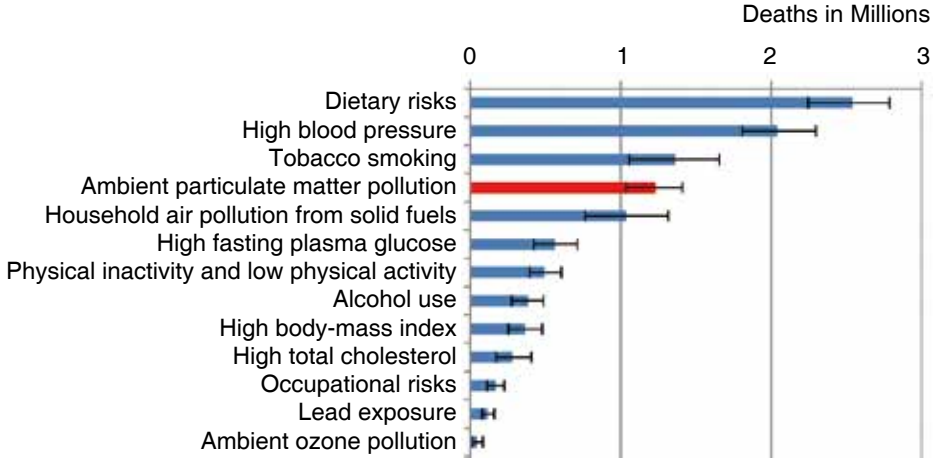


Figure 6-6 Distribution of premature death risks of China from Global Burden of Disease study 2010 [1]

Similarly, Lelieveld et al. (2015) estimated 1.36 million deaths per year in China in the year 2010 due to outdoor exposure to $PM_{2.5}$ and ozone.[2] Rohde and Muller (2015), using new monitoring data from China's several hundred ground-level air reporting stations (showing $PM_{2.5}$ levels in China around 50 μg/m^3 or higher, above the ambient regulatory limits setin China at 35 μg/m^3, in the European Union (EU) at 25 μg/m^3 and in the US at 12 μg/m^3), estimate that there were 1.6 million deaths per year in China in the year 2014

1 Yang G, et al., Rapid health transition in China, 1990—2010: findings from the Global Burden of Disease Study 2010. *The Lancet* 381, (2013), 1987-2015.

2 Lelieveld, J., J. S. Evans, M. Fnais, D. Giannadaki & A. Pozzer (2015). The contribution of outdoor air pollution sources to premature mortality on a global scale. *Nature* 525: 367-371 (17 September 2015).

due to $PM_{2.5}$ or more than 4,000 deaths per day.[1] In addition to these heavy health burdens caused by outdoor air pollution, almost as many lives are lost in China due to indoor air pollution, primarily from burning solid fuels for cooking and heating (Figure 6-6).

The long-term health harm of PM pollution cannot be ignored any more. The public has gradually recognized the health risk of $PM_{2.5}$ along with a more general increase in environmental awareness. As a result, China's *new Ambient Air Quality Standards* (GB 3095-2012) included $PM_{2.5}$ and marked a shift in the environmental management model from an orientation on pollution control toward an orientation on improving environmental quality.

Currently, the public has high concern about $PM_{2.5}$. Meanwhile there is insufficient concern about other pollutants that also bring health and ecological risks and that will gradually become a bigger problem. These include short-lived climate pollutants or SLCPs (that is, black carbon and tropospheric ozone) as well as carbon dioxide and methane emissions acting as greenhouse gases.

③ Water pollution

The situation of water pollution in China is serious. According to the *Environmental Quality Bulletin* released by MEP, the proportion of water inferior to class V ("inferior V water")[2] is 9.2% for state-controlled monitoring sections in seven river systems in 2014. Inferior V water sections are mainly located in the Haihe, Yellow, Yangtze, Pearl, and Huaihe rivers. In 2013, the Chinese Center for Disease Control and Prevention (CCDC) issued a report titled *Water Environment and Gastrointestinal Cancer Death Atlas in Huaihe River Basin*, which shows consistency between heavily polluted waters and high gastrointestinal cancer rates in the Huaihe River Basin. The long-term environmental health risk due to water pollution cannot be neglected.

④ New chemicals and emerging pollutants

Emerging pollutants are chemical pollutants that are newly identified or were not confirmed in the past-and therefore are not listed in relevant regulations-and that pose risks to human health and the environment. These pollutants are normally generated from human activities, and will not easily decompose in the environment. Many newly introduced materials and chemicals have shown obvious health hazards and an environmental

1 Robert A. Rohde and Richard A. Muller (2015). Air Pollution in China: Mapping of Concentrations and Sources. Univ. of California at Berkeley, http://berkeleyearth.org/wp-content/uploads/2015/08/China-Air-Quality-Paper-July-2015.pdf.

2 China's *Environmental Quality Standards for Surface Water (GB 3838-2002).* Surface water quality is classified into five classes with different functions. Class I is the highest quality and applicable for river sources and nature reserves, while Class V is the lowest and applicable for general agriculture and landscape use. http://kjs.mep.gov.cn/hjbhbz/bzwb/shjbh/shjzlbz/200206/t20020601_66497.htm.

presence, for example, nano material pollution, fluorinated organic compounds, environmental endocrine disruptors, antibiotics, and flame retardants. In recent years, more studies show that emerging pollutants have been detected in environmental media at many places in China, and so the risk of these pollutants to the environment and human health deserves attention.

Taking antibiotics as an example, research conducted in Jiangsu and Zhejiang by Fudan University on exposure of children to multiple antibiotics shows that among 1000 children tested, at least 58% were detected with one type of antibiotic in urine samples and 25% were detected with two types of antibiotics[1]. Furthermore, the *Ten Years Investigation Report of Antibiotics in China* issued by CAS Guangzhou Geochemistry Institute in 2015 concluded that the resistance of bacteria to antibiotics can be partly attributed to antibiotics found in the environment.

Thus, the environmental and health risks of emerging pollutants need to be addressed in environmental risk management to avoid a repetition of the way that pollution from heavy metals, organochlorine pesticides, and PCBs has become a major environmental risk.

⑤ Solid waste

Along with rapid industrialization and urbanization, environmental pollution due to industrial solid waste (especially hazardous waste) and municipal solid waste are becoming more prominent.For example, it is estimated that up to 5 million square meters of soil have been contaminated by chromium slag[2]. Improper disposal of solid waste risks damage to environmental quality and to ecosystem and human health. Solid waste issues may cause social conflict, such as the public protest events against waste incineration projects in recent years. Environmental risks of solid waste warrant review.

⑥ Ecological impact of regional development

With rapid industrialization and urbanization, China's long-term and chronic ecosystem changes caused by regional development are a part of the environmental risk management challenge. The *Ecological Footprint Report of China 2012* indicates that since the 1970s the consumption of renewable resources in China has exceeded their capacity to regenerate. Ecosystems face ever increasing pressure from population and development. The long period of overdevelopment has resulted in serious degradation of ecosystems. Regional development has led to the continuous decrease of natural ecosystems such as forest, bush, grassland, and wetland, as well as the decrease of natural habitat quality and

1 http://www.chinadaily.com.cn/hqgj/jryw/2015-04-13/content_13536869.html.

2 *From the 12th FiveYear Plan for Hazardous Solid Waste Pollution Control of China*.

biodiversity.

Ecological risks brought on by regional development have major implications on national ecological security. In 2015, the State Council issued the *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*, signalling that the "Belt and Road" is in the process of moving from concept to reality. The Silk Road Economic Belt will pass though sensitive ecosystems in Western China. Large-scale infrastructure construction and regional development may pose further threats to regional ecosystems.

⑦ Radiation sources and nuclear wastes

Radiation sources have been widely used in different sectors including medical and health care, scientific research, and industrial production. Radiation sources may affect the environment and public health if there is improper management. The radiation sources census conducted by the former Environmental Protection Administration, Ministry of Health, and the Ministry of Public Security in 2004 shows that there were more than 10 thousand units with more than 140 thousand radiation sources in China. Radiation source accidents have occurred in recent years, including the radiation source lost incident in Nanjing in 2014[1]. Clearly, China's radiation source management levels need to be improved.

Meanwhile, China's nuclear power industry is developing rapidly. As of March 2015 23 nuclear power units were operating while 26 were under construction. Furthermore, 45 units are "under preparation" and 177 are planned[2]. With more use of nuclear power in China, the environmental risks of nuclear waste disposal will become a prominent issue. The inherent hazards of used nuclear fuel are primarily its radiotoxicity and its chemical toxicity. Due to radioactivity and cumulative characteristics, the long-term presence of even small amounts of radiation sources and nuclear wastes may cause long-term and cumulative health damage to humans and the environment.

6.1.2.2 Current situation of public perceptions of environmental risks in China

Although the frequency of environmental pollution incidents has shown a decreasing trend since the 1990s, the level that the public is likely to regard as acceptable or tolerableis also decreasing. This leads to a new characteristic of environmental risk in China: increasing public demand for environmental protection (Figure 6-7).

1 http://news.xinhuanet.com/politics/2014-05/11/c_126484963.htm.

2 Park Duri (PIAO, Douli), Study on China's nuclear power development in coastal regions and environmental issues, undergraduate thesis of Peking University, 2015. Park Duri obtained these data from *World Nuclear Association, Medium and Long-term Development Plan for Nuclear Power (2005—2020), and Action Plan of Energy Development Strategy (2014—2020).*

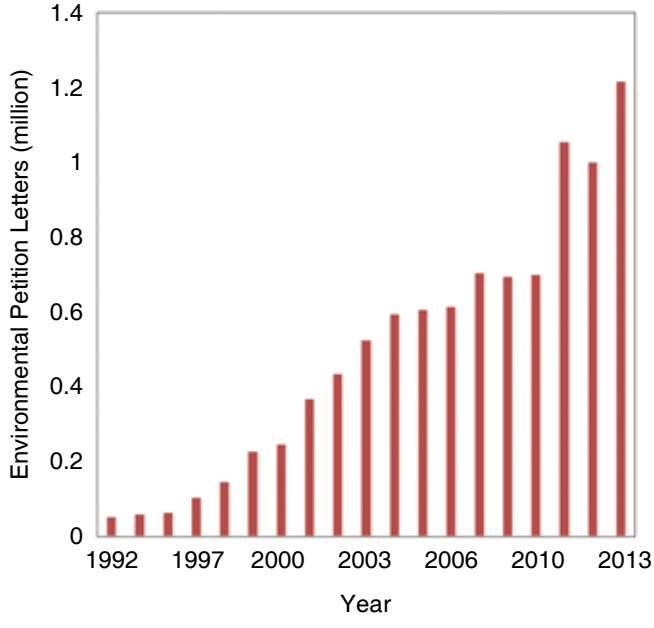


Figure 6-7 National Environmental Complaints Letters[1]

Note: Environmental complaints though internet and telephones were counted separately. Data after 2011 include complaints from letters, internet, and telephones.

This demand is seen with the increase in environment-related mass protests every year. The adverse effects of numerous pollution incidents have resulted in growing resentment, panic, and public resistance to industries posing potential risks, and the "not in my backyard" effect. Mounting public demands and their dissemination through various media are having more influence on infrastructure construction projects and policy development, such as the many protests against the PX (para-xylene) chemical and waste incineration projects which have occurred in recent years[2]. Environmental complaints and demands have become one of the main challenges in China's socioeconomic development.

Therefore, environmental risk management cannot be isolated from the public's perceptions of risk and acceptable risk levels. On the one hand, as long as actual environmental risk levels are higher than what the public will tolerate, conflict will be inevitable. On the other hand, the large gap between actual risk levels and the public's

1 Data from China Environmental Yearbook.

2 http://www.mzyfz.com/cms/minzhuyufazhizazhi/jujiaoyuzhuanti/html/696/2012-11-30/content-591810.html.

risk perception may be caused by lack of knowledge, not by policy choice. Information dissemination through news media may result in amplification or exaggeration of risk information, which may magnify perceptions beyond the actual risks, especially regarding sudden highly visible incidents.

At the same time, there are also many instances of the public being unaware of the risks surrounding them, especially chronic long-term exposures. The public's misunderstanding about actual risk levels (either overstating or understating them) could make it difficult to achieve the objectives of risk management.

One should keep in mind that public risk perception is not uniform: there is a wide distribution of preferred risk levels that individuals find acceptable or tolerable. Public estimates of acceptable risk levels are also not uniform among risk sources. Data about public perceptions are important to understand public concern and to design better communications about risks and more socially acceptable risk management strategies.

6.1.2.3 Current environmental risk levels in China

According to the above analysis, types of environmental risk are complicated and so it is inappropriate to use a single indicator to characterize environmental risk levels. For this study, seven representative indicators from seven environmental risks were selected to characterize current environmental risk levels in China: accidental pollution events, soil, air, and water pollution, climate change, economic loss, and public complaints. Together, these indicators can form an "environmental risk rose" (Figure 6-8).

Overall, environmental risk levels in China remain high. Note that this figure presents the result of only a preliminary and semi-quantitative analysis and that the distances between circles are not to scale-the points around a given circle do not necessarily represent equal levels of risk or seriousness. Specific and systematic environmental risk assessment is needed in China to add more indicators to complete the risk rose and obtain more accurate risk level assessments. Detailed descriptions of the environmental risk rose are shown in Annex 6-3.

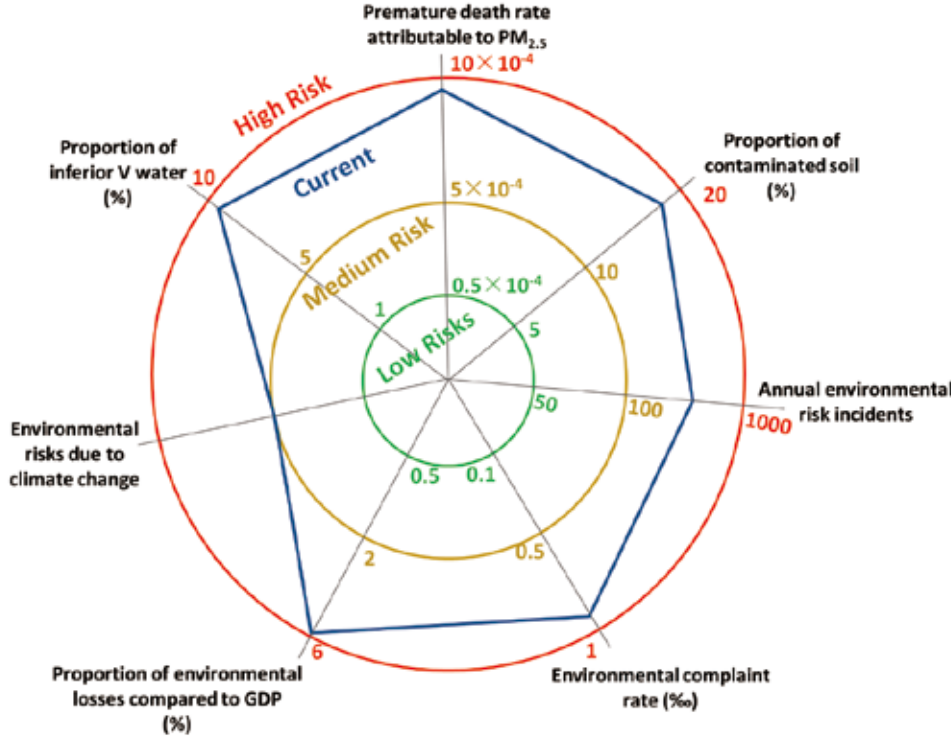


Figure 6-8 Environmental risk rose of China (Based on Annex Table 6-3-1; the blue solid line represents current risk levels)

6.1.3 Prospects for environmental risks in China

6.1.3.1 Overall prospects for environmental risk levels in China

Based on the analyses of prospects for driving forces of environmental risk levels and public risk perceptions(Annex 6-4), this study puts forward three management scenarios to discuss the future prospects for environmental risk levels.

Scenario 1: Environmental management will be maintained in the current mode, that is, event-driven, focused on environmental quality without systematic risk management (Business as Usual scenario).

Scenario 2: A systematic environmental risk management system is established.

For Scenario 1 and Scenario 2, the study does not consider the effects of environmental risk communication and engagement.

Scenario 3: Based on Scenario 2, the effects of environmental risk communication and engagement are also incorporated.

Figure 6-9 shows the historical and future prospects for environmental risk levels and public environmental risk acceptance levels. It should be noted that the lines are illustrative. Levels of actual risks, and of public acceptance of risk, are more complex and multifaceted than can be depicted in simple lines. The scientific basis for claiming that environmental risk was much higher in the past is based on the historical trend of accidental pollution events, but there is a lack of information about other risks, particularly long-term chronic risks.

The ability of a new risk-based environmental management system to reduce overall risk is anticipated, but the line shown here (Scenario 2) is a qualitative and intuitive perspective and is not based on a forecasting model. Is it clear in some cases that the public risk acceptance level will be higher following risk communication and engagement (Scenario 3, blue area with black boarder) than the cases without communication (grey line), because communication and engagement will reduce rumours and fears. In other cases communication and engagement may increase the awareness level of previously neglected risks and hence decrease the acceptance level. The overall trend of risk acceptance level is expected to decrease, with early involvement of risk communication and engagement,which can reduce unnecessary public concerns.

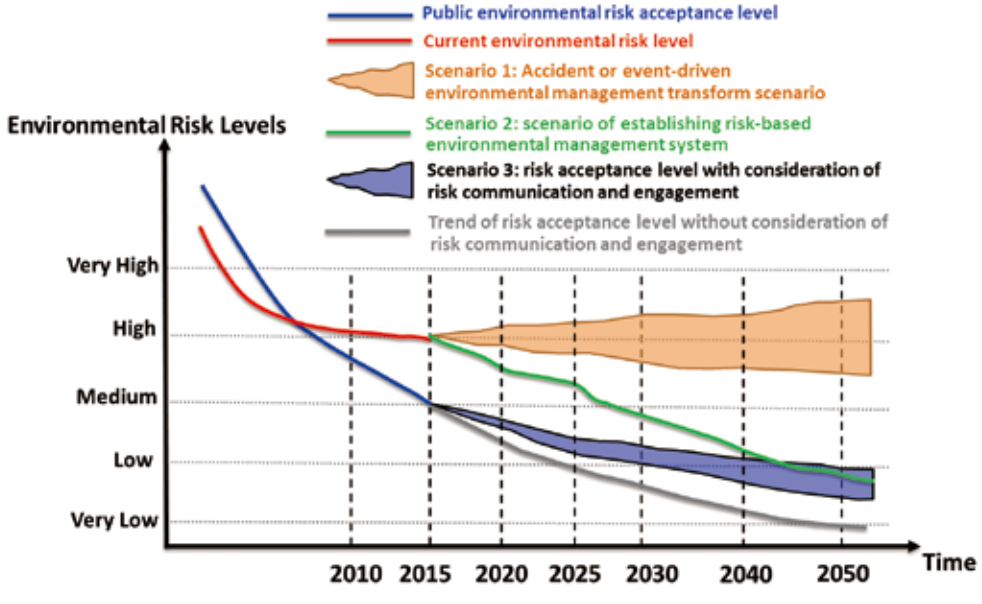


Figure 6-9 Prospects for environmental risk levels and public environmental risk acceptance levels in China

(1) Historical trends

An underlying premise in Figure 6-9, indicated in the red line for current risks, is that, driven by environmental events, environmental risk management level shave been improving in recent years, that is, current risks have declined in response to new policies. For example, since the Songhua River water pollution accident in 2005, China has implemented a series of measures to address sudden pollution accidents. After a series of heavy metal pollution incidents, China issued the 12th *Five-Year Plan of Comprehensive Heavy Metal Pollution Prevention*. The overall accidental environmental risk level has kept decreasing since the 1990s (red line) which is attributed to improvement in environmental risk management levels. This may depict the trend for acute accident events, but it may not represent the trend for long-term chronic risks which appears to have been increasing through this period (see Section 6.1.2.1 above). The large increase in risk sources, for example, for heavy chemical industrial capacity and combustion of coal, and a generally higher ecosystem vulnerability may thus point in the direction of higher risk levels over time. Latent risks from years of chronic air, water, and soil pollution are beginning to materialise over time.

Meanwhile, along with increases in national income and education levels, the public acceptance levels for environmental risk are decreasing more rapidly than the actual environmental risk level (blue line). In recent years (especially the last 10 years), public risk acceptance levels have been lower than the actual environmental risk levels. The gap between them keeps growing, which contributes to continuing social conflicts.

(2) Future prospects

Figure 6-9 offers three possible scenarios. These are “educated perspectives” and are not based on data or forecasting models.

Scenario 1: Driven by economic growth and industrialization (especially the growth of heavy chemical industries and coal combustion), the pressure on environmental risks will keep growing. However, based on historical experience-where environmental management responses were driven by accidents or by acute environmental risk events-the increasing ambition of environmental risk management policies and the progress of environmental protection science and technology will limit the increase in environmental risk to some extent. Environmental risks which have been known for some time will stabilize or decrease slowly. Meanwhile, emerging risks will complicate the environmental risk situation. The environmental risk prospect in this scenario includes uncertainties (orange area). Risk levels, however, will not meet public acceptance levels. The gap between them will also keep growing, and the risk situation will remain problematic.

Scenario 2: Establishing and completing the risk-based environmental management system will comprehensively elevate the level of ambition of environmental risk management in China. Thus, environmental risk levels will keep decreasing and the gap between actual risk levels and public perceptions will shrink. The environmental risk gap could be significantly alleviated under this scenario.

Public risk acceptance level (without consideration of environmental risk communication and engagement). With socioeconomic development, national income and education levels will keep rising, which will lead to a continual decrease in public risk acceptance levels (grey line). At the same time, other risks may be under estimated or neglected by the public. As the public gains knowledge about the underestimated or neglected risks, however, the acceptance levels for these risks are expected to decrease. If there is no risk communication and engagement, the public would probably conclude that these risks are too high to be tolerated.

Scenario 3: Establishing and implementing a reasonable environmental risk communication and engagement system, along with the expected actual risk reduction achieved by Scenario 2, will help change the risk perception levels in line with socioeconomic development levels (that is, bringing the grey line up to the blue area). This will lead the actual environmental risk levels to meet the increasing public demands on environmental safety. At the same time, risk communication may increase awareness of some previously neglected risks. This resolution of the gap between actual risk levels and public preferences could be a major overall goal of environmental risk management in China. However, it is hard to determine when China will achieve this goal. The goal should take account of the benefits and costs of actual policy options to reduce risks.

6.1.3.2 A Preliminary Scan of Environmental Risks in the Short and Medium Term Future

Based on the analysis of the current status and future prospects of environmental risks in China, this report provides a preliminary identification of environmental risks of high concern in the near future for the three categories of risks (Figure 6-10).

During the 13th Five-Year Plan period and beyond, China should continue to take measures to address those environmental risks to which attention is already being paid in the current stage to the year 2015 (for example, chemicals, eutrophication, heavy metals, $PM_{2.5}$ and so on). Soon after 2015,China should start paying attention to those risks which are overlooked currently (for example, ozone, black carbon, greenhouse gases, nuclear wastes and radiation, and so on)and also to the risks that may occur in the future (for example, ecological risks associated with the Belt and Road construction). Note that this is

a preliminary analysis. Further in-depth research and assessment is needed to identify and prioritize the future environmental risks in China.

Climate change presents an ongoing risk. In November 2014 China committed to have its greenhouse gas (GHG) emissions peak by 2030 and decline after that. Major policy measures are being put in place, including for a national GHG emissions cap-and-trade program, and targets to increase the use of renewable energy sources.[1]

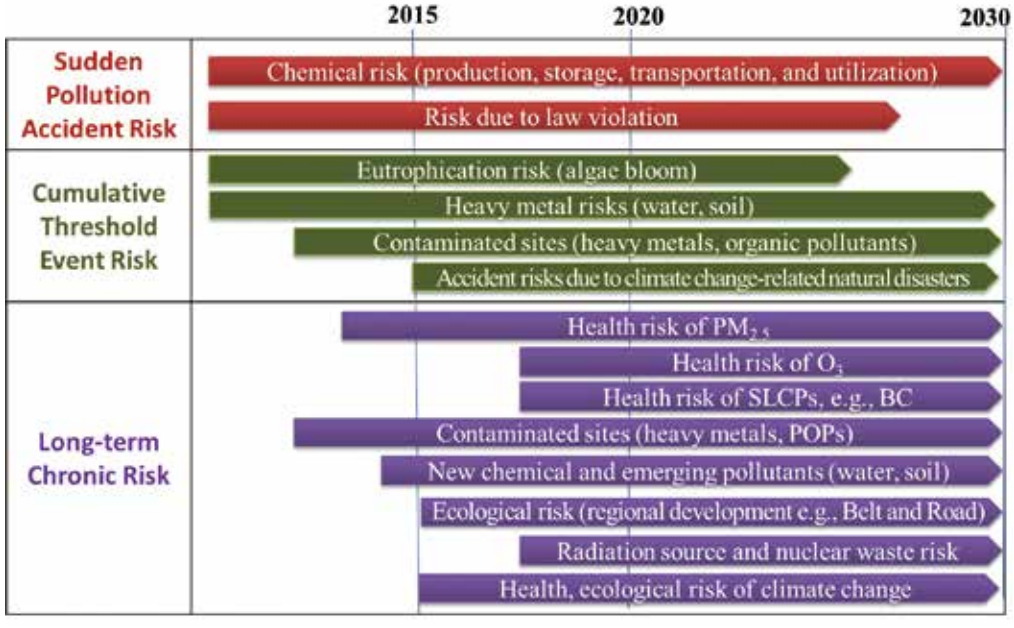


Figure 6-10 Preliminary scanning of environmental risks of concern in the short and medium term future

Note: SLCPs: Short lived climate pollutants; BC: Black carbon; POPs: Persistent organic pollutants.

6.1.4 Principles of environmental risk management

Based on the analysis of the current status and future prospects for environmental risks in China, this report summarizes the principles for environmental risk management that will provide a basis for policy recommendations.

6.1.4.1 Cost-effective/cost-beneficial management

Since environmental risk management resources are limited, it is important to

1 http://www.nytimes.com/2015/09/25/world/asia/xi-jinping-china-president-obama-summit.html.

manage environmental risks in a cost-effective way. Cost-effective management of environmental risk is obtained when a given objective is attained at least cost; a cost-benefit approach seeks to optimize objectives where the marginal value or benefit of environmental risk reduction action is equal to the marginal cost of the action. Across the elements of environmental risk assessment and management, these approaches can play a role, for example in target setting based on cost-benefit analysis, modelling to forecast environmental risk outcomes, and the valuation and selection of environmental risk reduction measures including legal and economic measures.

6.1.4.2 Synergistic management and tradeoffs

Different environmental risks are interrelated, and are related to other risks such as food safety, workplace safety risks or social risks. Reduction of a risk may increase or decrease another risk. Thus the synergistic effects among risks, and tradeoffs among them, should be considered in environmental risk management — with the objective of reducing overall risk.

6.1.4.3 Differentiated management for different risk types

Different environmental risk management schemes and measures are needed for different risk types, which require the clarification of the characteristics of different risks based on a comprehensive environmental risk analysis and assessment in China.

6.1.4.4 Dynamic and adaptive management over time

Environmental risk management measures need to be in line with the characteristics of the particular stage of social and economic development. Further, risk management policies need to learn from and respond to changes over time in knowledge, technology, and public values. This requires dynamic evaluation and adaptation through monitoring, analysis, and the adjustment or revision of environmental risk management policies.

6.1.4.5 Differentiated management across regions

Environmental risk management measures need to be in line with the social and economic characteristics of different regions. This requires regional environmental risk analysis and assessment, and targeted risk management strategies.

6.1.4.6 Environmental risk communication and engagement

The development and implementation of any environmental risk management measure needs to communicate information to the public, and as well, elicit and consider the preferences of the public and relevant citizens groups and communities. This requires that sufficient and effective risk communication and engagement be carried out.

6.2 Current status and demands of environmental risk management systems in China

6.2.1 Urgency of environmental risk management system construction in China

The 18th National Congress of the CPC introduced the goal of building a moderately prosperous society by 2020 and incorporating ecological civilization into the overall design of socialism with Chinese characteristics (that is, promoting economic, political, cultural, social, and ecological progress). *Opinions of the Central Committee of the Communist Party of China and the State Council on Further Promoting the Development of Ecological Civilization*, issued in 2015, maintains the basic state policies of conserving resources and protecting the environment. It puts the development of ecological civilization in a prominent strategic place that is incorporated into the whole process of economic, political, cultural, and social development. In the same year, the Central Committee of the Communist Party of China and the State Council issued the *Integrated Reform Plan for Promoting Ecological Civilization System* to accelerate the establishment of a complete ecological civilization system and to promote the construction of ecological civilization.

Now with China at the critical point of completing the building of a moderately prosperous society and accelerating the construction of ecological civilization, a serious environmental risk situation and gaps between risk levels and public perceptions have become major factors restraining development. Furthermore, environmental problems have grown to become a major issue affecting national security.

The *National Security Law of China*, implemented in 2015,notes the need "to strengthen the early warning, prevention, and control of ecological risk, and to address accidental environmental incidents properly". Environmental safety thus is being recognized as part of the national security system.

In the face of increasing public demands for environmental protection and the needs of national security, it is urgent to transform environmental management policy into an environmental risk management system that focuses on risk prevention and reduction and thus supports the achievement of ecological civilization.

To improve the environmental risk situation in China, to eliminate the gap between environmental risk levels and public acceptance levels, and to protect national security, an effective and efficient environmental risk management system is needed. The release of *Ambient Air Quality Standards (GB 3095-2012)* showed that environmental policy has begun to transition from an approach focused on pollution control to a more proactive

approach focused on improving environmental quality.

The environmental risk management system, however, remains incomplete. It cannot support the ultimate transformation to the environmental risk management mode with the objective of risk prevention and reduction, and it cannot meet the increasing public demands for eco-environmental safety.

To support policy recommendations on an environmental risk management system for China, this chapter analyses the current status and deficiencies of the environmental risk management system from four perspectives: environmental risk governance, goals and strategies, enabling measures, and environmental risk communication and engagement.

6.2.2 Incomplete environmental risk governance system in China

During the past 30 years, to address the environmental problems accompanying rapid socioeconomic development, industrialization, and urbanization, environmental governance has been improving. However, during the past 10 years, frequent accidental environmental incidents have attracted more public attention — and environmental risk management has attracted the government's attention.

The Songhua River water pollution accident in 2005 led to improvements in prevention and emergency response capacity. Conditions such as elevated levels of lead in children's blood and $PM_{2.5}$ air pollution pose environmental risks due to cumulative pollution levels have attracted more attention from government. Environmental risk issues have been gradually incorporated into national decision-making system.

The 18th National Congress of the CPC proposed to incorporate ecological civilization into the overall layout of socialism with Chinese characteristics. Environmental risk prevention was introduced into the *12th Five-Year Plan for National Economic and Social Development*. *The Opinions on Strengthening Major Environmental Protection Tasks by the State Council* in 2011 proposed to establish more efficient environmental risk management and emergency response systems. The *National Security Law of China*, implemented in 2015, formally incorporated environmental safety into the national security system and notes the need "to strengthen the early warning, prevention, and control of ecological risk, and to address accidental environmental incidents properly."

Overall, the environmental management system in China is still at an early stage. It is still event-driven in many cases, and still focuses on short-term pollution control. A risk prevention and reduction environmental management mode has not been formed. From the macro perspective, the environmental governance system remains incomplete.

6.2.2.1 A comprehensive environmental risk-based decision making system has not been established

At the national strategic level, the current environmental management system has not considered sufficiently the risks posed by economic development or regional development, or the risks due to industrial layout from the perspectives of environmental risk in decision-making. Environmental risk assessment has not been comprehensively and substantially incorporated into major national strategies and plans (such as the Five-Year Plans, new-type urbanization, the Belt and Road initiative, integrated development of Jing-Jin-Ji area, and the Yangtze River Delta economic zone).

Although environmental risk prevention has been incorporated into the *12th Five-Year Plan for National Economic and Social Development*, environmental risk management is still in a relatively weak position compared to economic development. The 12th Five-Year Plan only requires the prevention of environmental risks during the implementation of the plan; it does not require a decision on whether and how to implement the plan based on environmental risk assessment results. In any event, consideration of environmental risks in the process of developing policies and plans is lacking for governments at all levels.

6.2.2.2 A neutral and scientific institution to oversee and support environmental risk assessment and management is missing

Environmental risk assessment and management are professional tasks requiring objectivity and impartiality during environmental risk assessment and supervision. Thus, government should value the results produced by science-based environmental risk institutions that provide a neutral and credible source of information and risk assessments. However, China lacks a neutral institute to provide scientific risk assessments for national decision making to guide, coordinate, and oversee environmental risk management practices.

6.2.2.3 The institutional structure of environmental departments cannot meet the needs of environmental risk management

The environmental management system in China is vertically and horizontally fragmented. Technically, local environmental departments receive guidance from higher-level environmental departments, but administratively they are subject to management from local governments. The routine environmental supervision of local environmental departments is restricted by local governments, which results in weak enforcement.

Within MEP, due to the lack of an integrated, top-down design, various departments have overlapping responsibilities. This has caused difficulties in the coordinated management of environmental risks. For instance, the departments of Pollution Control,

EIA, Laws and Regulations, and the Emergency Response Center have individually developed their own environmental risk assessment methods. Some departments have too broad functions. For example, the Department of Pollution Control is known as "mini MEP" because it has responsibilities in multiple fields including water, air, solid waste, chemicals, vehicles, and oceans.

According to analysis of risk sources of accidental environmental pollution incidents, the production, storage, and transportation of hazardous chemicals are the major sources of these accidents in China. The 2015 hazardous chemicals warehouse explosion in Tianjin again shows the need to strengthen the integrated management of these chemicals and environmental risk control. Currently, several government agencies, including those responsible for safety supervision, public security, environmental protection, and health are involved in chemicals management. Within MEP, chemicals management involves departments such as Department of Pollution Control and the Emergency Response Center. The power and responsibilities for chemicals management overall are unclear, which has led to ineffective control of environmental risks of chemicals.

6.2.3 Lack of environmental risk management goals and strategies

According to the China Environmental Statistical Yearbook, the frequency of environmental pollution accidents is down to about 500 every year after 2005, which indicates some effectiveness in environmental risk management work. However, public perception of acceptable risk levels keeps lowering while social and economic development levels rise. Meanwhile, long-term chronic exposures, such as to air pollution, continue at high levels. The conflict between acceptable environmental risk levels for risk control and the public's acceptable levels will be become more prominent in the future.

It is necessary therefore to control environmental risks within levels acceptable to the public. To achieve this objective, environmental policy must be changed from pollution control and quality improvement approaches to a more proactive risk prevention and reduction approach.There is still a long way to go, however, to advance the risk management system. It requires the development of relevant objectives and strategies to facilitate the transformation of the environmental management mode.

A more robust overall objective is to maximize social well-being through the management of environmental risks. Public perceptions can be highly varied (no single risk acceptance level is possible), so the net benefits of different risk management policies and measures will depend on the type of risk and the costs of control. While public valuations need to be incorporated into those benefit estimates, public perceptions can

sometimes misjudge risks, overstating or understating them.

To date, a complete set of environmental risk management goals, and the strategies to meet them, have not been developed in China. The State Ministry of Work Safety issued the *Personal and Social Acceptable Risk Criteria for Hazardous Chemical Production and Storage Enterprises (trial)* in 2014, which proposes management criteria for new and existing facilities in different types of areas. Although this standard is for safety risk management of hazardous chemicals, it offers a reference for criteria for the management of accident environmental risks, since safety accidents involving hazardous chemicals are closely related to pollution accidents. In addition, the *Technical Guideline for Risk Assessment of Contaminated Sites*, released in 2014, recommends the methodology and sets acceptable levels for non-carcinogenic and carcinogenic risks. These recommended criteria, however, mainly rely on US criteria for reference. Further studies are needed to determine whether these criteria are suitable for China.

Already there have been preliminary attempts to set environmental risk management goals in China, but there are no goals in national strategies or laws to support the overall goal of controlling environmental risk levels due to socioeconomic development at levels acceptable to the public. Environmental risk types are complicated, and environmental risk levels are different for different socioeconomic development levels in different regions and periods. Further studies are needed to explore environmental risk management goals and criteria for different regions, periods, and types of risks.

An environmental risk management strategy and system has not yet been established in China. The current situation and prospects for environmental risks are unclear. There is a lack of a comprehensive and integrated national environmental risk assessment and ranking of priority risks. Furthermore, there is a lack of research on the mechanisms through which environmental risks induce other risks, such as social stability, economic security, and national and regional security. The management priorities for environmental risks are unclear, and cannot support the development of environmental risk management strategies.

6.2.4 Insufficient enabling measures system for environmental risk management

In recent years, to meet the needs of environmental risk management in the context of frequent environmental pollution events, environmental protection departments have been constantly improving the enabling measures system for environmental risk management. Overall, however, the system of enabling measures remains incomplete, and cannot yet

meet the requirements for effective and comprehensive environmental risk management.

6.2.4.1 Environmental laws and regulations are incomplete, and the environmental judiciary is still at an early stage

After several major environmental incidents, China has started to develop relevant laws. Both the *Emergency Response Law* and the newly revised *Environmental Protection Law* put forward the principle of "Prevention as priority with combination of prevention and emergency response". It clarified the environmental risk management responsibilities on the part of governments at all levels, departments, and enterprises.

Individual laws such as the *Water Pollution Control Law* and the *Solid Waste Pollution Control Law* have special provisions for "environmental pollution accidents response". They state the requirements for site selection and layout of pollution emission enterprises, prevention and emergency response preparedness, response and restoration. Preliminary revisions to the *Air Pollution Prevention and Control Law*, which will be implemented in 2016, incorporate risk management issues.

Overall, however, the system of environmental risk management law and regulation is incomplete. First, legal gaps still exist. For example, the lack of an environmental liability law prevents the determination of liability and compensation for damage following environmental pollution events. And there is a lack of relevant laws and regulations related to soil environment protection, contaminated sites remediation, and re-use management. Existing environment-related laws and regulations address environmental risk issues to some extent, but relevant provisions are not specific or clear enough, and their operability is low.

The environmental judiciary is an important guarantor that environmental protection laws and regulations can play their roles and be enforced. China's first environmental protection court was established in Qing zhen City in Gui zhou province, in 2007. By the end of 2014 there had been more than 300 environment resource trials, collegial panels, and circuit courts. The Environment Resource Trial Court under the Supreme People's Court was established in July 2014.

So, an initial environmental judiciary system has been established in China; however, it cannot yet play its role well. There is a lack of professional judiciary human resources, and environmental judiciary capacity needs to be improved.

6.2.4.2 There is no unified environmental risk information database and data sharing system

Providing and sharing information is essential for the improvement of environmental management. Currently, there is no overall coordinated approach to the management and

sharing of environmental risk and management information. Each government department involved with environmental issues ─ environmental protection, water conservancy, ocean, meteorology, land and resources, agriculture, and so on ─ has one or more sets of data but no unified data interface, data sharing mechanism, or basic database. Data redundancy and conflicts exist.

Even inside environmental protection departments, data sharing is weak. This means that the information requirements for environmental risk assessment and management cannot be met. During an emergency response, weak data sharing may affect the implementation of the response measures. Thus it is necessary to integrate the data from different departments and develop a unified environmental risk information system that can be shared across departments.

In addition, basic data about environmental risks are still lacking. First, there is no exposure information for environmental risks such as numbers, distribution, and location of contaminated and high hazard sites, concentration data for emerging pollutants, and so on. Second, research on exposure-response relationships between environmental risk factors and receptors is still weak with a consequent lack of exposure response information, for example, environmental baselines relating to human and ecological health.

In 2015 the State Council issued the *Construction Plan for Eco-environmental Monitoring Network* to address these issues: the incompleteness of the scope and elements covered by the current eco-environmental monitoring network; the lack of unified data construction plans, standards, and information disclosure; gaps in information sharing; and the low quality of monitoring data. This new plan proposes to establish an eco-environmental monitoring "big data" platform, and to establish mechanisms for eco-environmental monitoring data integration, sharing, and unified disclosure. The plan provides a good opportunity for environmental risk data to be incorporated and integrated into this system.

6.2.4.3 A system of financial instruments for environmental risk management has not been developed

China is still at an early stage of using financial instruments in environmental management, although it has seen certain achievements. For instance, in 2007 MEP and the China Insurance Regulatory Commission (CIRC) jointly issued the *Guidance on Environmental Pollution Insurance* and in 2013 conducted a series of pilots, and then issued a follow-up Guidance on Pilots of Mandatory Environmental Pollution Insurance.

The current financial instruments for environmental risk management still have many problems, however, and the system is incomplete. First, there is no mandatory legal

requirement for financial assurance at a national level. The new Environmental Protection Law will only "encourage enterprises to buy environmental pollution liability insurance," although some provinces have adopted some form of insurance pilots. Such mandatory requirements need to be specific to ensure that they respond to the risks to be managed. Second, the value of the environment and natural resources has not been commonly recognized in the current economic system. Environmental financial instruments cannot be well integrated with current financial systems, a fact that has hindered the development of financial instruments for environmental risk management.

In addition, there is a lack of technical directives and guidelines to support pollution liability financial assurance. For instance, even though MEP and CIRC jointly issued *Technical Guidelines of Environmental Risk Assessment-Environmental Risk Classification for Chlor-alkali Sector and Technical Guidelines of Environmental Risk Assessment-Environmental Risk Classification for Sulfuric Acid Enterprises (trial)*, there are large gaps in sectoral coverage, and a lack of appropriate provisions to assist in determining premium rates, liability limits, damage verification, or compensation.

6.2.4.4 Environmental risk emergency response capacity is weak

China has established an initial emergency response preparedness plan network including national, special, and departmental plans, plans for local institutes and enterprises, and temporary preparedness plans. These constitute an overall environmental emergency response plan management system. Nonetheless, the overall levels and operability of emergency response plans in China are relatively low. Most of the responses to environmental emergencies have shown that joint emergency response across regions and departments is insufficient, information collaboration is inadequate, equipment and technologies for emergency monitoring, early warning, and disposal remain weak, and the operability of emergency response plans is poor. It is necessary to increase the capacity for environmental emergency response to the same high level of capacity exist for natural disaster response in China.

MEP released the *Measures of Accidental Environmental Event Emergency Management* in 2015, which requires that enterprises, public institutions, and environmental departments at all levels conduct regular emergency response exercises based on the emergency response plans, write exercise evaluation reports, analyse existing problems, improve their emergency plans based on the exercises, and publicize their response plans and exercises. The implementation of this regulation will improve the operability and overall level of emergency response plans in China. However, there remains a lack of relevant guidelines and effective punitive and incentive measures that

will drive and facilitate emergency response exercises and revisions to plans.

6.2.4.5 Weak industry and enterprise responsibility

Analysis of the main causes for environmental pollution incidents in chapter 6.4 shows that low awareness of environmental responsibilities and violations of laws and regulations by industries and enterprises are the main reasons. From the perspective of environmental management, increasing the compliance level of China's enterprises is a long-term challenge. Therefore, building a corporate environmental risk responsibility system, adjusting relationships between government and enterprises,creating economic incentive instruments such as taxes, fees, and tradable quotas, and stimulating the inherent vigour of enterprises to lower environmental risks, are important pathways for a new model of environmental management.

Since the adoption of the ISO 14001 international environmental management system standard, many international enterprises have improved their internal environment, health, and safety (EHS) systems, thus lowering corporate environmental risk and social cost. With the more recent ISO 26000 corporate social responsibility (CSR) guidelines, many enterprises are considering the implementation of CSR practices as being important for their business. Many enterprises in China have established their EHS systems and have also gradually implemented a CSR strategy, for example, SINOPEC and the Shenhua Group.

Most enterprises, however, do not have a strong motivation to establish an internal EHS management system. This gap has been reflected in the 2015 Tianjin explosion accident, where insufficient information disclosure for hazardous chemicals contributed to improper emergency response. Regulations like the Seveso Directives in the EU could provide a possible model for China.

6.2.5 Weak environmental risk communication and engagement system

China is in a stage of transformation in which the traditional environmental risk management approach is no longer compatible with modern risk management requirements. First, environmental risks are becoming more widespread, diverse, and complex. More than ever, environmental risk management requires more cooperation among departments, across governments at all levels, and with the public at large. It also requires more flexibility to adapt to local natural and socioeconomic situations, and more modern information technologies. It is essential to establish an environmental risk communication system with the participation of government, enterprises, and public

organizations through information sharing, disclosure, and public participation in risk management. This is an inevitable choice for the rule of law in China.

In 2006, China's State Environmental Protection Administration (now MEP) released the *Temporary Measures of Public Participation of Environmental Impact Assessment* which facilitated and normalized public participation in EIA. *Measures of Environmental Information Disclosure(trial)* released in 2007 facilitated and normalized the environmental information disclosures of environmental protection departments and enterprises. The 2015 *Environmental Protection Law* has a chapter on "information disclosure and public engagement" which explicitly stipulates that citizens, corporations, and other organizations have the right to obtain environmental information and to participate in and oversee environmental protection issues. Furthermore, it stipulates that environmental protection departments at all levels, other departments which have environmental protection duties, and major pollutant discharging units should disclose relevant environmental information. MEP released the *Measures of Public Engagement in Environmental Protection* as the supplemental regulation to the *Environmental Protection Law* in the same year, which stipulates the rights and ways for public participation in environmental protection.

Thus, preliminary environmental information disclosure and public engagement systems have been established. However, some problems still exist:

First, current laws and regulations are mainly for environmental protection departments. They lack provisions for information integration, sharing, and disclosure across ministries. Although the *Measures of Environmental Information Disclosure for Enterprises and Public Institutions* was released in 2014, there remains a lack of supporting and operable punitive and incentive policies and regulations for information disclosure by enterprises. This has led to poor implementation of environmental information disclosure and public engagement by enterprises.

Second, an effective and responsive environmental risk communication and negotiation system has not been established. There are few provisions or specific plans to ensure that environmental risk levels remain within those that the affected populations regard as acceptable. Communication and engagement can help inform the public and elicit public preferences that will bring official policies on acceptable risk levels in line with what social groups and the public at large expect. Communication can also help adjust risk perceptions to the local economic situation and political standards. Meanwhile, education and training in the field of emergency management is lacking, including for self-rescue, evacuation, and damage avoidance by members of the public, especially vulnerable people. Communication is an integral part of emergency response education. It can inform

people how to behave in emergencies and crisis situations. This is particularly important for vulnerable people such as the elderly.

Third, the Measures of Public Engagement in Environmental Protection offers citizens, corporations, and other organizations the right to engage in policy making and to oversee illegal behaviour by corporations and other organizations. However, concrete ways, measures, and procedures for public engagement are still lacking. Public engagement is a mere formality. A discussion is needed to specify what type of policy should be open for public debate and engagement. China also lacks provisions on how to incorporate stakeholders into policy making procedures.

6.3 International experiences of environmental risk management

6.3.1 The history of environmental risk management systems in developed countries

A number of countries have established robust and systematic environmental risk management systems. For example the Netherlands, the United Kingdom, the United States, Canada, Australia, New Zealand, Singapore, and South Korea all have strong risk assessment systems and risk-based policy regimes. Their history shows however that these risk control systems were only gradually developed, driven by a series of major pollution accidents or events, and or by longer-term chronic pollution during their process of industrialization.

In the US, for example, there were several photochemical smog incidents in the 1940s and 1950s in the Northeast and in Southern California. The smog spurred the development and implementation of the US *Clean Air Act.* By the 1970s, after several amendments of the *Clean Air Act*, the laws and regulations governing air pollution control and risk prevention were established. The *Act* requires US Environmental Protection Agency (EPA) to set national ambient air quality standards (NAAQS) and other policies to protect public health and welfare.

Similarly, the *Clean Water* Act (1972) was enacted after crises at Lake Erie and the Cuyahoga River. Another example is the Love Canal crisis (1978), which spurred the enactment of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA, also called the *Superfund Act*) in 1980. A series of technical guidelines were developed under the superfund system. A national priority list of contaminated

sites that threaten harm to human health and the environment was also developed. While much remediation was achieved and risk management systems for contaminated sites established, studies have shown that CERCLA has required clean-up of low-risk sites at a very high cost.

In Europe the development of these systems has also been event driven following the great smog of London in 1952, the Seveso disaster of 1976, and the Sandoz chemical spill of 1986. All these events led to more stringent regulation.

Risk prevention is an important principle of environmental legislation in European Union (EU) countries. Environmental risk assessment is considered one of the bases for applying environmental risk prevention. Relevant legislation mainly focused on worker safety and health protection, then gradually shifted to environmental pollution prevention and response. The EU's Maastricht Treaty, promulgated in1992, and raised risk prevention to the level of constitutional principle. The Bulletin on Environmental Risk Prevention Principles passed by the EU in 2000 provided a clear and effective guideline for environmental risk prevention, especially risk assessment. Meanwhile, the EU has developed a series of specific laws and directives to provide further regulation on the risk management of industrial activities, corporate environmental risk, and water environment, human health, and ecosystem maintenance.

Driven by a series of environmental pollution events, the US gradually established a robust environmental risk management system-though it continues to debate about and reform its system. During the process, the US Environmental Protection Agency (EPA) and US National Academy of Sciences (NAS) continually worked to rethink and research environmental risk assessment tools, all of which advanced environmental risk assessment and management approaches. For example, in 1994, NAS published Science and Judgment in Risk Assessment (the Blue Book) which evaluated the deficiencies of environmental risk management tools (including environmental risk assessment methods and procedures, priority setting methods, data acquisition, and risk communication). This tool was used by the EPA for toxic air contaminants management. In 2009 NAS published Science and Decisions: Advancing Risk Assessment (the Silver Book). The report conducted a review and evaluation of risk analysis and assessment approaches used by the EPA, and offered recommendations for practical improvements that the EPA could make.

Overall, the robust environmental risk management systems in European countries and the United States and Canada provide useful lessons for China. It should be noted however that the establishment of these systems was driven by a combination of pollution accidents, the demonstration of chronic health and ecosystem effects of chemicals, air and water

pollution, and soil and water pollution from contaminated sites. Thus the establishment and improvement of such systems should not be event-driven but instead should be guided by a strategy which incorporates accidental, acute threshold, and chronic environmental risks from a range of sources. Further, the development of environmental risk assessment systems suggests that there needs to be ongoing re-evaluation and improvement of the risk management system to adapt to changes in risk conditions.

6.3.2 International Experiences of Environmental Risk Governance

6.3.2.1 Vertical risk responsibilities and integration

In the US, several agencies are responsible for risk assessment and management, including the EPA, the Department of Energy, the National Oceanic and Atmospheric Administration (NOAA),the Department of Agriculture, the Food and Drug Administration, the Occupational Safety and Health Administration, the Department of Transportation, the Nuclear Regulatory Commission, and the Department of Homeland Security. In each of the 50 states, state-level environmental protection agencies, agriculture agencies, food and drug management agencies, and commodity inspection agencies are responsible for state-level environmental risk assessment and management. The state-level environmental bodies receive supervision from EPA regional offices, and often are delegated authority by the EPA to implement federal laws ─ subject to national oversight and enforcement by the EPA ─ in a system of "cooperative federalism".

In the EU, EU-level institutions adopt policies that need to be "transposed" into member state law. Within almost all EU member countries the national environmental ministry supervises environmental protection at the local level through regional offices.

6.3.2.2 Horizontal risk responsibilities and integration across ministries

Fragmentation across agencies is a challenge even in the most developed regulatory systems. As just noted, in the US multiple federal agencies manage multiple risk domains. This horizontal proliferation of agencies and missions can make priority-setting difficult, and can lead to tradeoffs in which reductions in one risk by one agency unintentionally yield increases in other risks under the domain of another agency (or failure to attain the co-benefits of reducing multiple risks in concert). The EPA has special authority over many environmental laws, and working relationships with other national departments with environmental risk responsibilities. For instance, relevant federal departments must provide environmental impact statements on new projects, and the EPA has the authority to review these statements and recommend improvements. But the major mechanism for horizontal

coordination across US agencies occurs at the White House (centre of government).

In other countries, the use of environmental risk in decision making has also been growing. The system in Norway is noteworthy for its integration of macroeconomic planning models and environmental scenarios. The Norwegian model informs policy makers and advisers in the ministries of finance, industry, energy, and environment about the consequences for environmental risk of macro- and sometimes micro-economic policies in the country.

In the EU, there are also agreements to share environmental data, and institutions are legally bound to submit data to central institutions such as the National Statistics Bureaus. The European Environmental Agency provides recommendations to member countries on policy development and decision making on environmental protection, and promotes environmental information communication among member countries, as well as environmental monitoring. The Environment Department of the European Commission (DG XI) is responsible for coordinating development of environmental quality standards, developing and revising environmental laws and regulations, and ensuring enforcement and implementation of relevant environmental policies. The science and technology department (DG XII) is responsible for providing support to policy making on environment, health, education, and energy. The Minister of the Environment is part of the cabinet in most EU member countries. Environmental ministries in several countries have set up internal departments based on environmental elements or media (air, water, soil, biodiversity).

6.3.2.3 Environmental risk boards

To reinforce the importance of building environmental risk into decision making — and to ensure national oversight of risk management — the establishment of "national risk boards" is emerging, and a few countries have taken this step. The World Bank, in its annual World Development Report (2014)[1], included as its first policy recommendation that every country should establish a National Risk Board. The World Bank report citing earlier reports[2,3] argued that countries often face numerous risks but have fragmented institutional structures for responding to those risks. One result of such fragmentation is that different risks are addressed separately, with little coordination, leading to skewed priority-setting and to poor risk tradeoff decisions (where efforts to reduce one risk

1 The World Bank, Managing Risk for Development, World Development Report 2014: 278-279.

2 John D. Graham & Jonathan B. Wiener, *Risk vs. Risk* (Cambridge: Harvard University Press, 1995), 257-260.

3 World Economic Forum (2007). Global Risks Report.

unintentionally induce other risks, or shift risks to other populations, or fail to attain co-benefits). Fragmented agencies also may lack mechanisms for longer-term foresight of emerging risks outside their domains.

A national risk board can help address these problems of fragmentation and provision of foresight by coordinating across the complex institutional structure and varying challenges of risk assessment and management. Its role can be advisory to official government policy makers, or it can have a more influential or even official role in shaping policy itself. Its membership can consist of experts outside of government, or government officials, or a mix of these and other types of participants.

Several countries have established versions of a national risk board. The US has created a White House Office of Information and Regulatory Affairs (OIRA), which oversees and coordinates across federal risk regulation and reviews cost-benefit analyses of federal regulation. The EU has created an Impact Assessment Board (IAB) located in the Secretariat General, and recently renamed it the Regulatory Scrutiny Board, to oversee and coordinate regulatory policies. Singapore has the strongest example of a fully national risk board, including risk assessment, horizon-scanning foresight, and priority-setting functions. The country takes a "whole-of-government integrated risk management" approach, advised by a Centre for Strategic Futures (now called the Strategy Group in the Prime Minister's Office) and a Risk Assessment Horizon Scanning (RAHS) office located in the National Security Coordination Secretariat.

In addition, the US and several countries in Europe have established post-crisis or post-disaster investigation bodies or "safety boards". In many cases, such post-crisis investigations are conducted by one-time, ad hoc commissions of inquiry, which can focus high-level attention on a major event (such as the US 9/11 Commission, and the US Deepwater Horizon Oil Spill Inquiry Commission), but these bodies lack the permanent expert staff, the historical perspective, and the credibility that come with repeated investigations over many incidents over time. Thus, some countries have gone further to establish permanent, independent post-crisis/disaster investigation bodies. A new study examines these national safety boards[1]. Strong examples include the single-sector US National Transportation Safety Board (NTSB), and the multi-sector Dutch Safety Board (DSB).

6.3.2.4 Roles of scientific institutions

Scientific institutions play a critical role in determining the facts behind the

1 Edward Balleisen, Lori Bennear, David Cheang, Jonathon Free, Megan Hayes, Emily Pechar, and A. Catherine Preston (2015), "Institutional Mechanisms for Investigating Crises and Regulation Reassessment: The Commission of Inquiry and the Safety Board" (in E. Balleisen et al., eds, Policy Shock, Cambridge Univ. Press,) forthcoming.

assessment and management of environmental risks. They can provide valuable input to the work of environmental risk boards and government policy makers. The EU has designated and tasked science-based institutions with bringing forward the factual basis for the regulation of environmental risks and advising on the environmental benefits (lower risk) of regulation. An example is the International Institute of Applied Systems Analysis (IIASA), based in Austria, which provides the scientific basis for air quality management in Europe.

Similar organizations providing the scientific basis for risk assessment and management exist in the US states, such as NAS, the Centre for Disease Control and Prevention CDC), the National Institute of Environmental Health Sciences (NIEHS), the National Oceanic and Atmospheric Administration (NOAA), the research office of the EPA, and the national labs of the Department of Energy. By means of transparency in operation, inclusiveness in participation, and scientific integrity, these institutions have earned the respect of policy makers as advisors on the factual basis of regulation of environmental risk.

6.3.3 International Experiences of Environmental Risk Goals and Strategy

6.3.3.1 Setting goals, targets, and acceptable risk levels

The US Clean Air Act(CAA) as amended in 1990 incorporates 10^{-6} risk frequency into Section 112 as the residual risk level for hazardous air pollutants (air toxics) in Section 112. But this quantitative probability level is unusual among US laws. And it is not the main regulatory requirement in Section 112 under which maximum available control technology, or MACT must be applied first. Besides Section 112, in other areas of the CAA, such as those addressing national ambient air quality standards (NAAQS) and other US laws, do not generally define a quantitative risk level. Instead, US laws often instruct EPA to “protect public health” or “prevent unreasonable risk,” and leave it to EPA to determine the quantitative risk level in specific policies.

The most elaborate approach to assessing and determining environmental risk in the EU is found in the case of classical air pollutants. Air quality guidelines for these pollutants are based on the impact pathway approach. This approach allows an estimate of risk of environmental damage associated with exposure and also expected reduced damage (that is, benefits) from reduced exposure. The actual emission levels are the results of negotiations that take costs as well as benefits into account. For hazardous chemicals the approach is cruder. In Europe the REACH directive specifies “substances of high concern”.

An influential study[1] found a wide variety of quantitative risk levels espoused in different US laws with many different levels or standards.A more recent study surveyed the actual regulation of many risks in the US and Europe and found no consistent principled approach to precaution. Rather, it found a complex pattern of different degrees of precaution addressed to different risks[2].

Annex Table 6-5-1 provides the risk goals under various laws and regulations in the US and the EU. These are variously expressed in quantitative, qualitative, or technology terms.

In the US and Europe, consideration of cost-benefit and cost-effectiveness also guide the determination of targets for environmental risk reduction. Cost-benefit means that the optimal level of risk reduction is selected by weighing the marginal benefit of environmental risk reduction against the marginal cost of risk reduction. Cost-effectiveness means that a given level of risk reduction is achieved at least cost. These principles are often presented in legal language such as the benefits should justify the costs, or seek to maximize net benefits, or aim for environmental risk to be as low as reasonably practicable, prevent unreasonable risk, protect public health using the least burdensome alternative, minimize risk given due consideration of cost, or best available technology given due consideration of cost.

6.3.3.2 National assessment and strategy

The main goal of national risk assessments is to identify current and emerging risks, estimate their seriousness, and contribute to setting priorities. Risk assessments provide a numerical or at least a qualitative basis for judging the likelihood, seriousness, and distribution of expected damages over time. A risk assessment seeks to measure the product of probability and outcomes, and helps estimate the benefits of reducing risks and the distribution of these expected benefits across target groups (for example children, elderly people, poor people, and so on).

As a complement to the science-based risk assessment, it is prudent to conduct a concern assessment among major stakeholders (industry, citizens, social organizations) to explore their risk perceptions and concerns. Public concerns may differ from expert risk assessments, potentially due to heuristic strategies of public perception.Depending on the outcome of the concern assessment, different management and communication strategies should be designed and aligned to the risk management options that are derived from the

1Alon Rosenthal, George Gray and John Graham, "Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals," 19 *Ecology Law Quarterly*, 1992: 269-362.

2J.B. Wiener, M.D. Rogers, eds., *The Reality of Precaution: Comparing Risk Regulation in the US and Europe* (RFF Press/Earthscan/Routledge, 2011).

priority setting exercise of the responsible decision making agency.

When setting goals and formulating strategies for risk reduction, international experience has shown that it is essential to involve the public ─ as per the guidelines of the International Risk Governance Council (IRGC)[1] ─to gain an understanding of perceptions.

Risk perceptions include four major triggers:

(1) Intuitive biases and heuristics that make a risk appear more (or less) serious than it actually is;

(2) Specific areas such as food or drinking water quality that lead to heightened public concern. These very sensitive topics vary from culture to culture and often from social group to social group;

(3) High concerns may come from distrust of or lack of confidence in any of the crucial actors involved (for example, industry or regulators);

(4) High concerns can be used to develop a strategy to promote specific policies or to get public attention for an issue or a group (strategic motivation).

It is essential to address these four elements of perceptions in risk management and risk communication. Being sensitive to public concerns helps to gain acceptance of official policies and to build up trust in management institutions.

6.3.4 International Experiences of Environmental Risk Enabling Measures

6.3.4.1 Risk data and monitoring

The European Environmental Agency (EEA) in Copenhagen is developing a European Environment Information and Observation Network (Eionet) with the aim of providing quality data, information, and expertise for assessing the state of the environment and stress factors. This information will support information dissemination and the development of policies and measures, and enable them to be monitored for their effectiveness. Eionet will provide systematic, nationally validated, high-quality environmental data.

The USEPA, and the US government generally, collects extensive data on overall environmental quality indicators (for example, e.g. ambient air and water pollution), as well as on the environmental impacts of each source of pollution (e.g. such as emissions and discharges from private firms, and environmental impacts of government programs). EPA also operates several information disclosure requirement programs, such as the Toxics Release Inventory and the Greenhouse Gas Reporting Rule.

1 International Risk Governance Council (IRGC). 2005. White Paper on Risk Governance: Towards an Integrative Approach. Geneva: IRGC.

6.3.4.2 Economic instruments

Environmental taxes and fees are used in Europe and the US mainly in energy management and air pollution risk control. Risks from water pollution are mainly regulated by permit. Risk of losing biological diversity is regulated in Europe by zoning (similarly to ecological red lines), but there are some financial instruments and incentives towards farmers and to a lesser extent fishermen.

Europe in particular regulates consumption of fossil fuels-an important precursor to risk from air pollution-and CO_2 by economic instruments. In the context of environmental risk, the lowering of fossil energy consumption and CO_2 emissions implies lower emissions of particulate matter, mercury, SO_2, NO_x and other air pollutants.

The US has long used tradable emission permits for air pollution control, including for lead, chlorofluorocarbons (CFCs), and SO_2 emissions control. The SO_2 tradable permits system, adopted in the 1990s, is considered a success story that has been cost-effective and has achieved considerable emissions reduction, hence lowering environmental risk to health and ecosystems. The low cost made possible by the trading system enabled the ambition for emissions reductions to be tightened in several rounds over time.The EU then adopted after 2001 a tradable permit system to reduce greenhouse gases, ─ the EU Emissions Trading System (ETS).

6.3.4.3 Financial security instruments for environmental risks

Financial security instruments (FSI) include secured funds, on-demand performance bonds, company guarantees, and insurance. These financial solutions are available to industrial operators and to government agencies. Financial security requirements may be applied on a sectoral basis, to industrial activities with the highest level of risk, for example, or on a regional or national level. They may incorporate risks associated with normal or abnormal operations, such as during accidental or natural hazard events.

A range of American, European, and Asian countries have adopted FSIs for environmental risk management. These are used to fund the prevention of environmental risks and remediation of damage to the environment. Some FSI's, such as insurance, have the added benefits of encouraging loss-reduction and risk prevention behaviour. Environmental pollution liability insurance was first adopted in the US in 1966, and now has become a relatively complete system. Special environmental protection insurance companies were also established in 1988. The entire EU has adopted environmental liability systems supported by encouraging the use of financial security instruments since the Environmental Liability Directive came into force, some on a voluntary basis, some mandatory. In 2016 South Korea will introduce a compulsory environmental insurance

program for industrial companies that handle hazardous chemicals.

Some common themes and developments that arise from countries' financial security systems are: mandatory or voluntary financial provisions; instrument choice including insurance, bonds, and funds; default options for insolvency; establishing minimum limits for insurance or bonds; evolution of legislation from pollution-centred to broader environmental damage; and, evolution of financial markets to incorporate risks.

6.3.4.4 Emergency response

In the US, the Federal Emergency Management Agency is responsible for leading and supporting nationwide environmental risk emergency response. The country has established a national emergency management information system and a National Incident Management System (NIMS). It has issued a national response plan, and established a comprehensive warning and emergency management system with the four key elements of prevention, response, remediation, and mitigation. It also has special emergency response systems for oil spills, nuclear accidents, and other specific types of accidents. And it has post-accident investigation bodies, notably the NTSB and the Chemical Safety Board, to assess the cause and to recommend improved prevention policies.

In the EU, emergency response is guided by the REACH chemical registration requirements, the Seveso II and III directives, the EU civil prevention mechanism, and the 112 emergency response mode. The Seveso directives that regulate production facilities distinguish between upper tier (high risk) and lower tier (low risk) facilities. Upper tier facilities are regulated much more strictly.

More generally, there are two main characteristics of the EU environmental risk management system related to accidents. First, close attention is paid to land use planning, in order to prevent environmental accidents. Strategic environmental assessment is carried out for land use plans. Second, public participation is given priority and is a formal prerequisite in the planning process.

In terms of emergency response, the International Commission for the Protection of the Rhine launched the Warning and Alarm Plan (WAP) in 1985. Within the framework of WAP, countries in the Rhine basin all established environmental warning centres. The EU put the Major Accidents Reporting System (MARS 4.0) into operation in 2001 to help member countries make reasonable decisions in addressing major environmental pollution accidents.

Environmental risk management in Japan covers various kinds of natural environmental incidents and man-made environmental incidents. Japan established a national crisis management system based on comprehensive disaster management, and formed a risk

management system of "risk prevention and reduction, crisis management, and national security". The country established a disaster prevention information system and emergency response system at central and local levels, and formed a horizontally and vertically integrated disaster relief and emergency response information network.

6.3.4.5 Industrial responsibility

In Europe and elsewhere, governments and regulatory authorities have put in place incentives for environmental risk practices by enterprises. They emphasize to companies the necessity and benefits of environmental risk assessment processes and management as an integral part of an enterprise's progress and success. These processes incorporate avoidance and management of hazards, opportunities for cost management, positive influences on internal culture, marketability of green products, and tools to communicate with stakeholders.

These government measures may include recommending to companies the adoption of international and national standards such as International Environmental Management Standards ISO 14000 series, Europe's Eco-Management and Audit Scheme (EMAS), and Risk Management Standards ISO 31000 series. Other standards for environmental risk management include the Global Environmental Management Initiative (GEMI) and the International Finance Corporation's Environmental and Social Performance Standards. Incentives for environmental risk planning by enterprises are also built into the Seveso and REACH directives in Europe, and US laws such as the *Clean Air Act* 112. Some countries have put in place codes of practice and standards such as Spain's UNE Standard 150008, Australia's Sectoral Standards and Government Agency Environmental Network (GAEN), and the UK's Pollution Prevention Guidelines (PPGs).

Industrial sectors in Canada, the US, Europe and elsewhere have implemented voluntary industry-developed performance standards to manage environmental risks and drive performance improvement. This has produced benefits which provide incentives to industrial sectors to reduce and manage environmental risks, with benefits including public safety, improved environmental performance, reduced management costs, increased community confidence, and reduced regulatory requirements.

Industry standards can be recognized in government regulations, providing further incentive to the industry to adopt and achieve the standard. Examples of voluntary standards programs include the Chemistry Industry Association of Canada's Responsible Care® program[1]; and, the Mining Association of Canada's Toward Sustainable Mining™

1 http://www.canadianchemistry.ca/responsible_care/index.php/en/index.

initiative[1]. The Responsible Care® program started in the late 1980s in Canada and is now is a global, voluntary initiative developed autonomously by the chemical industry in 52 countries. Combined, these chemical industries account for nearly 90% of global chemical production, including in Hong Kong SAR and China. In China, Responsible Care® is a program of the Association of International Chemical Manufacturers (AICM) registered in Hong Kong, which consists of 50 international chemical company members. State owned enterprises do not participate[2].

For European and American enterprises, the setup of EHS (Environment, Health, and Safety) departments and improvement of management systems has become a major part of these companies' sustainable development strategies.

6.3.4.6 Environmental risks reporting in financial reporting requirements

A number of countries in North America and Europe have put in place rules for environmental risk disclosure through their securities exchange regulators, , integrating environmental risk into financial reporting requirements. In Canada this is done through securities regulators' rules for public disclosure[3]. The US Securities and Exchange Commission (SEC) also administers guidelines on disclosure of environmental risks. A new European Union directive on non-financial (environmental and social) disclosure by corporations has a similar purpose[4].

All this has built on the mandatory financial reporting of environmental risks in the UK, France, Germany and other countries[5]. The Buenos Aires Stock Exchange has added to its information disclosure requirements regulations requiring public companies to include information about their environmental insurance[6].Disclosure is also a key element of environmental measures in Europe, for example in the Seveso and REACH directives.

6.3.5 International experiences of environmental risk communication and engagement

6.3.5.1 Communication

A major challenge for environmental risk management is that risk perception often differs from statistically or experimentally derived numerical risk assessments. Addressing

1 http://mining.ca/towards-sustainable-mining/how-tsm-works/tsm-verification.

2 http://www.icca-chem.org/en/Home/Responsible-care/Responsible-Care-Members/.

3 https://www.osc.gov.on.ca/en/SecuritiesLaw_sn_20091218_51-717_corp-gov-enviro-disclosure.htm.

4 http://ec.europa.eu/finance/accounting/non-financial_reporting/index_en.htm.

5 https://halshs.archives-ouvertes.fr/halshs-00658734/document.

6 http://www.iclg.co.uk/practice-areas/environment-and-climate-change-law/environment-and-climate-change-law-2015/argentina.

this gap between public perception and expert assessment is one of the most challenging tasks for inclusive risk governance. This can partly be addressed by effective risk communication[1].Risk communication needs to address the physical properties of a risk, the rationale for risk management options, the tradeoffs between risks and benefits as well as the agency's responses to people's perceptions and concerns. To accomplish all these goals is difficult, and meeting the various demands simultaneously often leads to value conflicts and communication contradictions.

It is important to use targeted, two-way public communications and engagement to build public understanding of environmental risks. Transparent and effective communication of environmental risks between the policy maker and the public is necessary to: elicit the preferences and meet the demands of citizens affected by development; and, build understanding of risks, including the differences between perceived risks and assessed risk.

Effective communication of risk will also build public and community confidence in government-if this is supported by sensible regulation or other demonstration of actions to reduce risks to citizens. Many international studies on risk management emphasize the need for intensive risk communication between different agencies and decision-making bodies. Even within an agency it is important to facilitate the dialogue among risk experts such as toxicologists, cost-benefit analysts, and legal staff[2].

International best practice guidelines for communication and cooperation among and between agencies have been proposed[3]. These guidelines should address the transparency requirements of data and action plans, a protocol of who has to be consulted or informed prior to going public with a specific policy, and a documentation plan that requires a structured approach to set up a data bank and a workable archive for all agencies involved. Respective agencies can establish a risk information sharing board that monitors the risk sharing practices and also determines what information is shared with a wider public.

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1 US-National Research Council (1989), Improving Risk Communication. Washington, D.C.: National Academy Press. And: Fischhoff, B., N.T. Brewer and J.S. Downs. 2011. Communicating Risks and Benefits: An Evidence-Based User's Guide. Report. Washington: US Department of Health and Human Services, Food and Drug Administration (FDA) (www.fda.gov/ScienceResearch/SpecialTopics/RiskCommunication/ default.htm).

2 Löfstedt, R., "Risk Communication and Management in the Twenty-First Century", International Public Management Journal (2001), 73: 335–346.

3 BfR (German Federal Institute for Risk Assessment) (2007). ERiK - Development of a Multi-Stage Risk Communication Process, edited by R.F. Hertel and G. Henseler.. BfR-Wissenschaft 04/2007. BFR: Berlin 2007.

6.3.5.2 Engagement

One of the major tasks in policy making is the need to ascertain support by major stakeholders. Many of these stakeholders not only have a special interest in risk reduction, they also have knowledge in risk reduction methods and practices. It is essential to include these groups in risk governance. Key stakeholders include: scientists and experts; affected citizens; the private sector; and social organizations. In addition, one needs to take account of the public media as mediators between the policy level and the wider public.

Public involvement can pursue the following functions[1] :

(1) Enhancing transparency: Publish exposure data. Inform people ahead of time of new developments or plans. Provide all public bodies with the necessary information so that they can act upon this information.

(2) Collecting feedback and preferences: Conduct surveys, set up focus groups, and conduct dialogue sessions with social groups and representatives of the affected public about their priorities, preferences, concerns, and anxieties. Use this information for both more effective risk communication programs, inputs to benefits valuation, and more sensitive risk management plans.

(3) Exercising and preparing people for emergencies: Conduct regular exercises and information programs for making people familiar with appropriate behaviour in emergency situations.

(4) Co-designing policies: Include representatives of industry, social organizations, and citizens in monitoring or measuring exposure. Provide telephone or mobile phone hotlines for reporting events. Use formats of citizen participation for urban and industrial planning. Consult stakeholder groups when preparing new or revised policies.

It is important to design public engagement policies in accordance with one or more of the four major purposes. Each purpose requires a different approach, different formats and moderation techniques. In the US and the EU, dedicated private and public institutions have specialized in designing the most appropriate risk communication and engagement programs depending on purpose and risk.

1 OECD (2002). Guidance Document on Risk Communication for Chemical Risk Management. Series on Risk management, No 16. Paris: OECD Press. And. Renn, O.: Risk Governance. London: Earthscan, p. 203.

6.4 Policy recommendations to establish an environmental risk management system in China

This study proposes policy recommendations for building a proactive environmental management system based on environmental risk prevention and reduction. Such a system will meet the basic needs of social and economic development and the eco-environment, and will support the intrinsic requirements for construction and implementation of China's *Integrated Reform Plan for Promoting Ecological Civilization System*. It comprises four strategic elements: environmental risk governance, risk goals and strategies, risk enabling measures, and environmental risk communication and engagement. Establishing and completing the environmental risk management system will focus on the prevention and reduction of the three categories of environmental risks presented in chapter 6.4. The basic framework for the system is shown in Figure 6-11.

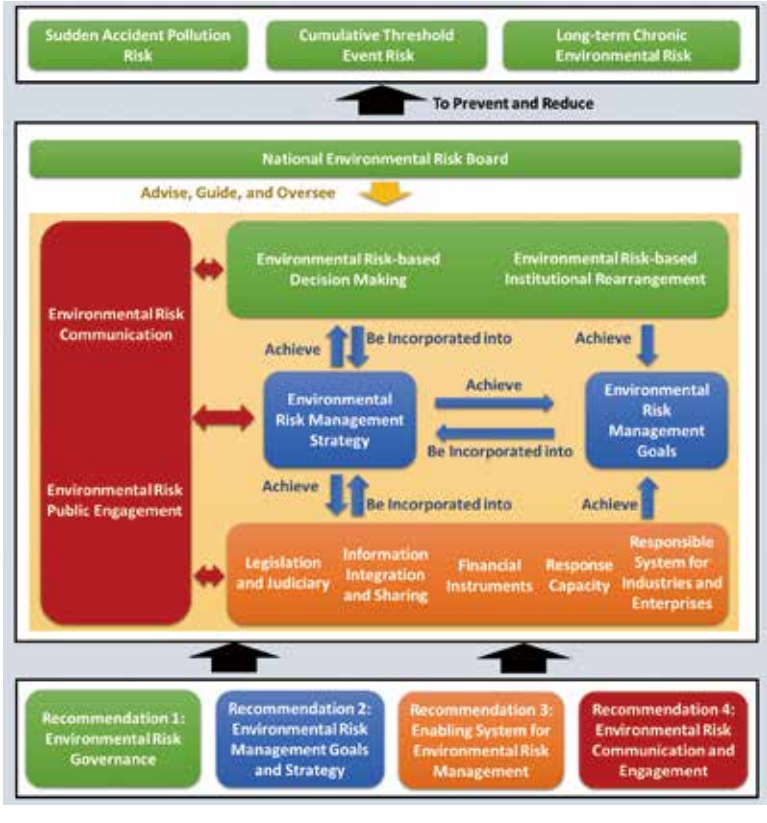


Figure 6-11 Framework for the environmental risk management system based on policy recommendations

6.4.1 Establish the risk-based environmental governance system

The recommendations in this study are founded on the urgent need to fully integrate environmental risk assessment and management into the environmental governance system of China at all levels. This will enable a proactive environmental management approach focused on prevention and reduction of environmental risks to replace the current reactive approach of environmental management with its focus on pollution control. By implementing these recommendations China has the opportunity to achieve major improvements in environmental quality, human health, and security.

6.4.1.1 Establish a high-level, permanent national environmental risk board

China needs a high-level, permanent National Environmental Risk Board at the centre of national government. The responsibilities of this board would be to: identify, assess, and prioritize current and potential environmental risks (sudden accidental, cumulative threshold, and long-term chronic risks); help identify opportunities to reduce multiple risks, and resolve tradeoffs among multiple risks and between economic development goals and environmental risk control; coordinate and oversee environmental risk management in an integrated way; ensure evaluation of ongoing policies with a view to learning and improvement over time; and, ensure that environmental risk assessments are undertaken to inform major national economic, legal, and environmental decisions. The board would provide the cornerstone for the national environmental risk management system.

The National Environmental Risk Board would mainly focus on environmental risk, but its work would be linked to other kinds of risks with strong environmental interactions, for example: natural disasters, food safety, workplace safety, and climate change. Its responsibilities and functions would include:

(1) Lead the development of national environmental risk management goals and a national environmental risk strategy. Guide their implementation.

(2) Undertake national and regional environmental risk assessments and horizon scanning to identify emerging risks, drawing on a wide network of researchers in many domains of environmental quality, ecosystem integrity, and public health.

(3) Analyze risks and decide on priority environmental risks at the national and regional levels related to policies, planning, and major investments. Assess benefits and costs of policy options, identify opportunities to reduce multiple risks, and help resolve tradeoffs among risks and between socioeconomic development goals and environmental risks.

(4) Assess the adequacy of government risk management policies at every level, with a view to learning and improvement over time.

(5) Identify responsibilities for risk management and oversee actions taken to manage risks by responsible government agencies. Provide support to science-based decision making for environmental risk management, and oversee policy impact assessments.

(6) Initiate and monitor effective risk communication and engagement processes and ensure that the results of risk perception studies are integrated into risk management and communication programs.

6.4.1.2 Establish a comprehensive environmental risk-based decision-making system

(1) Incorporate environmental risk management into the 13th Five-Year Plan

Strengthen environmental risk management in the *13th Five-Year Plan for National Economic and Social Development*, focusing on environmental quality improvement and starting to establish to establish a proactive environmental risk management system focusing on a risk prevention and reduction approach. Incorporate relevant policy recommendations of this study into the 13th Five-Year Plan.

(2) Establish an environmental risk assessment and prevention system for national macro-strategies for China's national modernization process

Carry out short-term, medium-term and long-term environmental risk assessments for national macro-strategies such as the building of an overall well-off society, new-type urbanization, integrated development of the Jing-Jin-Ji area, the Belt and Road initiative, and the Yangtze River Delta economic zone, and develop effective environmental risk prevention roadmaps for each macro-strategy.

(3) Incorporate environmental risk assessment and management into the decision-making systems of governments at all levels

Incorporate environmental risk assessment and risk management requirements into government decisions-at every level of policy, planning, and implementation — that have a potential impact on environmental quality, ecosystem integrity, or human health, and for the development of environmental standards. Establish a comprehensive planning system and assessment system for decision making of major policies and plans. This will contribute to the government's efforts to deepen reform and streamline regulatory measures. Specifically:

① Apply strategic environmental assessment (SEA) to incorporate environmental risks into policies, plans, and major infrastructure projects at all levels. Apply risk-based SEA strategic environmental assessment, incorporating cost effectiveness and benefits considerations, during the formulation of all national and sectoral policies and plans, including for energy, industry, agriculture, transportation, and regional development,

and during feasibility assessment of major infrastructure projects. Pay close attention to vulnerable people who may be affected by the implementation of such policies and plans. Incorporate environmental risk assessment and philosophy of environmental risk management into the development of environmental standards.

② Promote Multiple-in-One spatial plans, integrating economic and social development plans, urban and rural plans, land use plans, and ecological protection plans into one plan. Apply environmental risk assessment to evaluate environmental risks, including costs and benefits comprehensively in Multiple-in-One spatial plans to identify priority zones and risks, and draw ecological protection red lines. Establish a system to ensure synergies across multiple assessment processes including environmental risk assessment, environmental impact assessment, and social stability risk assessment.

(4) Incorporate Climate Change into Environmental Risk Decision Making

Conduct periodic assessments of climate change-related environmental risks, undertaken by third-party organizations under the guidance of the National Environmental Risk Board in cooperation with the National Climate Strategy Centre (NCSC), and involving extensive social participation. These assessments will inform decisions on environmental risk management.

6.4.1.3 Rearrange Environmental Risk-based Institutions

(1) Establish a management structure based on environmental elements

Support the transformation of the department structure of MEP to produce a coherent system for environmental risk management, with clear powers and responsibilities. Therefore, replace the current Departments of Pollution Control and Total Emission Control with new Departments of Air Pollution Control, Water Pollution Control, and Soil Pollution Control. Adjust the functions of the Department of Ecological Protection to include protection of ecosystem functions, nature reserve management, and biodiversity protection. It will be necessary to build in specific coordination mechanisms across the new departments to avoid previous problems of fragmentation and to ensure that cross-media shifts in environmental risks do not occur.

In addition, it must be recognized that much of the work for effective environmental risk management must still be done by other ministries, other levels of government, and enterprises. The role of MEP thus includes ensuring that a robust regulatory and policy framework is in place which fully integrates environmental risk management, and applies strong enforcement to ensure the prevention and reduction of environmental risks.

(2) Establish Chemical and Environmental Emergency Response Centres

Establish these centres by incorporating chemicals management into the current

environmental emergency response systems and strengthen their management of hazardous chemicals.

(3) Strengthen vertical connections of environmental departments

Build strong vertical connections from MEP to provincial and local environmental departments that will incorporate a consistent approach to environmental risk assessment and management. Increase the decision-making power of higher level environmental departments for cadre management, including appointment and dismissal. Boost the performance management of officials in lower level environmental departments. Ensure the relative independence between local environmental protection departments and local governments to avoid interference in environmental supervision and decision making by local governments.

(4) Strengthen regional Environmental Supervision Centres

Clarify the role of regional Environmental Supervision Centres through legislation, and clarify their mandate for supervision as well as their responsibilities and obligations. This effort should be undertaken with oversight by the National Environmental Risk Board. Increase investment in staffing and equipment. Convert public institutes to government units when appropriate.

6.4.2 Establish environmental risk management goals and strategy

6.4.2.1 Set Environmental risk management targets

The overall goal of environmental risk management is to prevent or reduce environmental risks in order to secure human health, environmental quality, the functioning and integrity of ecosystems and national security, increase social well-being, and make risk levels compatible with public perception of acceptable levels.

(1) Set comprehensive national environmental risk reduction targets for priority environmental risks. These targets should be developed by the National Environmental Risk Board, based on the results of a national environmental risk assessment and the setting of priorities it undertakes. Risk targets need to factor in the costs and benefits of risk control, the feasibility of applying risk control technologies, and public perception of risks.

(2) Require each province, region and city to set environmental risk targets. These are to be set according to regional socioeconomic development conditions and risk types relevant to each region, based on the national risk targets and using methods developed by the National Environmental Risk Board. Acceptable environmental risk levels differ for different types of risks and for different socioeconomic development levels in regions and

for different periods. International experience shows there is no one universally acceptable risk level. Examples of risk targets are shown in Annex 6-5.

(3) Require provinces, cities, and regions to prepare a roadmap to determine the pace and path to meet the environmental risk targets. These are to be based on priority regional environmental risks, environmental conditions, economic and social conditions, regional development strategy, and the need to maintain public confidence.

6.4.2.2 Establish and implement a comprehensive national environmental risk management strategy

Apply the principles of "whole process management" and "priority management" to establish and implement a comprehensive environmental risk management system in China. The goal is to transform the current reactive approach of environmental management, with its focus on pollution control, to a proactive environmental risk prevention and reduction mode.

It is necessary to establish priorities for environmental risks and identify the management urgency for different risks, so as to achieve the greatest environmental and social benefits with limited management resources.

(1) Conduct a full, comprehensive national risk assessment and ranking exercise to set national priorities. Priorities are to be set for each of the three categories of environmental risks - sudden accident risks, cumulative threshold event risks, and long-term chronic risks. Since environmental risk priorities and goals will change with the progress of socioeconomic development, this national risk assessment needs to be conducted periodically.

(2) Establish and apply a risk chain-based environmental risk management system. (Figure 6-1 shows the risk chain). This is to be based on the assessment results, emphasizing risk avoidance and prevention, and risk response, mitigation, compensation, and remediation where necessary, to reduce overall risks and yield public health, environmental quality, and ecosystem benefits that justify the costs.

Based on the results of this study, we propose a preliminary environmental risk management strategy roadmap (Table 6-1).Further in-depth research and assessment is required to identify and establish the detailed roadmap for future environmental risk management in China.

Table 6-1 Preliminary roadmap for environmental risk management strategy in China

Year	Strategic Roadmap	
	Management System	Risk Level
2020	• Environmental risk prevention and reduction is incorporated into the national macro strategy and into sector policies, spatial plans, and infrastructure development decision making; • "Whole process management" and "priority management" based environmental risk management system is partially established	• A number of priority risks are in progress to be reduced, for example $PM_{2.5}$
2025—2030	• Environmental risk management system is transformed to the proactive mode to prevent and reduce all categories of environmental risks; • Environmental risk management system is fully implemented based on "whole process management" and "priority management"	• A number of risks (e.g., environmental risks due to law violations, eutrophication, heavy metals in water and soil)are successfully controlled; • Overall environmental risk is reduced with improved ecological and public health, and is increasingly aligned with public risk perception
2040—2050	• Evaluate and adjust the environmental risk management system to fit evolving conditions and needs	• Some environmental risks will take longer into this stage to be managed successfully, such as those related to climate change; • Overall environmental risk is controlled at low levels and in line with public risk perception, and secures high levels of environmental quality, and ecological and public health

6.4.3 Establish and improve the system of enabling measures for environmental management

6.4.3.1 Strengthen and complete legislation and strengthen the judiciary for environmental risk management

(1) Complete the system of environmental risk management laws and regulations

With the goal of transforming the current reactive environmental management approach to a proactive environmental risk prevention and reduction mode, and applying whole process management, it is necessary to improve laws and regulations for environmental protection.

First, fill the gaps in law for environmental risk management.

① Develop a new Environmental Liability Law. This law would have provisions for ecological damage compensation and restoration, causality identification, public interest litigation, environmental damage evaluation, liability insurance and broader financial assurance, as well as systems for funding and dispute resolution.

② Develop environmental management laws for soils and contaminated sites. Issue

the *Soil Environmental Protection Law* as soon as possible and develop supporting laws and regulations for contaminated sites management. Soil environmental legislation should pay more attention to the protection of clean soil, especially farmland, and the management and control of contaminated sites.

Second, environmental risk-related provisions in existing laws and regulations are not specific and clear enough and their operability is low. Thus there is a need to revise existing laws and regulations to incorporate and make environmental risk control provisions more concrete.

① Develop a new law for chemical and hazardous material management. This law would be based on the existing *Hazardous Chemical Safety Management Regulation* and focused on implementing life-cycle risk management for chemicals, including comprehensive risk assessment of new chemicals, provisions for chemicals production, handling, transport, storage, use, and waste management, as well as disclosure of chemicals use, transportation, and storage by industry and government ministries and agencies at all levels. Strengthen comprehensive supervision and regulation of priority pollutants in the process of industrial production.

② Revise *Civil Law* or *Tort Liability Act*. Expand the scope of compensation for personal injury caused by environmental pollution, clearly incorporate potential health damage into compensation, clarify standards for direct and indirect loss identification, and incorporate pure economic loss into property damage compensation, as appropriate.

Third, conduct retrospective assessments for all relevant laws on a periodic (5 or 10 year) basis and revise or amend relevant laws according to results of these assessments and changing social, economic, and environmental risk conditions.

(2) Promote and strengthen the environmental judiciary

Although the environmental judiciary system in China is still in its early stages, the system is important to ensure that environmental protection laws and regulations are enforced. Put in place measures to promote the environmental judiciary in China, including the training of professional judiciary human resources and promoting public consciousness about environmental rights.

6.4.3.2 Enable environmental risk information integration and sharing

Vertical and horizontal fragmentation of environmental risk information, including its storage and management, has resulted in data redundancy and conflicts. Taking the lead from the State Council's 2015 *Construction Plan for an Eco-environmental Monitoring Network*, integrate environmental risk information which is distributed across multiple government departments into a national unified environmental information platform, or

data centre, and establish aspecific subdivision for environmental risk information.

This subdivision will include information on risk attributes and spatial information on environmental risk sources and surrounding sensitive receptors, monitoring and management information on risk sources, and relevant policies, laws, and regulations. Develop specific agreements and protocols for sharing environmental risk information, both horizontally and vertically across environmental protection departments and between MEP and other government ministries.

Support extensive research on environmental exposure and dose response functions based on ecotoxicology, human health risk, and environmental epidemiology to fill data gaps. These data can be incorporated into the unified environmental risk information database.

6.4.3.3 Apply financial and economic instruments to prevent and manage environmental risks

Higher quality environmental financial instruments are required for environmental risk management. Establish an enterprise financial security system, based on environmental risk, for sudden accident, cumulative event, and chronic environmental risks, including liability insurance for industries and enterprises, an environmental risk deposit system for high-risk industries, and special funds for legacy contaminated site clean-up and remediation. Economic measures such as market based regulation also should be used to prevent and reduce environmental risks.

(1) Improve the environmental liability and financial assurance system

Clarify the role of environmental liability insurance and other financial assurance instruments from the legal perspective, and apply mandatory liability insurance and/or other financial assurance for high-risk industrial sectors. Based on sector characteristics, develop guidelines for enterprise environmental risk assessment, damage verification, and determination of compensation methodology. This will provide technical support for improvement and implementation of an environmental risk liability insurance system and assist in the determination of premium rates.

(2) Establish and optimize special funds for environmental risk control

Establish an environmental risk deposit system for high-risk industries. Enterprises with high environmental risks would pay corresponding deposits to environmental ministries and bureaus, according to their risk classifications. This will enable environmental agencies to pay damage compensation and remediation costs using the deposits when environmental risk events happen. These ministries and bureaus can hold accountable the responsible enterprises after the events, so as to protect the environmental

rights of the people surrounding the enterprises.

Establish special funds for contaminated site clean-up and remediation. With the progress of urbanization, some contaminated sites in urban areas may be re-developed. Remediation management of contaminated sites is urgently required. However, remediation costs are high, which is a major barrier for the redevelopment of contaminated sites. Further, for some contaminated sites, the responsible enterprises cannot be found or have become bankrupt, so that funds for site remediation cannot be guaranteed.

6.4.3.4 Strengthen environmental risk emergency response capacity

First, develop relevant policies and measures to improve the effectiveness of environmental emergency response plans at all levels. The National Environmental Risk Board, in collaboration with professional organizations, should be responsible for developing guidelines for these plans and for supporting policies to ensure effective response plan development and training exercises.

Second, establish strong environmental emergency response capacities. Establish joint emergency response mechanisms with clear powers and responsibilities and requirements for information sharing, with emergency response plans as the core. This would involve government departments responsible for safety supervision, transportation, environmental protection, and public security, as well as enterprises. Optimize the allocation of regional environmental emergency resources.

6.4.3.5 Establish a responsibility system for industries and enterprises

Establishing corporate environmental risk responsibility needs to start from the relationship among government, the public, and enterprises, to motivate enterprises under internal and external pressure to establish and improve their acceptance of responsibilities for environmental risks. Government has a role in creating the right conditions, through a combination of law and regulation, with enforcement and incentives to industry to act responsibly.

First, drive and support industry sectors to be responsible for adopting environmental risk management practices. Clarify the response and remediation responsibilities of industries and enterprises for accidental and legacy risks, specify in law and regulation environmental risk information disclosure obligations, and provide regulatory recognition for adoption of leading practices by enterprises.

Apply a series of incentive measures in the fields of investment, green credit, taxes and fees, land, market access, government procurement, and tradable quotas to create an environment that encourages leading enterprises to establish their environmental risk responsibility system. Provide training in EHS practice for enterprises, and develop

measures to spur enterprises to establish their EHS systems.

Focus on sectors with critical environmental risks. These would include the chemical industries. Through their industry groups such as the Association of International Chemical Manufacturers (AICM), encourage them to broaden in China the application of the successful international Responsible Care® Program. Similarly, engage the China Mining Association to address environmental risks.

Second, develop and implement a program for environmental risk management improvement in state enterprises. Require state enterprises to raise the level of environmental risk management to the international standards applied by foreign companies, and provide incentives and support for them to become national leaders. Led by MEP and working with each sector ministry, develop environmental risk assessment and EHS training for state enterprises, based on priority risks identified by the National Environmental Risk Board. Promote a third-party service market making full use of professional organizations in corporate environmental risk management, and provide professional services to small and medium enterprises in this field.

Third, put in place rules for mandatory environmental risk disclosure in the financial reporting requirements of the China Securities Regulatory Commission. Through mandatory information disclosure, environmental risk management becomes a major factor that can affect enterprise financing and stimulate stock exchange listed enterprises to consciously and actively implement environmental risk management practices.

6.4.4 Establish an environmental risk communication and engagement system

6.4.4.1 Ensure effective information disclosure and communication

The diversity and complexity of environmental risks requires more effective and responsive communication, cooperation, and negotiation among government agencies and multiple stakeholders. Poorly informed public risk perceptions may result in the exaggeration or the attenuation of the actual risks, or the neglect of other risks. It may also result in inappropriate emergency response to risk events.

First, establish an environmental risk data sharing mechanism across ministries, and with provincial and local environmental bureaus. This can be based on the *Plan for an Eco-environmental Monitoring Network*. Establish an accessible mechanism for public disclosure of risk information, to be implemented by government ministries and provincial and local environmental bureaus. The mechanism will include requirements for disclosure of multi-source risk information, including risk sources and location, regular environmental

monitoring results for the sources, risk assessments, environmental emergency response plans, and information on public perception of risk. Such information provides a basis for the building of an efficient and orderly environment risk communication and public engagement system.

Second, develop a multi-dimensional, transparent environmental risk communication and engagement system. This should involve multiple stakeholders including government ministries, enterprises, representatives of citizens and communities, media, and social organizations. The system should use various measures such as information transfer, round-table conferences, and community engagement.

Establish mechanisms for risk knowledge transfer to and from the public, including on specific risk reduction strategies and hazard chain information, so that government ministries and bureaus better understand public preferences and the public has a better perception of environmental risks.

It is also essential to familiarize citizens and communities with risks that they will face in everyday life. They need to know how to behave in emergencies and gain knowledge about self-rescue, evacuation, and strategies for avoiding damage after an environmental risk incident. Effective communication lowers public vulnerability to risk events, especially for vulnerable people and the most exposed segments of the population.

6.4.4.2 Establish effective environmental risk engagement programs

Environmental risk management is not only a matter for government departments and enterprises, but also an opportunity to involve the relevant stakeholders such as affected communities, social organizations, scientific research institutions, and the broader public. Establish an environmental risk management and emergency response system involving all relevant stakeholders and specify their roles in environmental risk management including emergency response. It is important to value their contribution to environmental risk management, including emergency response, with their special knowledge, their familiarity with the region or locale, and the specific mitigation or adaptation skills they possess.

Develop community and public engagement models for dialogue and feedback from affected communities. Involve relevant stakeholders to co-design environmental risk management policies and include the feedback from stakeholders in policy and planning design. Promote public participation in policy and regional plan development, and in the conduct of policy and plan-level SEA and project EIAs.

Annex

Annex 6-1 Description of three categories of environmental risks

Category 1: Sudden pollution accident risk. This type of environmental risk event occurs mainly due to the natural or human-caused fire, explosion, or leakage of hazardous chemicals from production, storage, transportation, and waste treatment facilities. A quantity of pollutants is released suddenly and poses acute effects on ecosystems, environmental quality, and human health.

Category 2: Cumulative threshold event risk. This type of risk event happens mainly due to human-caused long-term and chronic discharge of pollutants. The acute consequence occurs when exposure accumulates to certain levels exceeding a threshold or tipping point. For example, the Taihu Lake blue algal bloom event in 2007 was the result of long-term discharge of nitrogen and phosphorus together with the appropriate weather conditions suitable for algae growth. Many episodes of elevated blood lead levels in children that have occurred in recent years were the result of long-term discharge of heavy metals which accumulated to toxic levels. Acute air pollution episodes are another example.

Category 3: Long-term chronic environmental risk. This type of risk poses chronic adverse effects due to human-caused long-term discharge of pollutants or persistent pollution in environmental media, for example: chronic ecosystem effects, human health effects from $PM_{2.5}$ pollution, contaminated sites, new chemicals and emerging pollutants, radiation sources and nuclear wastes, as well as long-term ecological degradation due to infrastructure or regional development. Some pollutants with climate change effects, such as short lived climate pollutants (short-lived climate-forcing pollutants, that is, black carbon and tropospheric ozone), have both adverse health effects and a greenhouse effect.

It should be noted that Categories 2 and 3 may share the same risk sources. For example, exposure to contaminated sites may not only cause unnoticed chronic health effects, but also may cause visible and acute events when contamination reaches a threshold. Another example is that $PM_{2.5}$ pollution not only causes chronic health risks, but also may cause heavy pollution episodes when weather conditions limit its diffusion.

In Figure 6-3, Category 1 sudden pollution accidents may involve persistent pollutants. After the emergency response to the accident, persistent pollutant residues may remain in environmental media for a long time and thus form contaminated sites or sediments. In that case, environmental risk before pollution accidents can be classified to Category 1. After emergency disposal, contaminated sites or sediments would become new

risk sources and thus can be classified as Category 2 or 3. For example, nitrobenzene in the 2005 Songhua River pollution accident, crude oil in the 2010 Dalian oil pipeline explosion, and cadmium in the 2012 Longjiang River cadmium pollution accident, all may lead to residues in sediments and would pose long-term ecological and health risks.

Annex 6-2 Problems of current environmental emergency responses

This study selected the 50 typical pollution incident cases from *Typical Environmental Accident Cases (Part I)* (MEP Emergency Response Lead Group Office, 2011) to analyse the main reasons for the ineffectiveness of environmental emergency response, as shown in Annex Table 6-2-1.

Annex Table 6-2-1 The main reasons for ineffectiveness of environmental emergency response from 50 cases

Reasons	Proportion
Emergency response monitoring was not reasonable with incomplete or unreasonable monitoring indicators and lack of post supervisory monitoring	48%
Insufficient cross-department and cross-region coordination, with information sharing and joint action to be strengthened	40%
Lack of emergency response and protection equipment, resulting in ineffective pollution reduction and health threat to emergency response staff	28%
Did not disclose relevant information at the early stage of incidents, causing public panic and influencing social stability	28%
Lack of effective emergency response plan and scientific decision making, improper emergency response measures at the early stage of incidents which contributed to inadequate pollution control and even caused secondary pollution	26%
Did not have scientific and timely warning on air and water environment, a circumstance which was unable to provide support to decision making	22%
Limited emergency response monitoring capacity and shortage of staff	20%

Annex 6-3 Current environmental risk levels in China

For this study seven representative indicators from seven environmental risks were selected to characterize the current environmental risk levels in China, including accidental pollution events; soil, air, and water pollution; climate change; economic loss; and public demands (Annex Table 6-3-1). Meanwhile, based on the consideration of current levels of the indicators, Annex Table 6-3-1 suggests a preliminary comparison of each current indicator level with three risk levels-low, medium, and high-sketching a rough range of possibilities. For example, for the indicator of "annual environmental risk accidents," considering that the pollution accident frequency in China before 2005 was relatively

high (over 1,000 events each year), 1,000 is identified as the high level and reflects the effectiveness of environmental risk control since 2005.

According to Global Burden of Death (GBD) 2010study data[1], the premature death rate attributable to $PM_{2.5}$ is 0.6×10^{-4} in Australia, which is one of the least $PM_{2.5}$ polluted countries in the world (where the population weighted annual $PM_{2.5}$ concentration is 2.3 $\mu g/m^3$). Thus 0.5×10^{-4} is set as the low risk level. And 10×10^{-4} is set as the high risk level, which is near the current level of China.

For the environmental complaint rate, considering that it continues to increase since the 1990s, this study suggests that levels in the early 1990s were at a low level and 1‰is the high public demand level, which is near the current situation. Risk levels of other indicators are set based on their current status and relevant demands for environmental management in China.

Annex Table 6-3-1 Current environmental risk levels in China

Indicators	Low	Medium	High	Current
Annual environmental risk accidents[1]	50	100	1,000	452
Proportion of contaminated soils/%[2]	5	10	20	16.1
Premature death rate attributable to $PM_{2.5}$ [3]	0.5×10^{-4}	5×10^{-4}	10×10^{-4}	9×10^{-4}
Proportion of inferior V water[4]	1	5	10	9.2
Environmental risks due to climate change[5]	NA	NA	NA	Medium
Proportion of environmental losses compared to GDP/ %[6]	0.5	2	6	6
Environmental complaintrate/‰[7]	0.1	0.5	1	0.89

1 Current level: From *China Environmental Statistical Yearbook (2014)*.
2 Currentlevel: From the first national soil pollution investigation results released by MEP and Ministry of Land and Resources in 2014.
3 Currentlevel: Calculated from GBD 2010 and Chinese population.
4 Currentlevel: From *Environment Quality Bulletin (2014)*.
5 Including health risks of complex air pollution and biodiversity losses due to climate change, secondary environmental pollution accidents due to climate change-related natural disasters such as coastal and river flooding and extreme weather events, etc. Based on the current trends of global warming, environmental risks due to climate change will be more serious in the future. Thus the current risk level is set to medium. A quantitative analysis has not yet been undertaken by this study.
6 Current level: From the report of *Impacts of Environmental Protection on Economic under New Normal Situation* issued by MEP in 2015. http://news.xinhuanet.com/fortune/2015-09/09/c_1116513933.htm.
7 Current level: Calculated using data from *China Environmental Yearbook (2014)* and China population.

The "environmental risk rose" (Figure 6-8) is based on Annex Table 6-3-1. The figure intuitively demonstrates examples of multiple environmental risks and the associated levels. The environmental risk rose can be applied to demonstrate the risk management

1 http://vizhub.healthdata.org/irank/heat.php.

goals in the future. Note that this figure presents the result of only a preliminary analysis, which cannot completely characterize risk levels for all kinds of environmental risks. The risk examples are preliminary and the risk levels represent semi-quantitative results. The distances between circles in the rose diagram are not to scale. The points around a given circle do not necessarily represent equal levels of risk or seriousness. For example, around the outer-most circle, 10×10^{-4} risk from $PM_{2.5}$ air pollution corresponds to roughly 1.3 million deaths per year in China, whereas 10% inferior V water or 1,000 environmental incidents may not be associated with such high mortality levels. And movements along the radius lines of the rose, from the outer circle toward the center, do not necessarily represent equal or proportionate reductions in risk.

Annex 6-4 Prospects for driving forces of environmental risks in China

I Driving forces of environmental risk

i Driving forces of environmental risk levels

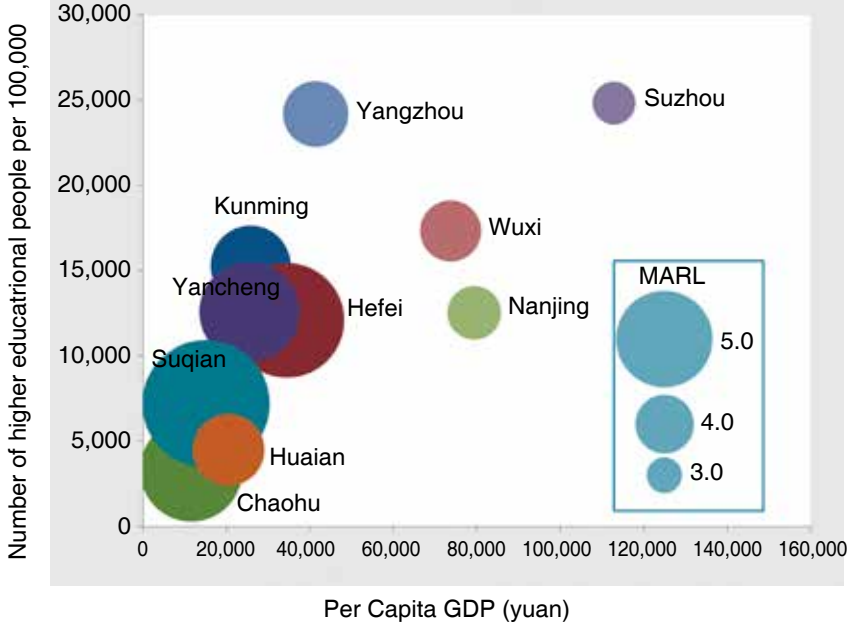
Based on the model of the environmental risk chain (Figure 6-2), social needs are the origins of the formation and existence of environmental risk sources. Environmental risk sources are formed during the process of socioeconomic activities. Thus environmental risk pressure factors can be characterized by indicators which can reflect socioeconomic activities, such as GDP and industrialization. And along the whole process of the environmental risk chain, causes of environmental risk events may exist in any risk chain node with poor management. Thus the level of environmental risk management applied is also an important factor which can influence risk levels. In addition, technological progress can also benefit environmental risk reduction.

ii Driving forces of public environmental risk perceptions

The public response to environmental risk based on people's own subjective perceptions may vary significantly with differing socioeconomic status and education levels, which will influence judgement and acceptable risk level. A total of 3550 samples from 16 cities in Jiangsu, Anhui, and Yunnan provinces were surveyed for determining the desired level of acceptable risk[1]. The analysis concluded that economic development level and education level are the two most important factors influencing acceptable risk level (Annex Figure 6-4-1). Acceptable risk level decreases with the increase of per capita GDP (or national income) and education levels.

1 Bi, J et al, 2012. Research report of China's 863 project of "Research on Integrated Technology System of Major Environmental Pollution Accident Emergency Response". Unpublished.

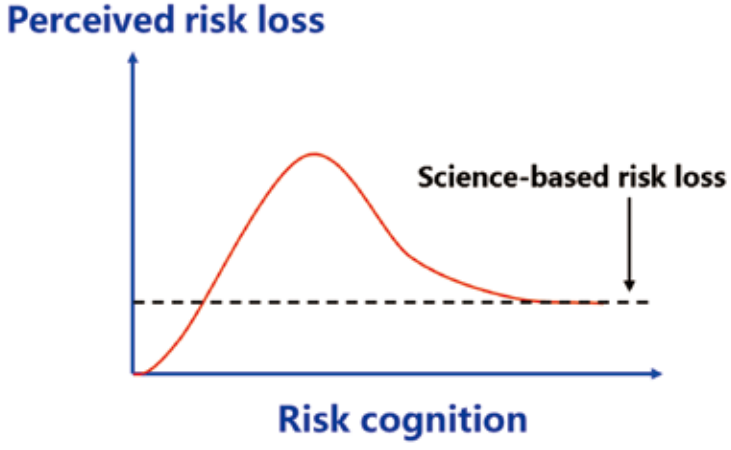
In addition, the emergence of new media such as the internet facilitates faster dissemination of information. Information dissemination through new media may result in exaggeration of risk information which may magnify the actual risks and lead to larger gaps between public perception levels and objective risk levels. For example, several para-xylene (PX) projects have had mass protest incidents in recent years. In some cases, rumours may be disseminated. For example, the rumour of explosions of chemical plants in Xiangshui county, Jiangsu, in 2011 caused panic and the relocation of tens of thousands people in nearby communities. In other cases risks are underestimated or poorly communicated, such as when smog was once dismissed as "fog" or people in some cancer villages are unaware of the risk they are exposed to. Thus appropriate risk communication to bridge the gap between environmental risk levels and public acceptance levels needs to be considered.



Annex Figure 6-4-1 Relationship between acceptable risk and per capita GDP and education(The area size of the circle represents the public Maximum Acceptable Risk Level, i.e., MARL)

Studies have shown that risk cognition and public perceived risk loss have the relationship shown in Annex Figure 6-4-2. In recent years, with the increase in public education levels and development of information dissemination technology, the public has

gained more knowledge about environmental risks than ever before. However the public is still at a stage with insufficient knowledge (left side of the curve peak).The increase in risk cognition results in increasing perceived risk loss, which lowers the risk acceptance level. Without proper risk communications, the risk level will be exaggerated when public risk acceptance level decreases to a certain level. This explains why there are so many "not in my backyard" events in China in recent years. Thus proper environmental risk communication and engagement are needed to continually increase public risk cognition to ensure that the public perceived risk loss is in line with the science-based risk loss (right side of the curve peak).



Annex Figure 6-4-2 Relationship between risk cognition and public perceived risk loss[1]

Ⅱ Prospects for driving forces of environmental risk levels and public risk perceptions

i Prospects for driving forces of environmental risk levels

(i) **GDP growth and industrialization.** Using data from the *China Statistical Yearbook*, Annex Figure 6-4-3 shows GDP growth and its composition in China from 1978 to 2014. It can be seen that China's economy has had a high rate of growth since the 1990s.With the World Wide Fund for Nature and China's Policy Research Center for Environment and Economy, MEP issued a report on *Indicator Instrument and Empirical Study for Green Economic Decision Making* in 2015. The results show that China's

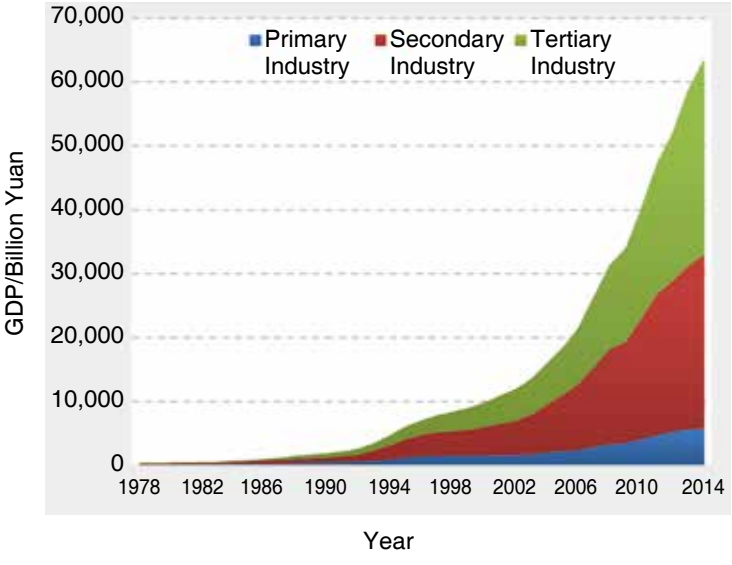
1 Bi, J et al., *Regional Environmental Risk Analysis and Management*, (BeiJing: China Environmental Science Press, 2006).

economic growth is still driven by heavy chemical industries, which account for more than 70% of the industrial gross output since 2005. The gross output of heavy chemical industries keeps increasing and its energy consumption has increased from about 1.5 billion tons of standard coal equivalent in 2001 to 3.75 billion in 2013, with significant increase in air pollution risk including $PM_{2.5}$.

In recent years, China's economic growth rate has been slowing and it is going through structural adjustment. The GDP growth rate in 2014 was 7.3%-down from about 10% in preceding years, but still at a high level. The Economic Research Institute of the National Development and Reform Commission issued the interim report *Research on Development Environment, Trend, and Strategy of China during 13th Five-Year Plan,* showing that the GDP growth rate during the 13th Five-Year Plan period will remain at about 7% and gross output of heavy chemical industry will also keep increasing.

In addition, to promote economic development, China will implement a series of national development strategies such as the Belt and Road initiative, integrated development of the Jing-Jin-Ji area(the Beijing-Tianjin-Hebei "supercity"), and the Yangtze River Delta economic zone. These will become new economic growth points. The construction and operation of infrastructure and industrial projects during the implementation of these strategies will pose great pressures on regional environmental quality and ecosystems, especially fragile ecosystems.

(ii) **Climate change.** In addition to growth and industrialization, global warming and climate change may also add stresses to China's public health and ecological challenges. Climate change can create both direct and indirect environmental risks for humans and ecosystems.For example, higher temperatures may exacerbate air pollution that may pose more long-term and chronic health risks. Higher temperatures may also reduce ecosystem resilience to environmental risks; for example, extended droughts may undermine fragile eco-systems. Sea level rise, storm surges and flooding may damage coastal eco-environments along waterways. Meanwhile, the increased probability of natural disasters induced by climate change may also increase the probability of secondary sudden pollution accidents. Global warming has been a universally accepted fact. Climate change in the future will increase the environmental risk levels.



Annex Figure 6-4-3 GDP growth and its composition in China(1978—2014)

ii Prospects for driving forces of public risk perceptions

During the 13th Five-Year Plan period and in the years following-although China will see a in a slowing of economic growth and structural adjustment-the growth rates are still at relatively high levels, and per capita GDP and average income level will keep rising. According to the *China Statistical Yearbook*, China's per capita GDP in 2014 was around 7,500 US dollars. The report of *Research on Development Environment, Trend, and Strategy of China during 13th Five-Year* Plan shows that China's per capita GDP in 2020 will be over 10,000 US dollars and reach the levels of moderately developed countries.

For the education trend, according to *National Middle and Long-term Education Reform and Development Plan (2010—2020)*, the population with a level of education will reach 145 million in 2015 and 195 million in 2020. It can be expected that public demands for education and the national education level will keep rising after 2020. Thus the public environmental risk acceptance levels will keep decreasing as educational level and individual income continue to grow in the future.

iii Overall prospects for environmental risk driving forces in China

Based on the above analysis, the prospects for driving forces of environmental risk levels and public perceptions are summarized in Annex Table 6-4-1.

Annex Table 6-4-1 Prospects for environmental risk driving forces in China

Driving forces		Short and Middle Term 2015—2030	Long Term 2030—2050[5]
Driving forces of environmental risk levels	GDP	Increase rapidly [1]	Keep increasing, but more slowly
	Gross output of heavy chemical industry	Increase rapidly [2]	Keep increasing, but more slowly
	Climate change	Become more serious	Become more serious
	Environmental risk management level	Keep improving but driven by environmental risk events or activities	Keep improving but driven by environmental risk events or activities
	Environmental science and technology level	Keep increasing	Keep increasing
Driving forces of public environmental risk acceptance levels	Education	Increase [3]	Increase
	National income	Increase [4]	Increase

1 According to *China Statistical Yearbook*, the GDP growth rate in 2014 was 7.4%. The interim report of *Research on Development Environment, Trend, and Strategy of China during 13th Five-Year Plan* by the Economic Research Institute of the National Development and Reform Commission shows that the GDP growth rate during the years of the 13th Five-Year Plan will remain about 7%.

2 According to the report of *Indicator Instrument and Empirical Study for Green Economic Decision Making* issued by the World Wide Fund for Nature and China's Policy Research Center for Environment and Economic, MEP, heavy chemical industries account for more than 70% of the industrial gross output-a figure that keeps increasing.

3 According to *National Middle and Long-term Education Reform and Development Plan (2010—2020),* the population with high education level will reach 195 million in 2020-which is 50 million more than 2015.

4 According to *China Statistical Yearbook*, China's per capita GDP in 2014 was around 7500 US dollars. The report of *Research on Development Environment, Trend, and Strategy of China during 13th Five-Year Plan* shows that China's per capita GDP in 2020 will be over 10,000 US dollars.

5 Preliminary analysis based on short and middle term prospects.

Annex 6-5 The risk goals under various laws and regulations in the United States and the European Union

Annex Table 6-5-1 provides the risk goals of various laws and regulations in the United States and the European Union. These are variously expressed in quantitative, qualitative, or technology terms.

Annex Table 6-5-1 Risk Goals in Risk-Based Laws and Regulations

United States			
Risk Goal/Target	Domain	Scope/Objective	Law/Regulation
Apply Maximum Available Control Technology (MACT). If residual risk of most exposed individual remains greater than 10-6, then more stringent measures must be adopted	Environment	Air toxics: Develop air pollutant-based air quality standards according to protection target. MACT is set to equal the best 12% of industry performance in each source category	US *Clean Air Act*, section 112
Protect public health and welfare with an adequate margin of safety	Environment	National ambient air quality standards (NAAQS)	US *Clean Air Act*, sections 108-109
"Best technology" requirements, which explicitly or implicitly may include cost-benefit considerations	Environment	Integrity of chemical, physical and biological contents of national waters	US *Clean Water Act*, sections 304, 316
Maximum contaminant levels (MCLs) that approach the level of "no observed adverse effect"	Environment	Drinking water standards; 1996 amendments authorized EPA to set "alternative MCLs" using cost-benefit and risk-risk tradeoff analysis	US *Safe Drinking Water Act*
Prevent unreasonable risk	Environment	Manage the production and circulation of industrial chemical products	US *Toxic Substance Control Act*
Food additives allowed only if reasonable certainty of no harm	Food safety	Manage consumer health risks from food additives in processed food	US *Food, Drug and Cosmetic Act; Food Quality Protection Act*
Set standards that ensure a "reasonably safe and healthful workplace". Regulate workplace toxic substances "to the extent feasible"	Workplace health and safety	OSHA must demonstrate some "significant" risk before regulating (as clarified by 1980 Supreme Court decision). "Feasible" interpreted by 1981 Supreme Court decision as the maximum degree the industry could afford without shutting down	US *Occupational Safety and Health Act*

European Union			
Risk Goal/Target	Domain	Scope/Objective	Law/Regulation
Best available technology (BAT) in different industries	Environment-air	Prevent, reduce and mitigate to the extent possible industrial pollution through establishing a framework to control industrial activities	Industrial Emissions Directive
Quality goals for Good Ecological Status and Good Chemical Status	Environment –chemicals + water	Standards and measures through enforcing basin environmental quality and integrated management; Based on available scientific and technical data, environmental conditions in the various regions, and the economic and social development of the EU as a whole	Water Framework Directive
Burden of proof on companies-to demonstrate how the substance they manufacture and market can be safely used	Environment-chemicals	Protect human health and eco-environment from risk of chemical products, and enhance competitiveness of EU chemical industry; ECHA has marked a number of Substances of Very High Concern (SVHC) as having particularly high environmental risk	REACH Directive-Registration, Evaluation, Authorization, and Restriction of Chemicals
Promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements and making a contribution to sustainable development	Environment-ecosystems	Reduce and manage regional ecological risk	Habitats Directive

Chapter 7
Soil Pollution Management

7.1 Current status of soil pollution management in China and need for legal regulation

7.1.1 Soil pollution in China

Along with air and water, soil is key to sustain life. If China were to destroy its soil, it would destroy itself. The understanding of soil's value and its impact on China's economy and the ongoing development of Chinese society is critical for the nation to thrive. Good quality soils are essential to achieve Ministry of Environment Protection (MEP), Ministry of Agriculture, Ministry of Housing and Urban Rural Development, Ministry of Water Resources and other stakeholder goals of a thriving farming sector and a healthy, sustainable food supply, as well as securing a healthy environment in which future generations can prosper without the threat of adverse impacts from soil contamination.

Recent reports have revealed that soil pollution in China is serious, the farmland soil environmental quality is alarming, and the soil environmental problems of waste land of the mining industry have become prominent. Industrial activities, former and current mining operations, agricultural activities as well as atmospherically transported pollutants are all important reasons for the soil pollution challenges China is facing today. In addition, there are high background levels of certain metals and elements in the soil, bedrock and groundwater in some regions, contributing to increasing the man made pollution problems.

7.1.1.1 The first national survey on soil pollution

Ministry of Environment Protection and the Ministry of Land and Resources jointly conducted a national survey on soil quality in China between 2005 and 2013. Summary of the results were released in 2014 in the Bulletin of National Soil Pollution Survey[1] (hereafter the Bulletin), concluding that the general condition of China's soil environment is not optimistic. Some areas are suffering from serious soil pollution, the environmental quality of the arable land is worrying, and there are outstanding environmental problems

1 Source:http://english.gov.cn/policies/latest_releases/2014/08/23/content_281474983026954.htm.

in industrial and mining deserted lands. 16% of the surveyed soils were classified as polluted[1]. For the agricultural soils the ratio of polluted soil was even higher, at 19.4%.

The spatial distribution/pattern of the data summarized in the Bulletin has not been published, but the Bulletin indicated that the pollution in the southern part of China is worse than the northern part, and that it is particularly serious in areas of Yangtze River Delta, Pearl River Delta, and the historical industrial bases in northeast China. South-western and central regions of China have found wide range heavy metal pollution. The content of cadmium, mercury, arsenic and lead elevates from northwest to southeast, and from northeast to southwest. Though no specific data on soil pollution trends have been exposed, the Bulletin indicated that the soil pollution in China is increasing. The survey reported in the Bulletin had a strong focus on heavy metals pollution, although other aspects were also covered.

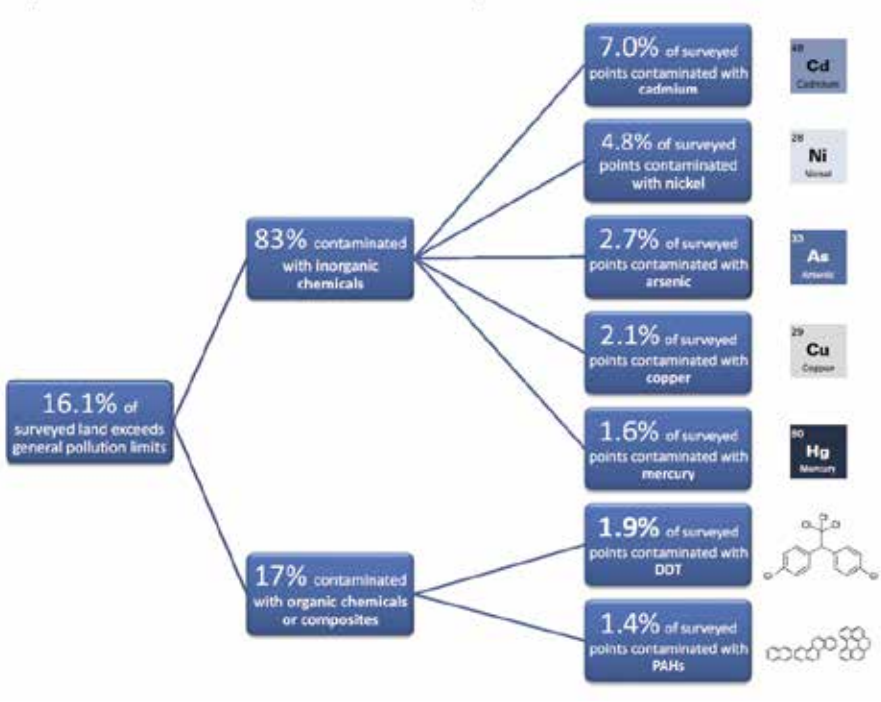


Figure 7-1 Polluted soils in China

Figure 7-1 is an illustration of the results of polluted soils in China as reported in the National Soil Pollution Survey Bulletin by the Ministry of Environment Protection and

1 Divided into 11.2% classified as slightly polluted, 2.3% mildly polluted, and 1.5% moderately polluted and 1.1% severely polluted.

the Ministry of National Land and Resources. 16% of all soils and 19% of the agricultural soils are categorized as polluted. Around heavily polluting enterprises, more than a third of the soils were polluted. Drawing from the Goldman Sachs report on China's environment[1].

7.1.1.2 National survey on beneficial and harmful elements in soil

In 2015, China Geological Survey under the Ministry of Land and Resources published another national soil quality survey "Geochemical Survey Report on Chinese Farmland"[2]. The focus in this survey was the presence of beneficial and harmful elements in the soil. The study reports that nearly 92% of the investigated agricultural soils had heavy metals concentrations below the national standard limit values; in other words, 8% of total investigated arable land has been contaminated. 5.7% was classified as slight-mild heavy metal polluted and 2.6% moderate-severe. The survey also reported on changes in other soil quality properties, including reduced organic matter content in the North-east, increased acidity in the South and increased alkalization in the North. More than 20% of the soils were reportedly badly hit by acidification, and almost 30% showed a tendency of alkalization with soil hardening, reduced fertility and nutrient availability.

7.1.1.3 Soil's ability to sustain food production and food safety

In another national survey, where the primary focus has been the soil's ability to sustain food production and food safety, maps have been published showing the quality class, taking both nutrient status and heavy metals pollution into account[3] (Figure 7-2). In this study, as much as 34% was classified as having some level of nutrient deficiency, while regarding heavy metals, 60% were classified as clean, 29.5% as less clean and 2.6% as polluted.

The large fraction of soils with nutrient deficiency is also an illustrative example of how the environmental compartments are interlinked: The nutrient deficiency of soils first of all illustrates that the soils have lost some their important functions. As a response, the farmer will add more fertilizer, resulting in more nutrient runoff to surface waters, causing eutrophication, deteriorated water quality and toxic algal blooms. It also causes increased atmospheric emissions of nitrogen compounds, which will contribute to increasing levels of secondary particles ($PM_{2.5}$), as well as being potent greenhouse gases. Hence, keeping soils healthy not only matters for the soil function and food production, but also for water quality and air quality.

1 13 July 2015 Goldman Sachs Report on China's environment.

2 Source:http://en.cgs.gov.cn/UploadFiles/2015_06/30/r-SuntGeochemical%20Survey%20on%20Chinese%20Farmland.pdf.

3Yang ZF, Tao Y, Hou QY, Xia XQ, Feng HY, Huang CL, et al. Geochemical evaluation of land quality in China and its applications. J Geochem Explor 2014;139:122–35.

7.1.1.4 Pesticides

Another important link between soil and water quality is pesticide use in the agricultural sector and subsequent pollution of aquatic ecosystems. This is an issue that is not easily covered in the large scale soil quality surveys, and requires assessment of biological sample matrices. China is one of the largest producers and consumers of pesticides in the world today and the increase in pesticide use and production the last two decades is enormous. Along with the widespread use of pesticides and industrialization, with direct impacts on soil quality and function, there is a growing concern for water quality deterioration from pesticide residues. In a recent literature review, the eco toxicological risk pesticides pose in aquatic ecosystems were assessed. A large fraction of the results from the reviewed studies are given an environmental classification of "very bad" based on pesticide levels in biota, with the risk for DDT generally being the highest (Figure 7-2).

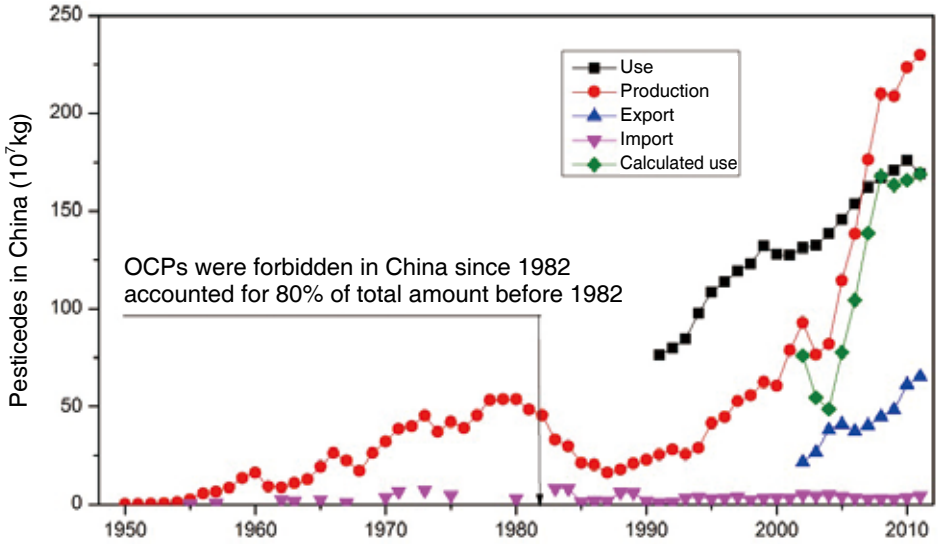


Figure 7-2 Historical Production, Use, Export and Import Amounts of All Pesticides in China[1]

1 Grung, M., Lin, Y., Zhang, H., Steen, A.O., Huang, J., Zhang, G., Larssen, T., 2015. Pesticide levels and environmental risk in aquatic environments in China - a review. Environ. Intl. doi: 10.1016/j.envint.2015.04.013t.

The review also revealed a poor geographical representation, with the majority of studies have been undertaken in vicinity of the largest cities. Hence, many of the most important agricultural provinces (e.g., Henan, Hubei and Hunan), with the largest pesticide use, have been the subject of few studies on the environmental levels of pesticides. Also, there is a lack of studies in remote Chinese environments.

7.1.1.5 Acid rain and soil acidification

Soils are also impacted by pollution depositing from the atmosphere, including heavy metals and acid rain. Acid rain has been a major concern in China, especially due to sulfur emissions from the burning of coal, but also to some extent from atmospheric nitrogen emissions. This has resulted in deteriorated soils, with lowered pH, lost base cations and reduced buffer capacity, being a threat to forest health. It has been estimated that 16% of the Chinese territory has soils where the critical load of acid from the atmospheric deposition is exceeded. Soil acidification poses a long-term risk both for forest ecosystems and for agricultural production, since acidification of soil result in loss of beneficial base cations in the soil (such as calcium) and mobilization of aluminum ions, with potential harmful effects on plant roots. Reduced growth of forests and crops is already happening. In the longer term, forest death is a possible scenario.

7.1.1.6 Heavy metals from mining areas

Heavy metal pollution from, and in the surrounding areas of mining areas is of particular concern in China. The affected areas may be relatively limited, but the pollution levels might be high, posing a particularly high risk for the local population. A recent review paper summarized available data in the literature (2005—2012) on heavy metal polluted soils in mining areas in China and estimated risk levels to human health[1]. The review demonstrated severe heavy metal pollution and subsequent high carcinogenic and non-carcinogenic risks to the public, especially to children and those living in the vicinity of heavily polluted mining areas.

7.1.1.7 Irrigation with polluted surface water

A considerable fraction of China's agriculture and grain production is dependent on irrigation and water shortage is a severe challenge, especially in northern China. As a result, irrigation water of poor quality is being used, including polluted surface water

1 Li, Z., Z. Ma, T. J. van der Kuijp, Z. Yuan and L. Huang, 2014.A review of soil heavy metal pollution from mines in China: pollution and health risk assessment. Sci Total Environ 468-469: 843-853.

and waste water[1]. This is resulting in a gradual build-up of contaminants in the soil, potentially being transferred to the crops and posing a food safety risk. The use of waste water or sewage contaminated surface water for irrigation may also increase the risk of contaminating food crops with pathogens.

7.1.1.8 Contaminated groundwater

Soil pollution is closely linked with groundwater pollution, as pollutants stored and accumulated in soils may gradually migrate to the ground water. Once groundwater is contaminated, recovery is a very slow process. The quality status of Chinese groundwater is poor: According to a report by the Ministry of Land and Resources in 2014, almost 60% of the nation's groundwater is polluted and classified as unsuitable for drinking. 44% of the monitored sites were ranked as "relatively poor" and 16% as "very poor".[2]

Mr. Li Ganjie, Deputy Minister of MEP, expressed his great concern on the soil pollution issue in China as follows:

> *"If no powerful measures would be made, the soil pollution in China will be irreversible, and soil pollution will be an important problem that will harm the public health and social order."*
>
> *"As showed by the various surveys and investigations, the soil pollution in China has arrived very serious degree. If the soil pollution is left untreated, even the food supply will be a problem in some areas."*

7.1.1.9 Soil pollution in China is particularly challenging

Soil pollution in China is a complex issue and the challenges can be summarized in the following three key points:

First, China's rapid development has caused a superposition of a range of serious pollution issues developing rapidly and within the same, short period of time. In many developed countries and regions the process of industrialization, urbanization and modernization lasted for more than a century and the related environmental pollution problems to a larger extent occurred at different stages and periods in time. In China, on the contrary, most types of pollution became serious in a short period of time in the last

1 Li, Z., Z. Ma, T. J. van der Kuijp, Z. Yuan and L. Huang (2014). "A review of soil heavy metal pollution from mines in China: pollution and health risk assessment". Sci Total Environ 468-469: 843-853.
Lu, Y., S. Song, R. Wang, Z. Liu, J. Meng, A. J. Sweetman, A. Jenkins, R. C. Ferrier, H. Li, W. Luo and T. Wang, 2015. Impacts of soil and water pollution on food safety and health risks in China. Environ Int 77: 5-15.

2 Source:http://english.gov.cn/policies/latest_releases/2014/08/23/content_281474983026954.htm.

20—30 years. This may be particularly challenging, but also gives opportunities in terms of integrated pollution control.

Second, China's soil pollution challenges are complex, due to the many different pollution types and sources, the large quantities of pollutants involved and the large areas and number of people affected. Pollution types include heavy metals and organic micro pollutants; pollution on agricultural land and on industrial land; caused by human activities, geological process, sewage irrigation, atmospheric deposition, and improper disposal and treatment of solid waste.

Third, various risk caused by soil pollution. The soil pollution for agricultural land can lead to the absorption of pollutants by crops, polluting the food chain and triggering food safety problems. The soil pollution in residential land can lead to human health risk through direct exposure, and the pollution to ground water and surface water raises problem for potable water. In addition, soil pollution can also lead to microbial pollution and spread of pathogens.

7.1.2 Current status of soil governance and management

A major milestone in Chinese soil pollution management took place in 2005, when the State Council issued a Decision on "implementing scientific outlook and strengthening environment protection" (hereafter the Decision). This Decision explicitly stipulated the following points: a) soil pollution prevention is a focal point in order to strengthen the environmental protection in rural areas; b) a national soil pollution survey and a comprehensive management of contaminated arable soil should be undertaken; c) the use of pesticides, fertilizer, agriculture plastic film and so on should be reasonable and well controlled; d) severely contaminated soil that requires complicated remediation should be regulated by law. This was the first time that Chinese government issued a document directly related to soil pollution problem, and the Decision thus became a prelude to the soil pollution management in China.

As demanded by the Decision, the Ministry of Environment Protection and the Ministry of National Land and Resources began a nationwide survey on soil quality in 2005. The survey lasted for nine years, and the final survey report was released on April 17 2014. The survey provided a data basis for the soil pollution management in China. In order to implement the Decision of 2005, the Ministry of Environment Protection issued an "Opinion on strengthening soil pollution prevention", providing a comprehensive plan and specific demands for soil pollution management.

On 15 December 2011, the 12th Five-Year Plan on National Environment Protection

was issued by the State Council. This plan stated that soil environment protection should be strengthened, and that soil environment protection should be regarded as an urgent and important environmental problem. It also emphasized the construction of soil environment protection legal systems, soil environment supervision and the soil remediation on key contaminated area.

On 23 January 2013, the State Council issued a "Notice on recent work arrangement of soil environment protection and comprehensive management", which provides the objective, main tasks and measures on soil environment protection and comprehensive management. According to the Notice, the main tasks are to strictly control the increasing of soil pollution; define the priority protection area for soil environment protection; highlight the risk control of soil pollution; carry out the soil remediation; strengthen the soil protection supervision capacity, and accelerate the soil environment engineering construction. From the year 2014, the Ministry of Environmental Protection has been working on the development of an "Action Plan on Soil Pollution Prevention", which is expected to be issued before the end of 2015.

Table 7-1 Main responsibilities and major legislation supports of relevant government departments in soil pollution management

Government Department	Main Responsibilities	Major Legislations
Central Government Ministries		
Ministry of Environmental Protection	• Overall administration on pollution management including soil pollution management; • Monitoring on pollution; • Environmental Emergency Response	Law of Environmental Protection
Ministry of Land & Resources	• National Administration of land resources (ownership, land-use planning, etc.); • Organize land survey & land statistics; • Land reclamation; • Protection of cultivated land; • Land revitalization	Land Administration Law & Regulation on Land Reclamation
Ministry of Water Resources	• Soil & water conservation; • Soil erosion monitoring	Law of Soil & Water Conservation
Ministry of Agriculture / State Forestry Administration	• Monitoring of agricultural soil & soil improvement; • Administration on soil safety for agro-products; • Safety administration on use of Pesticides and fertilizers in agricultural land; • Administration on use of forestry land and protection of forestry land	Law of Agriculture, Law on Quality and Safety of Agricultural Products, Law of Forestry
Ministry of Housing & Rural-Urban Development	• Administration of rural urban planning; • Administration of construction projects	Law for Rural Urban Planning

Government Department	Main Responsibilities	Major Legislations
National Health & Family Planning Commission	• Develop and implement interventions for public health issues that seriously endanger people's health; • Develop regulations, standards and policies on environmental health, public place health and sanitary standards for drinking water	
Relevant local government & departments		
Local Government	• Responsible for environmental quality of its jurisdiction; • Responsible for the management of public utilities, facilities and services in water supply, sewage water treatment and sanitation	
Local environmental protection department / bureau	• Overall administration on environmental management including soil pollution management within jurisdiction	Law of Environmental Protection
Department of Land & Resources	Within its jurisdiction: • Land administration and supervision; • Land survey with other departments; • Supervision on land reclamation; • Protection and treatment of soil erosion	Land Administration Law & Regulation on Land Reclamation
Department of Water Resources	• Water & soil conservation	Law of Soil & Water Conservation
Department of Agriculture & Forestry	Within its jurisdiction: • Monitoring of agricultural soil & soil improvement; • Administration on soil safety for agro-products; • Safety administration on use of Pesticides and fertilizers in agricultural land; • Administration on use of forestry land and protection of forestry land	Law of Agriculture, Law on Quality and Safety of Agricultural Products, Law of Forestry
Department of Housing & Rural-Urban Development	Within its jurisdiction: • Administration of rural urban planning; • Administration of construction projects	Law for Rural Urban Planning
Provincial and municipal Health & Family Planning Commission	Within its jurisdiction: • Develop and implement interventions for public health issues that seriously endanger people's health; • Develop regulations, standards and policies on environmental health, public place health and sanitary standards for drinking water	

Table 7-1 presents a brief description of the respective current responsibilities of the government ministries and departments related to soil pollution management in China. Table 7-1 also identifies the relevant laws and regulations that defines each of their responsibilities. Government ministries and departments promote their own plans and priorities for soil protection and pollution management, as there is no comprehensive law or regulation to coordinate the efforts of each department. It was determined during our research for this study that a new law that is focussed on soil pollution management that is under development, has

decided to clearly define the responsibilities of relevant government departments involved in soil protection and pollution management at both central and local level.

From 2011, soil environment management has been explored at the local level in China. Some examples of cities and provinces having established measures or action plans are:

(1) Beijing, where an environment management experts committee of contaminated sites has been established in October 2014.

(2) Shanghai, where measures are established on environment safety in the process of redevelopment of industrial and municipal sites in April 2014.

(3) Jiangsu, where a trial plan on soil environment protection and comprehensive management has been issued in July 2013.

(4) Zhejiang, which has established an action plan on clean soil in July 2011.

(5) Chongqing, which has issued a Notice on environmental protection measures on industrial solid waste left by enterprises to be closed, faced with bankruptcy and to be relocated in February 2011.

The above mentioned plans, policies, regulations and standards concerning soil pollution management both on the national and local level, have accumulated practical experience for the management of soil pollution in China.

Environmental standards are important as tools for environment management. The standards in China consists of two categories: a) environmental quality standard, this is the standard to evaluate the environmental quality of a certain object; b) standard monitoring methods, this category consists of the certified methods by MEP which will be used by all the official monitoring stations in China, and is usually the only accepted method for official use. Currently there are several standards related to soil environment protection in China, including national standards for soil environment quality, environmental standards for various agricultural products, assessment standards for soil environment quality, standards for soil pollution control and methodology standards for soil pollution monitoring. The most relevant standards for soil pollution are summarized in Table 7-2.

Table 7-2 Overview of Environmental Standards and Environmental Monitoring Methods for Soil Pollution[1]

Code	Name	Issued	Into force
HJ 350-2007	Standard of Soil Quality Assessment for Exhibition Sites	2007-06-15	2007-08-01
This standard applies to exhibition sites, consists two categories: Category I, human beings may be directly exposed to soil; Category II, other sites except Category I, for example, venues, green area, commercial or municipal facilities. The environmental levels consists two classes: Class A, uncontaminated soil; Class B, contaminated, if the level exceeds Class B, actions must be taken to remediate to reach Class. Contaminant levels exceed Class A but below Class B can be used for Category II sites. 92 contaminants are included in this standard, including 14 inorganic, 24 volatile organic, 47 semi volatile organic and 7 other types (pesticides, PCBs etc.)			
HJ/T 332-2006	Farmland environmental quality evaluation standards for edible agricultural products	2006-11-17	2007-02-01
This standard applies to agricultural soil, consists three limit values depending on the soil pH: below 6.5, 6.5~7.5 and above 7.5, and two limit values depending on types of crop: paddy field or dry land. 12 contaminants are included in this standard, including 8 metals, 2 pesticides, total rare earth elements and salinity. Any soil that contains contaminants above the limit values cannot be used as agricultural production			
HJ/T 333-2006	Environmental quality evaluation standard for farmland of greenhouse vegetables production	2006-11-17	2007-02-01
This standard applies to vegetable production soil in greenhouses, consists three limit values depending on the soil pH: below 6.5, 6.5~7.5 and above 7.5. 11 contaminants are included in this standard, including 8 metals, 2 pesticides and salinity. Any soil that contains contaminants above the limit values cannot be used as vegetable production in greenhouses			
HJ 53-2000	Interim regulation for acceptable levels of residual radionuclides in soil of site considered for release	2000-05-22	2000-12-01
This standard applies to decommissioned sites for nuclear facilities or activities that cause increased radiation levels above the natural levels. If the standard is met, the decommissioned sites can be open for public use. The standard is set based on the annual radiation dose is 0.1 mSv. And corresponding concentrations of radioactive elements that can cause this level radiation dose are limited			
GB 15618-1995	Environmental quality standards for soils	1995-07-13	1996-03-01
First environmental soil standard. This standard divides the soil into three categories: Category I, national nature reserve, collective drinking water sources and some other protected soils; Category II, normal crop or vegetable farmland, tea yard, fruit yard and pasture land. The environmental levels consists three classes : Class I, natural background level; Class II, elevated but still suitable for agricultural activities and not harmful for human health; Class III, elevated but plants can still grow unaffected. Class II which is the standard for agricultural use consists three limit values depending on the soil pH: below 6.5, 6.5~7.5 and above 7.5, and two limit values depending on types of crop: paddy field or dry land. 10 contaminants are included in this standard, including 8 metals and 2 pesticides. Note: new draft standard of GB 15618-2008 has been opened for public opinion feedbacks for years, but still not issued			
HJ/T 166-2004	The Technical Specification for soil Environmental monitoring	2004-12-9	2004-12-9

1 All the environmental standards in China are summarized on MEP's official website http://kjs.mep.gov.cn/hjbhbz/.

Code	Name	Issued	Into force
This standard explains in details how to do soil environmental monitoring, including routines for deciding sampling points, sample preparation, analysis method, results presentation, information collection and quality assessment. It applies for all the soil related monitoring in China.			
GB/T 18834-2002	Soil quality-vocabulary	2002-9-11	2003-2-1
This standard defines all the soil quality related terms, explains the technical meanings of each all the terms.			
Standard analytical methods for a range parameters of soil, including organic carbon, metals, pesticides, dioxin, organics, nitrate, sulfate, phosphorus, etc.: HJ 695-2014, HJ 680-2013, HJ 679-2013, HJ 658-2013, HJ 650-2013, HJ 649-2013, HJ 642-2013, HJ 635-2012, HJ 634-2012, HJ 605-2011, HJ 613-2011, HJ 614-2011, HJ 615-2011, HJ 631-2011, HJ 632-2011, HJ 491-2009, HJ 77.4-2008, GB/T 17134-1997, GB/T 17135-1997, GB/T 17136-1997, GB/T 17138-1997, GB/T 17139-1997, GB/T 17140-1997, GB/T 17141-1997, GB/T 14550-93			

7.1.3 Challenges of soil management in China

Since the 11th Five-Year Plan (2006—2010) there has been a growth in China's awareness regarding soil pollution management resulting in several soil pollution management policies and regulations being issued. However, compared to water and air management, soil management in China is still at the primary stage.

The main problems for soil management in China can be summarized in four reasons which have greatly restricted or hindered the effective development of soil management in China:

First, China lacks acts and regulations on soil environment protection or soil pollution prevention. The "Opinion" of the Ministry of Environment Protection clearly pointed out that a series of acts and regulations on soil pollution prevention would be promulgated in 2015. However, no acts or regulations have been passed so far. The primary basis is the "Opinion" of the Ministry of Environment Protection and the "Decision" of the State Council.

Second, there is a lack of soil management institutions and weak capacity for surveillance on soil environment. Chinese environment protection bureaus at any level have currently not created a special soil environment protection or soil pollution prevention department. Responsibility for soil environment protection and soil pollution prevention currently lies with the rural work department under the direction of the ecological division of MEP. At local levels, the function of soil environment protection and soil pollution prevention is also undertaken by the counterpart of rural work department under direction of ecological division of MEP.

Third, an improved soil environment standard system is lacking. In China, the "Soil environment quality standard" (GB 15618-1995) is mainly applied to the soil environment

management of rural land. However, standards such as the "Soil environment quality standard", "Soil pollution risk control standard", "Standard for soil remediation", "Standard of reception for soil remediation" which will apply for industrial sites remain absent.

Fourth, there is the issue of lacking a financial guarantee for soil remediation, which potentially requires large funds. Presently, the main financial support for soil remediation comes from the government as well as the land developers, which can be limited and unstable.

7.1.4 The need for legal regulation for soil pollution management in China

Law is the basis or guarantee for management. The absence of effective acts and regulations is a key reason for the soil management problems faced by China.

Despite the lack of adequate legislation, there are relevant provisions related to soil environment protection and soil pollution prevention in the *Environment Protection Act, Water Pollution Prevention Act, Air Pollution Prevention Act* and others. However, these provisions are not sufficient to meet the requirements of soil environment protection or soil pollution prevention for four reasons:

(1) Insufficient legal systems on soil environment protection or soil pollution prevention leads to a lack of basis and guarantees for soil pollution management.

(2) The provisions related to soil environment protection, usually comprising one or two articles in an act, are fragmented and less than systematic, which is far from satisfactory.

(3) Further, the current related provisions lack relevance, and are by-products of other *Acts*. They are not specifically tailored to meet the requirements of soil environment protection or soil pollution prevention, which makes these provisions relatively ineffective.

(4) The current related provisions are abstract and lack operationalization, which makes them impractical and difficult to implement.

These insufficiencies of soil environment legislation have significantly affected the soil pollution management in China. China should quicken its pace on the legal management on soil environment, especially regarding the pace of soil environment legislation, with the aim of strengthening soil management generally and improving the capacity level of soil pollution management specifically.

7.2 International experience and enlightenments on soil pollution management

7.2.1 Formulating legal frameworks for comprehensive, integrated systems of soil environment protection

It wasn't until the 1970's and thereafter, in response to the discovery of the severe damage to the environment from the unregulated management and disposal of hazardous substances and an urgent call for action from concerned citizens, that developed countries world-wide began enacting laws both to protect the soil and also to clean up the legacy of existing soil contamination. Although the background for legislation and the design of soil laws themselves vary, most developed countries went from regulating soil pollution indirectly through multiple, piecemeal laws regulating media specific contamination in the air and water, to the enactment of special legislation directed expressly at the protection and remediation of soil.

7.2.1.1 Germany

The German government has enacted a systematic legislative system to address soil contamination with the Federal Soil Protection Act at its core. The Federal Soil Protection and Contaminated Sites Ordinance, the Closed Substance Cycle and Waste Management Act, the Federal Pollution Control Act, the Fertilizer Act, the Soil Valuation Act and other federal laws serve as support to this law and various sub-federal laws also act as complements.[1]

The Federal Soil Protection Act, which came into force in 1999, is a specific law to protect soil at the federal level. The act obliges the owner and the user of the land and those who may impact soil to prevent and remove soil pollution. On the basis of soil value and other related requirements, the federal government can enact policy and regulations to regulate suspected contaminated sites, identify sites, protect against harmful soil change, and provide for clean-up of pollution.On the basis of the Federal Soil Protection Act, the Federal Government passed the Federal Soil Protection and Contaminated Sites Ordinance on 17 July 1999. The ordinance includes: the investigation and evaluation of suspected sites, the remediation of adverse soil alterations and contaminated sites, preventing the risk of adverse soil alterations resulting from soil erosion by water, precautions against the formation of adverse soil alterations and so on.

7.2.1.2 Netherlands

The Netherlands was one of the first European countries to pay take legal action to

1 Source:http://faolex.fao.org/cgi-bin/faolex.exe.database=faolex&search_type=query&table.

respond to the problem of contaminated sites. In the 1970s, soil pollution was discovered in LEKKERKERK, which triggered the enactment in 1983 of the Interim Soil Remediation Act. In 1987, the government revised the Interim Soil Remediation Act and published a Soil Protection Act, as amended in 1994 and in 2006. The provisions of these laws are particularly instructive because of the method they use for allocating legal liability for protection and clean-up of soils is based on ownership of the property, contribution to contamination of property and the timeframe in which the contamination occurred relative to the passage of the Federal legislation. This framework for assigning liability, particularly as it relates to the establishing liability from the date of passage of legislation, is a potential model for China due to China's unique system of state-owned land and enterprises.

7.2.1.3 Denmark

The Danish government also recognized the problem of chemical waste landfill pollution enacting the Chemical Waste Disposal Act in 1983; a revision in 1990 included management of numerous pollutants. In 1999, the government promulgated the Contaminated Soil Act addressing all types of soil.

7.2.1.4 United States

In response to public outrage and concern over the health impacts from former hazardous waste disposal sites like the Love Canal and the Times Beach, the U.S. Congress enacted a series of laws, commencing in the 1970's, that provide a comprehensive and integrated system for the protection of soil and of the ground and surface water, air, and ecosystems associated with the land. The basic components include: a) RCRA, which was designed to prevent and control solid waste pollution from operating industry from "cradle to grave"; b) CERCLA, which is targeted at the clean-up of uncontrolled or abandoned hazardous waste sites and also of spills, accidents and other emergency releases of pollutants or contaminants into the environment; c) the Surface Mining Control and Reclamation Act of 1977 ("SMCRA"), which applies to the impacts caused by mining activities; and, d) OPA, which directs clean-up of oil spills on land or water. General mechanisms and responsibilities for preventing and controlling soil waste pollution are mainly in RCRA while compensation and clean-up liability are in CERCLA, respectively.[1]

In 1986, the US Congress enacted SARA, based on lessons learned during the first years of implementing CERCLA. These amendments were to strengthen the implementation provisions of CERCLA, encourage voluntary clean-ups by legally responsible parties, reduce litigation, emphasize the importance of permanent and innovative treatment technology, increase participation by state governments in all aspects of implementing

1 Source: http://www.epa.gov/agriculture/llaw.html.

CERCLA, and to facilitate and encourage public participation. Besides, SARA also includes the first Emergency Planning and Community Right-to-Know Act ("EPCRA"). The U.S. Congress passed the Small Business Liability Relief and Brownfields Revitalization Act (the Brownfields Act) in 2002 in order to encourage brownfields redevelopment, as a supplement of CERCLA.

7.2.1.5 Japan

The Japanese government passed the Agricultural Land Soil Pollution Control Act in 1970 and has amended it numerous times. In 2002, the government promulgated a Soil Contamination Countermeasures Act and the Ministry of Environment published implementing regulations. The Agricultural Land Soil Pollution Control Act's goal is to prevent and clean-up farmland contamination resulting from specific, harmful substances and rationally use the contaminated agricultural land. The Act includes: designation and modification of agricultural land; soil pollution measurement area zones; enactment and modification of agricultural land soil pollution measure projects; designation and modification of special area zones; investigation and measure of the conditions of agricultural land soil pollution; criteria for field surveys: and recommendations concerning the production of agricultural crops.

The Soil Contamination Countermeasures Act facilitates the implementation of countermeasures against soil contamination by Designation of Hazardous Substances so as to protect the health of citizens and prevent harm to human health resulting from such contamination. This Act includes soil contamination investigation, designation of contaminated zones, pollution clean-up, change of form of land and the plan of land use, designation of an investigation institution, promoting substantive law, etc.

Japan has legislation not only specific to soil protection, but also a large number of other laws related to soil prevention such as an Air Pollution Control Act, an Act with Special Measures concerning Dioxin, a Water Pollution Control Act, a Waste Disposal Act, a Fertilizer Banning Act, and a Mine Safety Law. By controlling air pollution, dioxin pollution, water pollution, solid waste pollution, certain chemical pollution, fertilizer and pesticide pollution and mine pollution, these laws collectively prevent pollution from different sources so that the objective of soil pollution prevention can be achieved.[1]

7.2.1.6 South Korea

In 1995, South Korea enacted its Soil Environment Conservation Act, which has been amended six times. The purpose of this Law is to prevent soil contamination resulting in

1 Liang Jianqin, Main Models of Legislation on Soil Pollution Control in the World, *law Review,* Vol149, issues3, 2008: 85-91.

risks to human health and the environment, protect healthy soil ecosystems, enhance the value of soil resources and create a healthy living environment.

Generally, legal frameworks for soil pollution prevention internationally include most of the following items:

(1) A specified scope or objective for the law including: pollution prevention; remediation of contaminated sites, economic incentives for the redevelopment of contaminated property and/or risk abatement of imminent and substantial endangerment threats to human health and the environment.

(2) Specific goal(s) for the law e.g., protection of human health and the environment; insure that agricultural lands are safe for food production; mitigation and/or elimination of risk, etc..

(3) Clear identification of individuals or enterprises regulated under the law, i.e., property or enterprise owners, business operators, remediation contractors, polluters, real estate developers, financial institutions, government entities, etc..

(4) An assignment of responsibilities for implementing the provisions of the law, i.e., owners and operators of facilities handling hazardous substances must provide financial assurance during the operation of their business to address any spills or releases of these substances.

(5) A management framework for implementation of the law; e.g. the roles and legal authorities of various national government agencies and the relationship with and authorities of sub-national jurisdictions.

(6) Enforcement provisions and penalties for non-compliance with the law and incentives to encourage voluntary compliance.

(7) Express provisions for public participation, community involvement and transparency.

(8) A funding mechanism to insure adequate resources to satisfy the law's objectives and build capacity, e.g. training, resources and education, for implementation: and,

(9) Requirements for monitoring, record keeping and reporting of activities, emissions and releases of hazardous substances.

7.2.1.7 Research Conclusions

While the research group was doing its foreign investigation and survey work, many experts and scholars suggested that some current soil environmental protection laws are deficient by not emphasizing soil pollution preventive measures enough and by over-emphasizing remedial, clean-up measures. Further, this research suggested that too much reliance was being placed on the actions of the government in some countries

rather than placing responsibility squarely on the polluter. Therefore, in designing China's new Soil Environment Protection Law, the soil pollution prevention system should be further perfected and the principle of "polluter pays" should be implemented. Additionally, due to the legal and technical complexity of protecting and remediating soil, China's special legislation for soil environment protection cannot itself include all of the detailed requirements necessary for soil environmental protection. Therefore supporting administrative and technical regulations and regional and provincial legislation also will be necessary. China's soil legislation framework needs both a specific and comprehensive environmental protection law and a soil environmental protection regulatory system.

7.2.2 Establishing a comprehensive soil management system and remediation action plan

The management of soil pollution must not rely on emergency responses to accidents, spills and accidental releases of hazardous substances but must focus instead on prevention, management of risk, and long-term remediation. The laws of different countries establish management systems and require governments to formulate comprehensive soil management action plans, in order to establish short-and long-term targets and implementation procedures, all with the goal of protecting human health and the environment.

7.2.2.1 European Union

Given the increasingly severe pollution and deterioration of its soil, the EU passed a Soil Thematic Strategy to strengthen soil protection in Europe. This Strategy includes: A proposed legislative framework for the protection and sustainable use of soil, in order to integrate soil protection into national and EU policies; Measures to improve knowledge of soil functions; and Measures to increase public awareness. It seeks to establish rational land use planning practices at all levels of government to ensure the sustainability of soils, consistent with a "precautionary principle" used by the EU in establishing environmental policy.

In November 2007, the European Parliament passed the EU soil framework directive which requires that Member States may adopt measures tailored to local needs, while establishing common principles, objectives, and actions to guide land use planning and management. The framework requires Member States to adopt a systematic approach for identifying and combating soil degradation. Member States also must integrate soil protection into other policies-especially with respect to agriculture, regional development, transport, and so on. Member States must identify areas at risk for erosion, organic matter

decline, compaction, soil sealing, salinization, and landslides, as well as soils where these processes have occurred. Under the directive, a soil status report provided by the seller or buyer to government and other parties in the transaction must accompany the sale of a potentially contaminated property. Member States must adopt programs to reduce these risks, inventorying contaminated sites and establishing national strategies for their remediation. Actions must include mechanisms to fund the clean-up of orphaned sites and steps to rehabilitate brown field sites.

The draft EU Soil Directive has not been finalized. In November 2007, the European Parliament did reaffirm its support for public soil inventories, a list of potentially contaminated sites, and the requirement that Member States establish soil remediation strategies. Supporters of the directive have argued that a soil directive is important to help fight climate change because of the role soil plays as a carbon repository. Environment ministers from the United Kingdom, Germany, Austria, in particular, however, have taken the position that the Directive would interfere with existing Member State soil management measures and that it would be too costly to justify its environmental benefits.

On 13 February 2012, the European Commission published a policy report on the implementation of the EU Soil Thematic Strategy, which provides the implementation of the Strategy for Soil Protection since its adoption in September 2006 and ongoing activities. It has been estimated that, in 2004, the turn-over of the soil remediation industry in EU-27 amounted to €5.2 billion, of which 21.6% spent in Germany ranking first among all the member states. In the period 2007—2013, €3.1 billion have been allocated to the rehabilitation of industrial sites and contaminated land. Hungary, the Czech Republic and Germany have allocated the most funding (€475, 371, and 332 million respectively).[1]

7.2.2.2 United States site remediation

In the United States, over 40,000 contaminated sites have been listed in the current Superfund Enterprise Management System data base since tracking began in 1980. Of these sites, approximately 1,700 sites have been listed to date on the National Priorities List ("NPL") of sites requiring remediation, under CERCLA authorities. Sites are listed after undergoing a preliminary assessment of existing records and information, a site inspection, scoring using criteria in the Hazard Ranking System to evaluate and rank the threats from the site to human health and the environment and public notice and comment along with concurrence from the governor of the state in which the site is located sites on the NPL can be cleaned up either voluntarily by or through enforcement actions against

1 The implementation of the Soil Thematic Strategy and ongoing activities, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0046.

parties deemed responsible pursuant to the law including past and current owners and operators, transporters of hazardous substances, and generators of materials disposed of at the site. In the absence of parties that can be identified or that are financially viable or responsible parties that refuse to act, the U.S. EPA can utilize the Hazardous Substance Response Fund, commonly known as "Superfund", to clean up the site itself. Over the 35-year history of the Superfund program, Federal funding (minus settlement and private party clean-up expenditures, which are unknown) is roughly $40 billion dollars.[1]

7.2.3 Establishing appropriate risk based standards

From a review of the current practices of relevant countries and regions, most developed countries have established health-based standards for the protection and remediation of the soil environment. These standards support the management system contained in their specific soil legislation and regulations and clearly state the function of the soil environmental standard value. The United States, the United Kingdom, the Netherlands, Canada, and Australia are among the countries that rely on risk control to set standards for contaminated soil. These countries establish risk evaluation methods for polluted soil, and formulate the soil environmental standard value based on risk, to assist in initial site screening and the investigation and evaluation of soil pollution. At contaminated sites, these countries generally conduct an evaluation of the polluted soil by analysing the site's specific characteristics in conjunction with its intended land-use e.g., agricultural, residential, commercial or industrial, to determine the remediation target value of the contaminated soil. The relevant laws and regulations of some of these countries distinguish between and define "old" and "new" polluted soil based on criteria such as the promulgation date of various soil protection laws, e.g., the Netherlands, allowing for different clean-up values and measures for "old" contamination versus "new" pollution.

7.2.3.1 Netherlands

In 1983, the Netherlands promulgated the Interim Soil Remediation Act, which includes the first generation of the A, B and C Values, based on background concentrations and expert judgment[2]. In 2009, the government revised the intervention values. If the

1 In 2008, U.S. Government Accountability Office estimated that since 1981, Superfund appropriations have totaled over $32 billion in nominal dollars, or about $1.2 billion annually, http://www.gao.gov/products/GAO-08-841R.

2 F.A. Swartjes, , M. Rutgers, J.P.A. Lijzen, P.J.C.M. Janssen, P.F. Otte, A. Wintersen,E. Brand, L. Posthuma,State of the art of contaminated site management in The Netherlands: Policy framework and risk assessment tools.http://ac.els-cdn.com/S0048969712003294/1-s2.0-S0048969712003294-main.pdf?_tid=dc1d3872-57a9-11e5-88e7-00000aacb362&acdnat=1441882456_3da54389ddff2b7632b9f746bdbcf3e1.

average concentration measured of at least one substance in a soil volume of at least 25 m^3 in the case of soil contamination, or a pore-saturated soil volume of at least 100 m^3 in the case of groundwater contamination, exceeds the intervention value, a case of serious contamination is deemed to exist. [1]Urgency of remediation is determined according to the present or future use of the soil.

7.2.3.2 Denmark

According to the Contaminated Soil Act, the government of Denmark promulgated the Quality Criteria for Soil to more effectively supervise contaminated sites. The Quality Criteria for Soil are based on an assessment of risk to human health and have been established for sensitive land use. The Danish EPA registers sites where the concentration of contamination is higher than the Quality Criteria for Soil by placing them on a list of contaminated sites. Cut-off values have been established for pollutants. If the concentration of contamination is lower than the cut-off values, soil remediation is unnecessary, because the exposure of people can be limited to an acceptable level by reducing the opportunity for exposure to the soil pollutant. In addition to the Quality Criteria for Soil, the Danish Government also uses an evaluation of ecological risk to establish Eco-Toxicological Soil Quality Criteria.

7.2.4 Assignment of responsibility

The promulgation of new law can be a boundary and take stricter control measures to new polluting source and polluting equipment in order to prevent new pollutions and clarify the legal responsibility.

Before the promulgation of soil environmental protection law, many countries have blank space in soil environmental protection system and supervision, which cause the accumulation of the problems of pollution. Therefore, it is necessary to take the promulgation of law as an opportunity, and strictly control the pollution and damage which may happen and eradicate new pollution. For example, the Dutch soil protection law which was promulgated in 1987 has stipulated the soil pollution which was caused after January 1st, 1987 should be repaired to the initial quality when the soil was first used; the soil pollution was caused before January 1st, 1987 should be considered whether it should be repaired or not based on relevant regulations. The Denmark soil pollution law has stipulated the soil pollution which was caused in 1991 should strictly implement soil pollution enforced investigation system; the soil pollution which was caused after

1 Soil Remediation Circular 2009.http://esdat.com.au/Environmental%20Standards/Dutch/ENGELSE%20versie%20circulaire%20Bodemsanering%202009.pdf.

January 1st, 2001 should strictly implement the accountability system of remediation's responsibility.

The legislations of many countries have stipulated that the polluter, the owner and user of land should take the obligation of protecting soil environment, take risk control and management and remediation responsibility for soil pollution. The Superfund Law has one of the strictest liabilities for compensation and remediation of US environmental legislations. It has significant effect to solve the soil environmental problems rapidly and effectively.

7.2.5 Establishing adequate financial mechanisms to meet soil remediation needs

The management and the recovery of soil pollution require a large amount of fund, so the fund which fits the remediation responsibility provided by law is the key to implement the law effectively and recover the environment. The main problem the US Superfund Act aims at is that the problem has happened or the dangerous material pollution which has emergent threat. These problems require government to react immediately, when the actions of government can be defined as emergent reactions, so that when the parties can't be found or can't shoulder the responsibility, government should take measures beforehand and the government's actions can be defined as the administrative replacing managements. No matter what situations, the fund safeguard is always needed. The establishment of superfund has not only guaranteed the law enforcement capacity of government but also safeguarded the authority of laws and government.

7.2.6 Combining environmental protection with economic revitalization

In the past, the soil polluted by dangerous material means it would be abandoned permanently. Even though it can be safe after being cleaned or remedied, once it was tagged to the label of polluted soil, it might be isolated which becomes a permanent flaw in economy. Many countries' legislations have created relevant system which combines pollution remediation with redevelopment of polluted land. The recovery plan of brownfield sites has not only encouraged more people to participate in the remediation and management of polluted land, but also promoted the redevelopment of land to achieve fine environmental, economic, and social effect.

There were some brownfield site issues in the US after a period of time from the promulgation of CERCLA. Brownfield site is real property of which the expansion,

redevelopment, or reuse is very difficult because of the presence or potential presence of a hazardous substance, pollutant, or contaminant. Specifically, brownfields include those abandoned gas stations, dry cleaners, photo studios, industrial land and buildings that may contain hazardous substances etc. The fundamental reason why brownfields sites generated in the US is that the economic structure and industrial structure were readjusted and investment and industrial activities were expanded and transferred to remote underdeveloped areas, suburbs and overseas since the 1970s. The direct reason could be attributed to the promulgation of CERCLA of 1980. Since this Act provides severe environmental pollution liability and accountability mechanisms, some potential investors and business activities prefer to choose some safe green lands, which are located in urban fringe or undeveloped areas, instead of these contaminated brown lands. As a result, on the one hand, there are a lot of abandoned lands in the city centre, producing numerous brownfields. On the other hand, developing a lot of good farmland in the edge of the cities and suburbs resulted in the rapid disappearance of green lands. This phenomenon not only caused wasted land but also generated serious social problems. Therefore, some old communities were reduced to poverty, at the same time, employment opportunities were greatly reduced and crimes in these places were increased etc. In order to solve these problems as a whole from a long-term, the federal EPA launched a Brownfield's Initiative Plan, authorizing the states, communities and other developers to govern and reuse brownfields jointly. In addition, the EPA drew up the Brownfields Federal Partnership Action Agenda in 1997. The US Congress passed the Small Business Liability Relief and Brownfields Revitalization Act in 2002 to encourage SMEs to participate in the brownfield redevelopment plan.

The main contents of this plan include: a) Provide funding for brownfield assessment and clean-up demonstration projects. b) Clarify responsibilities and cleaning items. This plan helps determining the limitation of the right of the EPA and clarifying the responsibilities and obligations of states and local governments when they develop these brownfields sites jointly. c) Build partnerships. It was designed to establish partnerships among federal agencies, states, cities and communities in order to promote the clean-up process and public participation and community involvement in decision-making process. d) Promote employment and training. Through environmental education programs, this plan can enhance the level of labour. Recruiting students, training workers from brownfields can create employment opportunities for the residents who live near these lands.

There were more than 500 projects that get money under this plan until 2000. The total

numbers of this money got to $160 million and these projects generated more than 7,000 jobs, driving $2.3 billion private investments. This plan is not only a successful business program but also a successful social policy. According to the reuse of brownfield sites, these abandoned areas have the new hope and the employment, security and environment at these places get better than before.[1]

Local governments in Canada bear the main responsibilities in land exploitation and soil environmental protection. Municipal governments are responsible for fixing all their own brownfields sites, the lands whose ownership returned to the city and some ownerless lands. And they also govern and regulate some related activities and programs of brownfields sites, which belonged to public institutions and private person. The useful experiences of municipal governments when they repair and redevelop brownfields sites are: a) Provide tax incentives and exempt part of the municipal fee to encourage development. b) Offer subsidies to environmental and feasibility study. c) Guide developers through process management and approval. d) Reclassify the brownfields to enhance their value. e) Make a list of unutilized real estate and fit it into the city plan. f) Adopt a team approach to enable developers and public participating in the planning process. g) Cooperate with other cities, the provincial governments and the federal governments to make regulation rational and clarified and share successful experiences. h) Establish a protection fund to support urban brownfields sites restoration and development program. i) Redevelop brownfields by sensible development principles and integrate the economic, environmental and social benefits using triple-bottom-line approach. j) Use sustainable dismantling and removal methods, including ecological restoration and building materials reuse.

7.3 Policy recommendations for soil management in China

7.3.1 Confer on Soil Protection Fundamental National Policy status

Fundamental National Policy in China is conferred on the most important policies for stabilizing society and the country. It is also the basic rule and guarantee for the existence and development of the country, as well as the basis for establishment of law, policy and plans. Given that soil is an irreplaceable resource it is recommended that soil be given Fundamental National Policy status.

1 Environmental Protection Agency of US: Superfund's 25th Anniversary: Capturing the Past, Charting the Future. http://www.epa.gov/superfund/25anniversary/.

Soil is unique amongst mediums of air and water, as it is an irreplaceable limited natural resource without which sustainable social and economic development is possible. Soil is the resource of life on the earth but soil fertility and structure continues to decline from increasing agricultural, forestry and animal husbandry activities. The formation and recovery of soil is long term, with new soil formed at an estimated rate of 1 centimetre over 300 years. Soil differs from air and water as it does not have the same ability to move or cleanse itself. When soil is polluted it becomes a root cause for ongoing long-term adverse effects on health, safety and the environment. Soil is limited in its area of coverage in China (mountain tops and deserts do not have soil) and good soil is even in less supply as the types of soil vary from location to location. Since soil forms slowly, is in limited areas with varying quality and under siege from economic development and agricultural overuse, the case for National Policy Status cannot be underestimated.

Soil is the growing medium for food, forest and agricultural crops. China needs good soil to feed its people which represents one-sixth of the world population, but has only 10 percent of the earth's total arable land. Ensuring clean soil, proper use of soil and rehabilitation of soil is a necessary precondition to food safety. The conferring on soil of Fundamental National Policy status is the first step in the guarantee for a safer food supply in China.

Soil has the ability to serve as a natural filter to transform chemicals that could adversely affect water, air and food and they contain an essential component of China's biodiversity and support and/or influence all the country's ecosystems. The complex movement, transformation and exchange of substances and energy are carried out between the soil and other biological species in the ecosystem, thus constituting a dynamic balance. The soil serves as a platform for the exchange of substance and energy between species and the environment.

Currently soil pollution in China from industrial, agricultural and commercial activities has not been effectively controlled. Soil pollution is not only a challenge for China but an international challenge as well. In 2014, the Ministry of Environment Protection and the Ministry of National Land and Resources jointly issued China's Bulletin of National Soil Pollution Circumstances Survey, which shows that the general condition of the nation's soil environment is not optimistic. Some areas are suffering from severe soil pollution including heavy metal contamination and the overloading of nutrients such as nitrogen.

The production and service capacities of soil, especially those of arable soil, have been degraded because of soil pollution. Soil is the basis for agriculture, industry and

social service. Hence the capacity of soil is necessarily connected with the economic and social development. The production and service capacities of soil declined as the degradation of soil fertility from poor agricultural, forestry and animal husbandry activities became apparent.

The protection of soil will ensure China's capacity for sustainable and social development. Recognizing soil protection as a Fundamental National Policy is a guarantee for sustainable and social development of China.

7.3.2 Develop a comprehensive Soil Environment Protection Act, and gradually establish a regulatory system for soil pollution management based on this Act

It is a common and effective practice in many countries all over the world to protect the soil environment by developing and implementing laws and regulations. In China we note that the Standing Committee of 12th National People's Congress has listed the "Soil Pollution Prevention and Control Act" in its legislation agenda in order to set up a legal framework for soil pollution management. However, based on the international experience and China's specific problems with soil pollution, we believe that it is more appropriate to develop in China a more comprehensive "Soil Environment Protection Act" rather than a piece of legislation only about prevention and control of the pollution.

7.3.2.1 China's Soil Environment Protection Act must reflect China's soil reality

The general situation of China's soil environment is revealed by the following numbers: 16.1% of the nation's soil is contaminated and 19.4% of arable land has been polluted. Further, soil pollution continues to worsen as it is not yet under effective control.

It is widely accepted that soil is the "basis of life and mother of all creatures". It is the most important material foundation to the survival and development of human's society, while in the same time an indispensable strategic resource to the economic and social development of any nation. Once the soil is polluted, it will not only result in a degraded soil quality and directly influence agricultural, food security and human health, but will also generate other problems, such as water pollution, atmospheric pollution and the degradation of biodiversity. In the long term, this could influence the healthy balance of the whole ecosystem and threaten a country's environment security.

Over the past decade, along with China's rapid economic development, soil pollution has increasingly become a major problem and is developed in a worsening trend. Therefore, the basic and main objective in the coming soil legislation should be on the protection of clean land not yet polluted and the prevention of soil pollution and soil

degradation by taking effective measures. Then the objective of repairing and restoring polluted soil follows.

China is a country with large populations where one sixth of the world's population should be fed. Because of this fact, it is the core and essential point of China's soil legislation to protect and improve the soil environment, especially by keeping the arable land in a good condition.

Also regarding to China's current soil environment situation, protecting the clean soil should be the priority of this legislation. This is a legislative position concluded in taking into account Chinese soil environment protection needs and soil pollution reality.

7.3.2.2 China's Soil Environment Protection Act must fit with the country's capacity to solve soil pollution problems

The protection of soil environment indicates a scientific and appropriate way of using soil resource, in preventing any adverse impact on soil quality in the utilization process. The protection of soil means control of pollution from the very beginning, while the prevention and control of soil pollution means to prevent any pollution related to utilization activities of soil resource and to recover and repair soil that is already polluted by using technical measures.

China's soil pollution is currently at a dangerous level. Studies show that the ratio in the costs of proactive protection versus repairing the soil is 1:100. The investment that is needed to repair and recover soil is at least 100 times that of the initial investment that could have been made for proactive protection of the soil environment.

7.3.2.3 The recommendation of developing a Soil Environment Protection Act is because that the prevention of soil pollution should mainly be achieved by revising and improving other relevant environmental laws

Soil pollution indicates the phenomenon that by introducing physiological toxicity substances or an excess of plant nutrition into the soil, the properties of soil degrades or the plant physiological function of soil comes into disorder.

Soil pollution, mainly caused by human's inappropriate activities. Different situations will all cause soil pollution, such as toxic and dangerous waste water filters into the soil, harmful gas or floating dust fall into the soil with rainwater, solid waste dumped on the surface of soil. Preventing soil pollution, in the final analysis, is to prevent toxic and harmful water, solid waste and gas enter into the soil. Once these channels are blocked, the soil pollution will not occur. Thus the soil environment is protected.

According to what is said in the paragraph above, preventing soil pollution mainly concerns regulating behaviours of discharging polluting water, polluting gas and polluting

solid waste. These behaviours are regulated under the Water Pollution Prevention and Control Law, Atmospheric Pollution Prevention and Control Law, Solid Waste Pollution Prevention and Control Law and other relevant environmental laws. To be clear, we should depend on these laws to regulate people's pollution discharge behaviours, so that the soil environment can also be protected. If the current laws on water, air and solid waste are properly drafted and implemented, China's soil environment should be in a much better condition. In that case, we may even not need a specific law on soil environment protection.

The prevention of soil pollution should mainly be achieved by revising and improving other relevant environmental laws such as Water Pollution Prevention and Control Law, Atmospheric Pollution Prevention and Control Law, Solid Waste Pollution Prevention and Control Law.

7.3.2.4 The recommendation of developing a Soil Environment Protection Act is based on the lessons learnt from other countries' soil environment legislative experience

By looking at many examples of soil environmental laws abroad, most countries have used the name Soil Protection Law or Soil Environment Protection Law. Some examples include Soil Protection Law in Germany (1998), Soil Protection Law in Netherlands (1998), Soil Protection Law in Canada (1988), Soil Protection Law in British Colombia of Canada (1996), Soil Protection Law in Queensland of Australia (1986), Soil Protection Law in New South Wales of Australia (2004), Soil Protection Law in the Republic of Georgia (1994), Soil Environment Protection Law in South Korea (2004). There are also certain legislations that are addressed specifically to tackle soil pollution, for instance, Soil Protection Strategy Law in Japan (2002), Soil Pollution Law in Denmark (1999), the comprehensive act on environment, damages and liabilities known as Superfund Act in the United States (1980) and Soil and Groundwater Pollution Control and Remediation Act in Taiwan District of China (2001).

The protection of soil environment is a key concept which covers comprehensively areas such as the protection of clean soil, the improvement of soil environment quality, the prevention of soil pollution, the risk management of polluted soil and remediation and recovery of polluted soil. A Soil Environment Protection Law, compared to Soil Pollution Prevention and Control Law, has an expanded scope and is more comprehensive in regulating the interrelationships that exist in the soil environment. A Soil Environment Protection Law is also more focused on proactively protecting the soil environment and is able to accommodate soil carbon and soil resiliency aspects especially as they relate to climate change.

Experts from Germany and Taiwan District of China who have participated in their soil legislation development all agree that a Soil Environment Protection Law reflects the new way of thinking where an integrated approach is taken. Soil Pollution Control and Remediation Law, Soil Pollution Remediation Law or Soil Pollution Prevention and Control Law are reflections of the past as they embrace the idea of reparation after damages have happened, with no ability to embrace emerging issues.

It is worth noticing that the notion of soil and the notion of soil environment is not the same concept. To be more precise in expression, using soil environment is more appropriate and precise in the relevant legislations.

7.3.3 Identify effective management framework for soil pollution management

Creating a clearly defined management framework is critical to the establishment of a national soil protection management system, for consensus building and joint effort of stakeholders.

A comprehensive and clear framework should be identified for strengthening and improving soil pollution management. We suggest that China should identify an effective management framework for soil pollution management as the following:

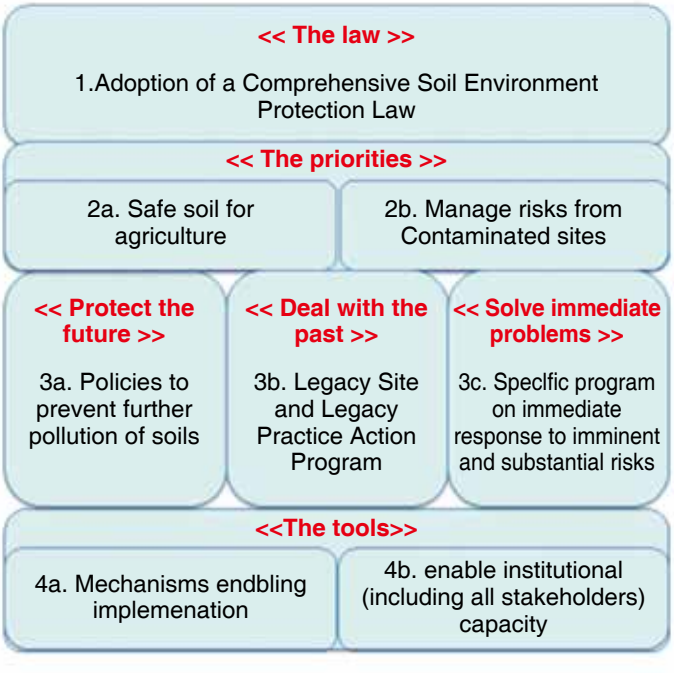


Figure 7-3 Framework on soil pollution management

7.3.3.1 A soil management framework that is consistent with the national vision for soil environment protection and reflects the comprehensive *Soil Environment Protection Act* is recommended to be established

Legislation is the precondition of the rule of law. Till now, China has not yet established a systematic legal system on soil pollution management. Hence, the lack the legal basis for soil pollution management in China can easily lead to the arbitrary management among various administrative authorities.

It is the first task for China to develop a special soil act, and gradually establish a comprehensive legal system consisted of laws and regulations concerning soil pollution management. The legislation is the basis and guarantee for management.

Experience learnt from many developed countries shows that having a special soil protection Act, or soil pollution prevention Act is essential. These acts provide a legal basis for soil pollution management, as well as the guidelines and procedures for the authorities to manage the soil.

7.3.3.2 Safe soils for agriculture (with a focus on food safety) and the management of risks

Based on the current situation and actual needs of China, two aspects should be identified as the priorities for soil management system development: the protection of clean soil, especially that of arable soil; and the risk management of contaminated sites. The emphasis of protection clean soil should be put on encouraging stakeholders to recognize the value of clean soil, and protecting clean soil through scientific methods and strict legal systems, especially for clean arable soil. Besides, the protection of clean soil should also involve the improvement of soil quality. While managing environmental risks from contaminated sites refers to assessing and control the environmental risks of contaminated sites through various ways.

7.3.3.3 Different measures should be taken in order to ensure the future of soil is protected, problems of the past are managed and have the flexibility to solve immediate problems

From the perspective of soil pollution prevention, soil pollution management refers to three main issues: Legacy Site and Legacy Practice Action Program; Specific program on immediate response to imminent and substantial risks; ad Policies to prevent further pollution of soils.

Legacy contamination is a very special problem which requires special principles and methods to address. The key to address legacy contamination is to establish a liability system and a financial mechanism. With regard to imminent and substantial risks, an

emergency responding system should be established. Face with the further pollution of soils, soil legislation is essential in order to regulate activities of all the stakeholders.

7.3.3.4 The management system will define the tools: mechanisms enabling implementation; and enable institutional (including all stakeholders) capacity

Law is not only for providing rules for behaviours, but also for creating conditions for the effective implementation of these rules, thus enabling the stakeholders to effectively comply with the laws and regulations.

Four aspects should be emphasized. The first is to establish an effective regime for soil pollution management and improve the management capacity. The second is to develop a standard system based on the high background value of soil and on the management of environmental risk, thus providing a basis for the strict implementation of legal systems concerning soil protection, management of environmental risk of soil contamination and soil remediation. The third is to establish a technical system for the remediation of contaminated sites and agricultural sites. The forth is to an enabling mechanism which includes incentives for soil pollution management, to activate stakeholder participation.

7.3.4 Establish a scientific and integrated soil environment standard system and incorporate it into *Soil Environment Protection Act*

The soil environment standard system is indispensable for the effective implementation of soil environment protection laws and regulations.

7.3.4.1 China needs to develop a comprehensive soil environment protection standard system

The soil environment protection standard system should include soil environmental quality standards for agricultural land, risk based index on contaminated sites, technical standards and guidance on soil pollution investigation, sampling, evaluation and remediation, in order to meet urgent needs of soil environmental management in China.

In addition, the soil environment protection standard system should be designed using the primary principles of protecting human health, protecting continental and groundwater ecosystem; preventing soil pollution and the degradation of soil quality; separately establishing soil environment standards for agricultural land and land for development.

7.3.4.2 The soil environment protection standard system should be consisted of classified and regional soil environment standards, as well as national and local soil environment standards

It is recommended that the principles of the system and the status of the standards

be incorporated in the *Soil Environment Protection Act*. The methods for doing a site investigation and a risk assessment should be defined by the national government. The background values and the screening values should also be set by the national government. The national government should provide a guidance document for setting site specific target values. It is recommended to incorporate the methods and values in regulations underneath the *Soil Environment Protection Act*, because these methods and values need to be updated on a regular basis, as new insights and information about risks will become available.

Each province or region can then develop its own specific soil environment background value, using national uniformed technical requirements and methodologies. A national risk screening guideline should be developed for agricultural land and land for development, respectively, while provinces, municipalities and autonomous regions can develop more specific standards within the framework of national standards if needed. A national soil environment investigation, supervision, assessment and remediation technical standard should be developed, while provinces, municipalities and autonomous regions can develop their own standards in the framework of national standard. A national soil environment supervision guideline should be development in order to clearly define the technical requirements for arranging the points, sampling, analytical test and quality control. Then, a national basic standard for soil environment, or a standard system for developing and revising standards, should be developed in order to define the terms, definitions and principles, styles, methods for developing and revising soil environment standards. Finally, technical guidelines should be developed for soil environment management, according to the actual development of soil environment standard system.

7.3.4.3 The principles of developing soil environment standard system in China

There are three principles for developing soil environment standard system in China that should be considered. Firstly, the Chinese characteristics and the actual need for soil pollution management should be fully considered into the process of developing soil environment standard system. The emphasis should be put on two main problems: the safety of agricultural land and the contaminated sites which pose a threat to human health.

Secondly, the standard system should be developed in a systematic and scientific way. A comprehensive scientific soil environment protection standard system should include soil environment quality standard, soil environment quality assessment standard, standards for soil environment investigation, supervision, risk assessment and remediation, standard for analytical method, etc. Both international and national achievements in scientific research, and various investigation conclusion and data should be referenced.

Thirdly, limited and realizable objective should be set and a gradual improving process is needed for the establishment of soil environment standard system in China. The establishment of soil environment standard system is a long-term task which requires the development of a serious of standards instead of a single standard number. Besides, the soil environment standard system should be in accordance with concerning laws, regulations and policies. Hence there should be a long-term plan covering the process of developing and revising the standards for the establishment of this whole standard system.

7.3.4.4 This standard system should be incorporated into the laws and regulations by clearly identifying its role and function for soil pollution management

The standard for soil environment background value, soil pollution risk screening guidelines and remediation standard for specific sites should be clearly provided by the soil environment protection Act.

The standard for soil environment background value is important for the assessment of soil quality, the plan for soil environment protected area and setting up the objectives for soil environment protection. The soil pollution risk screening guidelines is the basis for soil investigation and risk assessment. The remediation standard for some specific sites is the basis for determining the scope and target for remediation.

7.3.5 Establish a fair and effective liability and financial mechanism to resolve legacy contamination

Many of China's soil pollution problems are at sites that have been contaminated in the past. The person or enterprise responsible for this historical contamination can be difficult to identify or find, may be no longer in business or lack the financial resources necessary to conduct a clean-up. This is a common problem in addressing legacy pollution in many developed countries worldwide, including the United States and Canada. In 1980, the United States enacted the Superfund Act specifically to tackle the issue of contamination at old, abandoned and uncontrolled sites. As China reinforces and improves its soil pollution management, it should be a priority to find appropriate solutions for these legacy contaminated sites. Otherwise, these historically contaminated lands can pose long-term environmental risks which not only threaten the country's ecological and environmental security, but also prevent these sites from being brought back into the economy through reuse and redevelopment. China's current piecemeal approach to legacy sites and its lack of a stable remediation funding source need to be addressed explicitly in any new soil legislation and policies.

7.3.5.1 The existence of historical soil contamination problems

The term "legacy contaminated sites" refers to sites that were polluted prior to enactment of a soil law or prior to a time specified in the law. As discussed above, the person or entity responsible for the contamination can sometimes be difficult to find or identify given the elapsed time. This poses a significant challenge for environmental protection of the soil and associated ground and surface water.

The existence of historical soil contamination problems is mainly due to the lack of an appropriate legal framework and management system at the time this pollution occurred. Therefore, certain specific measures must be taken to address these issues. The most important measure is for the Chinese government to establish both a clear liability mechanism to identify responsible parties for past, present and future contamination and a financial mechanism to support the remediation of legacy contaminated sites.

7.3.5.2 Establish a clear liability system in order to clarify the responsibilities for reparation and remediation of legacy contaminated sites

A comprehensive soil pollution law should include a clear identification of the individuals, entities, and enterprises that will be held liable for the remediation and/or costs of remediation of contaminated sites. Once these parties have been identified in the law, the law should also specify the scope of their legal obligations, or responsibilities, for correcting the problem either themselves or under government supervision, for funding someone else to do the clean-up and for any punitive damages. An effective liability system will both explicitly and clearly allocate legal responsibility of parties for all or part of the contamination found on a site. It will also delineate the party's specific responsibilities for land remediation.

In setting up its liability system, China should consider the full range of parties potentially responsible for legacy contaminated sites including: Generators of some or all the hazardous materials found at the site; Owners of the enterprises located at contaminated sites; Past and present operators of polluting enterprises; Transporters of hazardous materials to the site; Real estate developers; Financial institutions; Brokers; and Insurers, etc. Once responsible parties are established, the law should assign specific legal obligations to each or all of those parties for remediation and reparation.

The liability mechanism should contain provisions addressing the following situations: Where the polluter is clearly identified; Where the polluter is not clearly identified; Where the polluter is clearly identified but lacks the capacity to carry out the remediation of the polluted soil; Where the polluter can be identified but is either bankrupt or lacks the financial capacity to perform the remediation; and Sites requiring immediate remediation

to address imminent and substantial threats to human health and the environment.

When setting up a liability mechanism for historical soil contamination, three issues, unique to China, should be taken into consideration: a) China's land property system; b) China's State-owned enterprises; and c) China's current land tenure and land use regime together with the development of the real estate industry. These issues are the reality and specific circumstances of Chinese Society and cannot be ignored in designing a liability system.

The principle that should be followed in establishing a liability mechanism is the Polluter Pays Principle and the principle that whomever benefits from the land should compensate for the costs of remediation.

7.3.5.3 Create a fund dedicated to remediation and reparation of historically polluted sites

In addition to clarifying the responsibilities of relevant parties, a new soil law must address the issue of funding for remediation and reparation of legacy sites. The United States' experience with its legacy sites suggests that it is essential to create a dedicated fund for this purpose. China's soil remediation fund could be used for the clean-up of heavily contaminated, large-scale sites, or for the remediation of land intended for redevelopment, and/or for addressing important or urgent environmental risks generated by polluted sites.

The following issues should be considered when creating such a fund:

First, who should finance the fund? Should the revenue come from the Government's budget or that of enterprises? If the funding comes from the Government, it will be important to make clear the reasons that Government is providing the funding to justify it. If the funding comes from enterprises, it will be necessary to explain which companies are required to make contributions and why.

Second, it will be important to address the long-term stability and sustainability of the funding source(s). Experience shows that the remediation and reparation of legacy sites will not be achieved in a short time. China must be fully aware of the long-term character of this work, often over decades, making it necessary to consider the long-term stability and sustainability of the fund.

Third, how will the fund be used? This should include the use of the fund at both the national and local level. All uses of the fund should be regulated under clear criteria set forth in the law.

Fourth, what standards should be established for use of the fund? Are there limitations on or criteria for expenditures, timeframes for clean-up, types of clean-ups, appropriate scope of clean-up remedies, and when the fund can be used?

Fifth, how will be the fund be managed and how will information about its utilization be made public? It will be important that the management and use of funds is transparent and done with appropriate involvement of stakeholders, communities and the public. Periodic publication of information regarding use of the fund should be required.

7.3.5.4 Carry out investigation, classification and assessment of legacy contaminated sites in order to be prepared for the remediation and reparation of polluted soil

In order to successfully carry out the remediation and reparation of polluted soil, it is necessary to carry out first a nationwide investigation on current polluted sites. Then classification of polluted sites and environmental risk assessment could be carried out based on investigations. The sites to be remediated and recovered should be determined depending on the importance and urgency of the pollution.

The above work is fundamental. Thus this work should also be supported by the fund for remediation and recovery of legacy contaminated sites.

7.3.6 Establish an enabling mechanism which includes incentives and a series of measures for soil pollution management, to activate stakeholder participation

The management of soil pollution does not only refer to the approaches for legislation, enforcement and judiciary, but also refer to auxiliary conditions for the effective implementation of laws and regulations, for example, the incentive mechanism. The incentive mechanism is indispensable for soil pollution management, since soil pollution management is not aimed at punishment, but at encouraging and enabling the participation of the governments, enterprises and citizens for soil environment protection and soil pollution prevention.

China should take multiple incentive measures such as government guidance, economic incentives and public participation to encourage more active participation of government, enterprises, other social groups and individuals in soil environment protection and pollution control and more innovative cooperation between governments, enterprises and society. A cooperative relationship will help resolve the difficulties that exist in the market of soil remediation. It will also promote an urban and regional revitalization and sustainable development.

7.3.6.1 Government guided incentive mechanisms and measures

First, the redevelopment plan for contaminated sites is an important part of national planning system. By developing and publishing redevelopment and remediation plans for the contaminated sites, we should try to implement the policies of “who invests

in remediation takes the benefit" and "who remediates the land takes the privilege of redevelopment" to stimulate land redevelopment process and encourage investment from enterprises and society into the soil remediation. This could not only promote a healthy redevelopment of polluted sites but also stimulates the economy and creates more job opportunities.

Unlike the treatment of other types of pollution, the remediation of soil pollution is closely related to its future redevelopment and reuse activities. This needs soil management policies and laws that allow and encourage the cooperation of polluters, remediate, redeveloper and other interest parties. Establishing and improving incentive mechanisms and incentive measures reflects the emerging trend of modern soil pollution management.

Unlike the treatment of air and water pollution, the remediation of soil pollution is closely related to its future redevelopment and reuse activities. This needs soil management policies and laws that allow and encourage the cooperation of polluters, remediate, redeveloper and other interest parties. The central and local government should encourage a "wise development", using land in a high-density and cost-effective way and try to implement a principle of "the most effective utilization".

Second, it is recommended that a defined four step process that follows a plan, study, remediate and develop approach be established to guide the redevelopment of any contaminated sites at the national. Sub national or local levels. All stakeholders involved in the four step process from government agencies, insurers, financial institutions, developers, consultants and others will be deemed accountable for actions they are assigned responsibility for within the process. This will include but not be limited to assessing the site for contamination, identifying the regulatory requirements for site safety and clean up, developing and carrying out the appropriate remediation or risk management plans, reassessing the site and if needed implementing an ongoing monitoring plan.

Thirst, setting up Soil Bank to protect clean soil in the process of development and urbanization. A soil bank should be established at the subnational and local level to ensure all soil is saved for future use. Creating a Soil Bank means taking the soil from the original site during a development activity and stores it in a certain area according to its classification, or in another situation, store the contaminated soil on site which cannot be used and provide it to different land user for storage, exchange or development.

The establishment of Soil Bank can help protect the clean soil, promote conservative and effective use of soil resource and increase the possibility of cultivation. In order to develop the Soil Bank regime, the central and local governments should support and encourage the creation of soil storage sites, create and develop soil exchange market and

provide relevant information services. Financial and technical support should be given to the reuse of polluted soil in the Soil Bank after its remediation.

7.3.6.2 Economic incentive mechanism and measures

First, the economic incentive mechanism and measures should be included into the system of Natural Resource Accounting. Soil is an important natural resource, as well as key environmental elements. In the framework of institutional reform of ecological civilization, the economic value of soil should be integrated into the system of Natural Resource Accounting and the system of Natural Resource Damage Accounting.

Second, encourage and support the establishment of various types of soil protection fund in order to support soil environment protection. The sources of the state soil environment protection fund could include revenue of a special tax in industries with high soil pollution risks and relevant budget. For instance, the Superfund Act in the United States taxes the oil and gas industry, India takes 2% of GDP to this fund. The fund also welcomes social donations. The country gives awards to the regions which achieves effective protection and improvement of agricultural soil quality.

Several financial instruments are recommended to be developed specifically for those sites that are candidates for redevelopment. Tax incentives and waiving of governmental fees should be established at the national and subnational levels to serve as a catalyst for cleanup. This includes those that invest in remediation, share in any financial return. Grants for environmental and feasibility studies should be made available for those that need financial support and meet qualifying criteria for site redevelopment. Rezoning of land use to raise rehabilitated contaminated site value is another option recommended based on fit for use results from the site specific risk assessment undertaken.

Third, encourage and support the scientific research and technical application of soil pollution management. The lack of developed soil remediation industry and relevant techniques is an important and fundamental reason that hampers the development of soil remediation market. In many places, remediation of soil depends on foreign personnel and techniques. The scientific research, technical development, application and promotion of China's soil pollution prevention and control are all at an early stage of development. Thus they needs support, guidance and stimulation from the economic policies. It's necessary to take fiscal funds supporting, tax, price and credit and loans to support the scientific research, technical development, application and promotion. It is important to establish key regional pollution control technology integrated demonstration area. It is also necessary to select key area of soil pollution prevention and control and establish big-scale soil risk monitoring and remediation demonstration area, in the objective of achieving safe

utilization of agricultural land.

Fourth, it is recommended that a quality assurance process be adopted that covers all stakeholders involved in the process of site identification, classification, characterization, remediation and monitoring to ensure the integrity of the soil environmental management process. This includes but is not limited to: recognized professional status (ex. engineering, science, law, business);current license to practice (degrees/diplomas/professional certifications) associate; quality assurance certifications for all laboratories undertaking analyses; personal sign off accountability for site characterization, remediation, monitoring reports and data submissions; transport system and technology vendor certifications.

Offer financial aid and technical guidance for the investigation and assessment of soil. The investigation and assessment of soil pollution have high scientific requirements, but are very important to the scientific and rational reuse of soil being remediated. We should make technical, economic and industry policies to support the development of soil pollution investigation, assessment and remediation service organizations. To the companies that actively take the initiative to investigate and assess soil pollution, some financial aid and technical guidance should be given.

7.3.6.3 A clear encouragement of organic agriculture

The country should grand subsidies to companies producing organic fertilizer, slow-release fertilizer and low-toxic high-efficiency pesticide and biological pesticide and fertilizer. Subsidy and technical assistance policy will encourage and guide agriculture land user to adopt more organic fertilizer and biological techniques to prevent agricultural diseases and improve soil quality.

A clear encouragement to reduce fertilizer, pesticide and other substances use in agriculture: the government should increase financial support and organize periodical workshop to guide farmers and agricultural producers to properly use pesticide, fertilizer and agricultural film, so that the soil environment can be protected and improved.

Encourage the farmers and other agricultural producers to adopt measures such as the combination of planting and breeding and crop rotation, to protect soil environment. Give some proper compensation to the farmers and agricultural producers who suffer loss from this activity.

7.3.6.4 Public access to and distribution of all relevant information to all affected stakeholders regarding the status of soil and its potential impact on their health, safety or surrounding environment

The right to know, the right to be heard and the right of appeal by stakeholders are proven in international experience to be one of the best ways to ensure a proper solution is

identified and implemented. Traditional environmental management takes a command and control mode, while modern soil pollution management involves ideas of pro-activeness, service orientation and effectiveness, with more emphasis on enabling to get more public participation.

First, governments, companies and other organizations should publish soil environment information concerning soil and accept public scrutiny. The exchange and release of soil environment information is critically important to the formation of a cooperative pattern among governments, companies and society, as it is the foundation of that cooperation. In the same time, the release of information helps answers the questions that the public may have concerning soil pollution and answer the needs of the public on anticipated land use. We should use multiple methods to facilitate access to information of soil environment to the public, including government information and private enterprise information. We should also be serious in gathering the public's opinions and encourage enterprises, individuals, especially the ones that are influenced by soil pollution to exchange their ideas.

Second, open channels for complaints and reports from the public on soil pollution behaviors. By establishing and improving public participation mechanism, encouraging the public to participate in soil protection, urging companies to fulfill soil remediation obligations, guaranteeing the rights of organizations and individuals to make complaints and litigation, soil pollution prevention and control can better cater the need for economic and social developments.

Chapter 8
Coordinated Actions for Addressing Climate Change and Air Pollution
-With a Focus on Short-Lived Climate Pollutants and Non-Road Mobile Sources

8.1 Research progress and policy actions on Short-Lived Climate Pollutants (SLCPs) and Non-Road Mobile Sources (NRMS)

8.1.1 Research progress in China and the world

8.1.1.1 SLCPs

The SLCPs refer to substances that have a relatively short lifetime in the atmosphere and can cause climate warming especially in the near term. These are black carbon (BC), methane (CH_4), ozone (O_3) in the troposphere, and some HFCs. An SLCP strategy is one which implements measures that will reduce near-term warming and deliver air quality benefits from reduced $PM_{2.5}$ and ozone concentrations. The United Nations Environment Programme and World Meteorological Organization (UNEP/WMO) report of 2011 showed that emissions from sources that are the focus for SLCP strategies do harm to air quality, human health and crop production. This report also highlighted the potential magnitude of the benefits of action to mitigate SLCPs-in scale, cost-effectiveness and speed of impact-and argued the case for early international action. Studies show that taking into account all anthropogenic BC sources, and the influence of all co-emitted substances from these sources, the integrated warming effect is negligible. For this reason the UNEP/WMO assessment of BC and tropospheric ozone took a different approach-it only identified those measures that reduce BC but which also reduce net warming of the atmosphere. It did this by concentrating on those measures that reduced the emissions of short-lived warming substances (especially BC, but also CH_4, carbon monoxide and non-CH_4 VOCs) to a greater extent than they reduced the emissions of cooling substances (sulphur dioxide, organic carbon and NO_x). Efforts to reduce SLCPs should therefore focus on a subset of BC sources, and also on the CH_4 sources which are large contributors to global warming (UNEP, 2011a), while seeking synergies in air quality improvement and climate change

mitigation. UNEP led research also looked into the impact of HFCs and the reduction or use of alternative technologies (UNEP, 2011b). HFCs are mainly used as coolants in refrigeration and air conditioning such as in motor vehicle air conditioning, domestic and commercial refrigeration and cold storage, and blowing agents in insulating foams, and to a lesser extent, in some aerosol, fire suppression, and solvent applications. HFCs are powerful greenhouse gases that are currently increasing rapidly and if no action is taken to halt emissions, it is estimated that global HFC emissions could amount to up to 8.8 Gt CO_2 equivalent.[1]

With the introduction of a series of released reports by UNEP, the SLCP studies at the international level have been stepwise refined and have recommended a global rapid implementation of a number of BC, CH_4 and HFC measures that would provide a significant reduction in the rate of warming over the next few decades, as well as preventing millions of premature deaths and avoiding the loss of millions of tonnes of four staple crops (UNEP/WMO 2011). In 2012, the US Environmental Protection Agency (USEPA) submitted the Report to Congress on BC (USEPA, 2012), emphasizing BC as an important air pollutant and climate pollutant. The Report noted that the BC emissions have a negative impact on air quality, human health and crop yields and are mainly distributed in Asia, Africa and Latin America. Studies have shown that diesel combustion is an important source of the BC emissions (Jacobson et al., 2013). BC and its co-emitted pollutants lead to the formation of fine $PM_{2.5}$ which is a major cause of disease and premature death (Lim et al., 2012). The prevention of near-term warming brought about by implementing the SLCPs strategy can reduce impacts on threatened ecosystems and highly vulnerable areas including glaciers and snowfields, such as the Himalayas and the Arctic. According to the joint report of the World Bank and the International Cryosphere Climate Initiative (ICCI) (World Bank & ICCI, 2013), BC-included SLCPs in China can move with atmospheric circulation to the Tibetan Plateau, the Himalayas and the Arctic and exert a negative impact on ice and snow melt, snow and ice albedo, and near-term temperature rise. Meanwhile, the heat produced in China can affect the atmospheric temperatures of sensitive areas through heat circulation. In that sense, the reduction of emissions resulting from implementing SLCP strategies, especially on some specific sources of them, is crucially important in terms of mitigating near-term climate change and the impacts. This is because changes of emissions of CO_2 and other long-lived greenhouse gases do not rapidly change

1 Guus J. M. Velders, David W. Fahey, John S. Daniel, Mack McFarland, & Stephen O. Andersen (2009) The large contribution of projected HFC emissions to future climate forcing, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES USA 106:10949-10954. And Velders G. J. M, et al. (2012) Preserving Montreal Protocol Climate Benefits by Limiting HFCs, SCI. 335:922-923.

the concentrations in the atmosphere, as they can remain in the atmosphere for hundreds of years. This is why the SLCP strategies can affect climate in the near-term, but reducing GHGs is required now to protect the climate in the long term. Fortunately, all of the SLCP measures identified already exist and have been implemented to some extent and have been shown to be very cost-effective measures and, indeed, many of the CH_4 measures are expected to pay for themselves over the lifetime of the technologies implemented.

In China, holistic research on SLCPs has not taken place. While the studies on SLCPs, particularly socio-economic analysis, remain limited, current knowledge is able to identify key sources and mitigation options. Further research findings about emissions and source apportionment will be needed to support some of the decisions on integrated control and focus action in the most cost-effective manner. Considering air pollutants, research has progressed with regard to emissions, source apportionment, impact, abatement technologies and management practices. Chinese policies and actions are lagging behind the research on BC mitigation options. Current studies have noted the importance of BC emissions from the residential sector and the importance of abatement measures in this sector (Chen et al., 2009). BC has been considered as a component of $PM_{2.5}$ in air pollution source analyses (Cao et al., 2011; Zhang et al., 2013). A group of studies on the health impact of $PM_{2.5}$ dedicated an analysis to BC (Huang and Zhang, 2013). Overall, China has kicked off the analysis of urban point sources of BC based on PM capture and infrared monitoring. However, the dataset, mainly provided by the meteorological departments and environmental inspection departments, is unable to show the whole picture of BC emissions in major cities and rural areas, especially emissions from small and scattered sources and non-road sources. Research on the impact of BC is lagging behind, among which the health impact studies related to exposure of $PM_{2.5}$ based on epidemiological statistical methods have a small sample size and a relatively short time span.

CH_4 statistics and accounting rest on the First and Second National Communications on Climate Change which provide cross-sectional data of the years 1994 and 2005 respectively. With regard to the CH_4 inventory, relative scattered findings have been made covering agriculture (rice, ruminant, livestock manure management), landfill (solid waste and waste water), and fossil fuel development and production (coal, petroleum, natural gas), with reference to IPCC Guidelines for National Greenhouse Gas Inventories. On CH_4 abatement technologies, studies have probed into technologies for the control of low-concentration coal mine gas (Han and Ying, 2012; Liu et al., 2013; Han, 2013). The factors of CH_4 and nitrous oxide (N_2O) emissions from urban solid waste and wastewater and the abatement technologies are also discussed (Liu et al., 2014; Ma et al., 2014; Cai et al.,

2015). There are also studies of measures and technologies to address CH_4 in agriculture.

Regarding the HFCs research, the statistical data are mainly sourced from projects under the Clean Development Mechanism (CDM), of which the statistics on actual emission have been collected from 2013 onwards, but are not yet publicly available. Existing studies have covered the reduction of and alternatives to HFC-23 (Cui et al., 2013), HFC-134a and HFC-142b, and the general strategy of HFCs abatement (Lin et al., 2014; Hu et al., 2014; Han et al., 2015).

8.1.1.2 NRMS

NRMS mainly include construction machinery, agricultural machinery, vessels, and aviation, etc. In China, the NRMS population shows a rising trend with the acceleration of urbanization and infrastructure construction. There were more than six million pieces of construction machinery at the end of 2013 in China and the average annual growth rate exceeds 10%. NRMS emissions become increasingly prominent in the absence of effective control. Studies have shown that on-road and NRMS account for 60% and 40% of NO_x emissions respectively, while the latter has a larger role in the primary $PM_{2.5}$ emissions. Construction machinery, agricultural machinery and vessels are the three most important sources of NRMS emissions.

In the context of China, the construction machinery includes excavators, loaders, forklifts, rollers, bulldozers and graders, of which the former three take up 22.0%, 28.5%, and 28.0% respectively. In October 2010, China implemented USEPA Tier 2 emission standards to NRMM regardless of power difference. In this phase, NRMM mainly integrates the turbocharging and intercooling technology which improves combustion efficiency by increasing the intake pressure and reduces emissions, in particular NO_x, by intercooling. With the rapid development of shipping industry, China has occupied a dominant position in water transport in the world. In 2013, the cargo throughput reached 11.8 billion tons and vessels have become a major source of air pollutants in port cities (Box 8-1). According to the range of activities, vessels can be divided into inland vessels and ocean-going vessels. Currently, the regulation of vessel emissions is largely absent (except for engines smaller than 37kW) with no specific emission standards adopted, resulting in a very grim situation of vessel sourced air pollution control. In addition, the marine engine technology is also very outdated, and naturally aspirated engines are still used in inland vessels. These are responsible for poor fuel economy, but also a significant increase in exhaust pollutants.

Europe and the US have paid attention to NRMS since the 1990s. Studies show that non-road machinery and vessels are an important factor affecting human health and climate

change. To this end, Europe and the US applied the Tier 1 emission standards to non-road machinery in 1996 and over time the standards were ratcheted down with Tier 4 being the current standard. US also started regulating PM, NO_x, HC and CO emissions from domestic vessels with the introduction of the Tier 2 standards between 2004 and 2007, and started phasing in Tier 4 standards in 2014. EU implemented State IIIA standards (equivalent to US Tier 2) for inland waterway vessels in 2007, and proposed Stage V standards that should require the use of wall flow filters to control PM and BC emissions. On ocean going vessels, the International Maritime Organization (IMO) also began to regulate NO_x emissions in 2000 and later, SO_2 emissions, and currently, the regulation follows the Tier 2 emission standards. In order to reduce emissions from in-use machinery, the European and US governments require constantly reducing the sulfur content of fuel and introduce economic subsidies and incentives to encourage non-road machinery to adopt new technologies. Diesel particulate filters (DPFs) which are effective in removing PM and BC have been widely used in California and Switzerland, but its applicability to different kinds of machinery needs further testing. In terms of testing and measurement, Europe and the US have begun to use the portable emissions measurement system (PEMS) to test emissions in the actual conditions, rather than the past regulatory conditions. PEMS produces data about actual emissions in mechanical operation, which helps to better understand and grasp the actual level of emissions from non-road machinery.

To reduce emissions from vessels, clean fuels and shore power are favored. The Clean Fuels Program require vessels to use low-sulfur diesel fuel in the ECAs prescribed in Europe and North America, in order to reduce the SO_x emissions and PM generated indirectly (and reductions in NO_x in North America only, starting 2016), which is in line with the IMO's MARPOL Annex VI requirement. Furthermore, the North American ECA also requires reductions in NO_x emissions from new vessels built starting in 2016 and operating in the ECA. The use of shore power in berthing vessels can effectively reduce emissions of auxiliary shops, thereby reducing pollution in the port area.

Box 8-1 Serious NRMS air pollution in Chinese port cities

Shanghai is the economic center of China, the core city of the Yangtze River Delta and one of China's transportation and shipping center. Shanghai Port is the busiest container port in the world, with the cargo throughput in 2013 reached 780 million tons and a container throughput of 35 million TEU. Currently, Shanghai owns a total amount of approximately 90,000 non-road

machinery with an annual diesel consumption about 500,000 tons. With the rapid development of urban construction and port logistics, emissions from shipping and non-road machinery become more and more significant, comparing with the decreased emission from industrial and motor vehicles sectors under stricter pollution control strategies. According to the data analysis of tonnage between port entry and exit, internationalocean-going vessel accounts for the highest proportion of 51%. Inland vessels in the outer harbor waters, coastal vessels and inland river vessels account for 23%, 19% and 7%, respectively. In view of the pollutants emissions inventory, container shipping contributes to the highest share of 30% in all types of ocean-going vessels, followed by bulk carriers and tugs. In all types of the machinery, about 35%~55% are old machinery of more than 8 years and complied with only "China 0" standard. Among the total emission of NO*x* and the primary $PM_{2.5}$ in Shanghai, shipping and non-road machinery contribute 30% and 7%, respectively. Based on the source apportionment of $PM_{2.5}$ in 2013, shipping and non-road machinery emissions contribute to 7%~10% of the city's $PM_{2.5}$ concentrations, showing the important impact on air quality. Meanwhile, using the residual oil, heavy oil or diesel as the fuel, shipping and non-road machinery produce more BC (one major SLCP) with total share of 20%; among which, shipping contribute 13%. Therefore, strengthening the pollution control on NRMS will not only benefit the comprehensive air pollution in cities, but also provide a significant co-benefit on the reduction of SLCP.

As the third largest container port of the world, Shenzhen port (one major port in Pearl River Delta Region) also faces the prominent problems of air pollution due to large emissions from ships. In 2014, the annual consumption of heavy fuel oil by the ocean-going vessels into Shenzhen Port was about 200,000 tons, with the annual $PM_{2.5}$, NO_x and SO_2 emissionsas high as 1,250, 14,300 and 12,000 tons, respectively. They accounted for 5%, 16% and 59% of all emission sources in Shenzhen; and the emissions from container ships are the largest contributor to shipping pollution, accounted for about 74%. According to the $PM_{2.5}$ source apportionment results in Shenzhen, in 2014 the annual mean concentration of $PM_{2.5}$ was 36μg/m^3, in which the primary emissions from ocean-going vessels contributet o about 5% (2μg/m^3). The primary emissions from vessels have a higher contribution in summer, with the $PM_{2.5}$ concentrationsvaried between 2μg/m^3~4μg/m^3; and have a lower contribution in winter with the $PM_{2.5}$ concentrations varied between 1μg/m^3~3μg/m^3. Considering primary emissions and secondary conversion together, the contribution of vessels to annual mean $PM_{2.5}$ concentration accounted for about 13% (5μg/m^3), among which local vessels contribute about 2 μg/m^3.Air quality modeling analysis indicates that vessel emissions will lead annual mean SO_2 and NO_2 concentrations to increase by 4μg/m^3 and 8μg/m^3,respectively.

8.1.2 International Policy Actions and Experience Analysis

8.1.2.1 SLCPs

In recent years, new international initiatives to promote taking action to reduce

emissions of SLCPs have emerged. Recent scientific assessments coordinated by UNEP were instrumental in raising awareness of the benefits in addressing SLCPs both for the near-term climate protection and clean air benefits. In February 2012, the Climate and Clean Air Coalition to reduce Short Lived Climate Pollutants (CCAC) was launched by 6 governments and UNEP as a first global effort to address SLCPs. It has since grown to include more than 100 partners. The Coalition, a voluntary international framework for concrete and substantial action, is a partner-led effort to accelerate and scale up action on SLCPs by catalyzing new actions as well as highlighting and bolstering existing efforts. The Coalition partners have identified seven sector[1]-based initiatives that could yield immediate and scaled-up climate and clean air benefits by reducing SLCPs (CCAC, 2014).

As the Arctic is disproportionately affected by SLCPs such as BC, the Arctic Council has undertaken several technical and scientific assessments in this area, as well as recommendations for policy makers on mitigation opportunities related to BC and CH_4, and a number of pilot and demonstration projects. Recently, in April 2015, Arctic States agreed to a *Framework for Action for Enhanced BC and CH_4 Emissions Reductions*, which commits Arctic States to take action, and it also calls on Arctic Council Observer States to join Arctic States in these actions. The Framework focuses on such things as the development of inventories, reducing emissions, regular reporting to the Arctic Council, sharing best practices, and enhancing scientific cooperation.

International efforts have also been proposed to address HFCs under the Montreal Protocol, as most HFCs are used as replacement to ozone depleting substances being phased out under the Montreal Protocol. All CCAC partners are dedicated to taking actions to reduce SLCPs. Specifically, the European Union (EU) and the United States take SLCPs and air pollution into combined consideration, emphasizing the associated health benefits as a policy focus. The EU has identified BC as a separate measure of air quality and rolled out strict abatement and alternative policies. HFC-134a shall no longer be used in all vehicles in EU since 2011, according to EU Mobile Air-Conditioning Directive. The United States and Canada have adopted stringent emission standards for diesel engines found in non-road machinery. As part of Canada's Air Quality Management System, new, more stringent ambient air quality standards for PM have been developed to inform policies and measures to address BC emissions from industrial sources and non-industrial

1 The seven sector of CCAC activities to reduce SLCPS emissions are: a) heavy duty diesel vehicles and engines; b) brick production; c) municipal solid waste sector; d) promoting HFC alternative technology and standards; e) oil and natural gas production; f) agriculture and; g) household cooking and domestic heating. Cross- cutting efforts include: a) financing of SLCP mitigation; b) supporting national planning for action on SLCPs ; c) Regional assessments of SLCPs. Further information can be found at: http://www.unep.org/ccac/Initiatives.

sources. In addition, international efforts have increased, with regard to the regulation of CH_4 from the oil and gas sectors. For example Canada, the United States and Mexico have announced their intent to regulate these sources. In Canada, the government has announced the development of controls on the manufacture, import and use of HFCs. The United States is also committed to landfill CH_4 reduction and high GWP HFCs alternatives. It has designed the Biogas Roadmap to encourage CH_4 recovery and utilization and the Natural Gas STAR Program to address CH_4 emissions from oil and gas exploration, production, transmission and distribution. Mexico incorporates SLCPs into the National Special Program on Climate Change (2014—2018) and both Mexico and Chile have committed to achieving reductions in BC of 70% by 2030 in their Intended Nationally Determined Contributions (INDCs). A number of other countries, including Morocco, have included SLCPs in their INDCs. Bangladesh, Colombia, Nepal and other mountainous countries have launched plans about BC emission inventories and reduction actions.

8.1.2.2 NRMS

For Europe and the US, the NRMS emissions are still too high. The study of California showed that NRMS accounts for 14% of the NO_x emissions in the state. In the US, the new non-road engines are currently subject to the Tier 4 emission standards which keeps the CO limits, but tightens the limits on HC, NO_x and PM, compared with previous standards. In terms of emission control technologies, the Tier 4 emission standards intended to require exhaust after-treatment. Among them, DPFs which can effectively remove PM[1] and SCR can greatly reduce the formation of NO_x. In terms of certification, the NRMS engines are tested on the Non-Road Transient Cycle (NRTC) and must pass the 1,000-hour durability test. In Europe and the US, low-sulfur diesel fuel is also a common requirement for NRMM. In addition, the US implements an NRMM registration system to grasp the actual situation of emissions. Under this system, each machine has an identity number which is installed in a prominent position on the fuselage so users can identify the emissions limits to which the machine was certified by querying the identity number. Meanwhile, financial subsidies are allocated to encourage the installation of after-treatment devices in old machinery to reduce emissions. It is worth noting that Portable Emission Measurements Systems(PEMS) has been used in compliance testing and inspection in Europe and the US. PEMS performs well in measuring emissions under the operating conditions of construction machinery, which makes up for the deficiency in regulatory conditions.

1 Some manufacturers have been able to meet the standards without the use of DPFs and regulators are considering an additional tightening of the requirements.

Europe,the US and Canada have realized the impact of vessels on human health and the environment and taken measures to control air pollution caused by vessels and ports. To address emissions from ocean-going vessels, the International Maritime Organization (IMO) develops SO_x, PM and NO_x emissions standards. ECAs have been created in the Northern Europe and North America (except Mexico). Among them, ECAs in the North Sea and Baltic Sea focus on SO_x emissions; and North America and the Caribbean Sea ECAs, SO_x and NO_x. Vessels shipping and docking in the ECAs of North America and Europe shall ensure the sulfur content of fuel below $10{,}000\times10^{-6}$ which was reduced to $1{,}000\times10^{-6}$ (0.1%) in 2015. The limit is much lower than the world average sulfur content of fuel for vessels ($25{,}000\times10^{-6}$, 2.5%) (Smith et al., 2015) and the upper limit for global marine fuel ($35{,}000\times10^{-6}$, 3.5%). Since 2016, all newly-built ocean-going vessels that operate in North America and the US Caribbean Sea ECAs (waters within 200 and 50 nautical miles from shoreline respectively) shall cut the NO_x emissions by 75% compared with existing ones. The ECAs are expected to be highly effective: The EU ECAs, America ECAs are expected to result in health and environmental benefits worth four times and 10 times the cost of compliance, respectively. (AEA, 2009; USEPA, 2010). The above-mentioned regulations and incentives have promoted the development and application of alternative fuels and advanced emission control technologies in the shipping industry. In particular, main ports in North America and EU offers incentives to promote the use of clean shipping and port technologies and practices that go beyond regulatory requirements, and for example, leading ports like Los Angeles and Long Beach reduced diesel PM by over 80% in less than a decade as a result. (Port of Los Angeles, 2014; Port of Long Beach, 2015). As sulfur content of fuel becomes lower, shipping companies are trying to reduce the SO_x and NO_x emissions by installing after-treatment devices, and some have applied SCR and Exhaust Gas Recirculation (EGR). In addition, liquefied natural gas (LNG) as an alternative marine fuel has attracted increasing attention. LNG has an advantage over the low-sulfur fuel in NO_x, SO_x and PM emissions, but also price in North America and Europe. Given this, more and more European ports have begun to scale up LNG facilities. In addition, a number of ports in Europe and North America encourage, even mandate that ocean-going vessels use shore power when docking and reduce speed, in order to further reduce emissions in the port area.

8.1.3 Policy actions and challenges facing China

8.1.3.1 SLCPs

In recent years, the Chinese government has released many laws, regulations, policies

and action plans on air pollution prevention and greenhouse gas mitigation. In 2013, the Air Pollution Prevention and Control Action Plan was released as a milestone of the national actions in these areas. And in August of 2015, the lately amended *Law of the People's Republic of China on Prevention and Control of Atmospheric Pollution* is another significant national action, in which some very detailed air pollution prevention measures are stressed. These actions and measures will greatly reduce the air pollution and achieve some co-benefits in the reduction of SLCPs emissions. However, China has no dedicated policy actions to address SLCPs.

An SLCP strategy focuses on sources of emissions from incomplete combustion where the balance of all emissions indicates that the measures will reduce climate warming in the near term. These measures include emission reductions through coal policies covering clean coal combustion or fuel substitution outside the power sector which will reduce significant emissions of BC. Examples include residential stove and industrial furnace improvement, lowering emissions from diesel vehicles, vessels and non-road machinery. In particular, the Chinese National Improved Stove Program (NISP) vigorously promoted by Ministry of Agriculture (MOA) (Smith and Keyun, 2010) sets an example for the global action to improve stoves. Moreover, the Chinese Government has also rolled out a series of national standards to improve combustion efficiency and reduce emissions. All such policy actions, though not specific to BC, can simultaneously reduce BC emissions from different sources.

All measures that reduce methane will reduce near-term warming and ozone formation. Research has been conducted on rice production, animal manure management, urban waste, industrial waste water and coal bed methane (CBM). However, policy actions are aimed at increasing resource utilization, with CH_4 emission reduction as a by-product of policy effects, rather than a concerted and coordinated effort to comprehensively reduce methane emissions. Among the policy actions, the *Rural Biomass Energy Industry Development Plan* (2007—2015) and the *National Rural Biogas Construction Plan* (2006—2010) issued by MOA in 2007 established the principles and objectives for biogas development; the 12th Five-Year Plan for National Economic and Social Development stressed the need to accelerate biogas development. Fugitive CH_4 emissions from fossil fuel extraction, storage and transport have not yet been robustly addressed (though there has been some initial progress on coal-bed CH_4 utilization).

China has been making efforts to reduce the emission of HFCs. It is known that China has committed itself to reduce its HFC production, consumption and emission by using various options, especially by being actively involved in the negotiation and

implementation of the Montreal Protocol and by various bilateral agreements. It is worth mentioning that China binds itself to an HFC emission reduction target in its "Energy Conservation, Emission Reduction, Low Carbon Development Action Plan for 2014—2015" issued by State Council, which estimated that about 0.28 billion tons of CO_2 equivalent will be reduced during 2011—2015.China has already issued two batches of central budget investment plan of HFCs reduction major demonstration projects to support relevant enterprises building HFC-23 combustion facilities. Next step, China will continue to organize the yearly subsidy arrangements for HFC-23 emission reduction before 2019, develop non-carbon dioxide greenhouse gas emission standards and abatement action plans, promote the improvement of relevant laws and regulations, and accelerate the research and development of HFCs alternative technologies, aiming to achieve effective control of HFC-23 emissions by 2020. In addition, emission of HFC-23 has been reduced significantly (over 0.44 billion tons of CO_2 equivalent) by enterprises via the CDM mechanism.

8.1.3.2 NRMS

In the regulatory aspect, China implements Tier 2 emission standards for construction machinery. In Europe and the US, however, Tier 4 emission standards prevail, requiring new machinery integrated with post-processing technologies (DPF, SCR, etc.). China lags even more behind in the regulation of emissions from domestic vessels, as it has not yet issued the relevant emission standards. Europe is now implementing Stage IIIA standards for all inland waterway vessels (which is equivalent to US Tier 2 standards.) The US is now phasing in Tier 4 emission standards for Category 1 and 2 engines for domestic vessels to further reduce NO_x, PM, CO, HC emissions. The MEP is now developing a regulation that will control air emissions from marine engines (at or above 37 kW) for use on inland waterway vessels, sea-river vessels and coastal vessels. The proposed Stage I and II standards are equivalent to the US Tier 2 and 3 standards for Category 1 and 2 marine engines. Even if China Stage I standard were enacted in 2017 as proposed, China's standards would still be at least 10 years behind those enforced in the US and EU.

In the aspect of NRMS management, China has not yet introduced the law on the prevention and control of construction machinery pollution. The ongoing management system lacks unified monitoring and regulatory requirements, making it impossible to identify the actual level of emissions of non-road machinery. The mandatory retirement system for construction machinery has not been established. At this stage, there is a considerable amount of old machinery (older than 10 years), of which engines are poorly maintained, giving rise to large emissions. In regard to mechanical transformation,

government departments have not yet introduced support policies and incentives. Similar to the case of construction machinery, the regulation of marine engine emissions remains absent. The regulation of vessels currently relies on the Department of Marine Management of Ministry of Transport (MOT) and focus on sewage discharge.

In terms of fuel quality, construction machinery mainly uses regular diesel fuel which has high sulfur content (up to 350×10^{-6}, while that of road on-road diesel contains less than 50×10^{-6}). The quality of fuel-oil used by vessels is worse. At present, ocean-going vessels entering the country largely use heavy fuel-oil with sulfur content as high as 3.5% ($35{,}000\times10^{-6}$).wt. High sulfur content results in huge SO_2 and PM emissions from vessels. In Europe and North America, however, four ECAs have been established, where vessels are required to use lower-sulfur fuel oil (sulfur content less than 0.1%) in order to reduce SO_x emissions. California is phasing in a mandate on the use of shore power for the purpose of reducing emissions at berth.

8.1.4 Findings and Recommendations

Overall, China is facing many challenges in controlling of SLCP and NRMS pollution. Among the challenges isan absence of specialized regulations and standards; a lack of overall consideration to collaborative governance of conventional air pollutants and SLCPs; inadequate technology research and development, promotion and application; weak research base and insufficient statistical data supporting policy-making. This includes a lack of an official and comprehensive emission inventory for all sectors and emitted substances. Therefore, the following two areas need to be strengthened.

8.1.4.1 Strengthening the scientific research and technology development on SLCPs and NRMS

It is suggested to strengthen the research on the integrated effects of SLCPs on air quality and climate change, and carry out in-depth research into emission sources, emission characteristics, environmental impact and emissions reduction potential of SLCPs and NRMS strategies. The government should expand investment in the independent research on BATs to control SLCPs and NRMS emissions, such as development, demonstration and commercialization of advanced engine and after-treatment technologies (SCR/DPF, etc.) applicable to NRMS and research, development and demonstration of advanced technologies and equipment for monitoring emissions and concentrations.

8.1.4.2 Fully drawing on advanced international experience and promoting international cooperation in emission control and governance

It is suggested to strengthen experience sharing in SLCPs and ECAs under

existing international governance mechanisms, and fully refer and use the mechanisms of multilateral cooperation on SLCPs governance, including the Global Methane Initiative (GMI), Climate and Clean Air Coalition (CCAC), and the Global Alliance for Clean Cookstoves (GACC). By way of intensive involvement in relevant actions and mechanisms, China can not only gain direct benefits, but also strengthen its voice and influence in international affairs. Furthermore, China should set the agenda to develop, in line with national conditions and in the interest of public welfare, the SLCP control plan and introduce relevant policies.

China lags far behind the European and American counterparties in the level of NRMS emissions control and needs to quicken the alignment with international standards. It is suggested to refer to the successful experiences of Europe, the US and Canada in NRMS emissions control, including speeding fuel, tightening implementation of cleaner fuels, the emissions standards to reduce emissions of new machinery, strengthening the supervision of new machinery and in-use machinery, encouraging mechanical technological upgrading, synchronizing regulations and developing incentives to promote cleaner fuels and emission control technologies, setting up ECAs in key port regions and encouraging key ports to implement clean port plans.

8.2 Status and industrial characteristics of SLCPs and NRMS emissions in China

8.2.1 Status and industrial characteristics of SLCPs emissions

8.2.1.1 BC and its Co-emissions

In China, BC mainly comes from incomplete combustion of coal, biomass, motor vehicles, and in particular from heating and cooking activities in rural areas. It is estimated that China's BC emissions (excluding Hong Kong, Macao and Taiwan) during the years from 2000 to 2008 were 0.963—1.811 million Mt per year. There are large emissions of fine particles from coal combustion and straw and firewood burning in the residential sector as a combined result of low temperature and insufficient oxygen (i.e. giving rise to incomplete combustion) relative to large industrial boilers and power plant boilers (where the combustion is more complete), and inadequate or no corresponding control measures. It is generally believed (Cao et al., 2006) that the residential sector presents a high BC emission factor and is responsible for 40%~85% of the estimated BC emissions (Zhi et al., 2011), and the control of residential sources can effectively cut the BC emissions in

the short term. In latest emission inventories (Cao et al., 2011), industrial coal and fuel combustion accounts for approximately 30%~40% of the estimated total BC emissions and should also be brought under control. Relevant data are presented in Table 8-1.

The estimates of BC emissions are quite uncertain due to the lack of localized, measured emission factors, especially data about coal and straw used as energy sources in rural area (Bond et al., 2004; Zhang et al, 2009b) and the emission inventory uncertainty is generally above 100%. Experiments conducted in developing countries show that the emission factors of both vehicles and straw in rural areas are higher than estimated (Shen et al, 2010; Subramanian et al, 2009; Wang et al., 2012).

Table 8-1 BC emissions inventories in different studies

10,000 tons

Emissions inventory	Year	Industry	Power	Household	Biomass burning	Transportation	Total
Zhang et al., 2013	2008	69.50	1.16	63.60	6.77	19.46	160.49
G. et al., 2003	2000	8.89	0.68	78.07	11.24	5.98	104.86
Ohara et al., 2007	2000	9.90	1.80	93.80		3.80	109.30
Lei et al., 2011	2005	61.00	1.00	70.00		19.00	151.00
Zhang et al., 2009	2006	57.50	3.60	100.20		19.80	181.10
Cao et al., 2011	2007	52.90	1.30	65.10	10.40	14.50	139.90
Wang et al., 2012	2007	64.60	5.07	98.80	7.77	18.80	195.70
Lu et al., 2011	2008	51.00	1.90	88.80	11.00	25.90	178.70
M. et al., 2014	2007			39.20		8.60	96.340

Multiple aerosol particles and precursor gases are emitted into the atmosphere together with BC, and the synergistic effect deserves further study. Among these substances are POA, SO_2, CO, NO_x, and VOCs. Relevant research shows that the emissions of CO, NO_x and VOCs from the residential sector accounted for 34%~43%, 5.6%~11% and 16%~33% of the total. The importance of understanding the emission of all substances and the impact of measures upon them are not only from the perspective of near-term warming, where the balance of emissions of substances that affect radiative forcing is important. It is also from the perspective of $PM_{2.5}$ pollution, where the emissions of several substances that give rise to $PM_{2.5}$ and ozone concentrations can be affected by the SLCP measures implemented.

8.2.1.2 Tropospheric Ozone-related Emissions

Carbon monoxide, NO_x and VOCs are sometimes co-emitted with BC. These are the precursor gases with that lead to O_3 formation under the action of sunlight. Together

with methane, CO also controls the background levels of ozone, and the peaks are mainly related to non-CH_4 volatile organic compounds (NMVOC) and NO_x distributions. In 2010, China's NO_x emissions totaled 25.82 million tons, of which power plants, industrial boilers and road traffic were responsible for 31%, 18% and 17% respectively. Compared with 2005, the total emissions in 2010 showed an increase of 34.3%, of which road traffic, industrial boilers and cement sector contributed 24.6%, 21.7% and 19.3% respectively (Figure 8-1). There is also an intense interest in NO_2 in Europe, where it is believed that it is responsible for a greater impact on health than previously thought.

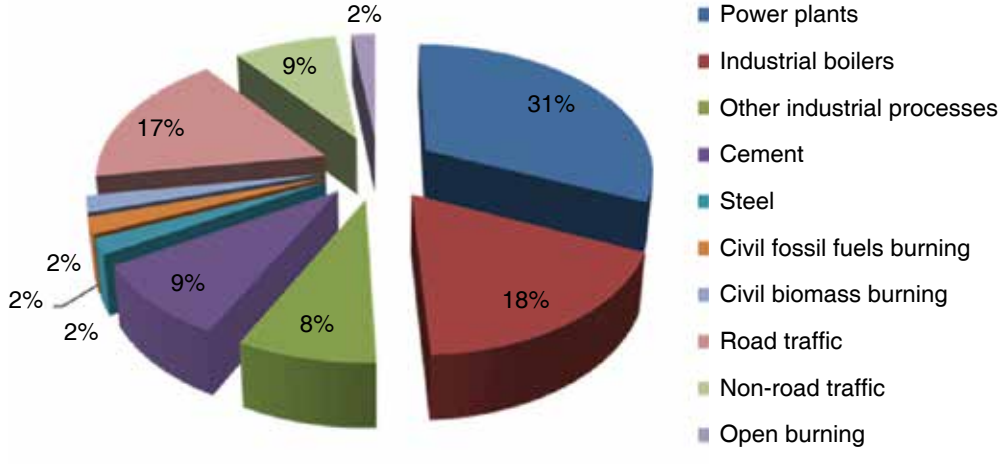


Figure 8-1 China's NO_x emissions sources and distribution in 2010

According to Zhao et al (2013), China's NMVOC emissions amounted to 22.86 million tons in 2010, of which industrial processes, industrial solvents and household burning accounted for 25.0%, 24.4% and 18.8% respectively (Figure 8-2). Compared with 2005, there was an increase of 21.0% in total, of which 90% was sourced from industrial solvents. While the VOC emissions arising from the use of industrial solvents grew by 102%, the emissions from households and road transport sector declined with the implementation of vehicle emission standards and the gradual control of biomass direct combustion.

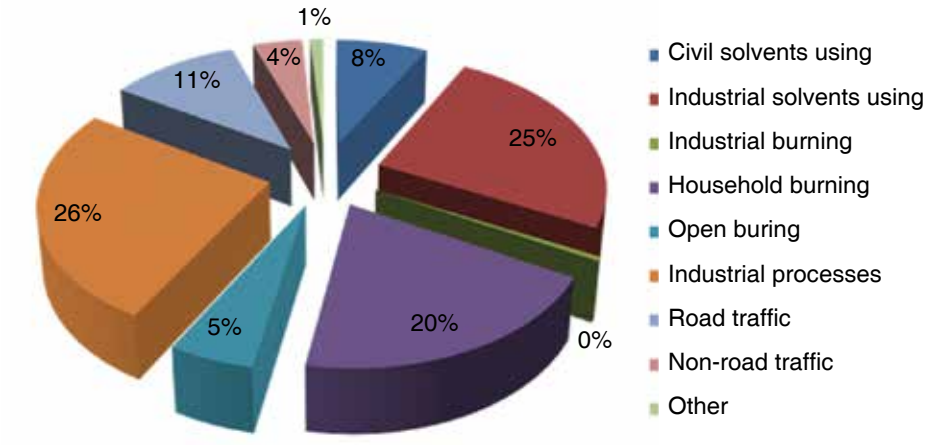


Figure 8-2 China's VOCs emissions sources and distribution in 2010

8.2.1.3 CH_4

Atmospheric CH_4 comes from natural sources and anthropogenic sources, where the former include wetlands, termites, oceans, vegetation and CH_4 hydrates and the latter include coal mining, natural gas production, landfills, livestock, rice paddies and biomass burning (Olivier et al, 2005). According to the Fifth IPCC Assessment Report (IPCC AR5), up to 50%~65% of the global CH_4 emissions in the past 30 years can be attributed to anthropogenic sources (Change, 2013).

The Second National Communications of the People's Republic of China on Climate Change said that in 2005, CH_4 emissions amounted to 930 $MtCO_2e$ in China, taking up about 12% of the national GHG emissions. USEPA suggested that China's CH_4 emissions totaled 920 $MtCO_2e$ in 2010, equivalent to about 13% or so of the global total, and per capita emissions were less than that of the world's top two emitters: the United States and India (Zhang and Chen, 2014). An SLCP strategy would place further emphasis on reducing methane emissions rapidly, as from the following text, it is clear that there is a lot of opportunity for further methane emission reduction in China.

It is worth noting that, based on estimates in 2010, coal mining, enteric fermentation, rice cultivation and sewage treatment have become the major sources of CH_4 emissions, accounting for 83% of China's total CH_4 emissions, and among them, coal mining takes up the largest share, which can be regarded as the situation in China.

(1) CH_4 from energy-related activities

Zhang and Chen (2014) estimated that energy-related activities contributed up to 45% of the national CH_4 emissions in 2007, of which coal production, biomass burning

and oil and gas production took up 38%, 5.3% and 1.6% respectively (Zhang and Chen, 2014). USEPA (2012) estimated that in 2010, the CH_4 emissions from energy-related activities reached 383.3 $MtCO_2e$ (USEPA, 2006), accounting for about 42% of the national total. In recent years, CH_4 emission sources and their proportion change little in China, and the energy sector remains the largest contributor through coal production, oil and gas production, and fossil fuel combustion (including fixed and mobile sources), as well as biomass burning. In 2010, the key CH_4-emitting sources in the energy sector were coal production (295.5 $MtCO_2e$; 32%), biofuels (48.5 $MtCO_2e$; 5.3%), and oil and gas production (4.2 $MtCO_2e$, 0.5%).

CH_4 emissions from coal production are concentrated on coal mine methane (CMM) extraction. From 2006 onwards, the extracted CMM increased at an annual rate of 1.0 billion m^3. In 2014, the national CMM extraction attained 13.26 billion m^3, of which 4.53 billion m^3 was utilized, up by 503% and 466 % respectively compared to 2005 (Figure 8-3). Gas extraction exceeded 200 million m^3 in 10 provinces, namely Shanxi, Guizhou, Anhui, Henan, Chongqing, Heilongjiang, Sichuan, Liaoning, and Shaanxi. The volume even hit 5.534 billion m^3 in Shanxi, accounting for 42% of the national total.

Currently, CMM is mainly used for residential and industrial fuel, power generation and vehicle fuel. From 2006 to 2014, a cumulative amount of 24.66 billion m^3 CMM was used, equivalent to 29.85 million tons of standard coal savings and 369.90 $MtCO_2$ of GHG emission reduction. In 2020, the national drainage volume will reach 20 billion m^3, 60% of which can be used, according to the Action Plan for CBM/CMM Exploration and Development issued by National Energy Administration on February 2, 2015. By then, the CMM installed capacity will exceed 4,000 MW and CMM benefit more than 6 million families, posing a huge potential of emission reduction in the coal field.

Due to complex conditions and low permeability of coal seam, the CMM drainage rate and concentration remain low in China, though recoverable CMM has increased significantly in recent years. According to statistics, the current national CMM drainage rate averages about 30% and the CMM with a concentration of less than 30% accounts for 70% of the total. In 2014, the national CMM utilization rate was only 34.2%, basically the same as 2007, and about 8.73 billion m^3 was directly discharged into the atmosphere. Low drainage rate results in a huge quantity of low-concentration (less than 1%) ventilation air methane (VAM). In 2014, the CH_4 emitted into the atmosphere via the ventilation systems, i.e. VAM, registered at 20 billion m^3.

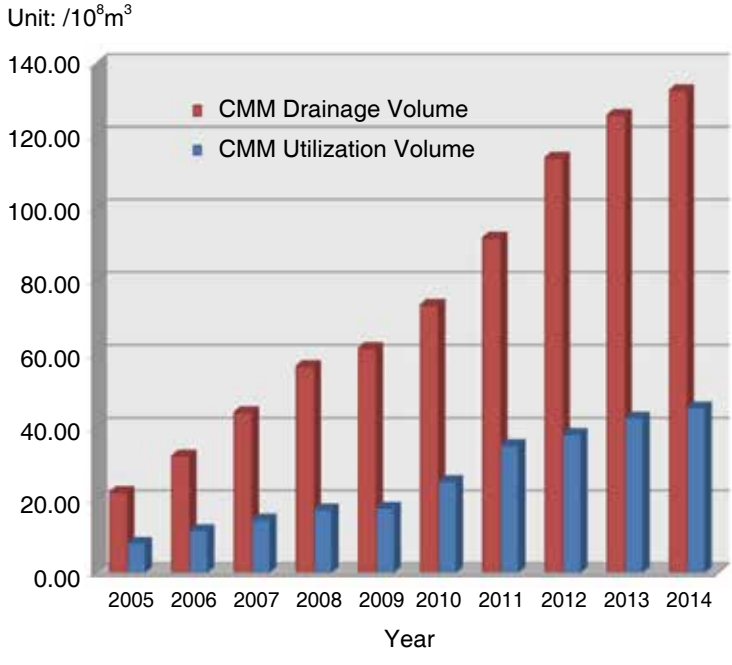


Figure 8-3 China's CMM drainage and utilization volume, 2005—2014

(2) CH_4 from agricultural activities

In 2010, China's agricultural sector contributed 358 $MtCO_2e$ CH_4 emissions, representing 39% of the national total, and became the second largest source of CH_4 emissions. The emissions from enteric fermentation, rice cultivation, manure management and biomass burning (crop residues) registered at 212.5 $MtCO_2e$, 124.6 $MtCO_2e$, 20.1 $MtCO_2e$ and 1 $MtCO_2e$ respectively, taking up 23%, 14%, 2.2% and 0.1% of the total.

(3) CH_4 from urban solid waste

In 2007, Zhang and Chen, 2014 estimated that 14% of China's CH_4 emissions came from urban waste, including urban solid waste landfills, industrial waste water and urban wastewater, with a share of 8.2%, 4.1% and 1.5% respectively.

8.2.1.4 Some HFCs in China

Due to data constraints, HFCs in China mentioned herein include: a) HFC-134a in the automobile air conditioning industry; b) HFC-410A (mixture of HFC-125 and HFC-32 with equal proportion) from room air conditioning systems; c) HFC-23 unintentionally produced and emitted during hydrochloro fluoro carbon (HCFC)-22 productions.

(1) HFC-134a in the automobile air conditioning industry

HFC-134a is mainly applied in mobile air conditioners, refrigeration equipment,

refrigerators and pharmaceutical aerosols, wherein the latter two accounts for a small proportion (less than 100 tons annually for refrigerators and to be replaced). Hence, the focus is put on the automotive air conditioning industry.

Figure 8-4 shows HFC-134a annual emissions in the automotive air-conditioning industry and emissions in each link of the life-cycle process of mobile air conditioners during 1995—2010 (Su et al., 2015). Total HFC-134a emissions increased at an average annual rate of 53.3% from 30 tons in 1995 tons to 16,700 tons in 2010, and the consumption further expanded with CFC-12 phase-out in the automotive air-conditioning industry and the rapid development of automobile industry. In the life cycle of mobile air conditioners, the maintenance and repair process sees the largest HFC-134a emissions, accounting for about 80%, which is largely related to the high maintenance and repair rate and immediate discharges of remaining refrigerants in the process.

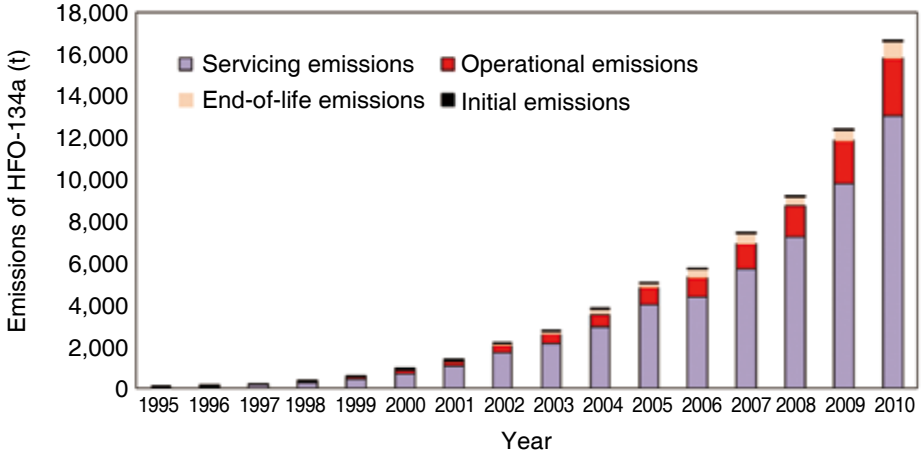


Figure 8-4 HFC-134a emissions in the lifecycle of automobile air conditioners, 1995—2010

(2) HFC-410A from room air conditioning systems

HFC-410A is a mixture of HFC-125 and HFC-32 in equal proportions with a combined GWP value of 2060 and is mainly used as refrigerant in room air conditioners.

Figure 8-5 shows HFC-410A annual emissions in the room air conditioning systems and emissions in each link of life-cycle process of room air conditioners during 2006—2014 (Su et al., 2015). Total HFC-410A emissions increased at an average annual rate of 175% from 127 tons in 2006 tons to 11,000 tons in 2014. It is a result of substantially increased use in room air conditioners for exports to Europe and the United States and

supply in China after the phase-out of HCFC-22. In the life cycle of room air conditioners, the maintenance and repair process sees the largest HFC-410A emissions, accounting for nearly 59.6%, while the proportion of the operation, retirement and production processes register 30.6%, 6.7% and 3.1%, respectively.

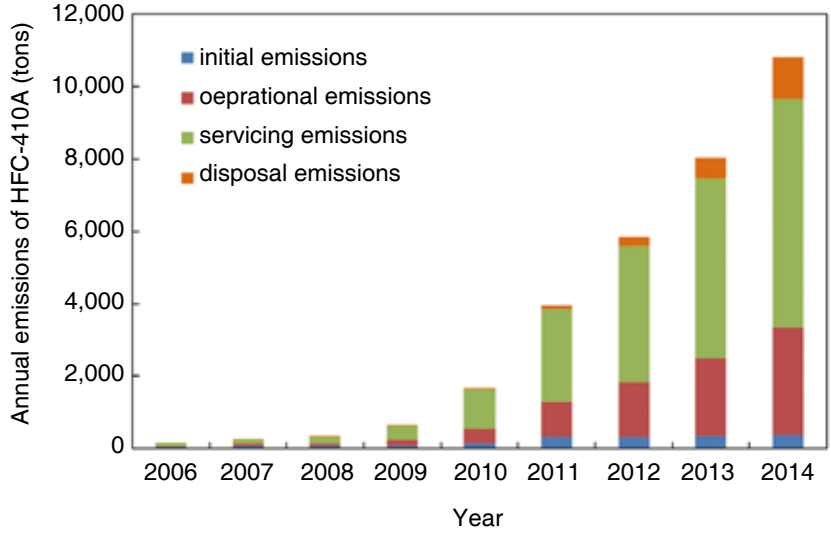


Figure 8-5 HFC-410A emissions in the life cycle of room air conditioning systems, 1995—2010

(3) HFC-23

HFC-23 production, incineration and emission in China during 1980—2012 (Fang et al., 2014) are shown in Figure 8-6, where global emissions are drawn from top-down estimates (1980—1989) and bottom-up estimates (1990—2008) (Miller et al., 2010), as well as predictions for the future (2009—2012) (Miller and Kuijpers, 2011). The results showed that the HFC-23 production expanded from 0.08 ± 0.05 Gg/yr in 1980 to 15.4 ± 2.1 Gg/yr in 2012, with a particular fast increase of annual production in the late 1990s. The annual growth of HFC-23 production reached 0.04 Gg/yr during 1980—1990, 0.18 Gg/yr during 1990—2000 and 1.1 Gg/yr after 2000.

HFC-23 production and emission are not always equal. Prior to 2006, the emission was almost equal to production, but became smaller with the launch of CDM projects that destroyed HFC-23 from 2006. During 1980—2012, HFC-23 emission peaked at 10.5 ± 1.8 Gg/yr in 2006, but fell down to 7.3 ± 1.3 Gg/yr in 2008 and 2009, followed by gradual increase to 8.5 ± 2.1 Gg/yr. In 2012, up to about 45% of HFC-23 was destroyed (incinerated).

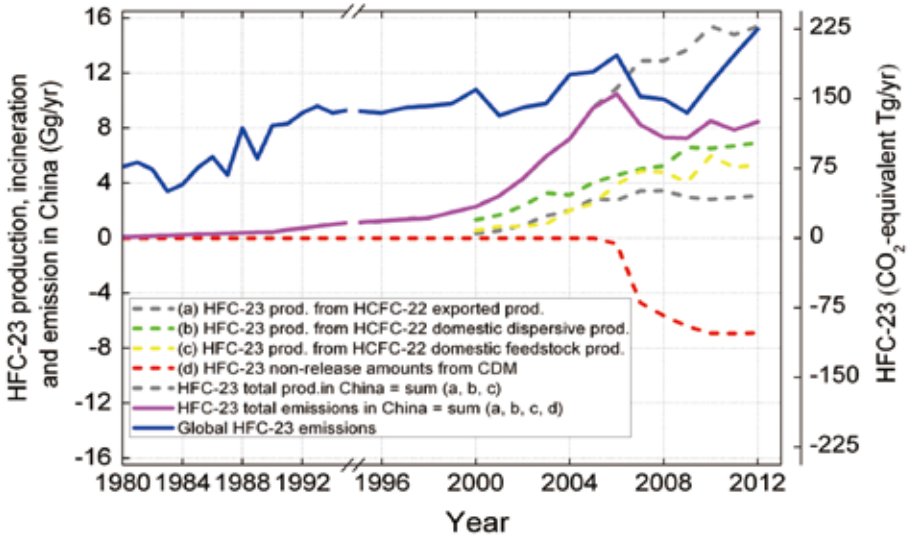


Figure 8-6 HFC-23 production, reduction and emission in China, 1980—2012 (Fang et al., 2014)

8.2.2 Status and industrial characteristics of NRMS emissions

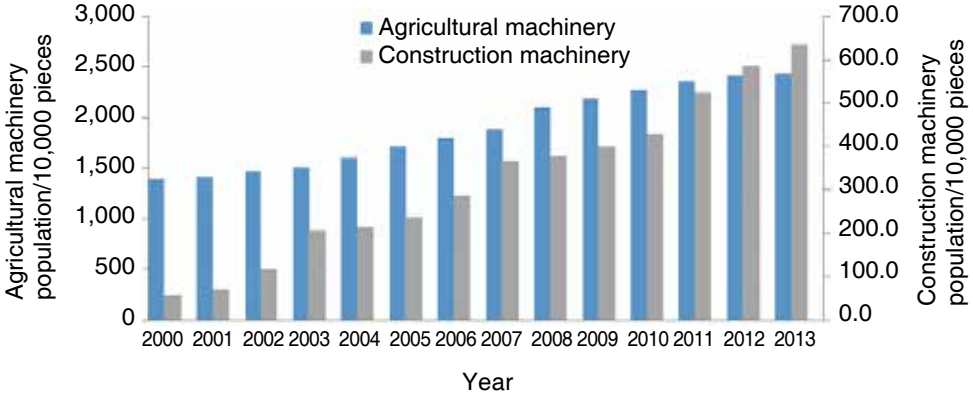
NRMS includes construction machinery, agricultural machinery, inland and ocean-going vessels, internal combustion engines for railway, portable generators, aviation, forestry machinery, and small gasoline engines. Construction machinery is the general term of machinery used for construction. In the process of rapid urbanization, there is a substantial growth in total operating time of construction machinery every year. Agricultural machinery mainly covers farm power, tillage, farmland construction, agricultural irrigation, plant protection, harvesting, planting and fertilizing, livestock production, agricultural product processing and agricultural transport. The number of agriculture machines in China is very high and they have very weak pollution control requirements. In China, civilian vessels include fishing vessels and transport vessels. According to the application of vessels, transport vessels can be divided into passenger ships, general cargo ships, container ships, oil tankers and chemical tankers, etc. and by sailing area, they are divided into river vessels, coastal vessels and ocean-going vessels. Emission from vessels have a significant impact on urban air quality and public health, particularly given the fact that major coastal ports and river ports are mainly located in developed, densely populated cities.

By the end of 2013, construction machinery population totaled 6.1~6.6 million in China. As shown in Figure 8-7 (a), the population of construction machinery was on fast

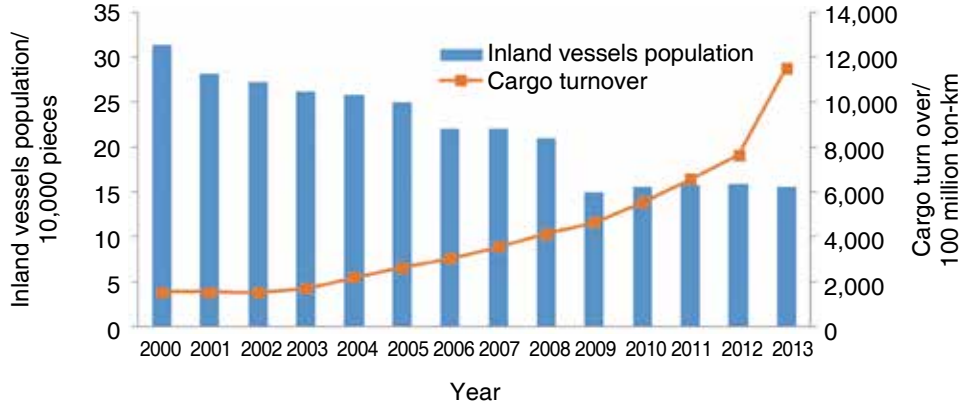
rise during 2000—2013. Agricultural machinery population amounted to 24.35 million in 2013, the population of agricultural machinery during 2000—2013 is shown in Figure 8-7 (a). Inland vessels numbered 155,000 in 2013. As shown in Figure 8-7 (b), despite a decline in the number of inland vessels, the cargo turnover exhibited an upward trend during 2000—2013, implying that vessels develop towards large capacity.

The studies on mobile source emissions in recent year have mainly focused on road motor vehicles while the study of emissions from non-road machinery is basically in its infancy. With the effective control of vehicle emissions, emissions from non-road machinery start to attract attention. For a systematic assessment of emissions emitted by non-road machinery, the Beijing Institute of Technology (BIT) and its partners conducted emission tests on 45 construction machinery products with different power, including 16 excavators, 19 loaders, 7 rollers, 2 bulldozers and 1 grader, under actual operation state. Rotary tractors and combined harvesters were selected for emission tests under the actual operation state according to the actual usage of agricultural machinery in rural areas. Given China's extensive network of inland waterway, heavily trafficked waterway systems, and numerous lakes, Jiangsu section of Beijing-Hangzhou Grand Canal and the Guangzhou section of the Pearl River, the most developed river systems in China, were selected for real ship emission test. The actual emission factors of non-road machinery are obtained through tests mentioned above.

According to the test results of non-road machinery emission factors based on fuel consumption (Figure 8-8), CO and HC emission factors are at their highest in idle conditions of construction machinery, while NO_x and PM, in operating conditions. The emission factors of various pollutants increase with power. With the implementation and tightening of the NRMM diesel engine regulation, the emission factors based on fuel consumption are drastically reduced. From Tier 1 to Tier 2 stage, CO, HC, NO_x and PM measured emission factors are reduced by 8.5%~29.1%, 17.8%~36.7%, 8.9%~19.3% and 31.2%~53.3% respectively. Agricultural machinery weretested in farmland in idle, walking and operating conditions. Among emission factors based on fuel consumption, CO and HC emission factors reached the maximum in the idle conditions, NO_x in walking conditions and PM in operating conditions. In operating conditions, NO account for over 93% of the total NO_x emission due to relatively larger load of diesel engine. From Tier 1 to Tier 2 stage, the CO, HC, NO_x and PM emission factors in rotary tillage reduced by 32.4%, 56.9%, 7.2% and 44.9% respectively.

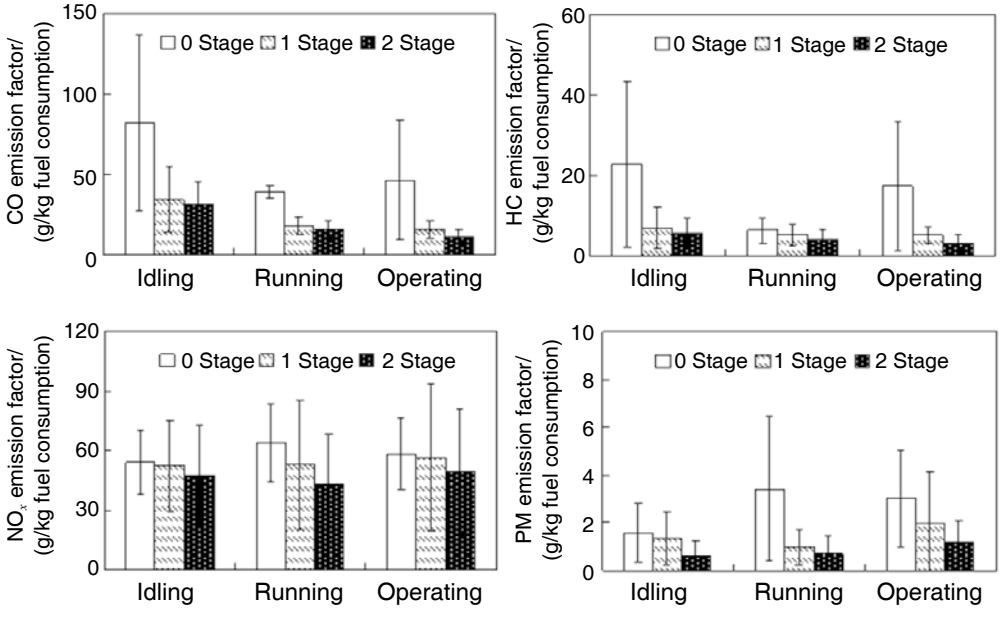


(a) Agricultural machinery and construction machinery population /10,000 pieces

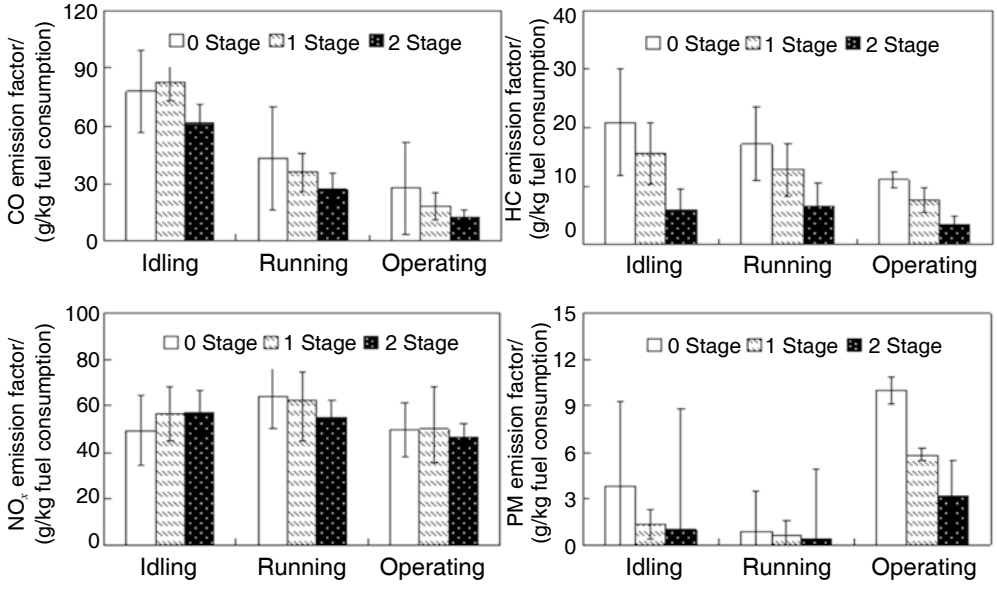


(b) Inland vessels (10,000) and cargo turnover (100 million ton-km)

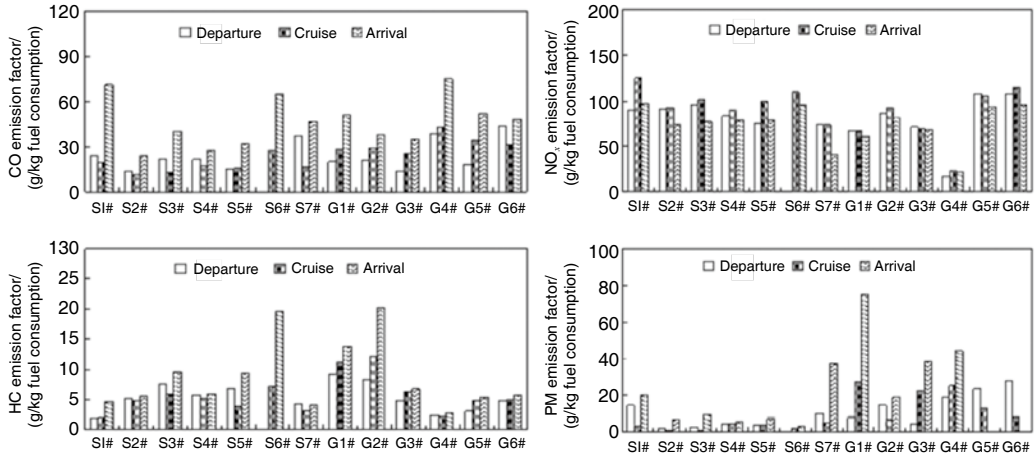
Figure 8-7 Population of typical non-road machinery, 2000—2013



(a) Fuel-based emission factor of construction machinery



(b) Fuel-based emission factor of agricultural machinery



(c) Fuel-based emission factor of inland vessels

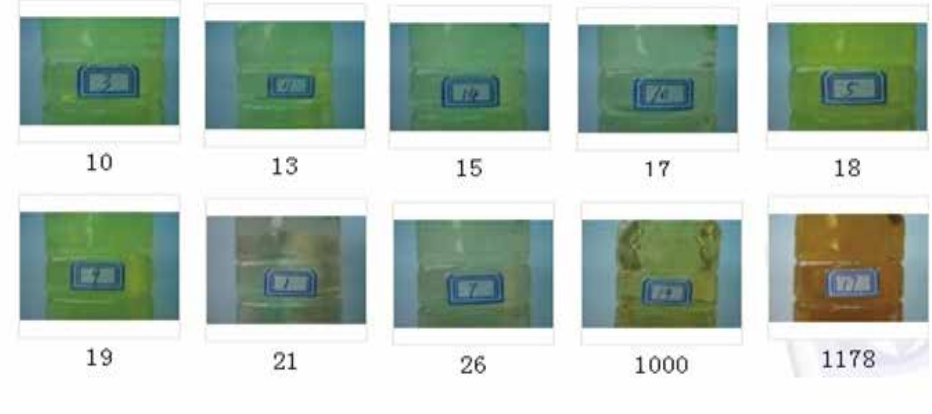
Figure 8-8 Observed emission factors of construction and agricultural machinery and inland vessels in China

It should be noted that the measured emission factors of non-road machinery in China are generally higher compared with the test results of other countries, which can be attributed to backward emission control and poor oil quality of diesel used by diesel engines. A sample survey of the quality of diesel actually used by diesel engine of non-road machinery was conducted in Beijing and the surrounding area, as described in Box 8-2.

Based on emission factor obtained from above-mentioned experimental tests, combined with fuel consumption of various NRMS in China, the Vehicle Emissions Control Center (VECC) and BIT produced the NRMS emissions inventories of the main pollutants, as shown in Figures 8-9 and 8-10. According to the calculation results, the ratio of the NO_x emissions from non-road and on-road mobile sources is close to 4: 6, wherein construction machinery, agricultural machinery and inland vessels are major contributors. NRMS accounts for a larger proportion of the primary $PM_{2.5}$ emissions than on-road mobile sources, and among all the mobile sources, agricultural machinery, construction machinery and inland vessels are the most responsible. It is clearly urgent to intensify the control of emissions from non-road diesel machinery.

Box 8-2 Survey on current diesel fuel market for non-road machinery

A sample survey of sulfur content of diesel sold in 30 stations was carried out in Beijing, mainly located along the 4th-6th Ring Roads, the Beijing-Yanqing section of G110 National Highway, and Beijing-Zhuozhou section of G107 National Highway (pictures of some sample shown below). In addition, a sample survey of sulfur content of diesel actually used by diesel engine was carried out. Diesel samples were taken directly from various operating construction machinery covering all kinds of construction machinery in 20 sites distributed in Beijing, Tianjin, Hebei. The results showed significant price differences and refined oil market turmoil. Low-quality oil is much cheaper and small oil workshops are common which cannot guarantee oil quality. The vast majority of samples have the sulfur content greater than 400×10^{-6}, and low-sulfur diesel is found only in Beijing samples, coexisting with high-sulfur diesel.



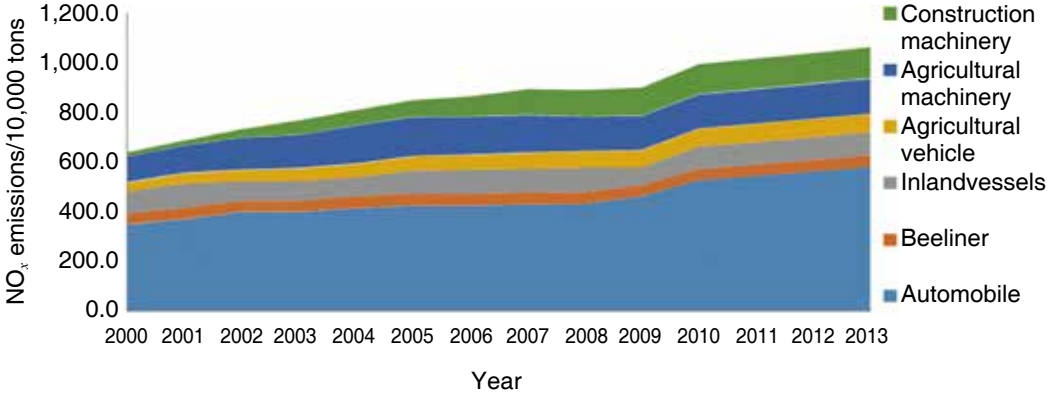


Figure 8-9 Estimated NO_x emissions from diesel machinery (10,000 tons) in China, 2000—2013 (note: beeliner is locomotives)

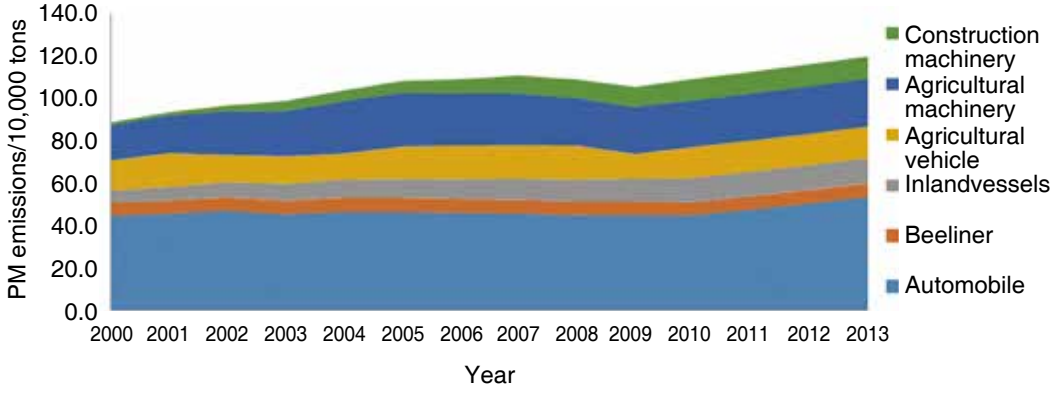


Figure 8-10 Estimated PM10 emissions from diesel machinery (10,000 tons) in China, 2000—2013

8.2.3 Findings and recommendations

8.2.3.1 Establishing a sound basic data compilation and accounting system for SLCPs and NRMS emissions

Complete emission inventories for SLCPs or NRMS have not been included in the pollution statistics for China, and the relevant data, scattered in various studies, are not systematic and comparable, or able to support the science-based policy formulation. It is suggested to establish a sound basic data compilation and accounting system for emissions relevant for SLCPs and NRMS that is consistent with the system for other atmospheric pollutants and on-road mobile source emissions. It is also necessary to strengthen the quantitative assessment of co-benefits of multi-pollutant and multi-source reduction, and also the study on analytic methods.

The research on integrated effects of removing multiple pollutants (SO_2/NO_x/POA/BC) on climate should also be strengthened.

8.2.3.2 Strengthening capacity building of environmental protection department and emission compliance management

Environmental protection departments should strengthen capacity-building to improve the management of SLCPs and NRMS. It is suggested to build a monitoring and regulatory network targeted at major SLCPs and NRMS emissions and an NRMS fuel quality regulatory network. Penalties for excessive or illegal emissions should be raised while more stringent emissions standards and measures are put in place.

A big data platform for monitoring and control decision-making and a mechanism for

scientific and regulatory data disclosure and sharing are also favored.

8.2.3.3 Cutting sharply the SLCPs emissions in key industries and sectors

Effective reduction measures for black carbon are mainly identified as: decreasing the use of lump coal in the suburbs and rural areas in the residential sector,cutting down black carbon emission of diesel engines in the transport sector, reducing black carbon emission of small and medium industrial boilers in the industrial sector. For the methane reduction, it is a good way to improve the extraction and utilization efficiency of coal mine methane in the suburbs and rural regions.

8.2.3.4 Upgrading the NRMS regulation

Accelerate adoption of stricter non-road diesel emission standards, import a variety of effective diesel emissions control technology by strengthening the standard, and reduce emissions of newly manufactured non-road diesel engine.

It is suggested to establish an NRMS registration system and non-road diesel emissions periodic inspection system; define regulatory responsibilities for the whole life cycle of NRMS; accelerate the phase-out and updates of old machinery, and carry out the studies and pilots on technological innovation for non-road diesel engine.

It is also necessary to strengthen the non-road diesel engines (including engines on domestic ships) and diesel fuel quality management, narrow the gap between ordinary diesel and automotive diesel, and strengthen upgrading the quality of marine fuel oil and the use management.

8.3 Analysis of SLCPs and NRMS control technologies & emission reduction potential

8.3.1 Analysis of SLCPs control technologies & emission reduction potential

8.3.1.1 Black Carbon

The UNEP and the WMO (2011) proposed nine major measures that at global scale would reduce global emission of BC and co-emitted substances. Generally speaking, such measures include DPF applied to modern engine technology, prohibited use of high-emission vehicles, shift from lump coal to briquettes in households, energy-efficient stove alternatives, clean fuel alternatives, prohibition of open burning of agricultural residues etc. BC emission measures can be grouped into those that aim to eliminate or reduce the use of fossil fuels for some uses, those that aim to improve fuel combustion efficiency,

and those that apply end of-pipe technologies. All the measures provide air pollution and climate benefits through reducing all emissions from these sources, including BC.

BC emission reduction technologies in the residential sector are mainly identified as follows: the first one is about stove improvement (stoves with high combustion efficiency); second, improve coal type in the suburbs and rural areas by shifting from lump coal to briquette coal; third, try to avoid the use of bituminous coal with medium maturity & higher ash content; fourth, facilitate community central heating system in the suburbs and rural areas; fifth and finally, substitute lump coal in the rural areas with clean energy such as electricity, solar energy and biogas. The research of Zhi et al. (2009) shows the emission of PM, organic carbon and BC can be brought down efficiently by burning honeycomb briquette in updated stoves. According to the research conclusions, China will be able to reduce the emission of PM by 63%, organic carbon by 61% and BC by 98% if the stoves are updated efficiently and uses honeycomb briquette in civil use sector. It is also discovered in this research that the improvement measures decrease the emission rate of BC / organic carbon and help slow down climate warming.

In the industrial sector, BC discharged by coke production accounts for over 50%, followed by brick production, use of industrial diesel and other industrial use of coal. The latest coke industry admittance standard of China, issued by the Ministry of Industry and Information Technology (MIIT), was implemented in April, 2014. It requires applying coal-based gas cleaning measures, including desulfurization and denitrification, to coke ovens, which greatly improves the efficiency of BC emission reduction, and applying BC control measures such as CDQ (Coke Dry Quenching) technology to facilitate $PM_{2.5}$ reduction. In accordance with Emission Standard of Air Pollutants for Brick and Tile Industry (GB 29620-2013), brick kilns are required to install electrostatic precipitators and fiber filters on the end-of-pipe process, so as to reduce $PM_{2.5}$ emission effectively and cut BC emission efficiently. Dust removal, desulfurization and denitrification in the power sector also play an important role in reducing the BC emissions. Measures of reducing BC emission in those industrial sectors taking diesel or coal as fuel range from fuel switching, use of clean energy, optimization of combustion technology and installation of end-of-pipe treatment facilities (such as de-dusting by ventilation, static, wetness and fiber) (CLRTAP, 2012). Since January 2015, China has imposed limitations on the use of coal with over 30% of ash and over 1.5% of sulfur, which provides favorable policy support for cleanliness of future fuel consumption and promotes BC emission reduction.

In the transport sector, technical measures to cut the BC emissions include emission control of new vehicles and non-road mobile devices, control of heavy-duty diesel

vehicles, and fuel and energy conversion for heavy-duty vehicles. Presently, China adopts the national emission standard IV for new heavy diesel engines. Improving from III to IV, China raises its emission standard for PM from diesel engines from 0.1g/kWh to 0.02g/kWh, reducing emission by 80% (Shao et al., 2014). Accelerating the phase-out and upgrading of old and high-emission vehicles, by retrofitting wall-flow DPFs, is another approach, which reduces emissions of PM by 85% and BC by 90%. Besides, the improvement of the operation of heavy trucks also helps reduce BC emissions. For example, the plan of "Green Freight" was carried out in Guangdong Province, committed to raising the efficiency of freight service and decreasing fuel consumption. Related measures include using energy-efficient engines, low rolling resistance tyres and parts with smaller aerodynamic drag. Additionally, China has been implementing the plan of "Inspection and Maintenance (I/M)", in order to keep motor vehicle operation at a minimum emission level. In accordance with the Air Pollution Control Action Plan issued in September 2013, National Motor Gasoline/Diesel Standard V (sulfur content $\leqslant 10\times10^{-6}$) regarding gasoline and diesel will be implemented in major cities of China by the end of 2015; and it will be carried out throughout China by end of 2016. It is predicted that motor gasoline/diesel standard upgrading will then reduce BC emission by 20%.

China has made great efforts to control the open burning of biomass. The Ministry of Environmental Protection monitors by satellites the daily changes in the distribution of straw fires and provides powerful technical security for the implementation of related regulations. Generally speaking, some technologies, such as straw turnover, bio-produced coal, biogas, biodiesel and deep plough (burying biomass deep under the land), can replace the open burning of biomass and thus reduce the emission of BC and co-emitted pollutants.

8.3.1.2 CH_4

In China, CH_4 emissions mainly come from fossil energy exploitation, especially oil and gas exploitation (including shale gas) and coal mining. Meanwhile, there is an increasing emission of CH_4 from livestock sector, but the relevant reduction measures are not so clear yet. These can include improved manure management, changes to animal feed, and general improvements in animal husbandry that can decrease the amount of CH_4 emitted by kg of meat or liter of milk produced. Measures to reduce CH_4 emission from coal production will be mainly discussed in this report.

China attaches great importance to the development and utilization of CMM, takes active part in greenhouse gas emission reduction activities under the CDM, GMI and other cooperative mechanisms and has produced a complete set of technical systems of CMM extraction, transportation and utilization that fits China's coal geology conditions,

where civil and industrial use of CMM and high-concentration CMM power technology have been applied widely, low-concentration CMM power technology is becoming mature and key technology breakthroughs have been made in the utilization of VAM and low-concentration CMM purification. See Table 8-2 for more details.

In addition to fossil-fuel related CH_4, intermittent irrigation of rice fields and increasing the capture of fugitive CH_4 from landfills have been identified as control measures that could provide large benefits in China (Shindell et al., 2012).

8.3.1.3 Some HFCs

(1) HFC-134a emission reduction technology and potential of automotive air conditioners

Substitution technology is mainly applied to reducing HFC-134a emitted from automotive air conditioners. At present, there are five or more kinds of HFC-134a substitutes with a low GWP, namely HFO-1234yf, HFC-152a, CO_2 and hydrocarbons (HCs) etc. Among them, HFO-1234yf system alone has been commercialized, whose production and utilization, however, are expensive due to patent protection(Table 8-3). As for China, economic cost, market feasibility and safety risks incurred by slight combustibility should be taken into consideration in the selection of substitution technology. In addition, due to its vast territory, China is likely to raise diversified requirements regarding automotive air conditioning systems. So the substitution technology being developed is of great significance.

Hu et al. (2015) considers no HFC-134a elimination in the automobile industry as the Business-as-Usual scenario (BAU). The consumption of HFC-134a will increase year on year under the BAU scenario and will reach a peak in 2037, after which it will remain around 166,000 tons. Emissions will lag slightly behind consumption, reach its peak in 2038 and then remain around 160,000 tons annually. Two substitution scenarios, namely phasing out HFC-134a from new autos from 2021 to 2025 as elimination scenario A and phasing out HFC-134a from all autos by 2040 as scenario B, are used in this paper. Analysis indicates that if HFC-152a is used as the substitute, totally 4.5 billion tons CO_2-eq emission will be reduced by 2050 under Scenario A and 4.1 billion tons CO_2-equnder Scenario B; if HFO-1234yf is taken as the substitute, totally 5.3 billion tons CO_2-eq emission will be reduced by 2050 under Scenario A and 4.8 billion tons CO_2 -eq under Scenario B. It can be seen that HFO-1234yf realizes a bigger emission reduction, compared with HFC-152a (Figure 8-11).

Table 8-2 China's major technologies of reducing coal mine methane(CMM) emission

Technology	Details	Parameters	Application
Domestic fuel	Domestic fuel technology is to collect, store, transport by pipe network and pressure regulating to urban residential areas the gas in the coalmines, whose concentration is over 40%, to provide residents with daily-use fuel gas for heating up water, cooking, firing boilers and warming		Applied in many regions, such as Anhui, Guizhou and Shanxi
Industrial chemistry	Industrial utilization includes substituting coal-fired boilers and producing chemical products such as carbon black, methanol and methanal. CMM with the concentration being 40% ~ 90% can be used to produce carbon black. Production of methanal by CMM includes direct oxidation and indirect production, where CMM is made into methanol and then oxidized into methanal		Production of methanol directly by CMM is classified as a state forbidden item currently
CMM power technology	CMM may produce power by gas-fired turbine or gas-fired engine according to its concentration. The principle is to mix CH_4 and air until they reach the explosion limit (5% ~ 15%) and deflagrate the mixture in the anti-explosion air cylinder for acting that promotes piston motion and drives the synchronous generator	Investment reaches 3,000-4,000 RMB/kWh generally	High-concentration gas (> 30%) and low-concentration gas (< 30%) power generations have been major methods of CMM utilization
CMM purification and compression technology	CMM of high and low concentrations can be used to produce compressed natural gas products through purification and compression, which enlarges the application of CMM. Currently, CMM is processed and purified through adsorption and analytical separation, osmotic separation and low-temperature separation	About 22 million RMB shall be invested for a compressed gas plant with 20 million m^3 pure CH_4	
CMM Purification and liquefaction technology	CMM is generally liquefied and used to produce LNG products after being processed by adsorption and analytical separation, osmotic separation and low-temperature separation. LNG cuts down transport cost significantly and transport route can be changed according to gas source and users' demands. What's more, existing natural gas pipelines can be used at peaks	A CMM liquefaction plant with 20,000 tons annual production consumes about 32 million m^3 pure CH_4 and requires an investment of around 90 million RMB	

Technology	Details	Parameters	Application
VAM utilization technology	There is a tremendous volume of VAM whose concentration is below 1%. A major measure adopted is evacuation. Available technologies include thermal and catalytic oxidation, and utilization as auxiliary fuel. The first one has been mature and applied in industries		China Oilfield Shengli Power Machinery Group Company LTD, Megtec and Haroworth have established pilot projects regarding VAM thermal oxidation technology

Table 8-3 HFC-134a substitution technologies in global automotive air conditioning industry

Substitute	GWP-100yr	Cost of Cooling Agent (US$/kg)	Market Status	Region of Commercialization
HFC-134a (Baseline)	1,300	$3~$4	Fully commercialized	Many regions
HFO-1234yf	<1	$20~$30	Commercialized	EU, Japan, South Korea, U.S., Canada
HFC-152a	138	$11	Experiment	None
CO_2	1	~$1	Experiment	None
HCs	1.8~5.5	$1~$10	Rejected	None
AC6 mixture	~130	＞ HFC-134a; ＜ HFO-1234yf	Test	None

Source: Alternatives to High-GWP HFCs (Published by the Institute for Governance & Sustainable Development and in cooperation with the UNEP Ozone Action Team)

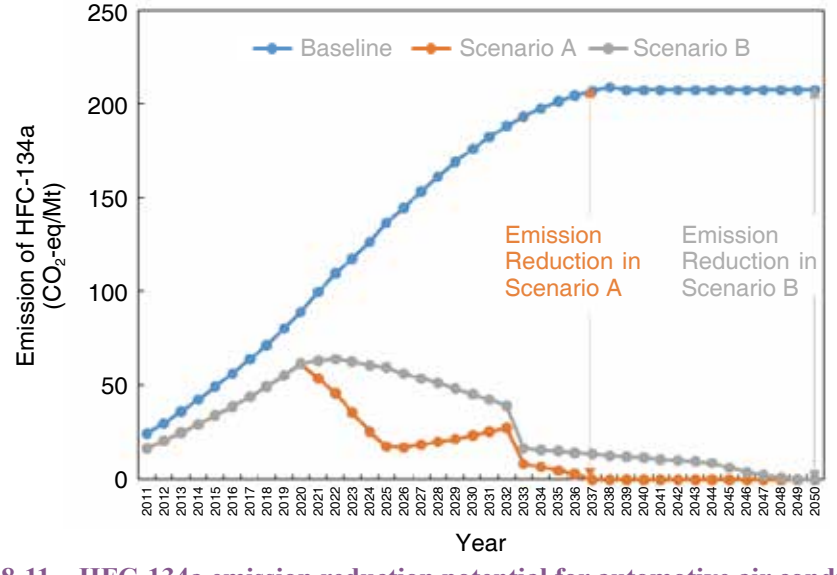


Figure 8-11 HFC-134a emission reduction potential for automotive air conditioning in China, 2016—2050

(2) Emission reduction technology and potential of HFC-410A for room air conditioners

Currently, a major substitute for refrigerant of room air conditioners is a carburetted hydrogen-propane, whose GWP is only 3.3. There are also various lower-GWP chemicals containing mixture of hydrofluoroolefins (HFOs) and HFCs currently being trialed and that are expected to come to the market within a few years. It is anticipated that the use of some of these alternatives will be demonstrated under pilot projects under the Montreal Protocol's Multilateral Fund in the next few years. In addition, a lower-GWP HFC, HFC-32 is already being used in some countries instead of the higher-GWP HFC, R-410AHFC-410A. HFC-32 is available in China, though it should be noted that it still has a GWP of 675.

In 2011, Gree-the largest air conditioner manufacturer of China-launched a production line, with the production being 100,000 propane household air conditioners. Currently, large enterprises are actively promoting the marketization of such products. Godrej, an air conditioning pioneer, has developed HC-290 room air conditioners, whose efficiency is 11% higher than the minimum value of the 5-star energy efficiency specified by India Energy Agency. This research also takes HC-290 as the substitute to predict the future elimination of HFC-410A. Under mitigation scenario A (MIT-A), HFC-410A emission will grow year by year and reach its peak from 2031 to 2037 and then remain at around 150,000 tons. After that, it will fall down substantially and by 2050, be less than 50,000 tons. Under MIT-B, HFC-410 emission will grow at a rate smaller than that under BAU after 2018 and reach the peak of 86,000 tons in 2030, and fall year by year afterwards. HFC-410A emissions in the MIT scenarios are shown in Figure 8-12. For room air conditioning industry, HFC-410A emission trends and emission reductions are different in the MIT scenarios. Using HC-290 as an alternative, the cumulative reductions by 2050 will reach 3.29 billion tons CO_2-eq under MIT-A and 7.74 billion tons CO_2-eq under MIT-B. An important consideration for promoting the wide use of hydrocarbons in air conditioning is the development and implementation of appropriate standards to ensure safety.

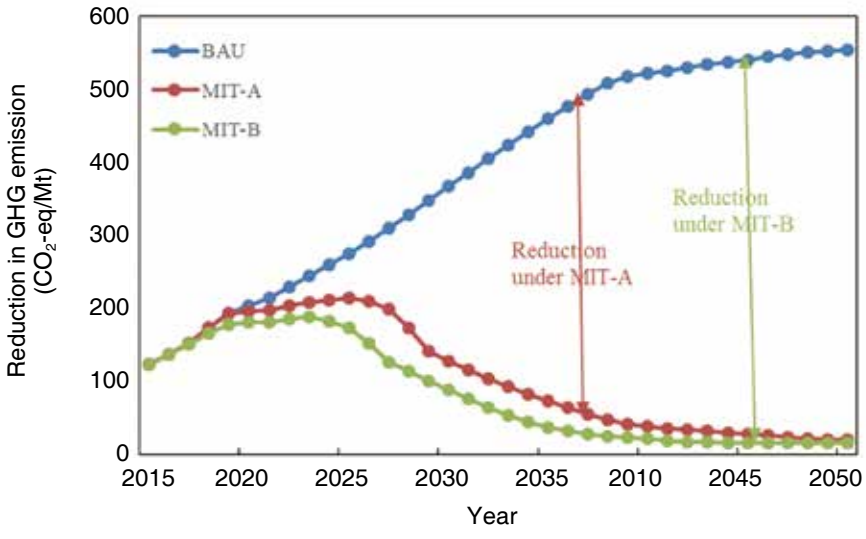


Figure 8-12 HFCs emission reduction potential for room air conditioners in China, 2016—2050

(3) HFC-23 emission reduction technology

HFC-23 emission reduction technology is divided into high-temperature decomposition and trans-utilization (Han et al., 2012). Regarding high-temperature decomposition, mature technology and practical application have been realized. Trans-utilization remains in the exploratory stage (Yang et al., 2014; Han et al., 2014). See Table 8-4 for the technical assessment.

Table 8-4 Major HFC-23 emission reduction technologies

	Method	Basic Principle	Characteristics
High-temperature Decomposition	Thermal decomposition of fuel gas	Decompose HFC-23 in an oxidation container under 1200℃	Post-combustion is needed for keeping temperature due to the low heat value of HFC-23. No Dioxin will be produced if the decomposition temperature surpasses 1200℃
	Superheated steam decomposition	Replace fossil fuel by an electric heating device to obtain the needed heat	It can be conducted in a small-scale fuel combustor under a relatively low temperature (800-1000℃), with high safety, maintainability, space efficiency and energy efficiency
	Plasma high-temperature decomposition	Decompose HFC-23 under a super-high temperature by argon plasma arc facilities	Swift cooling is involved, which can prevent the formation of such unnecessary organic molecules as dibenzo-dioxin and furan. A large amount of non-degradable gas can be decomposed under a high temperature in the compression reactor. The washing system is more economical

	Method	Basic Principle	Characteristics
Trans-utilization	Convert gas by dissociation into C_2F_4 and C_3F_6	Similar to using HCFC-22 as raw material	A higher temperature is required. The low yield can hardly compete with industrial routes. Under proper catalyst effects, reaction temperature can be brought down greatly and yield can be raised. It remains to develop appropriate catalyst
	React with CH4 to produce VDF (CH_2=CF_2)	Similar with producing VDF via gaseous dissociation of HCFC	C-F is more stable than C-Cl and C-Br and can hardly activate CH_4 to produce the needed CH_3 free radical. Many by-products are brought about
	React with I_2 to produce CF_3I	HFC-23 and I_2 react in gaseous phase under catalyst to produce CF_3I	CF_3I is most similar to Halon 1301 ($CBrF_3$) in property. It is more expensive to use CF_3I as fire extinguishing agent or freezing medium. Industrial pilot production has been realized by Japanese companies
	Work as trifluoromethylation raw material to produce drug and other organic intermediates	Preliminary lab attempt. The process requires rigor conditions and is more expensive. It will take a long time to study it for HFC-23 treatment	

8.3.2 Analysis of NRMS control technologies & emission reduction potential

Existing measures to control NRMS emissions include the application of advanced technologies, fuel quality upgrade, and clean energy.

8.3.2.1 Application of advanced technologies

(1) Non-road machinery

Currently, non-road machinery mainly integrates the after-treatment devices to meet emission control requirements. Exhaust after-treatment refers to the treatment of exhaust using a variety of filtration and purification devices and catalytic converters to reduce the emissions of various pollutants. To meet the requirements for NO_x and PM emission from non-road machinery, engine manufacturers mainly follow two technical routes: exhaust gas regeneration (EGR)+ DPF and combustion optimization + SCR. In the first route, the NO_x emissions from engines are cut through EGR and PM is trapped in DPF, and to avoid causing regeneration problems and prevent catalyst deactivation, the sulfur content of fuel must be strictly controlled. The second route increases the fuel injection timing to reduce PM emissions and applies SCR to reduce NO_x emissions which increase dramatically with combustion temperature. For non-road engines, the application of the second route is faced with such problems as urea supply facilities, onboard urea storage devices, and forced

continuous use of urea solution, but it is still a feasible technical program.

(2) Vessels

Measures to control emissions from vessels mainly focus on shore power, engine improvement and engine exhaust after-treatment.

① Shore power technology

The technology realizes the connection through cable between shore power system and power supply system of vessels when docking and turns off the auxiliary power generation of vessels for the purpose of reducing emissions. It has become widely used overseas after being introduced in Gothenburg, Sweden, in 2000. From January 2014 onwards, California requires an increased application of shore power in container ships anchored in ports and cruise ships and refrigerated cargo vessels berthing in ports. According to a directive of EU, the member states are required to, by the end of 2025, put in place shore power supply equipment and facilities in ports, to ensure the shore power supply for ocean-going vessels and inland vessels.

Up to present, shore-based power supply systems have been built in Shanghai Port, Lianyungang Port, Shenzhen Port, Guangzhou Port and Ningbo Port. However, the application is not satisfactory for two reasons: a) the capital and operational costs of providing shore power supply exceed the revenue, and the ports can hardly obtain direct economic benefits from offering shore power supply; b) oceangoing vessels lack the motivation to use shore power because the cost of generating electricity using auxiliary engines are less than the cost of using shore power.

According to the newly revised *Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution*, the new ports should build shore-based power; the existing ports should add shore-based power facilities, and the vessels should give priority in use of shore-based power. *The Special Action Plan for the Prevention and Control of Vessel Pollution Control (2015—2020)*, recently published by Ministry of Transport, proposed that 90% of harbor crafts and government vessels should be equipped with shore power equipment, and 50% of terminals serving container ships, roll on roll of (ro-ro) passenger vessels and cruise ships should provide on-shore power supply by 2020. It is estimated that SO_x, NO_x and PM emissions will be cut by 2%, 7% and 8% in the Bohai Economic Rim, Yangtze River Delta and Pearl River Delta due to this measurement.

② Marine engine technology

With advances in marine engine technology, more purification technologies could be used to reduce exhaust emissions. Technology upgrades of newly-built marine engines were based on the tightening of emission standards, and the emission reduction mainly

reflected in the upgrading of the ship fleet. The Specifications of Inspection Specification for Ocean and Inland Vessels required that diesel engines of vessels built in and after March 2015 shall meet the IMO Tier II emission standards. *The Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution* raised that the high emission vehicles and vessels scrapping in advance were encouraged and supported by the government. According to the estimated number of old vessels that will be retired and newly-built ones from 2015 to 2020, the NO_x emissions will be roughly reduced by 20% in the Bohai Economic Rim, Yangtze River Delta and Pearl River Delta in 2020, compared to 2015, due to the implementation of IMO Tier II standards. However, the *Ship Engine Exhaust Emission Limits and Measurement Methods (phases I and II)* being formulated by the Chinese government, might be more strict than IMO Tier II, which might lead to bigger emission reduction.

③ Exhaust after-treatment technology

Technologies for marine engine exhaust after-treatment, including SCR, SO_x scrubber and DPF, are effective in reducing the emissions of in-use vessels. Fast international progress is seen in the vessel-based SCR research and adoption, due to the urgent need to cut NO_x emissions and the limited effects of front-end emission control measures. The installation of an SCR system in in-use vessels entails little change to ship equipment, does not cause much impact to fuel economy and does not require high fuel and lubricant quality. It will reduce more than 90% of the NO_x emissions without increasing fuel consumption and the PM emissions. Nevertheless, the wide SCR application is confronted with a series of problems, for example, high installation cost and large equipment size that makes it difficult to fit into the engine room. The development of the SCR technology is subject to such factors as exhaust gas temperature control, catalyst deactivation, quantitative urea injection, and exhaust mixture uniformity, so we need to intensify the equipment research and localization.

8.3.2.2 Fuel quality upgrade

The fuel quality has great impact on emissions of non-road diesel machinery. Particularly, the sulfur content of diesel fuel not only directly affects emissions, but also restricts the use of advanced emission control technologies. Reducing the sulfur content of diesel fuel can produce a 10%~15% reduction of PM in exhaust gas. Presently, the quality of diesel used by non-road machinery is uneven in China. Agricultural machinery mainly uses ordinary diesel oil, heavy diesel oil and agricultural diesel oil, while vessels, mainly distillate fuel, residual oil and mixed oil. Fuel oils used by large low-speed vessels have the worst quality. They are commonly derived from recycled oil and industrial waste oil

and do not have compelling fuel quality standards to follow. Investigation found that the sulfur content of such fuel oils is up to 2.0%~3.5%, far higher than the level prescribed by on-road diesel standards (50×10^{-6}). Improving the non-road fuel quality is the first step to raise NRMS emissions standards and advance engine technologies.

Setting vessels Emission Control Area and using low-sulfur fuel in particular regions for the purpose of cutting the SO_x and PM emissions are adopted by several developed countries. According toThe International Convention for the Prevention of Pollution from Ships(also known as the MARPOL Convention) published by International Maritime Organization (IMO), the current sulfur content limit for marine fuel is 3.5%, which will be further lowered to 0.5% in 2020 or 2025.The limit is 0.1% in the ECAs under MARPOL framework, covering the Baltic Sea, North Sea, North America, and the Caribbean Sea.

PM can also be reduced with SO_x by using low-sulfur fuel. Ocean going ships switching from residual oil to distillate fuel reduce BC by 30%~80% (Litehauz et al., 2012). The newly revised Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution regulated that inland vessels and river-to-sea vessels must use standard diesel fuel and the transport competent department have the authority to designate the ECAs off the coast, which can improve the quality of fuel substantially. If ECAs are established in the Bohai Economic Rim, Yangtze River Delta and Pearl River Delta, we calculated huge emission reductions. Specifically, the SO_x and PM emissions from vessels will be reduced by 65% and 30% by 2020, respectively, compared to 2015, in accordance with the requirement of fuel sulfur content not more than 0.1% for international and domestic voyage ships and 0.001% for inland vessels.

8.3.2.3 Alternative clean energy

In the context of global climate change and growing energy shortage, biodiesel, as a clean alternative fuel and an important complement to fossil diesel, enjoys great potential. Biodiesel is non-toxic, renewable, and biodegradable, and reduces harmful emissions from diesel engines. It is easy to apply biodiesel which enjoys storage and replenishment convenience due to the small range of movement compared with diesel vehicles.

LNG powered vessels were considered as another effective energy-saving and emission reduction measurement. Internationally, the existing LNG powered vessels mainly use technically mature dual-fuel engines. China has intensified efforts to promote LNG application in vessels and ports and LNG filling systems. Presently, China has transformed 30 LNG powered inland vessels and built more than 10 new vessels. Now, 70 LNG vessels are under construction. LNG has also been used by nearly 700 port-related vehicles and its application in gantries and harbor tugboats is studied. LNG filling systems

have also been gradually improved.

Imperfect regulations and standards on LNG powered vessels hamper the LNG integration in ports.Especially the decline of oil prices significantly weakens the motivation of manufacturers to build LNG powered vessels. Under the combined impact, the large-scale promotion of LNG powered vessels is meeting resistance.

8.3.2.4 Other control measures

Oil vapor recovery technology addresses oil vapor (mainly VOCs) discharged from storage tanks during tanker shipment and has applied in the developed countries. Its application has been made mandatory in certain ports in Netherlands and South Korea, and strict emission standards and technical regulations for oil vapor recovery have been introduced in the US and EU. In China, however, oil vapor recovery is still in the inception stage, and only about ten units of oil vapor recovery facilities have been installed, but most of them have never been used or have stopped operation due to security and financial reasons.

Speed control is also an effective measure to reduce emissions from vessels, given that the fuel is proportional to the cube of speed. Measurements show that a 10% reduction in ship speed is accompanied by a 15%~20% reduction of fuel consumption and reductions in NO_x, SO_x, PM and CO_2 emissions. It also helps to cut the operating costs by 8%~10%. However, energy savings and emission reductions brought about by speed control will be limited because ship speed has been restricted in a reasonable range, due to congestion in ports and measures of shipbuilding enterprises driven by significant energy savings.

8.3.3 Findings and recommendations

8.3.3.1 SLCPs

(1) Considering the collaborative control of SLCPs and conventional pollutants

Co-control of SLCPs and conventional pollutants can be achieved by integrating SLCPs into the overall strategy and the target system for air pollution control and climate change mitigation.

(2) Developing sound SLCPs control regulations, standards and policies

Effective reduction of SLCPs emissions relies on energy use policies, decreasing the use of lump coal in the suburbs and rural areas, promoting a transition in residential and industrial sectors away from use of coal to efficient and clean energy consumption, comprehensive straw utilization, and facilitating continued decreases in SLCPs emissions from vehicles. Standards for allowances and financial subsidies for CMM utilization should be evaluated and additional reductions in CH_4 emissions from landfills and rice agriculture should be paid more attention. Relevant preferential tax policies should also be

further improved.

(3) Drawing up a recommended list of measures and technologies for emission reduction

A recommended list of technologies and measures to reduce the SLCPs emissions in China should be drawn up based on analysis and assessment of technologies and measures available in all sectors and recommended by UNEP.

8.3.3.2 NRMS

(1) Accelerating the improvement of engine technologies

To meet more stringent NRMS emission standards, engine manufacturers should apply advanced control technologies to reduce emissions. These technologies cover the optimization of engine block and combustion system, valve timing, and improvement of intake system and cold start performance. High-pressure common rail and turbocharged intercooler which effectively reduce emissions of diesel engines are also needed.

It is necessary to promulgate and apply the *Engine-based Exhaust Emission Limits and Measurement Methods for Ships (phases I and II)* to ocean-going, coastal and river vessels according to the upcoming timetable, and to upgrade it to phases III and IV when appropriate. With standard upgrade, technological advances are expected in fuel efficiency and emission reduction of marine engines, especially coastal and inland marine engines. Environmental labeling and emission nameplates are also introduced to regulate marine engines. Technological studies covering SCR should be strengthened to quickly improve the level of domestic production. SCR and applications alike should be gradually integrated into vessels according to emission standards.

(2) Speeding up the upgrade of marine fuel oil quality

Fuel quality regulation should be strengthened for construction machinery and agricultural machinery through market supervision and management. Technological research and development on desulfurization, such as catalytic hydrogenation of high-sulfur heavy oils, should be intensified to expedite the construction of desulfurized heavy oil production line.

Low-sulfur marine fuel should be gradually used in vessels within the supply capacity. China should strive to establish, before 2020, ECAs in key areas of air pollution control, where fuel used on coastal vessels should have less than 0.1% sulfur content, and fuel used on inland vessels meet Ordinary Diesel (GB 252) requirements. After 2020 or 2025, depending on the results of an IMO Fuel Availability Study, international voyage ships and coastal vessels in all coastal and inland waters shall use fuel with sulfur content less than 0.1%, and inland vessels meet Ordinary Diesel (GB 252) standards. Such fuel

requirements would enable the use of diesel particulate filters, the most efficient PM / BC control technology. China should also consider creating ECAs covering coastal and inland waters in line with IMO requirements.

(3) Speeding up technological research, development and promotion related to shore power facilities

Technological research, development and application should be advanced to facilitate high-voltage shore power supply system for international voyage vessels and coastal vessels and low-voltage system for inland, harbor, and official vessels. Key technologies in this regard include construction of shore power facilities, configuration of vessel-shore connection, oil circuit and power circuit switches of vessels. Appropriate technical standards should also be put in place. China should accelerate the penetration of shore power technology, with the goals of realizing shore power supply in coastal and inland ports in ten years and achieving, in 2025, shore power supply to 70%~80% of cargo ships and 100% of harbor craft and government ships.

(4) Expediting technological research and development on clean energy alternatives

Technological studies, and pilots and demonstration on biodiesel in the field of construction machinery and agricultural machinery should be advanced. Emissions standards equivalent to the IMO Tier 3 standards or more stringent NO_x emission standards should be accelerated to simulate LNG marine engine research and development. For LNG powered ships, it is suggested to strengthen vessel block research, develop safety standards for LNG ships, conduct research to increase fuel storage capacity, and explore ways for extending distance travel between refueling. LNG powered ship. It is also necessary to study technologies on the construction, management and operation of LNG filling facilities in coastal and inland waters and regulate the safety design and operational management. Clean energy powered vessels should be promoted and supporting facilities built from inland waters.

8.4 Coordination mechanism & policy analysis for SLCPs and NRMS emission reduction in China

8.4.1 Current Status of Coordination Mechanism among government agencies for SLCPs and NRMS in China

8.4.1.1 SLCPs

China has long paid its attention of air pollution control to urban air quality and acid

rain, without considering the influence on the climate as a consequence of air pollution control. As China has suffered more from air pollution in recent years, the attention at home and abroad on urban air quality in China imposed unprecedentedly large pressure on the country's control of air pollution. Under such circumstances, much more management and research resources of China are delivered to control of criteria air pollution, while SLCPs attract much less attention. Seen from policy and management points of view, China encounters problems regarding the control of SLCPs in the following respects:

Firstly, China lacks of SLCPs-related laws, regulations and standards. No specific SLCPs control requirement is specified in the *Environmental Protection Law* and *the Air Pollution Control Law* - basic laws of China to prevent and control air pollution. Besides, no requirement regarding the control of such major sources of BC, CH_4 and HFCs is specified in air pollutant emission standards, except the *Standard for Pollution Control on the Landfill Site of Municipal Solid Waste* (GB 16889-2008), which specified a limit for the control of CH_4 emission.

Secondly, more consideration on abating SLCPs emissions shall be given when suggesting and promoting emission control technologies. As they have yet to be included in the scope of China's air pollution control, no goal of SLCPs emission control is set up in the control policies or control technologies being promoted. SLCPs are not taken into consideration in the selection of control technologies. Instead, only simple analysis on reducing BC emission is conducted during the evaluation of several policies and technologies.

Finally, China suffers from a shortage of adequate emission statistics data. SLCPs are not included in the statistical scope of pollutant emission in the existing statistical system of China. Though CH_4 emission is reported in such government documents as National Communication on Climate Change, it is still not included in annual emission statistics. Regarding other SLCPs, no official emission report is given at the national level. Although Tsinghua University, Beijing University and other universities and some research institutions have studied the overall emission and distribution of SLCPs in China in some scientific research, these emission inventories cannot provide sufficient support for policy formulation and effect evaluation due to limited basic data.

8.4.1.2 NRMS

There is a wide range and a large number of NRMS widely used as an important tool for production and life, including machinery, vessel, locomotive, plane, etc. Due to the long-time lack of effective supervision and management, the NRMS products generally have, compared with motor vehicles, the characteristics of low level of technology,

long service life, poor maintenance, high fuel consumption, poor fuel quality, and large emissions. NRMS mainly uses diesel and emits NO_x and PM and BC. It is rising as another important factor of influencing urban and regional air quality. Regulation of NRMS and control of the emissions encounters more difficulties due to NRMS' wide variety.

China has requirements on type approval of engines for use on Non-road Mobile Machinery (NRMM). Emissions from existing NRMM, or engines larger than 37kW for use on larger inland and coastal marine engines, and railroad locomotives have not been managed effectively. Ocean-going vessels and aircraft emissions are subject to relevant international conventions as specific domestic emission standards have not yet been developed.

(1) Non-road mobile machinery (NRMM)

MEP is responsible for controlling the emissions from the NRMM products. Under the engine model examination and approval management, companies qualified according to information submitted as required, will be issued the model approval certificate. At the end of 2013, there were more than 14,000 diesel engine models and 1,280 small gasoline engine models of the NRMM products approved to meet the national emission standards. Existing NRMM products have not been included in the scope of management.

Among the NRMM products, the most important are agricultural machinery, construction machinery and garden machinery. Internal combustion engines are brought into the quality supervision and management of national competent departments. Machinery industries are subject to the management of respective authorities (for example, agricultural machinery is managed by the Department of Agricultural Mechanization of MOA), with assistances from industry associations (such as China Machinery Industry Federation, Small Gasoline Engine Branch of China Internal Combustion Engines Industry Associations, etc.).

(2) Vessels

At present, only marine engines with rated net power of 37kW or less are subject to emission standards through type approval certification, and standards for those greater than 37kW are being developed. Ocean-going vessels mainly follow the requirements stipulated in Annex VI of the MARPOL Convention. Civilian vessels are divided by nature into transport ships and fishing vessels. The management of transport ships, undertaken by the departments for marine affairs and ship inspection of Ministry of Transport, covers ship inspection, certification, supervision and regulation, as shown in Figure 8-13.

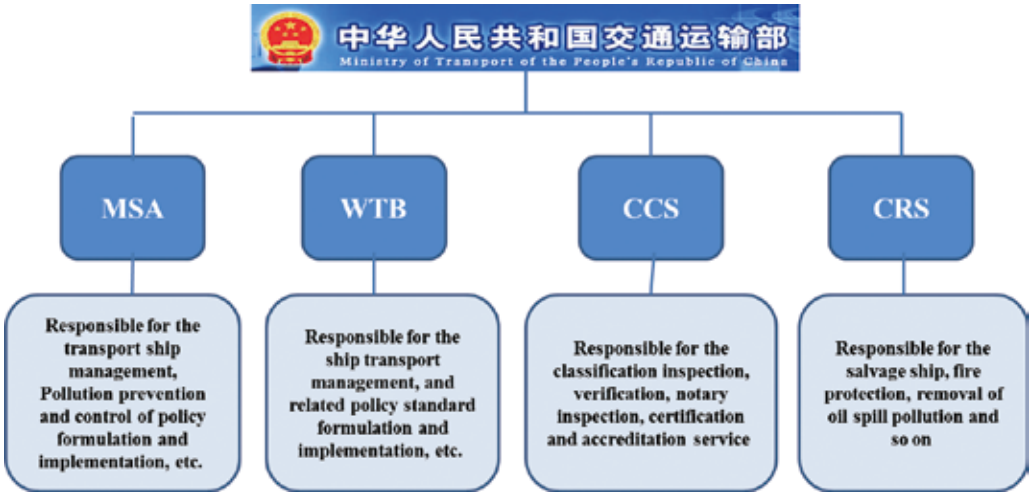


Figure 8-13 China's transport ship management system

The management of fishing vessels, undertaken by the departments for fishing affairs and ship inspection of Ministry of Agriculture, covers inspection, certification, supervision and regulation, as shown in Figure 8-14.

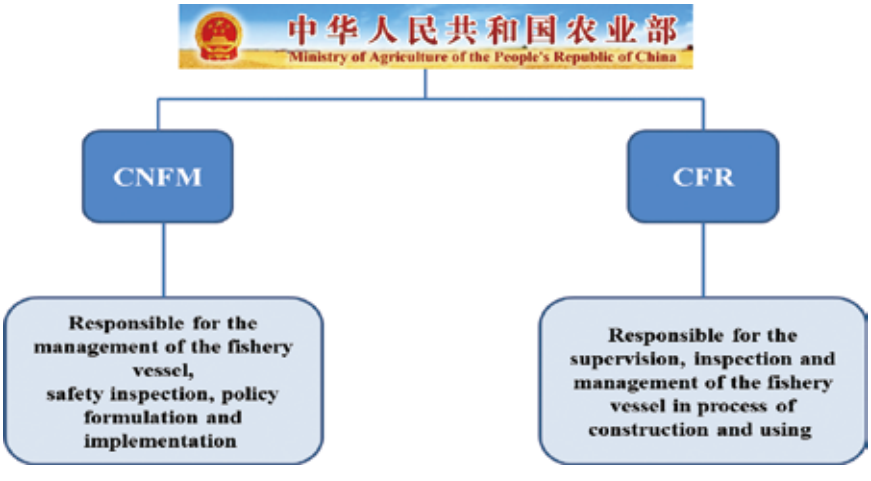


Figure 8-14 China's fishing vessel management system

(3) Fuel quality management

Diesel used by NRMM products, should comply with *Ordinary Diesel* (GB 252-2011) and have the sulfur content of not more than 350×10^{-6}. Marine fuel is more complex, including distillate fuel oil, residual fuel, and mixed fuel (a mixture of light oil and heavy

oil by a certain percentage). Presently, the existing marine fuel standard is *Marine Fuel Oils* (GB/T 17411-2012), which recommends controlling the sulfur content of distillate fuel between 1.0% and 1.5% and residual fuel, between 2.0% and 3.5%.

Non-road fuel generally have higher sulfur content and the quality is not secured due to the absence of effective regulation, which undermines the control of SO_2 and PM emission and the application of advanced after-treatment technologies. In May 2015, NDRC and other seven departments issued the Work Program to Speed up the Refined Oil Quality Upgrade, stipulating the national supply of standard V vehicle gasoline and diesel in January 2017, the national supply of standard IV ordinary diesel in July 2017 and standard V in January 2018, as shown in Figure 8-15. China also strives to issue the mandatory national standards for marine fuels before the end of 2015. 11 eastern provinces and cities have realized the supply of high-quality gasoline and diesel ahead of schedule. The accelerated process to upgrade fuel quality lays a basis for the implementation of more stringent emission standards.

Item \ Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gasoline	II	III				IV			V	
Diesel for Road	II		III				IV		V	
Diesel for Off-Road	II				III				IV	V

Figure 8-15 Fuel oil quality upgrade process (2009—2018)

8.4.2 Inter-agencies coordination mechanism & policy suggestions for China's SLCPs emission reduction

8.4.2.1 Including SLCPs control into air pollution control management and planning

SLCPs emission control is highly related with air pollution control in China. Seen from the pollution sources under control and the major measures adopted, many efforts produce a favorable effect in reducing SLCPs emission. Therefore, including SLCPs control into the existing air pollution control management system will not increase significantly the burden of air pollution control. Instead, it will help the Chinese government to build the image of a responsible great power that copes positively with global climate change. Attention shall be paid to the following three problems:

Firstly, a foundation of SLCPs management shall be constructed. Based on the existing pollutant emission statistics system, efforts shall be made to build a systematic

and reliable national SLCPs emission statistics and analysis approach, which will help to figure out the SLCPs emission volume and characteristics in the country and lay a solid foundation for the future management.

Secondly, SLCPs control should be included in the national plans on energy conservation, emission reduction and pollution control. SLCPs emission reduction objectives shall be defined in the said plan and related policy measures shall be formulated.

Finally, a national roadmap of controlling SLCPs should be drafted. Efforts should be made to propose SLCPs emission reduction objectives and schedules according to the goals of climate change treatment and air pollution control and define all geographic areas and industrial areas of reducing SLCPs emission and major cooperative control measures for realizing SLCPs reduction aimed at every stage.

8.4.2.2 Establishing collaborative emission reduction strategies

Since the sources of SLCPs are largely identical to those of criteria air pollutants, to which China pays much attention, the Chinese government should take wholly consideration of SLCPs and regular air pollutants and establish collaborative strategies that reduce their emissions as early as possible.

As for overall strategies of controlling air pollution, efforts should be made to set up overall targets for the implementation of SLCPs strategies that reduce emissions and air quality improvement as a whole, and put forward climate-friendly strategies that control air pollution. Based on this, detailed major objectives and indexes should be considered to guide the whole country to control air pollution.

Regarding specific control measures, priority should be given to the promotion of measures with the highest collaborative efficiency that improve air quality and reduce SLCPs emission. Special attention shall be paid to the measures that raise energy efficiency and improve energy structure, including decreasing coal consumption, cutting down the use of coal in small coal-burning facilities and raising the proportion of clean energy, which can relieve PM pollution and also reduce the emission of SLCPs.

8.4.2.3 Intensifying cooperation among government agencies

The establishment of an inter-agencies cooperation mechanism is an important step for the implementation of the Air Pollution Control Action Plan. It will also be of help in controlling SLCP emissions and realizing SLCPs emission objectives. So, it is suggested definite SLCPs control requirements be proposed and responsibilities of every department be defined on the basis of the control objectives and the department responsibilities.

Major cooperative agencies shall be determined according to the major sources of every kind of SLCPs. Regarding BC, a coordination comprising of energy, environment,

agriculture, transportation, and construction departments should be identified, responsibilities and relative rights should also be clarified. The work should start with decreasing the end use of coal, diminishing direct burning of biomass (such as straw) and controlling mobile sources. As for CH_4, a cooperation team of chemical, coal, municipal and industrial departments should be built and the emphasis of the control shall be paid to reducing the emission of CH_4 from energy exploitation and waste disposal. Regarding HFCs, the work shall be carried out according to the existing tasks under the joint implementation mechanism. As for tropospheric O_3, department responsibilities related to the control of NO_x and VOCs emissions should be defined further under the existing air pollution control system.

8.4.2.4 Formulating and improving corresponding laws, standards and policies

During the amendment of applicable laws and regulations, efforts should be made to include SLCPs management into air pollution control system and authorize government organs to reduce SLCPs emission and on this basis, improve the emission standard system. During the amendment of emission standards, emission limits regarding major sources of BC and CH_4 should be specified based on the best available technologies.

Inthe short term, BC control technical policies should be improved, in combination with $PM_{2.5}$ control requirements. On the one hand, energy use policies should be improved to promote the conversion of coal use from inefficient and dispersive end-use facilities (such as small boilers and coal stoves) to efficient and concentrated end-use facilities. On the other hand, policies for comprehensive utilization of straw should be propelled to facilitate the production of biomass briquette by straw and decrease the direct burning of straw.

In the meantime, positive economic policies and incentive mechanisms should be introduced gradually to stimulate the application of SLCPs emission reduction technologies.

8.4.2.5 Enhancing scientific research and technical development

Efforts should be made to enhance the studies on the BAT of controlling SLCPs emissions, reduce SLCPs emissions through tightening the emission standards, promote the research on SLCPs emission monitoring methodology and equipment and apply it to actual control management and emission reduction. Besides, more efforts should be made to propel the studies on the quantitative evaluation and analytical methods for benefits of SLCPs emission reduction coordination, establish model methods for evaluating climate change, health and agricultural benefits and on this basis, evaluate the comprehensive benefits of China's control of SLCPs.

8.4.3 Inter-agencies coordination mechanism & policy suggestions for China's NRMS emission reduction

That the State Council and relevant departments should gradually intensify the prevention and control of NRMS pollution by putting forward a series of requirements. *The 12th Five-Year Plan for Air Pollution Prevention and Control in Key Areas* (MEP [2012] No. 130), jointly issued by MEP, NDRC and MOF, provided "investigate emissions of NRMS, including construction machinery, locomotives, vessels, agricultural machinery, industrial machinery and aviation, and establish a management ledger to control mobile sources of air control". The *Action Plan for Air Pollution Prevention and Control* (SC [2013] 37), issued by the State Council in September 2013, also proposed "control the emissions from construction machinery and other NRMM and vessels". The new *Law on the Prevention of Air Pollution* issued by the Standing Committee of the National People's Congress in August 2015, put forward clear requirements for the non-road mobile source emission control. The control of the NRMS emissions is gradually being put on the agenda as a priority of future work.

To further implement the new *Law on the Prevention of Air Pollution* and effectively control the NRMS emissions and strengthen pollution prevention and control, it is suggested to focus work on the following aspects:

8.4.3.1 Establishing a NRMS emission control system for the purpose of air quality improvement

(1) Strengthen the unified supervision of all mobile emission sources for the environmental protection departments

Strengthen the responsibility of environmental protection department under the State Council for the overall regulation of mobile sources, and clarify the division of responsibilities between the related departments and sectors, covering NRMM and vessels. Environmental authorities and local governments should be authorized to implement more stringent emission standards and create ECAs where needed. It is also necessary to strengthen the integrated control and unified supervision of air pollutants and greenhouse gas emissions, including PM and NO_x from mobile sources. Industrial enterprises bear the responsibility for complying with the requirements adopted by the environmental authorities.

(2) Establish an NRMM environmental management mechanism that clarifies the responsibilities of state and local departments

MEP should establish a national environmental compliance system of new NRMM

products, covering product information disclosure, type approval, conformity of production, in-use compliance, recall, and environmental labeling. Local environmental protection departments should establish an environmental management system of in-use NRMM products, covering routine inspections, random inspections,low-emission zones, upgraded environmental governance, and accelerated phase-out.

8.4.3.2 Develop a the roadmap to prevent and control SLCPs and NRMS Emissions

(1) Introducing more stringent emission standards and fuel standards

Standards for general diesel should be implemented as scheduled to strengthen fuel quality control. National standards IV for NRMM products should be formulated and implemented in key areas and nationwide according to the timetable with the goal of integrating NO_x and PM after-treatment.

Emission standards should be introduced for new vessels, including coastal and inland vessels according to a phased schedule. Considering marine engine technology and vessel emission control, China should leapfrog early to US Tier 4 or equivalent standards. To smooth the successful implementation of these stringent emission standards, appropriate standards for marine fuel oils are urgently needed.

(2) Enhance compliance management and introducing innovative implementation mechanisms

Environmental protection departments should build up the capacity of environmental regulation of mobile sources to ensure the implementation of stringent emissions standards. Institutional innovation based on policy studies, covering control of total mobile source emissions, Green Top Runner Program, emission trading and environmental tax, is also expected to improve the flexibility and effectiveness of emission standards.

China should establish strong ECAs covering coastal and inland waters requiring the use of 0.1% sulfur fuel, in particular at seriously polluted areas and waterways and ports with heavy traffic. Key ports should be encouraged to implement clean port plans through which the world's most advanced emission control technologies and strategies can be tested.

8.4.3.3 Launch the "National Clean Diesel Engine Campaign"

Drawing on the U.S. successful practice in NRMM pollution prevention and control, China should launch the National Clean Diesel Engine Campaign during the 13th Five-Year Plan period, in line with China's initiatives of "the Belt and Road" and "Made in China 2025". The campaign will be led by the State Council and supported by ministries including MEP, MOT, MOHURD, MOA, NDRC, MIIT, and MOF. The campaign will encompass clean diesel engine projects for on-road diesel vehicles, construction machinery,

agricultural machinery, and vessels. The goal should be to require wall flow particle filters which greatly reduce particle mass, particle number and BC on as many vehicles and engines as possible as quickly as possible. Recent decisions to require low sulfur fuels for both on and off road applications facilitate this strategy. The system for mandatory retirement before deadline combined with financial incentives and market measures to encourage early retirement of old diesel engines and optimization of the fleet structure should substantially reduce both particulate and BC. The establishment and application of shore power facilities will be intensified and natural gas and other clean energy options will be favored for harbor utility craft, official boats, and ships on short fixed routes.

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Chapter 9
CCICED 2015 Work Report

The China Council for International Cooperation on Environment and Development (CCICED), a high-level policy advisory body now in its 24th year of operation, has steadfastly promoted sustainable development and enjoyed both recognition and support from the Government of China and international community. At the CCICED Annual General Meeting (AGM) 2014, Mr. Zhang Gaoli, China's Vice Premier of the State Council and CCICED Chairperson, said:

> *"The CCICED has provided a platform of dialogue between Chinese and international high-level officials, opened a door to international experience in sustainable development, and served as a bridge for bilateral exchange on environment and development best practices between China and the international community. It has played a positive role in supporting China's economic development and environmental protection for more than 20 years. The Chinese government will as always support the long-term development of the CCICED and hopes the Council will continue to provide knowledge and serve as a platform for bilateral exchange, thus contributing ever more to the green development of China and the world."*

Under the strong leadership of the Bureau and with the support of domestic and international partners, the CCICED has successfully completed the tasks set for the year and satisfactorily met its planned objectives. Below is an overview of the progress achieved over the past year.

9.1 Successful implementation of policy research

In 2015, the CCICED carried out policy research under the theme, *Enabling Governance Capacity for Green Development*. The policy research, which focused on exploring governance frameworks and support systems as well as on strengthening capacity development, formulated workable policy recommendations that will improve national governance capacity and promote transformation in China.

9.1.1 Completing the Council's planned policy research

In 2015, the CCICED completed three task force projects and three special policy studies, with findings reported to the 2015 AGM. The topics are listed below:

- Task Force on National Governance Capacity for Green Transformation (2015).
- Task Force on Rule of Law and Ecological Civilization (2015—2016).
- Task Force on Green Finance Reform and Green Transformation (2015).
- Special Policy Study on Soil Pollution Management (2015).
- Special Policy Study on Eco-Environmental Risk Management (2015).
- Special Policy Study on Coordinated Actions for Addressing Climate Change and Air Pollution (2015).

Also, as authorized by the Bureau and approved by the Secretary-General, the Task Force on Green Transformation Outlook (2015—2030) and the Task Force on South-South Cooperation on Ecological Civilization were established during the year. Their findings will be reported to the 2016 Annual General Meeting.

The Task Force and Special Policy Study teams put forward policy recommendations to the Chinese Government that integrated best practices in international and Chinese experience, taking due consideration of China's realities. This way of working reflected the unique role and value of the CCICED as a bridge for achieving international cooperation on environment and development.

9.1.2 Holding seminars and conducting background research focusing on urgent issues on environment and development, in China and internationally

In accordance with the 2015 work plan, the CCICED successfully hosted a seminar on *Promoting China's Green Development Story* and produced two special policy background papers entitled: *Overview and Implications of Sustainable Development* and *Environmental Protection Strategy for the "One Belt One Road" Initiative*. Experts, scholars and

journalists and business representatives were invited to discuss challenges and pressing issues related to these areas. Participants also drew on research findings and their own experience in China and internationally to share their views with the Secretariat and inform the Council's policy research agenda.

9.1.3 Engagement of CCICED members, donors, and partners in policy research

CCICED members, donors and partners were closely involved in our policy work this year. In particular, 12 Council members served as Co-Chairs or experts on Council research teams. Moreover, 11 donors and partners were involved in recommending 19 senior experts and scholars in a number of fields (environmental economics, environmental policy, public management, environmental law, sustainable finance, soil pollution, environmental risk, and atmosphere and climate change). These experts have greatly contributed to the high quality of this year's research.

Council members are also encouraged to submit papers to contribute to the Annual General Meetings' theme. This year, three members have provided thought-provoking papers on the issues of demographic transformation, electricity and transportation, and environment and health. All of these documents will be tabled at the AGM and available to council members and participants.

9.1.4 Further clarifying the direction and focus of work over the next two years

In line with the policy research framework of Phase V, the CCICED has a research plan for the next two years, based on analysis of the new international situation in environment and development, and China's need to implement ecological civilization. This proposal, which centers on the theme of the 2016 AGM and provides research direction for 2017 and Phase VI, has been submitted to the Bureau for consideration.

9.2 Expanding the influence of the CCICED

A major goal for Phase V is to promote the adoption and implementation of the CCICED's recommendations, share policy research findings with the international community, and expand the CCICED's influence within and beyond China's borders. The following specific activities were completed this year:

9.2.1 CCICED 2015 Roundtable Meeting

The 2015 CCICED Roundtable Meeting entitled *Modernization of National Governance and Green Transformation* was held on May 18—19 in Shanghai. Innovations were made in how the program was designed, the Roundtable was organized and participants were engaged. With the active participation of our CCICED partner, the China Executive Leadership Academy Pudong, research findings were shared with decision-makers and senior enterprise leaders undergoing training at CELAP. Participants had requested, and received briefings on ecological redlining, media and public participation to support China's green development, green accounting and environmental performance evaluation, as well as lessons learned from the green supply chain demonstration project. There were lively exchanges on ecological environmental governance and related capacity building. The CCICED's policy recommendations are of great help for lower level governments and enterprises in addressing practical issues and challenges. In turn, trainees' suggestions and feedback will inform how the Council can improve its policy recommendations. Some of our council members, research team co-chairs, donors and partners also attended this Roundtable.

9.2.2 International Advisory Meeting on Environment and Development for China's 13th Five-Year Plan

In collaboration with UNEP, the CCICED hosted in June the International Advisory Meeting on Environment and Development for China's 13th Five-Year Plan. The aim of the meeting was to promote greater integration of economic, social and environmental considerations in the development of the Plan. Renowned experts and leaders in their fields were invited to take part in an intensive 2-day session, culminating with a focused dialogue with Vice Premier Zhang Gaoli. Among those attending the session were Achim Steiner, UN under-secretary-general and UNEP executive director, Henry M. Paulson, chairman of Paulson Institute, and Kristalina Georgieva, European Commission Vice President for Budget and Human Resources. Participants analyzed the major environment and development challenges facing China during the 13th Five-Year Plan period and carefully designed a set of policy recommendations for China's consideration. Vice Premier Zhang Gaoli, who is also Council Chairperson, discussed these findings with the participants. This is the first time the Government of China solicits the advice from such an organization in the development of a Five-Year Plan-demonstrating the importance given by the government to the CCICED.

9.2.3 CCICED Environment and Development Think Tank Symposium

On 22 June, as part of the China-US strategic dialogue at Washington D.C., the CCICED held the Environment and Development Think Tank Symposium, in collaboration with the World Resources Institute. The objective of this symposium was to learn from the successful experience of world-renowned think tanks, strengthen relations with leading global environment and development think tanks, as well as expand the reach of the Council. The symposium attracted 40 participants including U.S. Environment Protection Agency officials, think tank leaders, the Council's international Chief Advisor and a China delegation composed of CCICED leaders and policy research experts. Experience was shared on how think tanks develop, the role they can play in government policy development, and their influence on the general public. Participants also discussed the opportunities and challenges facing think tanks, as well as opportunities for China-US think tank cooperation. Useful suggestions were made on how to bolster CCICED capacity building and expand research areas. The exchange contributed to this year's constructive 7th China-US strategic dialogue, and was officially listed as one of the specific outcomes of the exchange. It is our view that the CCICED has contributed to the positive evolution of US-China relations

9.2.4 Demonstration projects that promote the implementation of CCICED policy recommendations

Policy pilot projects are a proactive initiative to enhance the CCICED's impact at the central and local government levels, and are an effective way to demonstrate the CCICED's policy recommendations in realistic conditions.

9.2.4.1 Demonstration project on Media and Public Participation

In response to the 2013 CCICED policy recommendations, a demonstration project on media and public participation was implemented. The *Regulations of Hebei Province on Public Participation in Environmental Protection* were formulated to establish legal safeguards for public participation in environmental protection work. This statute supports information disclosure; it also protects the public's rights to know, to participate and to supervise. It also deals with related statues that need to be put in place to facilitate public involvement. With support from CCICED donors and partners, with the efforts of the local government, the Hebei Province *Regulations* were finally approved by the Hebei Province People's Congress standing committee, and have taken effect on January 1st, 2015.

9.2.4.2 Demonstration project on Sustainable Consumption

In January, the CCICED launched the "Sustainable Consumption Policy Demonstration Project" based on some of the Council's 2013 research findings. The project will explore institutional development models and evaluation systems for sustainable consumption by conducting a pilot project in one province or one city, and will lead to lessons learned and models that can be used to promote sustainable consumption nationwide. Hubei Province and one of its cities, Xiangyang, became implementation partners. The project's leading group was organized and will be key in issuing the required policy documents, establishing sustainable consumption publicity platforms and establishing used and recycled goods markets, as well as contributing to a sustainable consumption evaluation indicator system.

9.2.4.3 Demonstration project on Green Supply Chain

The 2013 CCICED green supply chain demonstration project implemented in both Tianjin and Shanghai, is contributing to the development of implementable policies, standards and measures to promote green production, green supply, green procurement and green consumption chains. In November, 2014, the proposal to establish the APEC green supply chain cooperation network and to open a demonstration center based on the outcome of the project was written in the Declaration of the 22nd Informal APEC Economic Leaders' Meetings. The Tianjin demonstration center officially opened in June. In addition, the APEC Green Supply Chain Cooperation Network proposed by China was approved by the 3rd APEC Senior Official Meeting. All of these achievements demonstrate that the idea of green supply chain and the various policy recommendations proposed by the CCICED are bearing fruit and proving to be a key element in Asia Pacific cooperation.

9.2.5 Disseminating CCICED's achievements through publications and websites

In line with the need to "strengthen its communications", the CCICED has made progress on implementing a more effective communication strategy. With the support of the Secretariat International Support Office (SISO) and related TF/SPS teams, CCICED has a more targeted communication plan to disseminate Council achievements among different target groups.

(1) *The Proceedings of the 2014 Annual General Meeting* (in English and Chinese), and *CCICED Annual Policy Report 2014* (in English and Chinese) were published and distributed.

(2) CCICED Brochure(in English and Chinese) was revised and updated, and

publicity document *CCICED: A Unique Think Tank* and other publicity materials were drafted and compiled.

(3) CCICED's official websites in English and Chinese undergo ongoing improvements. Content is provided in a more timely and user-friendly fashion. Annual site visits have increased by 29%.

(4) The CCICED also strengthened cooperation with the media to ensure in-depth reporting of CCICED major events such as the AGM, the Roundtable Meeting and the International Advisory Meeting on Environment and Development for China's 13th Five-Year Plan, as well as various CCICED policy research projects.

(5) A number of CCICED staff attended an environmental protection training seminar for representatives from 41 developing countries, sharing CCICED experience as well as disseminating research findings. This will provide a solid foundation for the CCICED's support of China's South-South Cooperation initiative.

9.3 Institutional strengthening, secretariat operations and management improvements

9.3.1 Increasing the number of vice chairpersons and council members

CCICED Phase V emphasized regional balance, diversified backgrounds, and academic status in selecting council members. There is now the need for the Council to strike a proper balance in terms of regions and areas of expertise, and to encourage the involvement of major international organizations, institutions as well as think tanks and internationally significant enterprises. After careful review and selection, the CCICED Bureau has approved the addition of Ms. Barbara Hendricks, Germany's Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety, as CCICED International Vice Chairperson. Also appointed to the Council are three more International Members including Mr. Magdy Martinez-Soliman, Assistant Secretary-General, Assistant Administrator and Director of the Bureau for Policy and Programme Support at the United Nations Development Programme (UNDP); Mr. Marco Lambertini, Director General of World Wide Fund for Nature; and Mr. Jan Gunnar Winther, Director of the Norwegian Polar Institute.

9.3.2 Strengthening partnerships through mutually beneficial cooperation

The CCICED established strategic partnerships with the Party School of the Central Committee of the Communist Party of China, the Asian Development Bank (ADB), the Global Green Growth Institute (GGGI) and the Sasakawa Japan-China Friendship Fund following pro-active communication and consultation.

At the same time, the CCICED signed strategic cooperation memorandums with the following organizations: United Nations Environment Programme (UNEP), World Wide Fund for Nature (WWF), World Resources Institute (WRI), International Institute for Sustainable Development (IISD), Stockholm Environment Institute (SEI), Chinese Academy of Governance (CAG), and China Executive Leadership Academy Pudong (CELAP). The Council worked with these organizations on policy research and demonstration projects, communications and event planning, as well as in personnel exchange and training. As a result, there has been solid progress in terms of greater institutional capacity, improved policy research, and expanded domestic and international reach. The CCICED and its partners have benefited mutually through these joint efforts.

9.3.3 Chief Advisors and the Chief Advisors Support Team

The work of the Chief Advisors and their Support Team is a fundamental factor behind the successful implementation of the CCICED's policy research. The Chief Advisors and the Support Team have provided the following services over the past year:

(1) Advice to the Secretary General on the formation of task forces and policy research projects; academic guidance on research; drafting concept papers, terms of reference, and outlines for new policy research projects; convening initial TF and SPS seminars; monitoring and reviewing research progress, providing timely guidance to the research teams; and evaluating project achievements.

(2) Proposing the themes for the AGMs and policy research projects in 2016 and 2017 to support the Bureau and the Secretary General in determining the Council's policy research agenda.

(3) Holding five Chief Advisors and Secretariat Joint Working Meetings, as well as holding monthly meetings among the Chinese Chief Advisor and the Support Team, to facilitate close coordination between the Chief Advisors and the Secretariat, and to ensure the orderly conduct of all activities.

(4) Drafting the 2015 Recommendations to the Government of China, the Issues

Paper, and the Report on Progress of China's Major Policies Pertaining to Environment and Development and the Impacts of CCICED Policy Recommendations (2014—2015).

9.3.4 Strengthening internal management and improving on-going operations.

In 2015, the Secretariat and SISO sought to introduce innovations to ensure effective implementation of the work plan and made necessary improvements to on-going operations. Continued capacity building programs were designed to improve the effectiveness of operations and management.

(1) Clarifying departmental divisions and conducting personnel training

Four departments were set up within the CCICED Secretariat with clear roles and responsibilities. They are: Administration, Policy Research, Communication and Partnerships, and Meetings and Event Planning. CCICED recruited new staff, adopted a systematic training approach involving both domestic and overseas study, training and joint research. These developments provide the needed conditions for the long-term, stable and healthy development of the CCICED.

(2) Enhancing policy research project management

In accordance with the *Rules for Implementing the Management of Policy Research Projects* that was formulated in 2014, the CCICED has improved policy research project management. There is now ongoing information sharing during the life of any research project, and this greatly supports higher research quality.

(3) The role of SISO

SISO has played an active and important role in such areas as financial and program management, communication and coordination with international Council members and international policy research experts, capacity development, expanding partnerships, and external communications.

9.3.5 Start-up of CCICED Phase VI preparation work to promote the establishment of a sustainable Council

Preparation for CCICED Phase VI (2017—2022) has already started. A special working group has been established to draw up initial plans, including vision and mission, basic principles, organizational structure, operational mechanisms, as well as key areas and directions of policy research. This entails active consultation with the relevant domestic organizations as well as our main donors and partners, in order to raise funds and provide the needed expertise to foster a sixth phase of the CCICED.