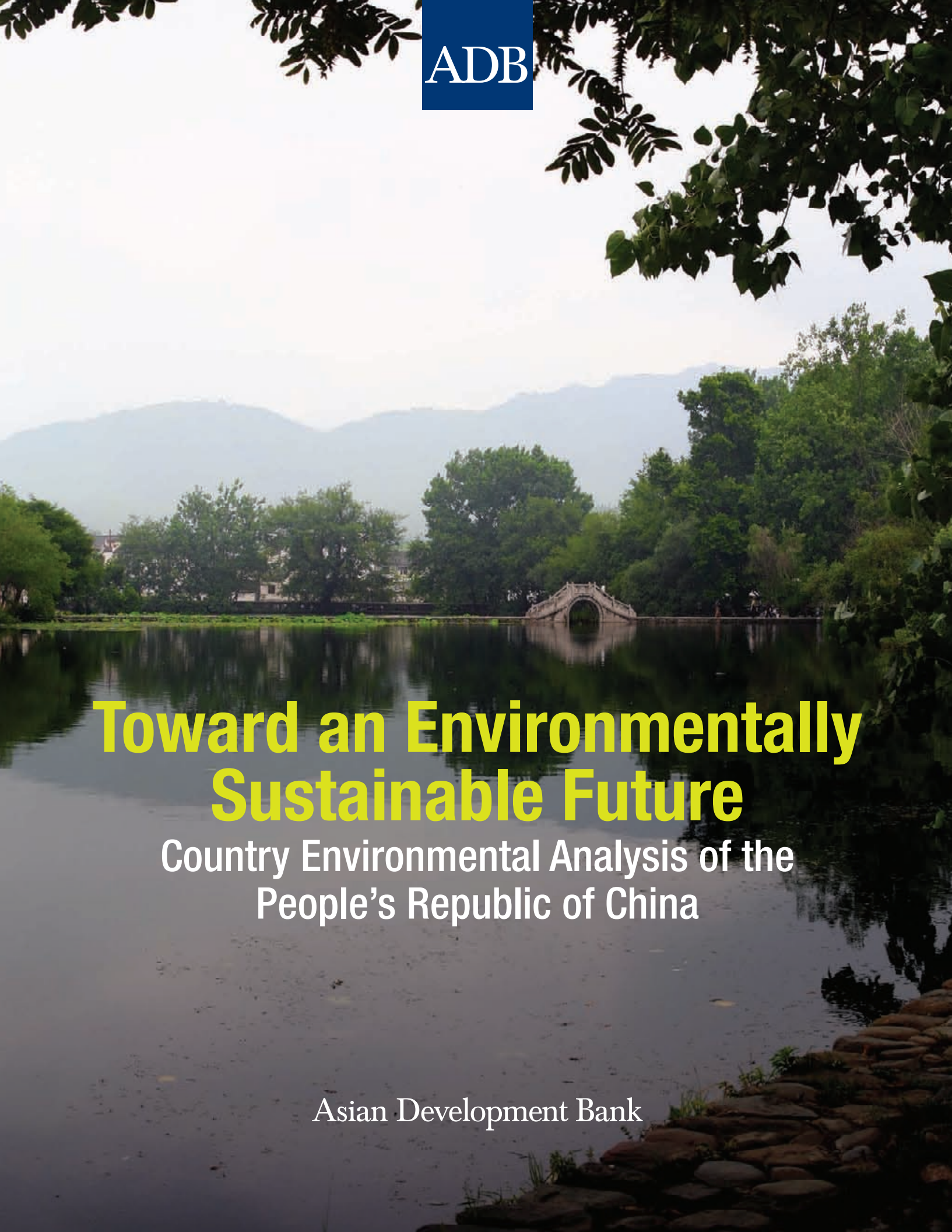

Toward an Environmentally Sustainable Future

Country Environmental Analysis of the People's Republic of China

Asian Development Bank

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Qingfeng Zhang and Robert Crooks

Asian Development Bank

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Endorsements

"This monograph not only presents an integrated summary of what the People's Republic of China has achieved during the 11th Five-Year Plan toward sustainable development, but also dedicates an in-depth discussion of the development of major environmental policies and programs the People's Republic of China has been undergoing over the last 3 decades. An assessment of the country's current environmental and ecological situations further highlights the grand challenges the People's Republic of China is facing for development while protecting the environment in the future.

Its major conclusions and recommendations are constructive, critical, and valuable not only to the government but also to the international sustainable communities as well as the general public."

Chen Jining
Professor and President
Tsinghua University

"Protecting the environment remains one of the great global challenges of our time. The Asian Development Bank has been instrumental in providing policy and technical analysis for the environmental efforts of the People's Republic of China. The second Country Environmental Analysis provides a comprehensive review on the government's environmental achievements during the period of the 11th Five-Year Plan and supplies insightful recommendations on how the country should approach sustainability in the future while maintaining rapid economic growth.

This report is a great resource for policy makers and researchers who desire to grasp the current state of the People's Republic of China's environmental progress."

Manish Bapna
Executive Vice President and Managing Director
World Resources Institute

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Tables

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Abbreviations

ADB	Asian Development Bank
ASL	above sea level
BAU	business as usual
bcm	billion cubic meter
Btce	billion tons of coal equivalent
CAS	Chinese Academy of Sciences
CCICED	China Council for International Cooperation on Environment and Development
CCS	carbon capture and storage
CDM	clean development mechanism
CEA	country environmental analysis
CMM	coal mine methane
CO_2	carbon dioxide
COD	chemical oxygen demand
CPS	country partnership strategy
DMC	developing member country
EARD	East Asia Department (of ADB)
EIA	environmental impact assessment
ENRPC	Environment and Natural Resources Protection Committee (of the National People's Congress)
EPB	Environmental Protection Bureau
EPL	Environmental Protection Law (of 1989)
EU	European Union
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
Gt	gigaton
ha	hectare
IEA	International Energy Agency
IEM	integrated ecosystem management
IPCC	International Panel on Climate Change
kg	kilogram
km	kilometer
km^2	square kilometer
m^3	cubic meter
MEP	Ministry of Environmental Protection
MLR	Ministry of Land Resources
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MSW	municipal solid waste

Mtpa	million tons per annum
MWR	Ministry of Water Resources
NBCC	National Basic Construction Commission
NDRC	National Development and Reform Commission
NEPA	National Environmental Protection Administration
NFPP	National Forest Protection Program
NFRI	National Forest Resource Inventory
NPC	National People's Congress
NPS	nonpoint source
OECD	Organisation for Economic Co-operation and Development
PM_x	particulate matter of defined size
POPs	persistent organic pollutants
PPP	purchasing power parity
PRC	People's Republic of China
RSC	regional supervision center
SEA	strategic environmental assessment
SEPA	State Environmental Protection Administration
SFA	State Forestry Administration
SLCP	Sloping Land Conversion Program
SO_2	sulfur dioxide
SOA	State Oceanographic Administration
SPS	Safeguard Policy Statement
TP	total phosphorus
TRWR	total renewable water resource
tSCE	tons of standard coal equivalent
UK	United Kingdom
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VOCs	volatile organic compounds
WWTP	wastewater treatment plant

Foreword

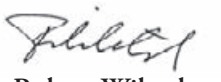
This report represents a further chapter in the continuing and constructive dialogue between the Asian Development Bank (ADB) and the People's Republic of China (PRC) about how the country can grow toward an environmentally sustainable future.

In 2007, ADB prepared the first country environmental analysis (CEA) for the PRC. The CEA was crucial in the development of a multiyear ADB program of environmental assistance to help the government address priority problems, such as pollution control and energy efficiency. Many of the recommendations in the first CEA have been adopted by the government, including the elevation of the State Environmental Protection Administration to the Ministry of Environmental Protection (MEP) with representation on the State Council.

However, more needs to be done. The recently released Macro Strategic Research Report on the PRC's Environment, which was supported by ADB technical assistance, noted that although the environment has improved in some regions of the PRC, the overall situation continues to deteriorate as environmental pressure continues to increase. The scope of the report extended beyond the traditional framework of 5-year planning and its recommendations included a strategy for environmentally sustainable development through to 2050. Many elements of the strategic road map recommended by the report were included in the 12th Five-Year Plan and its associated environment sector plan.

As the PRC embarks on its 12th Five-Year Plan, ADB and MEP have cooperated closely to update the CEA. The objectives of the update included reassessing the environmental situation in the PRC, examining the critical elements to ensure environmental sustainability, reviewing visions for the future, and articulating the role that ADB can play in helping to achieve these visions. A large team of Chinese experts contributed to the CEA update. Their first-hand experience and understanding of the challenges that the PRC faces were essential to making the CEA update a success, and this publication possible.

This publication conveys experiences from the PRC, where environmental management practices have rapidly advanced in recent years, and offers valuable lessons for other developing member countries. The ADB team also hopes that we have been able to transfer some of our international experience to help the PRC on the road to environmentally sustainable development.



Robert Wihtol
Director General
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Asian Development Bank

Acknowledgments

This report was jointly prepared by a group of eminent experts and a team from the Asian Development Bank (ADB). Robert Crooks led the team of experts comprising of Jinnan Wang, Chazhong Ge, Jiahua Pan, Ying Zhang, Zhong Ma, Guang Xia, Zhizhong Si, and Michael Bennett; while Qingfeng Zhang led the ADB team comprising of Yi Jiang, Antoine Morel, Hongliang Yang, and Ning Li. Robert Crooks prepared the earlier drafts while Qingfeng Zhang finalized the report.

Klaus Gerhaeusser, then director general of East Asia Department, initiated the preparation, inspired the team, and provided substantial inputs during the finalization of the report. Edgar Cua, deputy director general of East Asia Department, provided guidance in the report's preparation and opened various consultation workshops. Paul Heytens, former country director of ADB People's Republic of China Resident Mission (PRCM), provided insightful advice and opened the inception workshop.

ADB staff Raymond Renfro, Xuedu Lu, Alvin Lopez, Frank Radstake, Rokeya Sabur, and Zhiming Niu attended the consultation workshops and provided comments. Other ADB staff including Xiaoying Ma, Sergei Popov, Yue-Lang Feng, Fei Yue, Jeffrey Liang, and Lanlan Lu, as well as international and national experts including Ji Zou, Cy Jones, Sarah Forbes, Leshan Jin, Ying Zhang, Jinxing Peng, Zhifeng Yang, Changhua Wu, and Shaoming Zhang offered valuable comments at different stages during the preparation of the report.

Serving as external peer reviewers, two prominent scholars—Professor Jining Chen, president of Tsinghua University; and Manish Bapna, acting president of the World Resources Institute—provided detailed and thoughtful comments on earlier drafts of the report.

The report benefited from the close collaboration among the Ministry of Environmental Protection (MEP), the National Development and Reform Commission, and the Ministry of Finance. The ADB team is particularly grateful to Qing Su, Jianzhong Zhao, Xiaolong Mo, Wenhang Huang, Chunhong Li, Xuezhi Xiao, Xin Wang, Ying Wang, Xue Hua, and Yan Li.

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Executive Summary

The People's Republic of China (PRC) has just completed its third decade of sustained economic growth at rates exceeding 9% per annum. This economic achievement, however, has been realized at considerable environmental cost even though the government has been making great efforts in developing laws, regulations, institutions, and human resources necessary to sustainably manage the environmental consequences of economic growth. In doing so, the government has also created a significant public constituency for environmentally sustainable development within the PRC, and is playing an increasingly prominent international role on issues of global environmental significance.

The government recently released its first Macro Strategic Research Report on the PRC's Environment that includes visions and a strategy through to 2050 for environmentally sustainable development, and it also prepared the 12th Five-Year Plan (2011–2015) for Environmental Protection. The Asian Development Bank (ADB) has formulated its country partnership strategy for the PRC for 2011–2015. This country environmental analysis (CEA) was prepared in parallel with these activities and reviews the environmental performance of the 11th Five-Year Plan (2006–2010), examines the key elements that the government needs to keep in mind in its efforts toward an environmentally sustainable future, and articulates the role that ADB can play in contributing to these visions for the future.

Achievements and Challenges Ahead

The environmental performance of the PRC during the 11th Five-Year Plan period was a significant improvement over that of the 10th Five-Year Plan, even though the 2006–2010 period reported an average gross domestic product (GDP) growth of 10.5%, which was considerably higher than the 7.5% growth expected in 2006. Among the various achievements that the CEA documents, particularly notable are:

- The goal of 10% reduction in sulfur dioxide (SO_2) emissions was achieved in 2009, one year ahead of schedule, and is reflected in the noticeable improvements in ambient air quality in some areas.
- There was a 12.5% reduction in discharges of chemical oxygen demand (COD) as a result of increased treatment of municipal and industrial wastewater discharges, combined with significant improvements in industrial water use efficiency.
- Municipal wastewater treatment capacity increased by 450% over the past decade.
- Forest coverage increased to 20.4% in 2008, achieving the 2010 target two years early.

- Signs began to emerge during the 11th Five-Year Plan that land degradation and desertification are being reversed or, at least, the deteriorating trends have been stopped.
- Energy intensity per unit of GDP was lowered by 19.1% against 2005 levels, due to significant energy efficiency improvement and economic structural transformation. As a result, 1.5 billion tons of carbon emissions were avoided.
- Renewable energy including hydropower, wind, solar, and biomass has been promoted and developed progressively, which contributed to the mitigation of global climate change.

Notwithstanding these achievements, the PRC continues to face significant environmental challenges. The CEA report analyzes these challenges and makes recommendations on policies, investments, and improvements in technical capacity that will be required to confront these challenges.

- **Water pollution and water availability** continue to be critical problems. The government has made major advances in the control of industrial and domestic point sources of water pollution. But there is a growing challenge from nonpoint source (NPS) pollution from runoff of fertilizer, pesticides, and discharges from intensive animal production facilities. Water availability in the PRC also represents a major development challenge with some estimates showing that, by 2030, demand could exceed supply by as much as 200 billion cubic meters (bcm), unless major capital investments to strengthen water supplies are made beyond those presently planned.
- **Air quality** will continue to be a major environmental challenge, notwithstanding the advances that have already been made. Fewer than 1% of the 500 largest cities in the PRC meet the air quality standards recommended by the World Health Organization, and 7 of these cities are ranked among the 10 most polluted cities in the world. Although industrial emissions have stabilized in the past few years, a rapid increase in private car ownership is creating a new threat in the form of vehicle emissions.
- **Solid waste management** is becoming a top priority in the PRC. The country currently produces about 25% of the world's solid waste. Major investments in the development of facilities for the safe disposal of municipal solid waste were made during the 11th Five-Year Plan period, but these have not kept up with supply. Industrial solid waste management is an even bigger challenge.
- **The occurrence and economic consequences of natural disasters** in the PRC have progressively increased over the past 50 years due to a combination of factors including climate change. The consequences of disasters have been increased by a combination of increased wealth, population, and urbanization. Earthquakes, typhoons, floods, and droughts have had the greatest impacts historically and present the largest risks going forward.
- Other environmental challenges facing the PRC include **land degradation, reduced biodiversity, and inadequate forest resources.** One-third of the total

area of the PRC is prone to desertification, of which 80% had already been desertified by 2004. The country has also been suffering from large-scale land degradation caused by water erosion. Habitat destruction, unsustainable forest harvesting, pollution, and introduction of exotic species have imposed serious threats to the country's biodiversity. The government has made major advances in reforestation and afforestation but forest quality continues to be generally low, and there exists high pressure for the conversion of forested land to uses such as agriculture, urban development, or other construction.

Climate-related environmental problems will challenge the PRC's environment and economy for the foreseeable future, according to the national climate assessment report on the effects of global climate change scenarios. In 2007, total greenhouse gas (GHG) emissions from fossil fuel combustion in the PRC exceeded those from the United States for the first time, making the PRC the world's largest GHG emitter. In addition to its own contributions to climate change, global change threatens to (i) reduce the runoff for all watersheds and the availability of water across the country exacerbating water shortages and pollution in the northern PRC, (ii) increase flooding in the southern PRC, and (iii) inundate coastal areas. It is also expected to affect cropping patterns and reduce grain production by as much as 10%, reduce biodiversity, intensify desertification of grasslands, and increase morbidity and mortality from infectious diseases.

Climate change and environmental degradation are already imposing significant economic costs on the PRC. An assessment carried out by the Chinese Academy of Sciences in 2009 concluded that the total annual cost of resource and environmental degradation (the assessment took account not only of air and water pollution, but also of resource consumption and ecological degradation) amounted to 13.5% of GDP in 2005. The figure is considerably higher than those of Germany, Japan, United Kingdom, United States, and other developed economies and on par with countries such as Ghana, Mexico, and Pakistan. These estimates reflect the growth model of the PRC—high growth, high resource consumption and associated pollution—which makes decoupling environmental degradation from economic development a difficult task.

The Environment and Development Framework

The PRC's environmentally sustainable development challenge is arguably the most complex and difficult that any country has ever tried to confront. Over the past 30 years, since the modern period of economic reform began, the two most defining features of the development agenda have been persistent, rapid, and relentless economic growth accompanied by equally significant, even radical, economic and social changes. Much of the international discussion on the environment and development in the PRC fails to appreciate adequately the enormous challenges that economic growth and development are creating for environmental managers in the PRC.

The four most significant large-scale drivers of the environmental agenda discussed in the report are (i) the rapid pace of economic growth and development, (ii) the sectoral structure of the economy, (iii) the sources of energy used to drive the economy, and (iv) the increased urbanization.

Economic growth. The PRC's average annual real rate of economic growth over the past 3 decades has been 9.8% per annum. No other comparable country came even close to matching this performance. This extraordinary growth has been achieved in an environmentally profligate way. Economic development has been based on what has been described as a "high growth, high pollution" economy that makes it very difficult to decouple pollutant emissions from economic growth. One way of illustrating the nature of the PRC's "high growth, high pollution" mode of development is to consider the scale of the national economy and of the resources it consumes. In 2007, the PRC's GDP accounted for 6% of global GDP, but it accounted for 15% of the world's energy consumption, 54% of cement consumption, and 30% of iron ore consumption.

Economic structure. It is noted that development of the tertiary sector basically came to a halt at the end of the 9th Five-Year Plan. The economy has continued to be excessively reliant on investment, exports, and industrial development that, according to ADB analysis, has resulted in (i) declining total factor productivity, (ii) labor surplus, (iii) widening income inequality and regional disparities, (iv) high savings that constrain domestic demand as a source of growth, and (v) inhibition of tertiary sector development. Environmentally, this imbalance essentially creates more pollution per unit of economic growth than is necessary.

Energy. As the economy has grown, so too has overall energy consumption, although at a much lower rate than GDP growth due to steadily improving energy efficiency. However, the momentum on energy efficiency was reversed during the 10th Five-Year Plan, with the net effect that the economic efficiency of energy consumption in 2007 was only marginally better than it was in 2002. The environmental consequences of increased energy consumption are exacerbated by the economy's continued reliance on coal as the principal energy source, notwithstanding the government's huge investments in alternative energy production including wind, solar, hydro, and nuclear. The energy profile is a major factor influencing the quality of the atmospheric environment and will continue to represent a major challenge over the coming years.

Urbanization. The issue of urbanization is of immense significance to the PRC's future development since the higher the urbanization rate, the higher the potential for economic growth and for job creation. Increased urbanization will be an essential pillar supporting future growth and development, but it will also pose a variety of environmental challenges, including air and water pollution, solid waste management, and the loss of high-quality arable land.

These four factors are likely to be important drivers of the environmental agenda for many years to come, and certainly for the next decade. Any major progress in improving the quality of the ambient environment will be difficult unless changes can be made to the momentum of these issues.

Toward a Long-term, Macro-Environmental Strategy

The government recognizes the seriousness of the challenges and the need for a step-by-step approach that allows for sufficient time to make fundamental changes necessary for improvements. Against this backdrop and commencing in 2007, 50 academics from

the Chinese Academy of Sciences and the Chinese Academy of Engineering as well as hundreds of experts undertook a major long-term review of the PRC's environmental prospects and, after 2 years of work, the results of their analysis were published as the Macro Strategic Research Report on the PRC's Environment. The report, which was released at the Great Hall of the People in Beijing in April 2011, is the first of its kind for the PRC. The scope of this exercise extended beyond the framework of the traditional 5-year planning activities, looking forward as far as the year 2050, so as to provide a more comprehensive framework of what needs to be done to achieve the government's environmentally sustainable development objectives.

This CEA fully endorses the findings and recommendations of the macro-environmental strategy report. The report showed that, although the PRC's environment has improved in some regions, the overall situation continues to deteriorate as environmental pressure continues to increase. The country's overall environmental quality has not yet reached a turning point.

Measures recommended in the report would considerably reduce emissions of major pollutants by 2020, and environmental safety could be effectively guaranteed. By 2030, the aggregate emissions of all pollutants would be significantly reduced, and the overall environmental quality would be greatly improved. By 2050, the environmental quality would match the people's high quality of life as well as the country's status as a modern and powerful country. Many elements of the strategic road map are included, at least to some degree, in the 12th Five-Year Plan and its associated environment sector plan.

The environmental plan for 2011–2015 could reasonably be described as a continuation of the more balanced development approach that was fairly successful under the 11th Five-Year Plan, combined with certain logical augmentations to address new and emerging issues. It is also noted that the environmental plan addresses many of the priority issues identified in the macro-environmental strategy report. The key objectives of the environmental strategy for the 12th Five-Year Plan are:

- strengthening and expanding total emission control of pollutants,
- further improving people's living quality and standards by enhancing environmental management and strengthening protection of drinking water sources,
- promoting green development with environmental protection, and
- broadening efforts to address international environmental issues such as climate change.

In addition to the targets of reducing energy and carbon intensities that were included in the 12th Five-Year Plan Outline, the PRC government is also committing to (i) reduce carbon dioxide emissions per unit of GDP by 40%–45% by 2020; (ii) increase the share of nonfossil fuels in the primary energy consumption to around 15% by 2020; (iii) increase forest area by 40 million hectares by 2020; and (iv) strive to develop a green, low-carbon, and circular economy, and strengthen the research and development and dissemination of climate-friendly technologies.

Recommendations for Striving Toward an Environmentally Sustainable Future

The prospects for the environmental agenda under the 12th Five-Year Plan and beyond to 2020 will depend substantially on the progress in restructuring the economy, particularly the balance between the secondary and tertiary sectors and the role of large-scale, capital-intensive industries. The 11th Five-Year Plan had called for a change of course and promoted an environment-friendly and resource-efficient society, but not much success was realized.

As the government strives toward an environmentally sustainable future, it should keep in mind the following recommendations.

1. ***Removal of disincentives and change in the course of growth patterns.***

    - *Economic restructuring.* Economic growth should be redirected from the over-dependence on the manufacturing sector for export toward the services sector that depends on domestic demand. Essential to this shift is a reform of the resource prices to reflect such factors as scarcity and environmental externalities associated with resource consumption. Water, land, energy, mineral and extractive resources (particularly coal), and capital are the key resources that need attention.

    - *Fiscal reform.* To remove disincentives and growth patterns that undermine environmental sustainability, fiscal reform should accompany economic restructuring. Since the fiscal reforms of the mid-1990s, subnational, particularly sub-provincial, governments have been caught in an ever-tightening squeeze between the cost of implementing their health, education, welfare, and environmental obligations and the very limited sources of revenue available to them. They are becoming increasingly reliant on revenues from property development and loans contracted through "investment vehicles," which were established to bypass restrictions on their ability to issue bonds and borrow directly. In terms of environmental investments, this tends to focus the attention of local governments on investments that will produce short- to medium-term revenues rather than on investments that are needed to solve the environmental problems at hand but may not be revenue-generating. Some trial programs have already been undertaken to assess the feasibility of introducing property taxes (e.g., in Shanghai and Chongqing) and natural resources taxes (e.g., in Xinjiang Uygur Autonomous Region). Following a trial period in Xinjiang Uygur Autonomous Region, the PRC launched a new resource taxation system nationwide effective from November 2011. Consequently, oil and gas producers now face a tax of 5% of the sales value. The measure is expected to improve energy efficiency, combat pollution, and strengthen local government finances. However, the new tax system will not include coal, the source of about 70% of the country's total energy.

    - *Environmental investments.* Much of the PRC's environmental investment is made through special campaigns that are often hastily conceived and implemented to respond to environmental incidents or emergencies. This approach is inefficient, too "top-down," and extremely unpredictable in the

medium to long term. A more programmatic approach to environmental investment is needed with (i) timetables that spread across 5-year planning periods, (ii) increased flexibility for subnational governments to adapt programs to suit local conditions, and (iii) higher levels of grant financing for investments with significant externalities.

- *Urban development*. With continued urbanization becoming a central pillar of future economic development, significant improvements are needed in the planning and management of urban development. At present, there is an uncontrolled and often irrational quality to urban development that has much to do with the administrative hierarchy and the incentive systems that govern the behavior of local government officials. These incentive systems create a "rush to growth", regardless of whether the economics are favorable, and a proliferation of urban infrastructure that may not always be needed. Too much attention is being paid to the "quantity," instead of the "quality," of urban development. The government needs to (i) sustain and extend its financial commitment to the development of essential urban environmental infrastructure; (ii) look seriously at the incentive structure governing the work of municipal governments to improve its efficiency; and (iii) provide much better guidance and rewards for the implementation of environmentally sustainable urban development, which makes efficient use of scarce land and other natural resources and maximizes the application of reduce-reuse-recycle strategies.

2. ***Expanded use of market-based instruments to control pollution.***

- The next great pollution control challenge that needs to be addressed is nonpoint source (NPS) pollution. But this will require coordinated efforts between several different ministries, most importantly, the Ministry of Environmental Protection (MEP) and the Ministry of Agriculture, as well as coordination across administrative boundaries (e.g., transcounty and/or transprovincial). Given the significance of the challenge and the complexity of the measures required to control NPS pollution, consideration should be given to the creation of a high-level leading group, perhaps under the auspices of the National Development and Reform Commission (NDRC), to develop and supervise implementation of a national action plan.
- Further progress also needs to be made on using market-based mechanisms as an adjunct to the command-and-control approach to NPS pollution control. Some measures have already been taken (e.g., SO_2 trading for the "two control zones"), but much more could be done, particularly in relation to water pollutants such as nutrients and/or COD. The government, in particular through the work of MEP and the NDRC, is advocating the application of eco-compensation principles to solve certain intractable environmental problems such as the control of rural NPS pollution. Eco-compensation is another form of market-based mechanism, and the work on this subject also needs to move along as quickly as possible.

3. *Legal reform to clarify responsibilities and encourage cooperation.*

    - The Environmental Protection Law (EPL) needs to be updated to make it relevant to the 21st century. Revisions are required to (i) establish that MEP is the sole "competent department" tasked with the unified supervision and management of the environmental protection work of the entire nation, and that the environmental work of other departments must be consistent with and approved by MEP; (ii) confirm that, in the event of conflicts with other laws, the provisions of the EPL prevail; (iii) create unambiguous authority for inspectors from MEP and its subnational counterparts to enter and inspect enterprises and other locations that are, or are believed to be, sources of pollution; and (iv) develop legal frameworks for cross-jurisdictional coordination and cooperation.

Role of the Asian Development Bank

ADB has increased operational emphasis on environment under its Strategy 2020, which is one of the core areas of operations and one of the three strategic agendas. Environmental sustainability will continue to be a major strategic objective of ADB support to the PRC and will continue to be fostered in all of the sectors in which ADB operates, as well as support the PRC's delivery of environmental regional and global public goods. Climate change concerns will be both a focus of ADB policy and lending support in the priority sectors and a key consideration to be incorporated in project designs. Further, ADB's support will be firmly aligned with the objectives of the 12th Five-Year Plan to enhance environmental sustainability and mainstream climate change mitigation and adaptation. ADB will support the achievement of a growth process that is cleaner and more sustainable by prioritizing renewable energy and energy efficiency, encouraging use of low-carbon transport systems, protecting degraded rural ecosystems, and encouraging development of livable urban cities. ADB will add value by seeking innovative projects that simultaneously improve the environment while contributing to inclusive growth and poverty reduction.

A key element of ADB's operations for environment and natural resource management will be the sustainable management of land and water resources. Support will be provided for wetland protection, lake restoration, sustainable forest management, and land degradation prevention. To foster more sustainable rural resource use, ADB will assist the government in piloting eco-compensation schemes and encouraging use of resource-saving technologies. Climate change adaptation support will focus on climate resilience enhancement in water, forest, and fragile land areas.

ADB will also contribute to making the PRC's urban areas more "livable" by encouraging "cleaner" modes of urbanization. Support will be provided to improve urban planning, combat air pollution, address solid waste, encourage market-based systems for water pollution control, and help clean up selected cities along major river basin. In the transport sector, ADB will promote low carbon transport, which will involve development of (i) urban intermodal transport hubs and related logistical services; (ii) inland waterways as an integral part of transport; (iii) lower emission transport; and (iv) enhanced railway

efficiency through containerization. Improved multi-modal transport systems and better transport and trade logistics will be supported to save energy and reduce transport costs.

ADB will contribute directly to the PRC's carbon-intensity reduction and climate change mitigation goals. In the energy sector, ADB will assist the Government's efforts to phase out small-scale and inefficient power plants, improve urban energy efficiency, demonstrate cutting-edge renewable energy technologies, and pilot cutting-edge clean coal technologies. ADB will also promote the development of new financing instruments, including carbon financing to boost the country's capacity for financing environmental improvements.

ADB pursues a balanced mode of safeguard work in its operations in the PRC. ADB developed its Safeguard Policy Statement (SPS) in 2009 and made it effective in 2010. For environment, the SPS (i) brings in new policy principles in the areas of biodiversity protection and sustainable management of natural resources, occupation and community health and safety, and physical cultural resources; (ii) specifies pollution prevention and abatement policy principles; (iii) introduces climate change mitigation requirements; (iv) defines a project area of influence to encompass direct, indirect, and induced impacts; (v) specifies need for the environmental assessment process to mitigate impacts on livelihoods caused by project activities other than land acquisition, such as loss of assets or restriction on land use; and (vi) requires the preparation of full project environmental assessments, instead of summary assessments. The SPS also (i) enhances consultation, participation, and monitoring requirements; (ii) requires establishment of local grievance redress mechanisms; (iii) places more emphasis on results during project implementation; and (iv) requires the conduct of supervision missions with the participation of ADB's safeguard specialists.

Finally, experiences from the PRC, where environmental management practices have rapidly advanced in recent years, could offer valuable lessons for other developing member countries (DMCs). Developing and sharing knowledge on environmental management practices and innovations will have an increasing role in the partnership between ADB and the PRC. The potential areas that could benefit other DMCs are (i) practices of eco-compensation and payments for ecological services; (ii) urban wastewater management; (iii) rural biomass renewable energy development; and (iv) low-carbon emissions technologies.

1. Introduction

This country environmental analysis (CEA) for the People's Republic of China (PRC) has been prepared as an input to the preparation of the Asian Development Bank's (ADB) new country partnership strategy (CPS) for the PRC, which was endorsed by ADB's Board of Directors on 28 May 2012. The scope and content of the CEA are based on ADB operational guidelines, and are intended to provide information necessary for consideration in the design of the CPS. The CEA is also envisaged to

i. make a contribution to the government's deliberations on environmental issues and how best to address them,

ii. act as a document of public information regarding the current state of the environment in the PRC and the government's environmental planning and objectives, and

iii. function as a source document for ADB staff and consultants in mainstreaming environmental concerns in ADB's operations in the PRC.

This is the second CEA for the PRC and updates the first CEA that was published in 2007 (ADB 2007). The first CEA was published at a time when the country had just commenced implementation of its 11th Five-Year Plan (2006–2010). This updated CEA is being published as the country commences implementation of the 12th Five-Year Plan (2011–2015), providing an opportunity to look back at the government's environmental performance during the 10th and 11th five-year plans, draw conclusions, and provide guidance as the government contemplates the environmental plan for the 12th five-year period.

The 10th Five-Year Plan (2001–2005) was a period of explosive and largely unprecedented economic growth, but environmental performance was unsatisfactory; nine of the 20 targets of the environmental plan were not met, making it the only sector program that failed to fully meet its objectives.

Economic growth was sustained into the 11th Five-Year Plan, although at a more subdued rate (averaging at 11.2%); and environmental performance improved significantly, with 11 of 13 objectives being met. This improved performance was attributable to a number of factors but, arguably, the most important were some notable shifts in the government's strategic approach to growth and development. These shifts responded to the long-standing criticisms of the PRC's development policies that the nation was too focused on economic growth at almost any cost, too little concerned with environmental sustainability, and that its approach to environmental management was not sufficiently mainstreamed.

Thus, for the 11th Five-Year Plan, the State Council placed environmental protection at the top of the government agenda by proposing a shift in the whole mode of economic development to place more emphasis on the quality—rather than just the quantity—of growth, with the aim of building a "harmonious, resource-efficient and environment-friendly society" as an essential state policy. The transformation of the mode of economic growth—and restructuring of the economy that would necessarily be attendant to that transformation—was intended to lay a solid foundation for reversing the trend of structural and regional environmental pollution and ecological destruction that had characterized the PRC's development during the preceding 15–20 years.

Looking back on the experience of the 11th Five-Year Plan, and as will be discussed in further detail under the section on Environmental Strategy for the 12th Five-Year Plan, page 138, it is concluded that the government was not successful in significantly altering the overall mode of economic development to favor increased environmental sustainability. Thus, this remains an important item of "unfinished business" that must be pursued more vigorously during the 12th Five-Year Plan. Nevertheless, some significant steps were taken in constructing the institutional and regulatory frameworks that will be essential in achieving a state of environmentally sustainable development. Such important measures included

i. the creation of the Ministry of Environmental Protection (MEP) as a cabinet-level institution, with representation on the State Council,

ii. strengthening environmental enforcement by establishing six regional supervision centers of MEP to closely monitor the environmental performance of subnational levels of government,[1]

iii. further progress in strengthening the legal framework for environmental protection by amending existing laws and issuing new regulations and guidelines, and

iv. mainstreaming the climate change agenda into the work of all relevant departments.

Looking forward to the 12th Five-Year Plan, the government will once again try to shift the mode of economic development to a more environmentally sustainable direction. Important and relevant initiatives under the 12th Five-Year Plan will include a moderation in the gross domestic product growth objectives (to a target of about 7% per annum); more efforts to restructure the economy to promote greater domestic consumption; further initiatives to close the income gap, including raising the minimum wage and strengthening social safety nets; and further improvements in resource use efficiency, particularly in the use of water and energy.

This CEA summarizes the existing state of the environment in the PRC, outlines relevant aspects of the policy and institutional frameworks for environmental protection (including the government's position and strategic thinking on the climate change agenda), reviews environmental progress during the 11th Five-Year Plan, and summarizes the government's proposals for the 12th Five-Year Plan. The report concludes by shifting focus on ADB's environmental program for the PRC that was delivered during the 11th

[1] ADB has been supporting the establishment of the regional supervision centers through TA 4741-PRC: Institutional Development of the State Environmental Protection Administration's (SEPA) Regional Supervision Centers.

Five-Year Plan through investments in agriculture, environment and natural resources, urban development, energy, and transport sectors; and making recommendations on projects and programs that should be considered to support the government's environmental objectives under the 12th Five-Year Plan.

The CEA comprises eight chapters, as follows:

- Chapter 1 provides a general introduction;
- Chapter 2 discusses four important large-scale drivers of the environment agenda in the PRC—the extraordinary rate of growth that has been sustained for the past 3 decades; the structure of the economy, and the continuing dominance of the industry sector; the energy sector; and the urbanization rate. The objective is to emphasize the fact that progress on the state of the environment is dependent on much more than laws, regulations, institutions, and objective performance indicators. The environment is a cross-cutting theme that needs to be taken into account in all sectors and at all levels. Environmental progress cannot be made within an economic development framework that is inimical to environmentally sustainable development;
- Chapters 3 and 4 provide a general survey of the current state of the environment in the PRC. Chapter 3 focuses on the state of the natural environment (land resources, biodiversity, the state of the forests), while Chapter 4 focuses on the three main pollution control challenges (water, air, and solid waste management);
- Chapter 5 discusses the climate change agenda. This is a cross-cutting issue that impinges on virtually every aspect of the environment and development agenda. It is covered in a separate chapter as a means of drawing attention to the seriousness with which the government is confronting this issue;
- Chapter 6 outlines the policy and institutional arrangements for environmental protection and summarizes the main institutional and regulatory changes that took place during the 11th Five-Year Plan as part of the government's efforts to broaden its approach to the environmental agenda. Chapter 6 also touches on the fiscal dimensions of environmental management to draw attention to the need for fiscal reform to address financial challenges being experienced by subnational and, more particularly, subprovincial governments in the PRC;
- Chapter 7 outlines the government's long-term thinking on the environmental agenda, discusses the objectives and achievements of the completed environmental plan for the 11th five-year planning period, and provides a broad outline of the contents of the environmental plan for the 12th five-year planning period, as it is understood at the time of completion of this report;
- Chapter 8 outlines the environmental dimensions of ADB's country partnership program during the 11th Five-Year Plan and makes suggestions, in light of the issues discussed in the preceding parts of the CEA, on initiatives that were recommended for inclusion in the new CPS; and
- Chapter 9 lists references cited in the text.

2. The Environment and Development Framework

2.1 Introduction

The environmentally sustainable development challenge of the People's Republic of China (PRC) is arguably the most complex and difficult that any country has ever tried to confront. Over the past 30 years, since the modern period of economic reform began, the two most defining features of the development agenda have been persistent, rapid, and relentless economic growth accompanied by equally significant, even radical, economic and social changes. Much of the international discussion on the environment and development in the PRC fails to adequately appreciate the enormous challenges that economic growth and development are creating for environmental managers in the PRC.

As an introduction to Chapters 3 and 4 on the present state of the environment, this chapter provides a brief overview of the four key macro-level developments that strongly influence the current and potential future environmental situations, namely (i) the pace of economic growth and development, (ii) the sectoral structure of the economy, (iii) the sources of energy used to drive the economy, and (iv) urbanization. Particular attention is paid to the aspect of urbanization, which will be the most significant developmental and environmental issue facing the government in the coming years. The objective of this discussion is to emphasize the fact that progress on the state of the environment is dependent on much more than laws, regulations, institutions, and objective performance indicators. The environment is a cross-cutting theme that needs to be taken into account in all sectors and at all levels. Environmental progress cannot be made within an economic development framework that is inimical to environmentally sustainable development.

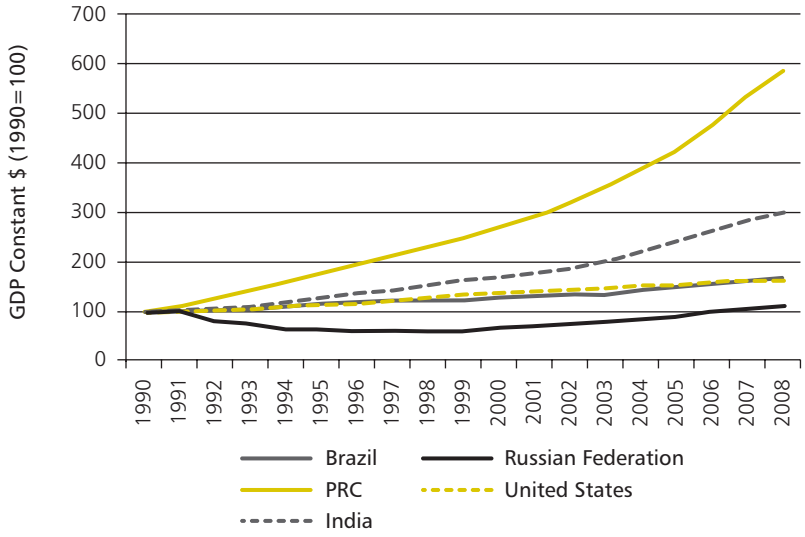
2.2 The Pace of Economic Growth and Development

Figure 1 illustrates the real rate of economic growth experienced in the PRC over the 18-year period 1990–2008 and compares it with the growth experienced in the three other "BRIC" countries[2] and the United States (US). The PRC's average annual real rate of economic growth over the period has been 9.8% per annum. As shown, none of the other countries included in the graph came even close to matching this performance.

This sustained growth has significantly changed the world and the PRC's place within it. At the time of preparation of the last country environmental analysis (CEA), the PRC was the world's sixth largest national economy. By 2009, when gross domestic product (GDP)

[2] BRIC = Brazil, the Russian Federation, India, and (the People's Republic of) China.

Figure 1 **Real Gross Domestic Product Growth of BRIC Countries and the United States, 1990–2008**



BRIC = Brazil, the Russian Federation, India, and (the People's Republic of) China, PRC = People's Republic of China, GDP = gross domestic product.
Sources: World Bank, World Development Indicators based on the World Bank National Accounts data; Organisation for Economic Co-operation and Development (OECD) National Accounts.

had increased to $4.909 trillion (calculated at the official exchange rate), the PRC had become the world's third largest economy[3] and, by the end of the first quarter of 2010, it had become the world's second largest economy.

The increase in the PRC's wealth, at current prices, has broadly kept pace with population growth. Nominal average per capita income very closely tracked GDP growth and reached CNY30,000 in 2010 ($4,760 at the exchange rate that applied at that time) according to the National Bureau of Statistics (NBS). Nevertheless, real growth in average per capita income has consistently lagged behind real GDP growth since the mid-1980s.

This extraordinary growth has been achieved in a very profligate way from the environmental point of view. Economic development has been based on what has been described as a "high growth, high pollution" economy that makes it very difficult to decouple pollutant emissions from economic growth.[4] One way of illustrating the nature of the PRC's "high growth, high pollution" mode of development is to consider the scale of the national economy and of the resources it consumes. In 2007, the PRC's

[3] The comparison is based on the World Bank's rankings (World Development Indicators [WDI] database, World Bank, Washington, DC). According to the WDI database, the world's biggest economy in 2009 was the US (GDP, $14.256 trillion) and the second biggest was Japan (GDP, $5.067 trillion). The European Union (EU) is not included in the comparison as it is not a country. If the EU (GDP, $12.456 trillion) is included, Japan moves into third place and the PRC moves into fourth place.

[4] World Bank (2010b), p.202.

GDP accounted for 6% of global GDP, but it accounted for 15% of the world's energy consumption, 54% of cement consumption,[5] and 30% of iron ore consumption. In the words of an eminent group of researchers from the Chinese Academy of Sciences (CAS), "High resource consumption, severe environmental pollution and ecologic destruction have become the byproducts of rapid economic growth (in the PRC)."[6]

The continuation of this mode of growth significantly increases the challenge of achieving the government's short- and medium-term environmental objectives.

2.3 Sectoral Structure of the Economy

The PRC's phenomenal economic growth could not have been achieved without significant changes in the structure of the economy and the patterns of employment. At the time that economic reform commenced in the early 1980s, the primary sector generated about 28% of GDP, the secondary sector about 48%, and the tertiary sector accounted for only 24%.[7] The majority (76%) of jobs accounted for in the government's statistics at that time were located in rural areas.

Thirty years later, in 2009, the role of the primary sector had declined significantly to 11%, the role of the secondary sector had increased to 47%, and tertiary sector contribution had increased to 43%. The trends are shown in Figure 2. The contribution of the tertiary sector grew fairly consistently through the 1990s until it produced about 40% of GDP in 2001. From 2001 to 2008, however, tertiary sector contribution stopped growing and even declined slightly between 2002 and 2008. At the same time, the steady decline in the contribution of the secondary sector during the 1990s was reversed in 2002 and rose to a peak in 2008 (its highest level of contribution to GDP in the preceding 30 years) before declining slightly in 2009.

These trends are a reflection of the government's growth strategy, which included heavy reliance on investment and exports for economic growth, with less focus on stimulation of domestic demand and a resulting emphasis on the role of industry, especially heavy industry, over services.[8]

From an environmental point of view, these trends are a matter of concern. It is difficult to see how the PRC can meet either its social or energy efficiency objectives unless it restructures to increase the role of the services (tertiary) sector—a fact that is explicitly recognized in the 11th Five-Year Environmental Plan, which noted that the economy relies too heavily on the secondary sector while the development of the tertiary sector is too slow.[9] The social objective of such restructuring would be to provide the jobs necessary

[5] Cement production has continued to increase since that time. In 2009, total production was 1.63 billion tons, an 18% increase from the previous year (Research and Markets 2010). The PRC's per capita cement consumption of 1,000 kilograms (kg) is the highest in the world. By way of comparison, India's per capita cement consumption is only 150 kg.

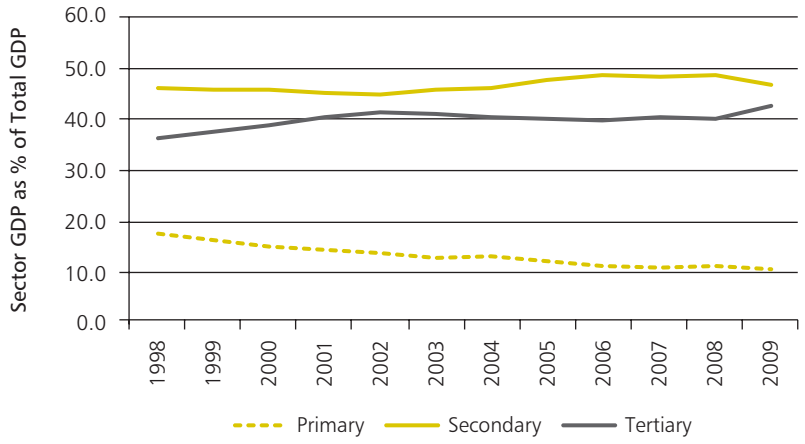
[6] CAS (2009).

[7] In the PRC statistical system, the primary sector includes agriculture, forestry, animal husbandry, and fisheries. The secondary sector includes mining, manufacturing, utilities, and construction. The tertiary sector is the residual (Gong 2002).

[8] Kuijs (2009).

[9] ADB (2007), p.74.

Figure 2 **Composition of Gross Domestic Product by Sector, 1998–2009**



GDP = gross domestic product.
Source: National Bureau of Statistics. 2010. *[The People's Republic of] China Statistical Yearbook.* Beijing.

to absorb the vast numbers of people who are moving off the farm and will continue to move off the farm as the country develops further. In general, the tertiary sector produces far more jobs per unit of investment than does the secondary sector. The contribution to environmental objectives arises from the fact that, superficially at least, the tertiary sector produces less environmental impact per unit of output than does the secondary sector.

The current imbalance in the economy, which appears to be restricting tertiary sector development, is a matter of greater concern than just the environment; it is influencing the whole pattern of development in the PRC. As noted in a recent ADB report, "Excessive reliance on investment, exports, and industrial development has created structural imbalances that jeopardize future growth. These include (i) declining total factor productivity levels resulting from overinvestment and excess capacity in key industries; (ii) labor surpluses owing to the capital-intensive nature of the growth model; (iii) widening income inequality and regional disparities due to the geographical bias of export-oriented industry; (iv) high savings that constrain consumption and downplay the role of domestic demand as a source of growth; and (v) an allocation of resources that undermined the development of services, particularly the provision of social services."[10]

2.4 Energy

The strong role played by the industry sector in the PRC's growth over the past 2 decades, combined with a huge program of public infrastructure development, increased personal consumption expenditures, and the development of a "car economy," has

[10] ADB (2010).

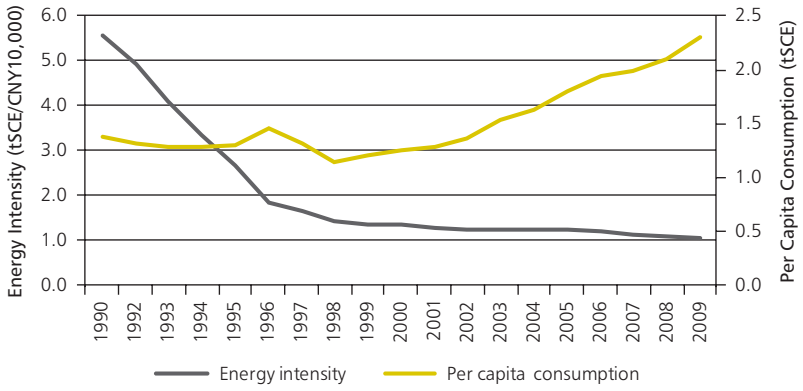
resulted in very large absolute increases in energy consumption, although much less significant in relative terms. The rate of increase in energy consumption has been only about half of the rate of GDP growth (Figure 3).[11]

Data from the International Energy Agency (IEA) suggest that the trend toward increased energy efficiency took a turn for the worse during the 10th Five-Year Plan period before turning for the better during the 11th Five-Year Plan period (Figure 4). The net effect was that the economic efficiency of energy consumption in 2007 was only marginally better than it was in 2002.

While the long-term trend in overall energy use efficiency has been in the right direction, per capita energy consumption has been headed in the opposite direction, increasing by 267% between 1990 and 2009 (Figure 3). The PRC's per capita energy consumption is now 25% more than the world average (1.82 tons of standard coal equivalent (tSCE) per capita), although still very much less than the US average (7.75 tSCE per capita).[12]

The environmental consequences of increased per capita consumption are exacerbated by the economy's continued reliance on coal as the principal energy source, notwithstanding the government's huge investments in alternative energy production including wind, solar, hydro, and nuclear.[13] Thus, in 1990, coal provided 76% of total energy consumed

Figure 3 **Economic Energy Intensity and Per Capita Energy Consumption, 1990–2009**



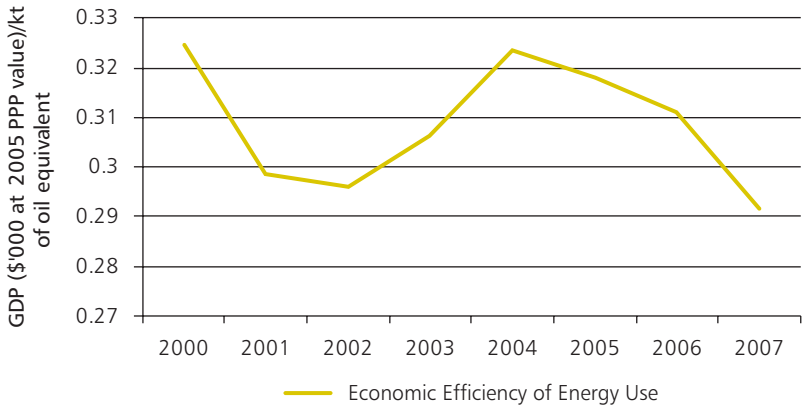
tSCE = tons of standard coal equivalent.
Source: National Bureau of Statistics. 2010. *[The People's Republic of] China Statistical Yearbook.* Beijing.

[11] Between 1990 and 2008, GDP (at constant prices) increased by 586% while total energy consumption increased by 290%, almost exactly half as much. (Data quoted are from the 2009 National Statistical Yearbook of the PRC's National Bureau of Statistics).

[12] Data from the IEA website (http://www.iea.org/stats/index.asp).

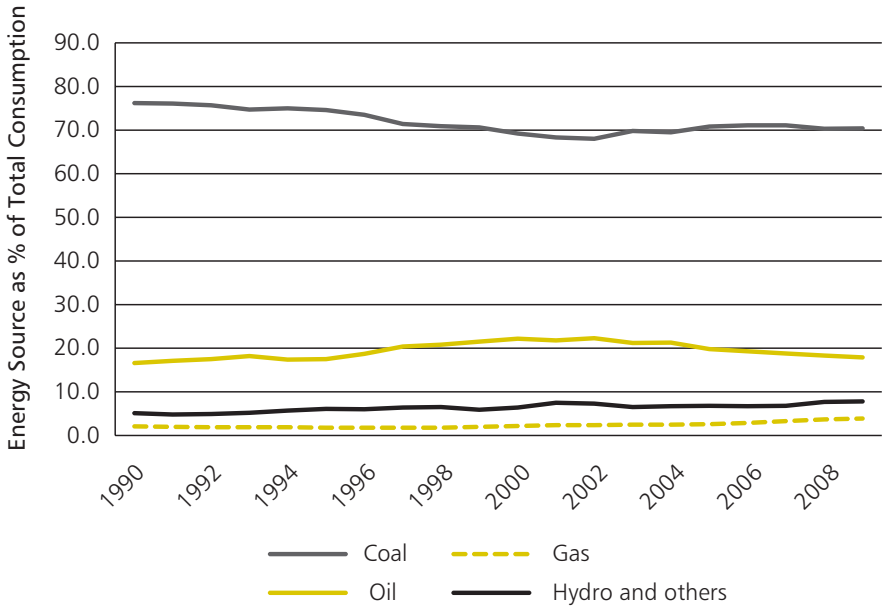
[13] A recent study of clean energy investments by G-20 countries (Pew Charitable Trusts 2010) concluded that, in 2009, the PRC spent more money on clean energy development ($34.6 billion) than any other G-20 country. The PRC's clean energy expenditure was 86% higher than that of the G-20's second biggest investor (the US at $18.6 billion) and represented a 145% increase over the preceding 5 years. The report credited the PRC's strong clean energy policy and development framework for its achievements, making particular mention of the government's "ambitious targets for wind, biomass, and solar energy" as being important driving forces.

Figure 4 **Economic Efficiency of Energy Consumption, 2000–2007**



GDP = gross domestic product, kt = kiloton, PPP = purchasing power parity.
Source: International Energy Agency. 2008. *World Energy Outlook 2008*. Paris: OECD/IEA.

Figure 5 **Components of the Energy Mix in the People's Republic of China, 1990–2008**



Source: National Bureau of Statistics. 2009. *[The People's Republic of] China Statistical Yearbook.* Beijing.

in the PRC and, by 2008, this had declined only slightly to 69%. In contrast, and over the same 1990–2008 period, the proportion of total energy generated by renewables increased from 5.1% to 8.9%—a 75% increase, but from a low base.

Furthermore, and as shown in Figure 5, most of the declines in the relative importance of coal took place prior to and including 1998, at which time the role of coal had already

been reduced to about 70% of the total mix. Since then, there have been no further significant and sustained reductions.

The PRC's energy profile is a major factor influencing the quality of the atmospheric environment and will continue to represent a major challenge in the coming years. It is almost impossible to foresee a medium-term future (10–20 years) in which coal does not maintain its leading position in the energy supply mix.

2.5 Urbanization

Significance of Urbanization

The issue of urbanization is of immense significance for the PRC's developmental future due to its close connection to the rate and form of economic development. The urbanization rate (i.e., the proportion of the total population that lives in urban areas) can have a positive effect on and greatly enhance economic development since urban areas, in general, allow many goods and services to be produced and traded more efficiently than in nonurban areas. Thus, the higher the urbanization rate (other things being equal), the higher the potential for economic growth and for job creation.[14]

There can be little doubt that urban areas are disproportionately important in terms of the national accounts of most countries because the economic productivity of urban land is so much higher than nonurban land.[15] As a specific example, it has been estimated that the average economic productivity of metropolitan land in the US is more than 18 times higher than that of nonmetropolitan land.[16]

A key urbanization question for the PRC, which is also the subject of much debate among both Chinese and foreign experts, is whether the PRC is "under-" or "over-" urbanized given the current state of national economic development and, in any event, at what rate should urbanization increase in the coming years and decades. These issues are environmentally important because urban development poses a wide range of environmental challenges that are already causing problems in the PRC and are having repercussions around the world. The growth of the PRC's cities is not only being accompanied by serious water and air pollution problems, but is also largely responsible for the PRC becoming the world's biggest consumer of steel, cement, and other resources used to construct buildings, roads, and infrastructure necessary to support increased urbanization, the supply of which extends environmental effects offshore.[17]

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[14] United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2005), p.19.

[15] Large cities typically produce a significant share of their country's GDP. For example, in the Asia region, Bangkok generates 38% of Thailand's GDP, Manila generates 25% of the GDP of the Philippines, and Shanghai generates 12% of the PRC's GDP (UNESCAP 2005).

[16] Global Insight (2006). In particular, for 2006, it was estimated that GDP per hectare (ha) of US metropolitan areas was $46,151, which was 18.4 times higher than the comparable figure for nonmetropolitan areas ($2,506).

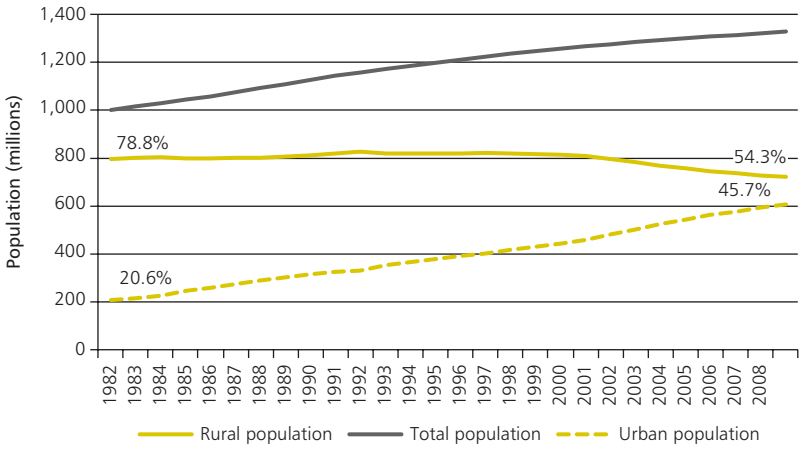
[17] Kamal-Chaoui et al. (2009), p.6.

At the end of the 1970s, the PRC was a profoundly rural country, with an urbanization rate of only 18%. By 1980, the urbanization rate had increased to only 20%, but even at that early stage, the PRC's urban population already exceeded that of the US which, hitherto, had the world's largest urban population. By the end of 2008, the official urbanization rate had more than doubled to 45.7%.

Figure 6 plots the changes in the PRC's total, urban, and rural populations between 1982 and 2008.[18]

Figure 6 was structured so as to highlight the numerical significance of the changes in the urbanization rate experienced over the period covering 1982–2008. During this period, the urbanization rate increased from 20.6% to 45.7%, an overall increase of 122% and an average annual increase of 0.94%. However, this was the result of a 180% (391.2 million) increase in the actual urban population.[19] That increase in the urban population exceeded the current total population of the US by more than 25%. This urbanization process and the rural–urban migration associated with it have been described as "the largest peacetime movement of people in history."[20]

Figure 6 **Urban and Rural Population Trends, 1982–2008**



Source: National Bureau of Statistics. 2009. *[The People's Republic of] China Statistical Yearbook*. Beijing; Zhou (2009).

[18] Plotting the population data is complicated by the fact that the PRC's National Bureau of Statistics changed its methodology for classifying urban and rural residents for the Fifth National Census (carried out in 2000) to bring the PRC's practices more in line with international standards. In subsequent statistical yearbooks, data for the preceding years were adjusted to match up with the 2000 data, which had the effect of overstating the growth rate of the urban population during the 1990–2000 period. The data plotted in Figure 6 are corrected data that were generated by Prof. Zhou Yixing of the Peking University as part of a study of urbanization prepared for ADB to provide a more accurate picture of recent urban growth in the PRC (Zhou 2009).

[19] With respect to the rural population, it declined by 31% from 78.8% in 1982 to 54.3% in 2008. The absolute size of the rural population, however, only declined by 78.8 million, or about 10%.

[20] World Bank (2009a).

This extraordinary increase in urban population has been achieved without any substantial development of urban slums, another aspect of the PRC's development, which is arguably unique in the world.[21] One of the main factors underlying this achievement is the high level of infrastructure investment that the government has made (almost 20% of GDP in 2004 according to one estimate[22]) to provide the housing and services necessary to accommodate such growth.

A final characteristic of note regarding the pattern of urbanization in the PRC is the number and size distribution of cities. Table 1 shows the size distribution of the PRC's 652 statutory cities as of 2005 based on a recent analysis by the Organisation for Economic Co-operation and Development (OECD).

Table 1 **Cities of the People's Republic of China, by Population Size, 2005**

	Population Size of Cities					
	≥10 million	5 million–10 million	1 million–5 million	0.5 million–1 million	<0.5 million	Total
No. of cities	2	6	61	90	495	652
% urban population	5.9%	6.8%	22.0%	11.5%	18.4%	64.6%

Source: Derived from Kamal-Chaoui et al. (2009), p.20, (Table 4), which was based on the Ministry of Construction's *2006 Urban Construction Yearbook* and the National Bureau of Statistics' *2006 [The People's Republic of] China Statistical Yearbook.*

At the prefectural level, there are 287 cities as of 2009 with urban population size distribution as follows:

> 4 million	2 million–4 million	1 million–2 million	0.5 million–1 million	0.2 million–0.5 million	< 0.2 million
14	28	82	110	51	2

There are several notable features of urbanization in the PRC, and these include the following:

i. The small number of "megacities" (population: ≥10 million)—there are only two, Shanghai and Beijing—and the comparatively small number of people who live in them (only about 35 million; the comparable figure for India is 58 million).[23] This is partly due to past decisions by the government to restrict migration into very large cities in favor of smaller cities, and partly an indirect effect of the PRC's heavy reliance on industry sector development to drive GDP growth, militating

[21] This is not to say that slums or "slum-like" areas are not a feature of urban life in some parts of the PRC. Most cities still have examples of dilapidated old workplaces and their associated housing compounds in inner city areas, although these are progressively being redeveloped. Also, on the fringes of major, fast-growing cities, migrants have created small enclaves where housing quality can be variable (Yusuf and Saich 2008, p.9). Nevertheless, these problems are miniscule compared to those being experienced by most other countries undergoing the same economic transformation being experienced in the PRC.

[22] Yusuf and Saich (2008).

[23] Although Chongqing has about 30 million people, it is not considered a "city", but rather an "urban area."

against tertiary sector development, which is generally associated with higher population densities and the development of very large cities;[24]

ii. The large percentage of the total urban population (22%) that is located in cities with populations between 1 million and 5 million. These are also believed to be the cities that have been growing fastest in recent years due to a combination of in-migration plus the movement of cities that were previously in the 0.5 million–1 million size class into the next higher class due to organic growth; and

iii. The large proportion (about 35%) of the urban population that is not accounted for at all in the PRC's statutory cities.[25] This "missing" urban population, amounting to some 199 million people in 2005, is located in the PRC's approximately 27,000 statutory towns, creating a substantial management problem in terms of the delivery of urban services. The OECD characterized these towns as having "…far lower population densities than the central metropolitan areas…; comparatively weaker control over conversion of land for urban development, leading to suburban sprawl; limited and, in many cases, rudimentary social services; small and scattered, labor-intensive enterprises; lower levels of human capital…; limited fiscal capacities; and governance systems largely designed to manage farm-based rather than urbanizing economies."[26]

Urbanization Projections

Many experts consider the PRC to be "under-urbanized" given its overall state of economic development,[27] while a key element of its long-term growth strategy should be to sustain the annual increase in the urbanization rate at 1% per annum or higher with a view to reaching an urbanization rate of 70% by 2050.[28]

Other experts would argue that the current urbanization rate is reasonable and about right when compared with other comparable countries when they were at a similar stage of development as the PRC. They also argue that this rate is reasonable if the PRC's urbanization rate is inflated to account for the "uncounted urban population" (i.e., urban migrants who are registered as living in rural areas but actually live in urban areas).[29] These analysts would argue that the annual rate of increase should be controlled to something considerably less than 1%, while more attention is paid to improving the quality of urban growth rather than just the quantity.

The urbanization objective contained in the 12th Five-Year Plan (i.e., to reach an urbanization rate of 60% by 2030) implies an average annual increase considerably less than 1% and is consistent with the more cautious end of the range of urbanization

[24] The Economist (2010), p.81.
[25] "Statutory" is used in this report to denote cities that have been formally designated as cities by the State Council.
[26] Kamal-Chaoui et al. (2009), p.41.
[27] Some examples include Li and Zhao (2003), Chang and Brada (2006), and Yueng (2006).
[28] Yueng (2006), p.3
[29] Zhou (2009), p.7.

Table 2 **Urban Population Projections, 2005–2025**

Year	Projected Total Population (billion)	Projected Urban Population (billion)			
		Urbanization Scenario			
		High	Medium	Moderate	Low
2005	1.302	0.560	0.560	0.560	0.560
2010	1.337	0.655	0.641	0.629	0.615
2015	1.369	0.753	0.725	0.696	0.671
2020	1.390	0.848	0.806	0.757	0.723
2025	1.396	0.935	0.880	0.810	0.768
Increase 2005/2025	0.094	0.375	0.320	0.250	0.208
% Increase 2005/2025	7.2%	67%	57%	45%	37%

Source: Study team projections.

opinions. The consequences of even a low rate of urbanization increase—in terms of the absolute numbers of people involved—are likely to be significant although not quite as significant as some analysts would posit.

Table 2 sets out some urban population growth scenarios that were developed as part of this study based on the average of two population growth projections that are consistent with recent statements from the government that it expects total population to peak at around 1.4 billion by about 2025.[30] The table summarizes a series of growth projections through to 2025, using a base population for 2005 of 1.302 billion, an urbanization rate of 43%,[31] and a series of four development scenarios, as follows:

i. A high urbanization development scenario in which the urbanization rate increases at a constant rate of 1.2% per annum, reaching urbanization rates of 61% by 2020 and 67% by 2025;[32]

ii. A medium urbanization development scenario of 1% increase per annum, reaching urbanization rates of 58% in 2020 and 63% in 2025;

iii. A moderate urbanization development scenario based on a variable rate of between 0.73% and 0.8% increase per annum, which would result in urbanization rates of 54% in 2020 and 58% in 2025; and

iv. A low projection of 0.6% increase per annum, which would result in urbanization rates of 52% in 2020 and 55% in 2025.

[30] The total population projections are the average of two somewhat similar projections. The first is by the International Institute for Applied Systems Analysis (IIASA) in Austria (Cao 2008), and the second is by the US Census Bureau (http://www.census.gov/ipc/www/idb/country.php, accessed 12 October 2010).

[31] These assumptions were based on Zhou (2009). The projection ends in 2025 because that is when total population is projected to peak. The size of the urban population will continue to increase thereafter, given the assumptions of the projections, although in ever decreasing increments. As of 2011, total population has been reported at 1.347 billion and urban population at 0.691 billion, or an urbanization rate equivalent to 51.27%.

[32] This is by no means at the upper limit of possibilities. The rate of increase between 2000 and 2004 inclusive ranged from 1.23% to 1.43%. Some analysts have suggested that the objective should be to increase the urbanization rate by as much as 1.5% per annum for the foreseeable future.

The urbanization objectives contained in the 12th Five-Year Plan are closest to scenario (iii).

The apparent minor differences in the urbanization growth assumptions have significant implications in terms of the absolute increases in the urban population. Total population is projected to increase by only 7.2% between the 2005 level and the peak in 2025 but, according to the assumptions made, the urban population will increase by between 37% (208 million) for the low-growth scenario, and 67% (375 million) for the high-growth scenario.[33]

While these projected increases are very large, it must be noted that the midpoint of the range of possibilities (an increase of 291 million) is somewhat similar to the increase in urban population that has already been experienced over the 26-year period between 1982 and 2008.[34] The main difference is that the PRC, in 2011, is much better positioned by every measure—financially, technically, and managerially—to handle a growth level of these proportions than it was in 1982.

In summary, it may be concluded that the PRC is facing a substantial urbanization challenge over the next 15 years but, numerically, it is nothing that has not already been dealt with. Provided that the necessary financial and human resources are used and that the lessons learned from the past 20 years of experience are fully applied, there is no reason why the challenge cannot be met.

Environmental Implications of Urbanization

Perhaps the greatest environmental challenge posed by urban development is the increased per capita resource consumption. Urban residents consume far more energy for transport, heating and cooling, and other forms of consumption than their rural counterparts.[35] This tendency is likely to increase as per capita urban incomes and consumer demand continue to increase.

Managing the resource consumption and air pollution implications of continuing urban development is one of the major environmental challenges facing the government. Ranking closely behind the problem of air pollution are the water and solid waste management implications. Finally, urbanization in the PRC is being achieved at great cost in terms of the loss of high-quality arable land, since the most rapid urbanization is taking place in the eastern coastal fringe, which is also the location of the nation's best-quality agricultural land.

The government has been investing substantial amounts of money to combat all dimensions of the environmental consequences of urban development. These efforts

[33] A study of urbanization in the PRC (McKinsey Global Institute 2009) projected an urban population of 926 million in 2025, which is at the upper end of the range between the medium and high scenarios summarized in Table 2.

[34] The increase in the urban population over the 26-year period between 1982 and 2008 was 391 million which, in crude proportional terms, is equivalent to an increase of about 300 million over a 20-year period.

[35] For example, it has been calculated that in 2005, urban households in the PRC consumed 360% more commercial energy than their rural counterparts (Yusuf and Saich 2008, p.10.)

have been rewarded in some cases by measurable increases in urban environmental quality and, in others, by stabilization of conditions or, at least, slowing of the rate of deterioration, as discussed in Chapters 3 and 4.

However, the overwhelming impression gained from looking into the urbanization process in the PRC is that, notwithstanding the achievements to date, there is an uncontrolled and often irrational quality to urban development that has much to do with the administrative hierarchy and the incentive systems that govern the behavior of local government officials. These incentive systems create a "rush to growth," whether or not the economics are favorable, and a proliferation of urban infrastructure that may not necessarily be essential or needed.[36] These problems are exacerbated by systemic problems with the fiscal system in the PRC that are part of the reason behind some of the social unrest being experienced across the country and are at the heart of many recurring problems in the implementation and ineffectiveness of many urban environmental programs (as discussed further in Section 6.5, page 115).

In conclusion, it may be said that the environmental challenge of the PRC's urbanization over the next 15 years or so will be significant, although not unprecedented in scale or complexity. The government needs to sustain and extend its financial commitment to the development of essential urban environmental infrastructure, and to look seriously at the incentive structure for municipal governments to improve the efficiency, effectiveness, and environmental sustainability of urban development. It also needs to reform the fiscal system to ensure that local government investments are proportional to and better targeted at real development needs.

2.6 Future Prospects

The four factors discussed earlier are likely to be the main drivers of the environmental agenda for many years to come, and certainly for the next 10 years. It is very difficult to see that any major progress can be made in improving the quality of the ambient environment unless changes can be made to the momentum of these issues. This reality was explicitly acknowledged in the 11th Five-Year Plan and in its various sector plans, and was recently reiterated by the Minister for Environmental Protection in his address at the 2011 National Working Conference on Environmental Protection on 13 January 2011, when he noted that, "In essence, (the) environmental problem is a problem of economic structure, production mode, consumption pattern and development road. We must look

[36] The job performance criteria against which local government officials are measured, to a large degree, relate to parochial economic indices (such as local GDP, GDP growth rate, levels of foreign direct investment, budgetary revenues, etc.), which encourage officials to aggressively pursue economic growth regardless of local conditions and the subsidiary and/or larger scale consequences. The government has attempted, with some effect, to broaden the range of assessment criteria to include environmental and social measures, although compliance with these subsidiary objectives seems to be largely a matter of individual preferences since they tend to be "soft" performance targets, whereas the economic targets tend to be "hard" targets that must be achieved. There are still recurrent stories of local governments neglecting to enforce environmental regulations in the interests of protecting and/or promoting local industries although MEP has been making strenuous efforts to combat this problem with the result that, while the problem still exists, it appears to be much less widespread than it was 5 years ago.

for the root cause in development pattern, find the outlet from the topmost economic and social development plan, and proceed from national macro strategic level."[37]

As will be discussed in Chapter 6, there are many elements of the 12th Five-Year Plan that are designed to turn the economy toward the direction of a more environmentally sustainable development path. But, as the experience of the 11th Five-Year Plan shows, turning the PRC's ship of state is difficult at the best of times, and only time will tell whether the government's environmentally sustainable development objectives under the 12th Five-Year Plan will be more successful. Chapter 7 outlines the environmental performance during the 11th Five-Year Plan, reflects on why there was more environmental success than the previous planning period, and makes recommendations for the government to move toward an environmentally sustainable future.

[37] Zhou (2011).

3. Natural Resources Management

3.1 Climate and Topography

Climate

The People's Republic of China (PRC) has a marked continental monsoonal climate, which is highly variable. Northerly winds prevail in winter and southerlies in summer. The four seasons are quite distinct, and summer is the rainy season. From September to April, the weather is dominated by dry and cold winter monsoons from Siberia and Mongolia, which gradually weaken as they progress south, resulting in cold and dry winters with great differences in temperature from north to south.

Climatically, the country is divided from south to north into equatorial, tropical, subtropical, warm-temperate, temperate, and cold-temperate zones. In terms of rainfall, the country is divided from southeast to northwest into humid (32% of land area), semi-humid (15%), semi-arid (22%), and arid zones (31%).

Topography

The PRC has a land area of about 9.6 million square kilometers (km^2), making it the fourth largest country in the world, next only to the Russian Federation, Canada, and the United States (US). The distance from north to south is about 5,500 kilometers (km), and from east to west is about 5,200 km, representing a time difference of over 4 hours (although the PRC has only one time zone). The country has 22,800 km of land borders, which touch on 15 countries.

The PRC's topography descends in four steps from west to east with the top step being the Qinghai–Tibet Plateau, which has an average altitude of 4,000 meters (m) above sea level (ASL). The second step (1,000–2,000 m ASL) includes the Inner Mongolia, Loess, and Yunnan-Guizhou plateaus, and the Tarim, Junggar, and Sichuan basins. The third step (500–1,000 m ASL) begins at a line drawn around the Greater Hinggan, Taihang, Wushan, and Xuefeng mountain ranges and extends eastward to the coast. It contains the Northeast Plain, North China Plain, and the Middle–Lower Yangtze Plain, which constitute the most agriculturally productive land in the entire country. The fourth step is the continental shelf stretching seaward to the east of the country with water depths generally less than 200 m below sea level.

3.2 Land Resources and Land Degradation

Land Resources

National land resources have three main characteristics: (i) variety in type (cultivated land, forests, grasslands, deserts, and wetlands); (ii) a predominance of mountains and plateaus over flatlands and basins; and (iii) unbalanced distribution, with farmland mainly concentrated in the east, grasslands largely in the west and north, and forests mostly in the far northeast and southwest.

The PRC's cultivated lands, forests, and grasslands are among the world's largest in terms of sheer area but, due to the large population, the area of these resources on a per capita basis is low; only about one-third of the global average and ranking the PRC as the 120th among the countries of the world.[38]

Statistics in the statistical yearbooks of the PRC's National Bureau of Statistics (NBS) suggest that there have been no significant changes in the areas or relative proportions of any of the main land use categories over the 5-year period from 2003 to 2008, which is more of a reflection of the unreliability of the statistical data than of any actual trends.[39] In fact, the conversion of high-quality agricultural land to residential use, largely engineered by local governments, is a matter of major concern with regard to national food security, since most of the country's scarce supply of well-watered and/or high-quality arable land is located along the eastern seaboard where most urban development is also taking place. For example, time-series analysis of satellite imagery shows that built-up land areas in large parts of suburban Shanghai expanded by 350% from 1988 to 2002.[40]

The Ministry of Land Resources (MLR) has initiated periodic inspections and clampdowns but the problem remains, largely because land leasing is one of the most important sources of funding for subprovincial governments under current fiscal arrangements. Without a change in the fiscal system, combined with tighter supervision of land use planning and zoning regulations, it is difficult to see that the problem will be fully resolved.

Land Degradation

Due to a combination of the PRC's long history, its extremely varied climate and topography, and the great pressure applied to the land due to its relative scarcity, land degradation has long plagued the country, especially the western region where neither

[38] The PRC has 0.11 ha of cultivated land per capita, which is about the same as countries like Georgia, Portugal, Tajikistan, the United Kingdom, and Venezuela. (Source: World Bank's World Development Indicators)

[39] For example, NBS statistical data suggest that the area of residential and mining land increased by only 6% over the 2003–2008 period (from 25.354 million ha to 26.916 million ha). During this same period, the urban population increased by more than 16% and average per capita residential floor areas more than doubled— from 10 square meters (m^2) per capita in 2000 to 28 m^2 per capita in 2008 (*China Daily* 2008). Such changes are not consistent with a 6% increase in the area of urban land.

[40] Kamal-Chaoui et al. (2009), p.62.

climate nor soils are suitable even for very low intensity uses.[41] The most serious forms of land degradation, in terms of extent of economic and social effects, are water erosion and desertification.

Water erosion

The PRC has several features that make it particularly prone to water erosion, including (i) the monsoonal climate in the south and the predominantly summer rainfall pattern in the north; (ii) the large areas of light-textured Loess soils, which are particularly susceptible to water erosion; and (iii) the large parts of the country that are subject to periodic freezing and the associated freeze-thaw erosion.

The government has devoted great attention and very significant financial resources to the control of soil erosion through its long-term program of soil conservation works on the Loess Plateau (Box 1), and more recently through the Sloping Land Conversion Program (see Table 7, page 30), among others. There are some suggestions that these efforts are paying dividends although the challenge remains substantial.

The second national soil erosion survey in 2002 revealed that 165 million hectares (ha), or about 17% of the country's total land mass, were affected by water-related soil erosion. An update was carried out by the Institute of Soil and Water Conservation of the Ministry of Water Resources (MWR) over the 2005–2009 period, and this suggested that the affected area may have been reduced to 161 million ha or by about 2% by 2009.[42] This represents a reversal in what had previously been an extended period of progressive deterioration, although the problem was still characterized as being very significant in both economic and social terms, requiring continued major efforts before it is brought under control.

The MWR estimates that, in 2009, a total of 1.073 billion tons of soil was lost across the country due to water-related soil erosion. Although it is a widespread phenomenon across the country, 85.6% of total soil loss due to water erosion occurs in the Yangtze and Yellow river watersheds, where the soil losses in 2009 were estimated to be 782 million tons and 137 million tons, respectively.[43]

Desertification

An estimated 3.31 million km^2 of land in the PRC—roughly a third of the total area— is prone to desertification.[44] Of this total, desertification is actually occurring (as of 2009)

[41] It is often stated that 40% of all land in the western PRC is degraded by one cause or another.

[42] There are reports of other significant reversals being achieved in certain regions of the country. For example, it has been reported that soil erosion in the Red Soils region of southern PRC decreased by 1.2% per annum between 2000 and 2005 as a result of concerted and large-scale erosion control activities throughout the region (Liang et al. 2010).

[43] Thus the catchments of the Yellow and Yangtze river systems (795,000 km^2 and 1.9 million km^2, respectively) account for only about 41% of national land area but 85.6% of total erosion.

[44] Desertification is defined in the United Nations (UN) Convention to Combat Desertification as "… land degradation in arid, semi-arid and dry subhumid areas, resulting from various factors, including climatic variations and human activities."

Box 1 The Loess Plateau Rehabilitation Program

The Loess Plateau covers an area of some 640,000 square kilometers (km^2) in the upper and middle reaches of the Yellow River Basin. The plateau is a gigantic deposit of "loess" or soil deposited by wind action. Deposition began about 2.4 million years ago and ended about 10,000 years ago, and the deposit is 100–300 meters in depth. Loess is particularly susceptible to water erosion, and one of the defining characteristics of the Loess Plateau is its deeply dissected landform.

Much of the erosion is natural and unavoidable. For example, it has been estimated from geological studies that 5,000 years ago, well before substantial human development of the region, the sediment load in the Yellow River, a large part of which comes from the Loess Plateau, was already about 1 billion tons per annum. The average annual load during the 20th century was about 1.5 billion tons. From this, it has been inferred that human activity can only be blamed for about one-third of the existing total. This also suggests that the plateau basically had developed its current shape of steep gullies and deep dissections well before significant numbers of humans entered the scene, about 4,000 years ago.

Nevertheless, human development pressure increased significantly about 2,000 years ago, during the Tang Dynasty, when Xi'an became a major political and cultural center and an estimated 2 million people lived in the area. Since then, population pressure has increased significantly until today, where an estimated 82 million people live in the area and the human and social consequences of erosion are very serious.

The government has long been conscious of the scale of the erosion problem on the Loess Plateau, and efforts to control it began in the early 1950s such that, by about 1990, a total area of 163,000 km^2 had been stabilized against erosion, 30,000 km^2 of terraces had been built, and 75,000 km^2 of land had been reforested. In the early 1990s, the government revised its strategy for dealing with the problem to place less emphasis on purely technical solutions and more emphasis on an integrated approach, including promotion of environmentally sustainable agriculture. It is not unreasonable to claim that the Loess Plateau program is the largest and most ambitious landscape rehabilitation program in the history of the world.

The program is ongoing and many experts predict that the problem will not be fully controlled until the end of the present century. The government's approach to the Loess Plateau has been widely studied throughout the world as a good example of a long-term, integrated social–environmental approach to an environmental problem. Although the program can claim many positive achievements, problems that need to be addressed continue to persist, including: (i) shortages of investment funds (usually due to financial problems at the county and lower levels), (ii) instability of government policy, (iii) unrealistic expectations on the economic benefits, (iv) too much emphasis on planting trees and insufficient emphasis on strategies other than tree planting, and (v) insufficient research into alternative vegetation restoration strategies.

Sources: Cai (2002); World Bank (1994); Zhang and Liu (2008).

on about 2.62 million km^2 of land or 79.2%.[45] This is believed to be the highest ratio of actual-to-potential desertification of any country in the world.

There are two main geographical areas where significant desertification is occurring: (i) the agro-pastoral transitional zone in the northern PRC, predominantly in Inner

[45] These are the most recent data available and are taken from the news release of the Fourth National Desertification and Sanding Monitoring Survey (2009) carried out by the State Forestry Administration (SFA) and other relevant departments. The new report shows that the area of desertified land decreased by an additional 0.49% between 2004 and 2009.

Mongolia Autonomous Region but extending into five adjoining and nearby provinces to some degree; and (ii) areas surrounding agricultural oases on the internally draining river systems of northwestern PRC, predominantly in Xinjiang Uygur Autonomous Region and Gansu Province. It has been estimated that as many as 400 million people are living in counties affected by or prone to desertification.[46]

The worst and most intractable problems are occurring in the agro-pastoral zone in the northern PRC. In this area, there is little doubt that the most significant contributor to desertification over the past 5 decades was excessive land reclamation during the 1960s and 1970s, combined with an excessive build-up in livestock numbers in the 1960s. The key human activities contributing to desertification in the northern PRC identified during the Fourth National Desertification and Sanding Monitoring Survey (2009) were (i) excessive firewood gathering, (ii) overgrazing, (iii) excessive land reclamation, (iv) irrational use of water resources, and (v) poor environmental controls associated with construction, mining, and transport.

The scale and significance of the problem of desertification became apparent to the government as early as the 1970s, at which time the first of a series of programs was implemented to address the problem. The program was referred to as the "Three-North Shelterbelt Program," also known as the "Great Green Wall," and covered some 4 million km^2 and 551 counties in 13 provinces, autonomous regions, and municipalities. The program has been renewed several times since its inception, with the last (Phase Four) being in 2001.[47]

In 1991, the State Council approved a 10-year plan on desertification control that had been prepared by the Ministry of Forestry (now the State Forestry Administration or SFA). The plan, "A National Plan to Combat Desertification, 1991–2000," involved 25 provinces and autonomous regions, and the main objectives were to develop an integrated system of forests, shrubs, and grasses using a combination of biological and engineering approaches in the north and northwest.

In 1999, the government launched another huge program known as the "Sloping Land Conversion Program" (SLCP) or the "Grain for Green Program," which was initially prompted by the disastrous flood and water erosion issues in the Middle Yangtze region but eventually expanded to become a substantially nationwide program that also included areas prone to desertification.[48]

In the spring of 2000, a series of more than a dozen powerful dust-storms swept across the northern PRC, leaving behind extensive damage in more than 20 major cities. This event

[46] Lu and Wang (2003).

[47] Various claims have been made about the success of the program. Proponents point to a 20% increase in forest cover in the "Three Norths" region (from 5% to 6%) since the program began. Others (e.g., Wang et al. 2010, pp. 13–22) argue that, while the program "may have had some beneficial effects on reducing dust storms and controlling desertification in (the People's Republic of) China," the results may not be as significant as proponents of the program have claimed.

[48] The SLCP is the largest land retirement program in the developing world, with the target of converting around 14.7 million ha of cropland to forests and afforesting a roughly equal area of wasteland by 2010 (SFA 2003). The program is being implemented in more than 2,000 counties across 25 provinces in the PRC, involves the participation of tens of millions of rural households, and has a total budget of CNY337 billion (over $40 billion).

led to the development of a new program to address desertification in areas surrounding Beijing involving 75 counties within the boundaries of Beijing, Tianjin, Hebei, Shanxi, and Inner Mongolia Autonomous Region. The major control measures include tree planting on barren land, grassland development, and protection of watersheds.

Finally, under the direction provided by the Western Development Strategy, which was launched in 2000, the PRC government, with the assistance of the Asian Development Bank (ADB), prepared the long-term PRC–Global Environment Facility (GEF) Partnership on Land Degradation in Dryland Ecosystems, under GEF's Operational Program on integrated ecosystem management (IEM). The purpose of the country programming framework is to assist the PRC government with developing and promoting an effective IEM approach that will generate global benefits from enhanced biodiversity conservation and carbon capture, and also support sustainable use and equitable benefit sharing to reduce poverty (see Box 2 for a discussion of the PRC-GEF Partnership).

In summary, the government has committed enormous human and financial resources to the problems of desertification over the past 40 years but, for much of that time, there were few signs of measurable success. In fact, available data by the end of the 1990s suggested that the problem was getting worse. However, data from the Third and Fourth National Desertification and Sanding Monitoring Surveys (2004, 2009) suggest that, at last, the corner may have been turned and that the long period of worsening desertification that stretched through to the end of the 1990s may have been reversed. Specifically, the total desertified area as of the end of 2009 (2.62 million km^2) represented a 0.49% decrease in the comparable figure for 2004 (2.64 million km^2). There were other measures of improvement over the same period. For example:

i. the proportion of desertified land that was classified as seriously or extremely desertified decreased significantly (no data available);

ii. the proportion of sand dune areas dominated by actively shifting dunes declined from 36% to 34%; but

iii. the areas of lightly and moderately desertified land increased to some degree.

Other indicators of success reported by others include signs of receding sand cover and ecological rehabilitation in the autonomous regions of Inner Mongolia, Xinjiang Uygur, and Ningxia Hui (all of which are key desertification zones), and declines in the frequency of dust storms. The problems are still great but the data suggest that the government may have found the key to controlling them.

3.3 Biodiversity

Biodiversity Status

The PRC covers a large area, is climatically and topographically diverse, and encompasses two major biogeographic realms: the Palearctic and the Oriental. Most of the country was unaffected by glaciations during the late Tertiary period, and thus the country's

Box 2 The People's Republic of China–Global Environment Facility Partnership to Combat Land Degradation in Dryland Ecosystems

With the assistance of the Asian Development Bank and the Global Environment Facility (GEF), the government of the People's Republic of China (PRC) established the PRC-GEF Partnership on Land Degradation in Dryland Ecosystems, which was initiated in 2002, to address land degradation issues, reduce poverty, restore dryland ecosystems, and conserve biodiversity through an effective integrated ecosystem management (IEM) approach. IEM is a scientific, ecological approach to natural resources management that aims to ensure productive and healthy ecosystems by integrating social, economic, physical, and biological needs and values. It provides an integrated planning approach within which the PRC government can develop legal, policy, institutional, and socioeconomic systems required to support the sustainable use of dryland ecosystem resources.

The PRC-GEF Partnership, through the capacity development component of the country programming framework (2003–2012) it prepared, assisted the western provinces of Gansu, Qinghai, and Shaanxi, and the autonomous regions of Inner Mongolia, Ningxia Hui, and Xinjiang Uygur in (i) improving the legal aspects of combating land degradation, (ii) formulating their own individual IEM strategies and action plans for land degradation control, (iii) developing land degradation monitoring and information management systems, and (iv) strengthening institutional capacity. These six provinces and autonomous regions are the worst-affected areas of the PRC, as they account for 79% of the country's desertified areas and 92% of its degraded areas.

The PRC-GEF Partnership also assisted the selected communities in identifying and adopting technical interventions and locally appropriate practices for controlling land degradation and improving ecosystem management. These interventions cover the following areas: alternative agricultural solutions, renewable energy, agricultural technology, salinity control, improvements in animal husbandry, combating desertification, support services, and biodiversity. The experience gained from these pilot projects has proven the cost effectiveness and sustainability of various local IEM approaches.

The PRC government focuses future work under the PRC–GEF Partnership on (i) scaling up activities to deepen understanding of the IEM approach, (ii) disseminating experiences along with policy and institutional reforms, (iii) piloting innovative sustainable land management instruments, and (iv) addressing remaining and critical new challenges (e.g., adapting to climate change, applying IEM through public–private partnerships, developing innovative financing mechanisms, and improving coordination with other programs).

Source: Adopted from ADB. 2010. *Dryland Ecosystems: Introducing an Integrated Management Approach in the People's Republic of China*. Manila.

flora and fauna contain many endemic and relic species. For this reason, the PRC is considered to be one of mega-diversity countries of the world, although it does not rank in the top five.[49] The known species in the PRC account to about one-tenth of the total number of known species of the world (Table 3).

Due to its geographic history, the PRC also exhibits a relatively high level of endemicity (i.e., species that originated in the PRC) particularly with mammals, amphibians, and fishes (Table 4).

[49] The World Conservation Monitoring Center (WCMC) of the United Nations Environment Programme (UNEP) has identified 17 countries, including the PRC, as being mega-diversity countries. The top five are (in declining order of significance): Brazil, Australia, India, South Africa, and Mexico.

Table 3 **Biodiversity of the People's Republic of China in Comparison to the World's Biodiversity**

Taxa	Known Species in the PRC (No.)	Known Species in the World (No.)	Species in the PRC as % of the World
Mammals	499	4,000	12.5
Birds	1,186	9,040	13.1
Reptiles	376	6,300	6.0
Amphibians	279	4,184	7.0
Fishes	2,804	19,056	12.1
Insects	40,000	751,000	5.3
Bryophytes	2,200	16,600	13.3
Pteridophytes	2,600	10,000	26.0
Gymnosperms	200	520	37.8
Angiosperms	25,000	220,000	11.4
Fungi	8,000	46,983	17.0
Bacteria	500	3,060	16.3
Algae	5,000	26,900	18.6

PRC = People's Republic of China.
Note: Taxa refers to the taxonomic units used in taxonomy, the practice and science of classification.
Source: Chinese Academy of Sciences. Biodiversity in [the People's Republic of] China: Status and Conservation Needs. (www.brim.ac.cn/brime/bdinchn/3.html)

Table 4 **Biodiversity Endemicity of the People's Republic of China**

Taxa	Known Genus/ Spp. (No.)	Known Endemic Genus/Spp. (No.)	Endemic/Total (%)
Mammals (spp.)	499	73	14.6
Birds (spp.)	1,186	99	8.3
Reptiles (spp.)	376	26	6.9
Amphibians (spp.)	279	30	13.1
Fishes (spp.)	2,804	440	15.7
Bryophytes (genera)	494	8	1.6
Pteridophytes (genera)	224	5	2.2
Gymnosperms (genera)	32	8	2.5
Angiosperms (genera)	3,116	232	7.4

Note: "spp." is a shortcut way of saying that something applies to many, if not all, individual species within a genus.
Source: Chinese Academy of Sciences. Biodiversity in [the People's Republic of] China: Status and Conservation Needs. (www.brim.ac.cn/brime/bdinchn/3.html)

Finally, the PRC is also very important in terms of agricultural biodiversity as it is one of the eight original centers of crop diversity in the world; it is the original source of approximately 200 of the world's 1,200 species of cultivated crops and contains nearly 600 varieties of domesticated animals and poultry.

Much of the PRC's important biodiversity is under threat. Studies by the Chinese Academy of Sciences (CAS) and affiliated universities suggest that 398 vertebrate species (7.7% of the total) in the PRC are endangered. Among the flora, it is estimated that 1,019 species of the higher plants (3.5%) are rare or endangered, including 28 species of bryophytes, 80 species of pteridophytes, 75 species of gymnosperms, and 836 species of angiosperms.

If the status of threatened flora species is widened to include vulnerable species,[50] it is estimated that between 4,000 and 5,000 species of flora in the PRC (15%–20% of the total) are vulnerable or endangered. The main threats to biodiversity in the PRC are habitat destruction (including land reclamation, clearance of forests, and draining of wetlands), unsustainable harvesting, pollution, and introduction of exotic species.

National Parks and Reserves

The PRC has been active in the establishment of protected areas since the first nature reserve was established in Dinghushan in Guangdong Province in 1956. Since then, new protected areas have been added to the national coverage, slowly until 1979, and then rapidly thereafter. By the end of 2008, the PRC had a total of 2,538 nature reserves covering a total land area of about 149 million ha or 15.1% of national land area—a significant increase in the area that was covered only a few years back (e.g., in 2003, there were only 1,900 terrestrial nature reserves covering 13% of national land area while in 1999, the coverage was only 9%) and slightly higher than the global average (about 13%). Of these, 303 (93.7 million ha) are national level reserves, that is, they are the direct responsibility of a national level agency.

Notwithstanding the impressive progress that has been made in establishing protected areas and nature reserves in what has been a "race against time" in the face of enormous development pressure, there are several problems with the PRC's system of parks and nature reserves that will need to be addressed as part of further strengthening the system. These include:

- **Scope and coverage.** Despite the relatively large area covered by parks and reserves, the coverage of the PRC's major biogeographical systems is rather uneven, with some important ecosystems being completely unrepresented or significantly under-represented. For example, a recent analysis showed that under-represented areas included the Tian Mountains (Xinjiang Uygur Autonomous Region), the eastern border region of Qinghai Province, Southeast Yunnan–Guizhou Plateau, Loess Plateau, and Northern Guangxi Province.[51] The survey also showed that many threatened species are not covered, or not covered well, by the protected area system. For example, it was estimated that 48 species of mammals, reptiles and/or amphibians are not covered by any protected areas.
- **Fragmented management and inadequate budgetary support.** The management of the PRC's parks and reserves is extremely fragmented; 10 different agencies have some responsibility for the management of parks and reserves although the two most important are the Ministry of Environmental Protection (MEP) and the SFA. Parks and reserves are funded by a variety of mechanisms. National-level parks and reserves may receive funding from ministries for infrastructure construction, while salaries may be paid from provincial budgets or, in many cases, county budgets. Provincial-level parks and reserves tend to receive much

[50] The term "endangered," as used by the International Union for the Conservation of Nature (IUCN), refers to species facing a very high risk of extinction in the near future. The term "vulnerable" refers to species facing a high risk of extinction in the medium term.

[51] Protected Areas Task Force (PATF) of the China Council for International Cooperation on Environment and Development (CCICED) (2004).

less routine operational funding; their funding tends to come through infrequent and somewhat unreliable project-based allocation. The establishment of most parks and reserves is dependent on the willingness of county governments, and economic arguments are essential to persuade them of the value of setting aside resources for protected area management. Even at the national level, funding is inadequate. The national government annually allocates about CNY30 million for national nature reserves, but these are mostly spent on infrastructure development (as mentioned previously, operational funds come from the lower-level governments). Only about 30 of the 303 national-level nature reserves get reliably funded each year.[52]

- **Inadequate legislative and/or regulatory framework**. There are many practical, day-to-day problems facing the managers of parks and reserves in the PRC that are generally related to problems with the legal and/or regulatory framework. These include the following:

    (i) When parks and/or reserves are created, they are often superimposed on a mosaic of different land uses, with little or no institutional jurisdiction or influence over the various holders of land-use rights. Although the government owns all land in the PRC, different individuals, organizations, or communities may enjoy various powers or rights to make decisions on land use or resource use and many of these powers or rights may predate the creation of the protected area, creating conflicts between the protected area managers and local communities or different departments.

    (ii) The regulatory framework governing the management of parks and reserves tends to be rather rigid and may often restrict the ability of protected area managers to solve practical problems confronting them. For example, there is hardly a nature reserve in the PRC where the experimental zone[53] does not contain human settlements, farming, and unsustainable harvesting of resources—all of which are technically illegal. However, it is often impractical or unreasonable for the concerned people to be evicted from the park, suggesting that some kind of middle course needs to be found, but the rather rigid regulations make this difficult.

    (iii) Many government agencies have influence over land use and development within and around parks and reserves, and problems can arise when agencies with overlapping jurisdictions pursue objectives that conflict with the objectives of the park or reserve. For example, the national policy of constructing a road for every administrative village has taken precedence over the mission of protecting many parks and reserves.

[52] Ibid.

[53] The regulations governing the management of nature reserves define three "functional areas" of any reserve including the "core area," the "experimental zone," and the "buffer zone." The "core area" is supposed to be strictly protected and only used for scientific observation and research. The "experimental zone" may be used for scientific experiments, educational activities, and tourism but activities such as logging, grazing, hunting, mining, quarrying, and dredging are forbidden. The "buffer zone" may be used for nonconservation activities although consistency with the conservation objectives would be encouraged. Changes to the boundaries or functions of a nature reserve have to be approved by the State Council.

A final, glaring deficiency of the PRC's national parks and reserves system, at least from an international perspective, is that there is no single "National Parks Service" that fully finances the capital and operating costs, and directly staffs and manages a network of parks and/or protected areas that are of national significance and are deserving of the highest possible standards of management and operation. Relevant models for consideration include those in countries of similarly vast land area and federal structure as the PRC, including the US National Parks Service, the Australian National Parks and Wildlife Service, and Parks Canada. The still developing experience in Brazil would also be worthy of study.

3.4 Forests

Forest Inventory

The total area designated as "forestland" in the PRC is about 304 million ha, but only about two-thirds of this is actually forested. The latest data from the 7th National Forest Resource Inventory (NFRI) (2004–2008) found that the PRC's total forested area was about 195 million ha, or 64% of total forestland. This represented a 20 million ha or 11% increase over the area measured in the 6th NFRI (1999–2003), which was a remarkable achievement by any measure. During the same period, the total forest volume increased by 10% to 13.7 billion cubic meters (bcm). These achievements were not only significant for the PRC, but also for the Asian region as a whole.[54]

The total forested area represented about 20% of the PRC's territory, which is low by international standards (the global average is about 30%), but again, a significant improvement over the previous inventory at which time forested area covered 18% of total land area. Both figures were major improvements over the situation in pre-revolutionary PRC; the lowest measured forest area in the 20th century was in 1934 when forests covered only 9% of total land area.

The most forested area in the PRC is in the southern region, which accounts for 34% of the total, followed by the southwest and northeast regions, each of which has around 24% of the total. The north and northwest regions each have less than 10% of the total forested area.

The great majority (about 90%) of the PRC's natural forests are found in only three regions: the northeast, south, and southwest regions. Plantation forests are even more concentrated, with more than half being located in the southern region. The total area of plantation recorded in the 7th NFRI was 61.7 million ha, which is the largest plantation area of any country in the world. Guangxi, Guangdong, Hunan, Fujian, and Sichuan account for 40% of the PRC's plantation forests by area.

[54] The Food and Agriculture Organization of the United Nations (FAO) estimates that over the 2000–2005 period, the area of the world's forests declined at an average rate of 7.3 million ha per year. Forest area declined in virtually every region of the world with the exception of Asia, which registered a net gain of 1 million ha per year. FAO concluded that the Asian region's achievement was almost entirely due to the PRC's large-scale reforestation programs implemented during that census period and which are continuing since initiated in the 1990s. (Source: FAO 2005)

Table 5 shows the area of forest according to the primary and secondary forest classifications used in the PRC, and highlights the fact that more than half the total forest resource is designated as Public Welfare Forest. This includes a wide range of non-production forest uses including soil and water conservation, windbreaks for farmland protection, fire control, science and education, biodiversity conservation, tourism, and cultural and memorial purposes.

Table 5 **Forest Area by Forest Classification, 7th National Forest Resource Inventory**

Primary Classification	Secondary Classification	Area (million ha)	% of Total Area
Public welfare forest			52.4
	Protection forest	83.08	45.8
	Special-purpose forest	11.98	6.6
Commercial forest			47.6
	Timber forest	64.16	35.4
	Economic forest	20.41	11.3
	Fuelwood forest	1.75	0.9
Total		**181.38**	**100.0**

ha = hectare.
Source: State Forestry Administration of the People's Republic of China.

In terms of age structure, the timber forest is unbalanced in terms of both area and volume. In terms of forest area, and as shown in Table 6, there is a preponderance of young and middle-aged trees (67% of total area in the 7th NFRI and not significantly different from the 6th NFRI), which is substantially a reflection of the major reforestation efforts of the 1980s and 1990s, and a significant deficiency in mature and over-mature forests (about 18% of the total), which are predominantly natural forests. This is a result of the extensive clearing of natural forests, which continued until the 1998 logging ban.

Table 6 **Forestland by Arbor Age Class, 6th and 7th National Forest Resource Inventory**

	6th NFRI		7th NFRI	
Arbor Age Class	Area (million ha)	% Total	Area (million ha)	% Total
Young forest	47.24	33	52.62	34
Middle-aged forest	49.64	35	52.02	33
Near-mature forest	19.99	14	23.05	15
Mature forest	17.15	12	18.71	12
Over-mature forest	8.77	6	9.19	6
Total	**142.79**	**100**	**155.59**	**100**

ha = hectare, NFRI = National Forest Resource Inventory.
Source: State Forestry Administration of the People's Republic of China.

Forest Programs

Activities in the forest sector and trends in forest area over the past 14 years have been very heavily influenced by a series of natural disasters that significantly affected the government's thinking on forest policy. The single most influential incident occurred during the summer of 1998, when massive floods occurred in the central Yangtze and

along the Songhua and Pearl rivers. The floods killed thousands of people, left 14 million people homeless, and caused $26 billion of damages. The main factor was the high level of sustained rainfall, but many local experts concluded that the floods were exacerbated by excessive conversion of forests to farmland, overexploitation of production forests, and unsustainable farming practices on steep land.

Partly in response to this and other disasters (e.g., severe dust storms in and around Beijing in 2001) but also partly in response to generally growing concerns about the state of the rural environment, the government instituted a new national forest policy focused on the sustainable management of forest resources and environmental protection. The policy was underpinned by six major forest initiatives with a planned investment through 2010 of some $85 billion.[55] Brief summaries of the objectives and contents of the six programs are provided in Table 7.

The combined effects of these policies were to increase significantly the PRC's plantation establishment rates, particularly during the early part of the decade. Figure 7 shows the

Table 7 **Six Main Forestry Programs of the People's Republic of China**

Program Name	Brief Summary
Natural Forest Protection Program (NFPP)	Activities include banning of logging in selected areas, ending commercial harvesting of natural forests in the upper reaches of the Yangtze River and middle/upper reaches of the Yellow River, and accelerated afforestation in the upper reaches of the Yangtze River and middle/upper reaches of the Yellow River. The program also provides retraining and reallocation of employees of state-owned forest enterprises affected by the bans and limitations.
Sloping Land Conversion Program (SLCP)[a]	The program covers vulnerable areas in 25 provinces and 1,897 counties and county-equivalents. Program activities include afforestation of barren lands, conversion of steep farm land to forested land, and stabilization of land prone to wind erosion. The total land to be treated is about 40 million ha. Subsidies paid to affected individuals and communities are in the form of cash and/or grain supplies (hence, the term "Grain for Green").
Program to Combat Desertification in the Beijing–Tianjin Rim[b]	The objective is to improve the ecological environment in the capital city in preparation for the Olympics (2008) as well as in the wider Beijing–Tianjin region and parts of Hebei Province and Inner Mongolia Autonomous Region. Activities include vegetation protection, tree and grass planting, land conversion from farmland to forestland, integrated catchment and grassland management, and ecological resettlement. Targets include 2.6 million ha of land conversion, 4.9 million ha of afforestation, 11 million ha of improved grassland management, construction of over 66,000 water resource facilities (stock watering points, etc.), installation of water-saving irrigation technology at over 47,000 locations, application of catchment management measures over an area of 23,000 km^2, and resettlement of 180,000 people.

continued on next page

[55] World Bank (2010c). Not all the programs were completed in 2010. In fact, one is not scheduled to finish until 2050.

Table 7 *continued*

Program Name	Brief Summary
Three North Shelterbelt[c]	The program commenced in 1978 and will extend to 2050. This program actually predated the Yangtze floods of 1998 by 20 years. The program covers 551 counties in 13 provinces in the northwest, north, and northeast regions. The total area covered is 4.1 million km^2. The program aims to increase the forest area in the program areas by 35 million ha, increase forest coverage from 5.05% (in 1977) to 15%, effectively control sand storms and soil erosion, improve ecological conditions, and improve the living conditions of farmers. Specific interventions include the development of windbreaks and reclamation of desertified, salinized and/or degraded pastures, establishment of firewood forests, and planting of improved pastures.
Establishment of Fast-Growing and High-Yielding Timber Plantations in Key Areas	The program was approved in 2002 and is due to close in 2015. The objective is to establish fast-growing and high-yielding timber plantations generally east of the 400 millimeter annual rainfall isoline which have favorable natural conditions, with gentle slopes not subject to soil erosion, and minimal or no adverse ecological impact potentials. The program covers 1,000 counties in 18 provinces. The objective is to establish 13.3 million ha of plantation, including 5.9 million ha for pulp production, 5.0 million ha for wood-based panels, and 2.5 million ha for large-diameter timber.
Wildlife Protection and Nature Reserve Development Program	This is less a forestry program and more of a substantial investment program to significantly upgrade and strengthen the management and effectiveness of nature reserves under the control of the SFA. Projects implemented up to 2004 included the development of conservation plans for 15 priority species for protection and rescue, and the establishment of breeding bases, resource monitoring systems, bird-banding networks, and gene conservation centers. The program is extremely diverse and complex but is considered to have made a significant contribution to upgrading the management of the SFA's 1,672 nature reserves, which have a total area of 119 million ha or 12.4% of the total land area of the country.

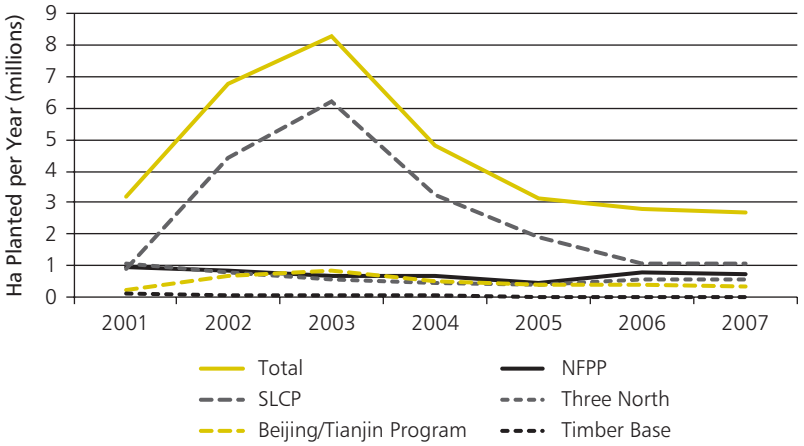
ha = hectare, km^2 = square kilometer, SFA = State Forestry Administration.
[a] Alternatively referred to as the "Program for Conversion of Farmland to Forests" or the "Grain for Green Program."
[b] Alternatively referred to as the "Program for Sand Control and Prevention around Beijing."
[c] Alternatively known as the "Shelterbelt Development Program in the Yangtze River Valley and Other Key Areas."
Source: State Forestry Administration of the People's Republic of China.

annual planting rates over the 6-year period, 2001–2007, under the five forest initiatives that involved plantation establishment; the dominant influence of the SLCP is apparent. Forest planting reached a peak in 2003, at a level of about 80% higher than in 2001. The average annual area planted between 2000 and 2005 was about 4 million ha, which far exceeded any other country in the world.[56]

The slackening off in the establishment rate after 2004 was due in part to questions that were being raised about the scale and wisdom of some of the programs, particularly the SLCP. Partly in response to these concerns, the government began to relax the policy of returning farmland to forests, and the plantation establishment quota for 2004 and the

[56] FAO (2009).

Figure 7 **Annual Plantation Establishment Rates, 2001–2007**



ha = hectare, NFPP = Natural Forest Protection Program, SLCP = Sloping Land Conversion Program.
Source: State Forestry Administration of the People's Republic of China.

following years was reduced significantly to around 2.7 million ha, its lowest level for 10 years.

All of the major forest programs, as outlined above, are intended to change the forest management agenda to at least some degree. The natural forests in the upper reaches of the Yangtze River and the Yellow River are no longer being logged, and protective forests have been planted along the midstream and downstream sections of many of the major rivers.

In 2003, the PRC launched a reform of collective forest tenure to encourage more individual responsibility and stimulate greater public involvement in forest management, while reducing the role of collective management that has tended to be poor due to excessive harvesting and lack of investment. Under these reforms, private individuals may now "own" collective forests by signing legal contracts and receiving authorized forest certificates conferring the right to utilize the forestlands for 70 years. The performance of privately-managed forests tends to be much better than state-owned forests.

Future Challenges

Notwithstanding the huge investments of money and time that the government has put into reforestation and afforestation, forest resources are still inadequate—per capita forest area is less than one-fourth of the world average, per capita forest stocking volume is only about 15% of the world average, and forest quality is poor (although constantly improving). At the same time, the pressure for conversion of forested land to uses such as agriculture, urban development, or other construction remains high. Over 8 million ha of forestland was converted to non-forest uses between 2004 and 2008. This was equivalent to 60% of the total area reforested over the same period. Greater emphasis

on preventing forest conversion would produce substantial benefits in terms of the cost efficiency of achieving national forest objectives.

At the same time, reforestation is becoming more and more difficult. Of the 44 million ha of land considered suitable for future forest development, only 13% is of good quality, while poor quality land accounts for 52%. About 60% of suitable land is located in Inner Mongolia Autonomous Region and the northwest region where the climate is not optimal for forest production.

These challenges will only increase over time. Major responses are likely to include (i) further efforts to improve forest management effectiveness within the context of an increasingly market-based operating environment, (ii) further emphasis on moving the center of timber production southward to capitalize on the better climate and better availability of water, and (iii) increased attention being paid to the value of forests for carbon sequestration and its associated economic opportunities.

4. Water and Air Pollution and Solid Waste Management

4.1 Water Quantity and Quality

The combined effects of increasing water demand, limited supplies, and poor water quality caused by widespread pollution suggest that water scarcity may be one of the greatest development challenges facing the People's Republic of China (PRC) over the next 10–15 years. Water demands are increasing, while supplies and the reliability of supply are decreasing.[57]

Water Availability

The PRC has more than 1,500 rivers with catchments greater than or equal to 1,000 square kilometers (km^2). These are classified as falling into any of the following nine river basins:

i. Song-Liao River Basin
ii. Hai River Basin
iii. Huang (Yellow) River Basin
iv. Huai River Basin
v. Changjiang (Yangtze) River Basin
vi. Zhujiang (Pearl) River Basin
vii. Southwest river basins
viii. Southeast river basins
ix. Interior-draining river basins[58]

The average annual precipitation in the PRC is 610 millimeters (mm) but it is very variable geographically, ranging from 320 mm per year in the northern river systems (north of the Yangtze) to 1,128 mm in the southern river systems (south of and including the Yangtze). The PRC's total renewable water resource (TRWR) attributable to the combination of rainfall runoff plus groundwater is estimated to be about 2,800 billion cubic meters (bcm) (Table 8).

[57] World Bank (2009b).
[58] These refer to rivers that do not flow outside national boundaries and discharge into inland lakes or disappear into deserts or salt marshes.

Table 8 **Average Total Renewable Water Resources, 1956–2007**

	Renewable Water Resources (bcm/year)			Per Capita Water Availability (m^3)
	Surface Water	Groundwater	Total	
Northern Rivers				
Song-Liao	165	62	193	1,704
Hai	29	26	42	358
Huai	74	39	96	505
Huang (Yellow)	66	41	74	750
Southern Rivers				
Chang	951	246	961	2,388
Zhu (Pearl)	468	112	471	3,327
Southeast	256	61	259	3,938
Southwest	585	154	585	31,914
Interior basins	116	86	130	5,271
Total PRC	**2,711**	**828**	**2,812**	**2,343**

bcm = billion cubic meter, m^3 = cubic meter, PRC = People's Republic of China.
Source: Ministry of Water Resources of the People's Republic of China.

An analysis by the Ministry of Water Resources (MWR) indicates that national and regional rainfall and rainfall–runoff relationships have changed significantly over the past 2 decades.[59] The most telling changes have been in the so-called 3-H river basins (Huai, Hai, and Huang) and the Liao River Basin, all of which are located in the northern PRC where water supply and/or demand issues are the most critical. Rainfall in the north has decreased by between 2.6% and 10.4% in the mentioned catchments, largely due to climate change. The resultant declines in water supply are being exacerbated by much greater declines in runoff (by between 10.4% and 40.8% in the same catchments) due to land use change and increased retention within the catchment.[60]

The amount of water actually available for consumption is significantly less than the TRWR due the seasonal nature of the rainfall and the lack of storage capacity in the water-abundant southern provinces. These factors mean that only about 30% (824 bcm) of TRWR is actually available for consumption. Of this, 69% (560 bcm or 1,100 cubic meters [m^3] per capita) is in the south (which has only 36% of available arable land), and only 31% (254 bcm or 424 m^3 per capita) is in the north.

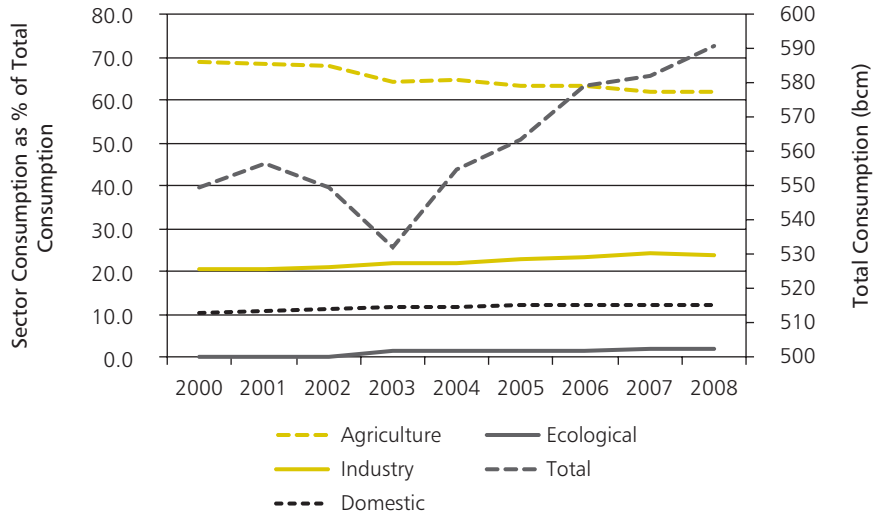
Water Demand

In 2008, a total of 590 bcm of water was consumed in the PRC, representing about 20% of the TRWR and 72% of the average quantity of water actually available for consumption. Total consumption is expected to rise to 620 bcm by 2015 (5% higher than in 2008) and 670 bcm by 2020 (13.6% higher than in 2008).

[59] Li (2010).

[60] The northern catchments, because they are so susceptible to water shortages, are also highly regulated. Storage capacity in the 3-H basins (Huai, Hai, and Huang (Yellow) River Basins) is equivalent to more than 90% of average annual runoff. The average for the PRC as a whole is less than 20%.

Figure 8 **Total Water Consumption and Sector Consumption, 2000–2008**



bcm = billion cubic meter.
Source: National Bureau of Statistics of the People's Republic of China.

As shown in Figure 8, total consumption between 2000 and 2008 increased by 7%, from 550 bcm to 590 bcm.[61] Gross domestic product (GDP) increased over the same period by about 300%, so the economic efficiency of water consumption improved significantly. Nevertheless, the PRC continues to be an economically inefficient user of water by global standards—economic water use efficiency is about three times higher than the global average.

The most remarkable trend over the 2000–2008 period in terms of sector consumption occurred in agriculture, which reduced absolute consumption by 3%, as a result of which agriculture's share of total consumption declined from 69% in 2000 to 62% in 2008. This achievement occurred at the same time that (i) the total irrigated area actually increased (by 8.6%), and (ii) the total value of agricultural output (irrigated and non-irrigated) increased by about 230%. This performance can be attributed to the effectiveness of the government's campaigns to promote the adoption of water-saving irrigation technology and alternative farm management techniques combined with changes in cropping patterns, particularly in northern PRC, in response to increasing water prices and changing patterns of demand for agricultural outputs.[62]

Nevertheless, efficiency gains in the agriculture sector were not sufficient to offset increasing demands for industrial and residential use. Total consumption increased by 7% over the 2000–2008 period with industrial demand increasing by 23% (from

[61] The large drop in consumption in 2003 occurred as a result of a drought, which was reported to have been the worst for 30 years.
[62] World Bank (2006), p.6.

114 bcm to 140 bcm), and domestic demand increasing by 28% (from 57 bcm to 73 bcm). Of the 591 bcm of water consumed in 2008, the overwhelming majority (481 bcm or 81%) was derived from surface resources, with only 108 bcm or 18% being supplied from groundwater sources.[63]

Urban residential consumption was 198 liters/capita/day in 2008, representing a significant improvement over the 220 liters/capita/day that was recorded in 2000 but still somewhat higher than average for a middle-income country.[64]

Industrial water consumption, in aggregate, increased steadily over the past 2 decades, although industrial water use efficiency improved by a factor of 10—a reflection of the substantial structural change that has occurred in the PRC's industry sector over the period.

Supply and/or Demand Balances

Water availability on a per capita basis in the PRC is low by world standards, largely due to the very large population, and has been declining significantly in recent years. The current level of availability of 1,911 m^3 per capita is among the lowest for any major country. By the time the PRC's population peaks (by around 2025), per capita water availability is expected to be about 1,800 m^3 per capita, which will be approaching the international standard for distressed water availability conditions (1,700 m^3 per capita).[65]

In 2008, the PRC's water utilization rate (i.e., total water consumption as a proportion of TRWR) was about 20% which, seen in isolation, does not suggest an unsustainable or critical situation. But, as shown in Figure 9, there is considerable variation between river basins, with the Hai River being notably overexploited, with a water utilization rate in excess of 100%.[66]

There are already substantial parts of the country, particularly north of the Yangtze River, that are experiencing severely constrained water availability problems. At present, 400 of the 600 largest cities in the PRC are suffering from water supply shortages, and 100 of these are characterized as being severely short of water. Per capita water availability in the national capital, Beijing, is less than 300 m^3.

Although groundwater consumption only provides about 18% of the water consumed on a national basis, three-quarters of this consumption occurs in areas north of the Yangtze River, where surface water resources are fully or at least very substantially utilized. Based

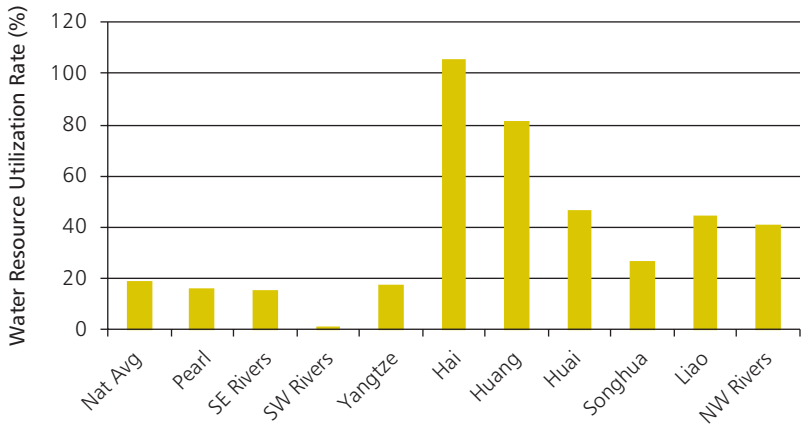
[63] Li (2010), p15. The remaining 1% was supplied from "other sources" such as desalinized seawater, and others.

[64] Zhang and Zheng (2008). The PRC's average per capita consumption of 198 liters per capita per day (lpcd) compares with the global average for low-income countries of 123 lpcd, for middle-income countries of 143 lpcd, and for high-income countries of 411 lpcd.

[65] The International Water Management Institute (IWMI) considers that once availability has declined to 1,000 m^3 per capita, water shortages start to measurably constrain economic growth.

[66] The degree of water stress that would result from any given water use/availability ratio is somewhat variable depending on particular circumstances but, in general, the World Water Council suggests that ratios less than 20% indicate no or low stress, 20%–40% is mid-stress, 40%–80% is high stress, and >80% is very high stress (World Meteorological Organization 1997). Thus, the PRC as a whole is between low- and mid-stress, but parts of the north are already in a high stress or very high stress situation. The Hai River would be considered to be in an extremely high stress situation.

Figure 9 **Water Utilization Rates by River Basin, Consumption as % of Availability**



NW = northwest; Nat Avg = national average; SE = southeast; SW = southwest.
Note: Where consumption exceeds availability, the difference is made up by transfers from other catchments.
Source: Li (2010), p17.

on data gathered by the China Institute for Geo-Environment Monitoring (CIGEM), groundwater resources are being overexploited in Beijing, Hebei, and Tianjin; are close to being overexploited in Henan, Shandong, and Shanghai (consumption is 80%–100% of recharge); and are being heavily exploited (consumption exceeds 70% of recharge) in Liaoning and Shanxi.[67]

Land subsidence due to over-extraction of groundwater is a widespread phenomenon in the PRC. According to surveys carried out by CIGEM, land subsidence is being experienced in all 50 of the PRC's largest cities. The total affected area is 90,000 km^2, which represents 7.5% of the PRC's total arable land area. The worst areas affected are in the Yangtze Delta region (around Shanghai), the North China Plain, and the Fen River–Wei River Basin (Shanxi Province).

Water Quality

The Ministry of Environmental Protection (MEP) maintains a national surface water quality monitoring system comprising 759 stations that monitor 318 rivers and 26 lakes within the nine river basins. Since 2003, all stations have been monitored on a monthly basis with samples being collected between the 1st and 10th days of the month. Samples are analyzed for 11 parameters, namely: water temperature, pH (or the acidity based on hydrogen ion concentration), conductivity, dissolved oxygen (DO), permanganate index (chemical oxygen demand [COD]), biological oxygen demand

[67] An "overexploited" groundwater resource is one in which annual consumption is greater than or equal to the recharge rate, which means that the groundwater resource is being "mined." This is usually associated with a decline in the level of the water table. In near coastal areas, this may also be associated with pollution of the groundwater resource by saltwater seeping into groundwater depression areas. Presently, seawater intrusion due to the decline of groundwater levels is mainly being experienced in Shandong and Hebei provinces. The cumulative seawater intrusion area in Shandong Province is estimated to exceed 3,000 km^2.

(BOD), ammonia nitrogen (NH_3–N), petroleum, volatile phenol, mercury, and lead. Some monitoring sections at provincial boundaries also measure river flow as a basis for determining interprovincial pollutant fluxes. Lakes and reservoirs are also monitored for five additional parameters: (i) total phosphorus (TP), (ii) total nitrogen (TN), (iii) chlorophyll-a, (iv) turbidity, and (v) water level.

Water samples are classified into one of six water quality grades depending on the concentration of the worst individual pollutant in the sample. The water quality grades defined in the Environmental Water Quality Standard GB3838-2002 are:

- Grade I—water suitable as a drinking water source (i.e., without treatment) and for national level nature reserves;
- Grade II—water suitable for use as a Class A water source for centralized drinking water supply, sanctuaries for rare species of fish, and spawning grounds for fish and crustaceans;
- Grade III—water suitable for use as a Class B water source for centralized drinking water supply, sanctuaries for common species of fish, and for swimming;
- Grade IV—water suitable for use as a general industrial water supply and for recreational use involving no direct human contact with the water;
- Grade V—water only suitable for agricultural water supply and general landscaping use; and
- Grade V+—water unsuitable for any use.

In qualitative terms, Grades I and II could be described as good quality water resources, Grades III and IV as moderate, and Grades V and V+ as poor to very poor. The main pollutants responsible for triggering lower water sample classifications are NH_3–N (which mainly derives from fertilizer runoff but is also found in emissions from certain industrial processes, discharges from municipal wastewater treatment plants, and overflows from septic tanks) and organic materials (BOD and COD), which are mainly a reflection of emissions of human and animal wastes as well as from certain types of industrial enterprise (notably pulp and paper making, food processing, and beverage manufacturing).

In 2009, MEP carried out a survey of 3,219 monitored and evaluated water functional zones throughout the country to assess the degree to which water quality within these zones was consistent with the dominant water uses within the zone—for example, whether a water resource being used as a drinking water source actually met the Grade I standard. Overall, it was found that only 43% of the zones evaluated had water quality consistent with their functional classification. The compliance level for Grade I uses was slightly better than the average (53%), but the level for Grade II uses was significantly less than average (37%).

Water quality of rivers

The PRC's surface water quality situation could best be described as being generally poor, and generally worse than it was 20 years ago, although the picture in that regard is somewhat mixed. Nevertheless, there are some signs that the government's massive efforts to reverse the problem in terms of physical and financial investments

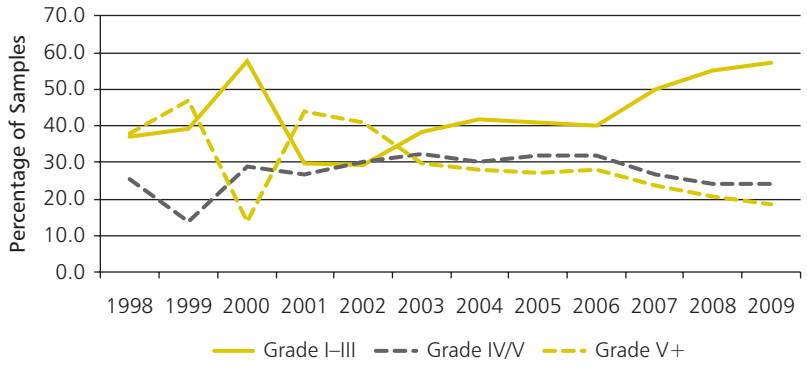
and institutional and regulatory reforms are having some beneficial effects, at least in terms of the relative abundance of good quality (Grades I–III) and very poor quality (Grade V+) waters (Figure 10).

Notwithstanding the somewhat questionable data for 2000 and the lack of any apparent effect of the drought in 2003, the data suggest that overall surface water trend through the 10th Five-Year Plan and continuing into the 11th Five-Year Plan period has been positive. The proportion of samples falling into Grades I–III categories has been increasing, while the incidence of poor and very poor quality samples has been declining.

However, the aggregated national data mask significant differences in water quality trends in the northern and southern rivers, which diverged significantly over the period, as shown in Table 9.

The difference in water quality between the northern and southern rivers is primarily a function of the differences in the quantity of water resources available to absorb pollution discharges and secondarily to the more concentrated nature of development in the north.

Figure 10 **General Surface Water Quality Trends, 1998–2009**



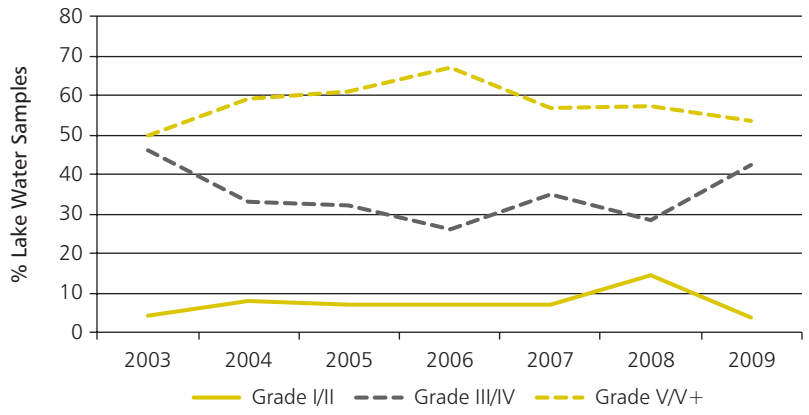
Note: These water quality data need to be treated with some caution. Huge fluctuations in the trend lines, as what occurred in 2000, are difficult to explain in highly aggregated data such as these. Also, the PRC experienced its worst drought in 30 years in 2003, and yet the water quality data barely moved.
Source: Ministry of Environmental Protection. 2009. *Environmental Statistical Yearbook.* Beijing.

Table 9 **Differences in Water Quality between Northern and Southern Rivers, 2009**

	Proportion of Monitoring Sections (%)	
Water Quality Class	Northern Rivers	Southern Rivers
Good (Grade I/II)	10	55
Moderate (Grade III/IV)	45	45
Poor (Grade V/V+)	40	10

Source: Ministry of Environmental Protection. 2009. *Environmental Statistical Yearbook.* Beijing.

Figure 11 **Water Quality of Key Lakes and Reservoirs, 2003–2009**



Source: Ministry of Environmental Protection. 2009. *Environmental Statistical Yearbook*. Beijing.

Water quality of lakes

Water quality in the PRC's lakes is extremely poor and, unlike the case of rivers, there have been somewhat uneven trends in recent years. As shown in Figure 11, between 2003 and 2006, there was a steady deterioration of water quality in the monitored lakes. The proportion of lake and reservoir water samples falling into the Grade V/V+ water quality classes increased, the proportion in Grade III/IV fell, and the proportion of Grade I/II samples remained constant. This was essentially a continuation of the deterioration that had been experienced throughout the 1990s.

The trend appears to have changed between 2006 and 2009—the incidence of Grade V/V+ conditions declined while Grade III/IV and Grade I/II conditions increased. In 2008, 14% of samples taken from lakes and reservoirs fell into the Grade I/II categories, the first time that this happened for more than 10 years. However, the data for the most recently available monitoring year (2009) suggest that the 2008 data might have been an isolated case—the incidence of Grade V/V+ samples continued to decline, but there was a significant increase in the incidence of Grade III/IV samples, and a consequent decline in the incidence of Grade I/II samples to levels not seen since 2003.

The PRC's lakes are being polluted by discharges from industrial enterprises, urban areas including municipal wastewater treatment plants, and from rural nonpoint pollution including discharges from intensive animal husbandry enterprises, and fertilizer and pesticide runoff. The government has been investing substantial amounts of money into lake cleanup campaigns, particularly under the "three lakes" program, which commenced at the beginning of the 9th Five-Year Plan. This program focuses attention on three of the largest and most polluted lakes in the country—Chao Lake (Anhui Province), Tai Lake (Jiangsu–Zhejiang provinces), and Dianchi Lake (Yunnan Province). In general, these campaigns have not been successful for a variety of reasons, including difficulties in controlling the growth of the underlying causes of the problem while control strategies are being implemented (Box 3).

Box 3 Tai Lake Cleanup

Tai Lake, with a surface area of around 2,400 square kilometers, is the third largest freshwater lake in the People's Republic of China in terms of area. Tai Lake has suffered various effects of development over the past 5 decades including the loss of most of its endemic fish species due to water resource developments, foreshore conversion, and overfishing, but culminating in severe deterioration in its water quality during the late 1990s, which led to the implementation of very large cleanup programs during the 9th, 10th, and 11th five-year plans. These programs have not had any notable beneficial effect on the condition of the lake.

The problem of Tai Lake has been the subject of many comprehensive planning studies over the years, and the investment programs have been very broad-based, reflecting the wide range of factors that have been identified to be impinging on the problem. However, most of the cleanup effort was focused on treating the symptoms of the problem and not the underlying causes including rapid economic growth, industrialization, urbanization, and development of rural industries. The main deficiencies of the plans were that they were

(i) too static and insufficiently forward-looking, taking inadequate account of the deleterious effects of continued economic and population growth occurring at the same time that the plan was being implemented. The plans had no effective measures to contain or restrict economic and urban growth within the catchment during either of the planning periods; and

(ii) although the plans included substantial funds for nonpoint source (NPS) pollution control, no measures were included to control the growth of livestock numbers during the planning periods, outweighing some success achieved in restricting the growth of in-lake aquaculture activities. The net effect of this oversight was that concentrations of total nitrogen and total phosphorus increased significantly even as the plans were being implemented (see table below).

Estimated Quantities of Total Nitrogen and Total Phosphorus from Nonpoint Source in the Tai Lake Basin, 1995 and 2004 (tons)

Form and Source of NPS Pollution	1995	2004	Increase 1995–2004 (%)
Nitrogen			
Livestock	24,601	33,248	+35
Households	19,710	39,973	+103
Aquaculture	9,302	18,752	+101
Total	**53,613**	**91,973**	**+71.6**
Phosphorus			
Livestock	4,911	6,514	+32.6
Households	3,185	6,459	+102.8
Aquaculture	900	1,814	+101.6
Total	**8,996**	**14,787**	**+64.4**

The Tai Lake experience provides an excellent example of why effective environmental cleanup programs must focus simultaneously on the symptoms of the problems as well as their underlying causes.

Source: ADB report

Quality of groundwater

Groundwater contamination can occur naturally due to geological conditions, the inflow of saltwater as a result of water table depression in coastal areas, or infiltration of polluted surface water. The major groundwater quality contaminants in the PRC are total hardness (generally due to geological conditions, not pollution), various forms of nitrogen (agricultural runoff, septic overflows, leakage from sewers), chloride and fluoride (geological conditions or saltwater intrusion), sulfate (usually due to agricultural runoff), and heavy metals (iron, manganese, and others, which are usually due to geological conditions, but sometimes can be due to industrial or mining pollution).

Groundwater quality in the PRC has been progressively worsening as the overall pressure on water resources increases, but the effects are somewhat variable across the regions. In the northeast, pollution problems tend to be localized and variable from location to location; whereas in the northern region, contamination is widespread and rather uniform. In the northwest, groundwater pollution is only very light; whereas in the south, groundwater quality is generally good with contamination, if any, being much localized.

Table 10 summarizes the results of the latest available national survey of groundwater conditions in cities across the PRC, which is carried out by the Ministry of Land Resources (MLR).

Groundwater quality data were available from 189 cities. Both deep and shallow groundwater tables were monitored and, overall, the deeper the resource the better the quality, and the lower the rate of exploitation the better the quality. There was little change in 2007 from the previous year—the main areas of declining water quality were the north, northeast, and northwest regions where groundwater utilization is highest.

In terms of shallow groundwater resources, 159 cities were monitored, and declines in quality from the previous year's survey were noted in only 16 cities, again mainly in the northern parts of the country. Quality was unchanged in 137 cities, spread widely across the country, and improved in 6 cities located in the northwest and in the eastern parts of the PRC.

Monitoring of deep groundwater was carried out in 76 cities of which water quality declined in 4 cities (in the northeast and northwest), was unchanged in 68 cities, and improved in 4 cities (in the north and the east).

Quality of coastal seas

The water quality classification system for seawater (GB3097-1997) defines four seawater quality classes as follows:

- Class I for marine fishery and marine natural reserves;
- Class II for aquaculture and human contact;
- Class III for areas of industrial use and seashore scenic and tourist activities (i.e., without direct contact); and
- Class IV for coastal harbor and ocean development.

Table 10 **Summary of 2007 National Groundwater Quality Survey**

Groundwater Depth	Item	Region					
		N	NE	NW	E	Central S	SW
Shallow	% Good[a]	44	41	45	36	53	48
	% Poor[b]	56	59	55	64	47	52
	Main contaminants	H TDS NO_3 NO_2 NH_3 Cl- F-	H TDS Cl- NO_3 NO_2	H TDS Cl- SO_4 NO_3	SO_4 NO_3 NO_2 Fe Mn	NO_3 NO_2 NH_3 Fe Mn	H Cl- SO_4 NO_3 NH_3 HCO_3 Fe Mn Ca Mg P Na
Deep	% Good[a]	45	50	61	77	50	
	% Poor[b]	55	50	39	23	50	
	Main contaminants	H SO_4 NO_3 F-	H TDS Cl- NO_3 NO_2	H TDS Cl- SO_4 NO_3 NO_2	H TDS pH Cl- SO_4 F-	H Cl- SO_4 Fe Mn	

E = East, N = North, NE = Northeast, NW = Northwest, S = South, SW = Southwest.
Symbols for main contaminants: Ca = calcium, Cl- = chloride, F- = fluoride, Fe = iron, H = total hardness, HCO_3 = bicarbonate, Mg = magnesium, Mn = manganese, Na = sodium, NH_3 = ammonia, NO_2 = nitrogen dioxide, NO_3 = nitrate, P = phosphorus, pH = hydrogen ion concentration (acidity), SO_4 = sulfate, TDS = total dissolved solids.
[a] The percentage of samples whose quality was good to very good.
[b] The percentage of samples that were poor to very poor.
Source: Ministry of Land Resources of the People's Republic of China.

In general, the quality of seawater off the coast of the PRC is poor. Water monitoring in 2007 showed that 25% of all monitoring stations were Class IV or worse, 49% were Class II or III, and 26% were Class I. The total area that was worse than Class I and thus unsuitable for marine fisheries or marine natural reserves was 145,000 km^2. This is equivalent to an area extending seaward for 10 kilometers along the full length of the PRC's coastline from the Republic of Korea to Viet Nam.

The most common oceanic pollutants are phosphates and NH_3–N (mainly from agricultural runoff, secondarily from municipal wastewater treatment plant discharges), COD (discharges of organic wastes), and suspended solids (from soil erosion). According to the *Bulletin of Marine Environmental Quality of China, 2007* compiled by the National Marine Data and Information Service, 88% of the 573 point sources discharging pollution to the PRC's coastal seas were exceeding the relevant discharge standards. The most heavily polluted areas are

- Liaodong Bay (Liaoning Province), which is the northern embayment of the Bo Sea, adjacent to a very large petrochemical development area centered on Jinzhou City, and downstream of the highly industrialized provincial capital of Shenyang;

- Bohai Bay (Hebei–Shandong Province), which is the western embayment of the Bo Sea and receives all the discharges from the Tianjin–Beijing urban and/or industrial complex;
- Laizhou Bay (Shandong Province), also part of the Bo Sea and which is mainly affected by discharges from the Yellow River and the substantial oil industry developments in the vicinity of Dongying City;
- Yangtze River Estuary (Jiangsu Province), which is mainly affected by the proximity of Shanghai;
- Hangzhou Bay (Zhejiang Province), which is mainly affected by the proximity of Hangzhou City; and
- the Pearl River estuary (Guangdong Province), which is mainly affected by developments in Hong Kong, China and/or Shenzhen urban and industrial areas.

Overall, the dominant contributor to marine pollution in the PRC is discharges from urban areas (municipal wastewater plus runoff) rather than industrial pollution. The only exception to this general pattern is the Bo Sea, where industrial pollution dominates.

Sources of Water Pollution

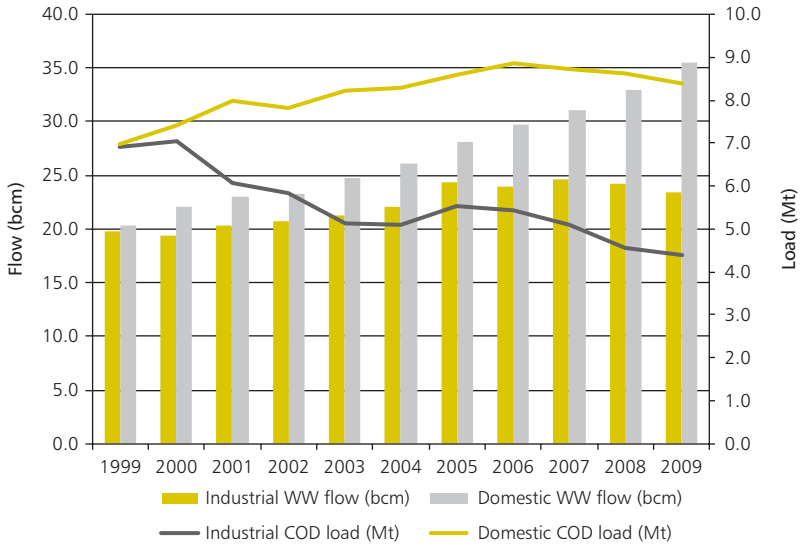
The three main sources of water pollution are (i) point source discharges from industrial and commercial enterprises; (ii) point source discharges of human waste, predominantly from urban areas (i.e., municipal wastes); and (iii) nonpoint discharges of surface runoff, which are mainly an issue in rural areas due to soil erosion, agrochemical (fertilizer, pesticide, herbicide) runoff, and/or discharges from animal or aquatic production activities.

Point source discharges

Although industrial, commercial, and municipal wastewater discharges contain a wide variety of pollutants, the pollutant of major concern to MEP that is used to track trends in point source discharges is COD, which is a reflection of the organic content of the discharge.

Figure 12 shows the trends in industrial and/or commercial and municipal wastewater flows and COD discharges for the period 1999–2009. The total industrial wastewater flow was exceeded by the domestic wastewater flow for the first time in 1999, and the gap has steadily increased ever since. Industrial wastewater flow started to flatten out in 2005 and then commenced a downward trend that has been sustained up to 2009. The total industrial COD load has shown even more noticeable improvements throughout the period. These are quite remarkable achievements given that industrial growth and development continued more or less unabated throughout the decade. The results highlight the effects of MEP's strenuous control efforts, combined with massive investments in new wastewater treatment infrastructure, particularly during the 11th Five-Year Plan period.

Figure 12 **Industrial and Domestic Wastewater Flows and Chemical Oxygen Demand Loads, 1999–2009**



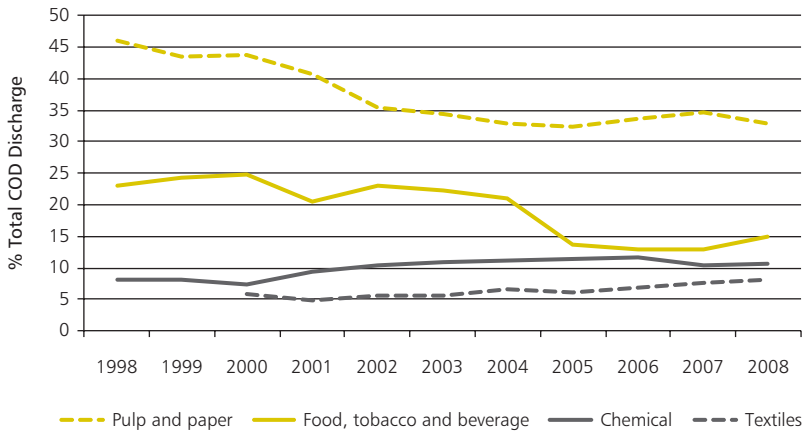
bcm = billion cubic meter, COD = chemical oxygen demand, Mt = million ton, WW = wastewater.
Source: Ministry of Environmental Protection. Various years (1999–2009). *Environmental Statistical Yearbook*. Beijing.

In contrast, domestic wastewater flows increased virtually every year throughout the decade with annual increases ranging between 4% and 8.4%. The domestic COD load, however, peaked in 2006 and then decreased in each of the subsequent years by between 0.9% and 2.9%. This shows the tangible benefits of the government's huge investments in new domestic wastewater treatment capacity—i.e., there was a 700% increase in municipal wastewater treatment capacity during the 11th Five-Year Plan, and installed treatment capacity at the end of the plan period was about 75% of estimated flow.

The two major contributors to industrial COD loads over the past 2 decades have been the pulp and paper industry and the food, tobacco, and beverage industry. In 2008, the pulp and paper industry accounted for nearly one-third of total industrial COD emissions, although this was a substantial reduction from its 1998 contribution, with over 45%. The contribution of the food, tobacco, and beverage industry was relatively stable from 1998 to 2004 but, since 2005, has dropped by 10%, while the contribution of the chemical industry rose slightly (Figure 13).

Geographically, the top three areas in terms of the quantities of industrial wastewater generated over the 2001–2006 period were the Pearl River Basin (Guangdong Province), the Taihu and Huai river basins (Jiangsu Province), and the Tai Lake Basin (Zhejiang Province). Nevertheless, as growth spreads to other provinces, the intensity of industrial wastewater pollution is also spreading. For example, in 2003, 2004, and 2005, wastewater discharges in Guangxi, Hebei, and Liaoning provinces exceeded 2 bcm per annum for the first time. An estimated 65% of total industrial wastewater generated in the PRC is

Figure 13 **Major Sources of Industrial Chemical Oxygen Demand Discharges, as % of Total**



COD = chemical oxygen demand.
Source: Ministry of Environmental Protection. 2009. *Environmental Statistical Yearbook.* Beijing.

produced in just 10 provinces—Fujian, Guangdong, Guangxi, Hebei, Henan, Hunan, Jiangsu, Shandong, Sichuan, and Zhejiang.

Nonpoint source water pollution

Nonpoint source (NPS) water pollution due to fertilizer runoff, pesticide runoff, and discharges from intensive animal production enterprises (including aquaculture activities) has become a major environmental issue in the PRC, and is likely to become the major pollution control challenge for the 12th Five-Year Plan period and beyond.

Table 11 summarizes the main results of the first National General Survey of Pollution Sources carried out by MEP between 2007 and 2010. The survey results are based on a total of 2.9 million agricultural survey points, 1.6 million industrial survey points, and 1.4 million domestic survey points. The results generally confirm what many experts and analysts have been saying for many years—i.e., that NPS pollution is a major contributor to water pollution in the PRC and, in some respects, is the major single influence.

The key findings from the survey are summarized as follows:

Nutrient pollution

- Agricultural NPS pollution is the source of 67% of all phosphorus pollution and 55% of all nitrogen pollution in the PRC.
- The biggest single source of nitrogen pollution is domestic wastewater (41% of total nitrogen discharged).

Table 11 **Estimated Nonpoint Water Pollution Discharges**

Source	Annual Pollutant Discharge (million tons) COD	Total N	Total P
Nonpoint Sources			
Diffuse runoff	Negligible	1.597	0.109
Livestock and poultry enterprises	12.683	1.025	0.160
Aquaculture enterprises	0.558	0.082	0.016
Total Nonpoint Sources (% total)	13.241 (44%)	2.704 (55%)	0.285 (67%)
Point Sources			
Industrial	5.644	0.208[a]	Negligible
Domestic	11.080	2.024	0.138
Total Point Sources (% total)	16.724 (56%)	2.232 (45%)	0.138 (33%)
Total Nonpoint and Point Sources (% total)	**29.965 (100%)**	**4.936 (100%)**	**0.423 (100%)**

COD = chemical oxygen demand, N = nitrogen, P = phosphorus.
[a] Industrial N measured as ammonia nitrogen (NH_3–N).
Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

- The biggest single source of phosphorus pollution is the intensive animal husbandry sector (38% of total phosphorus discharged).
- The biggest NPS of nitrogen pollution is diffuse runoff of fertilizer (59% of total nitrogen from NPS sources, and 32% of total nitrogen from all sources).
- The biggest NPS of phosphorus pollution is the intensive animal husbandry sector (56% of total phosphorus from NPS, and 38% of total phosphorus from all sources).

Organic pollution

- NPS accounts for 44% of COD pollution from all sources.
- COD from intensive animal husbandry enterprises is the single biggest source of organic pollution, accounting for 96% of NPS COD and 42% of total COD from all sources. COD from intensive animal husbandry enterprises exceeds the total discharge from domestic sources (the second biggest source) by 14%.

The significance of the findings regarding COD discharges is of particular note. As previously discussed, the government has been making significant progress in the control of COD discharges from industrial and municipal point sources, and this has been showing up in the ambient water quality data to some degree. However, much less progress has been made in the control of organic discharges from the animal husbandry sector. Further improvements in ambient water quality will require a broader water pollution control effort that (i) maintains the momentum that has already been achieved in industrial and municipal point sources; while, at the same time (ii) increases regulatory and development controls on rural NPS, most particularly, in the intensive animal husbandry sector.

Nutrient pollution. As mentioned earlier, the biggest single source of nitrogen pollution in the PRC is diffuse runoff of fertilizer from agricultural land—either as nutrients dissolved in runoff water or as nutrients adsorbed onto soil particles carried into rivers,

streams, and lakes due to soil erosion. This is also an important source of phosphorus pollution, accounting for 38% of phosphorus discharges from all nonpoint sources, and 26% of phosphorus discharges from all sources. Controlling the problem of nutrient runoff will require changes in the way farmers use fertilizers in the PRC, which is a matter largely outside the control of MEP.

Increasing fertilizer use has been a major factor in the remarkable growth of grain and food production in the PRC in the post-reform period. In fact, up until 1998, there was a direct linear relationship between fertilizer use and food production. Since that time, however, the correlation coefficient has been reducing rapidly (Zhu and Chen 2002)—meaning that, for the past decade at least, the nation as a whole has been getting less and less benefit from every incremental kilogram of fertilizer applied to the soil.

Between 1984 and 2010, annual fertilizer use in the PRC increased by 3,413%, from 1.6 million tons (of pure nutrient) to 54.6 million tons. The PRC is now the biggest fertilizer consumer in the world. The national average application rate is 400 kilograms (kg) per hectare (ha) of cultivated land, which is 23% higher than it was in 1999 (World Bank 2001), and somewhat higher than the world average.

The Ministry of Agriculture (MOA) estimates that the relative ratios of nitrogen (N), phosphorus (P), and potassium (K) applied in the PRC are 1.0: 0.47: 0.10. Applying these ratios to the 14.82 million tons of fertilizer applied each year in the PRC and comparing the resultant quantities with MEP's estimates of total N and P being discharged as nonpoint pollution (Table 11), it is calculated that 17% of total N and 2.4% of total P applied on farms in the PRC are ending up in rivers, streams, and lakes, representing not only a significant pollution problem but a significant waste of money.[68]

One of the major causes of the fertilizer runoff problem in the PRC is that most farmers tend to favor cheap, low-quality, single-ingredient fertilizers, which they often over-apply to make up for their poor quality, thus increasing fertilizer runoff. Compound fertilizers, which are more expensive but can help lessen the runoff problem, only accounted for 27% of all fertilizers consumed in 2005 (Chen 2006). Even when compound fertilizers are used, they tend to be general purpose, premixed fertilizers rather than specialized mixtures developed on the basis of soil testing or in-field fertilizer trials, and thus are not being used as effectively as they should.

The domestic fertilizer industry is characterized by considerable overcapacity, a high level of participation by small- and medium-sized producers,[69] and a high level of

[68] The total annual cost of procurement and application of fertilizer in the PRC is said to exceed CNY200 billion per annum, representing 25% of total agricultural input costs (Chen 2006). It is thus calculated that a total of CNY23 billion is being wasted each year on N and P fertilizers that are added to farmers' fields but are washed off and thereby yield no benefit in terms of agricultural production. This wastage is equivalent to 11.5% of total expenditures on fertilizer procurement and nearly 3% of total agricultural input costs. Other estimates of losses are much higher (e.g., Norse and Zhu 2004).

[69] The 20 largest fertilizer manufacturers in the PRC only account for about 50% of total production. The sector is considered to comprise around 200 "significant producers" (one of which is Sinofert, the world's largest fertilizer company), although this is a considerable improvement from 10 years ago when there were more than 1,000 "significant producers." Consolidation is likely to continue in response to overcapacity and the resulting cost pressures on inefficient producers.

competition. These factors tend to keep prices low and encourage over-application. Fertilizer subsidies exacerbate the problem.[70]

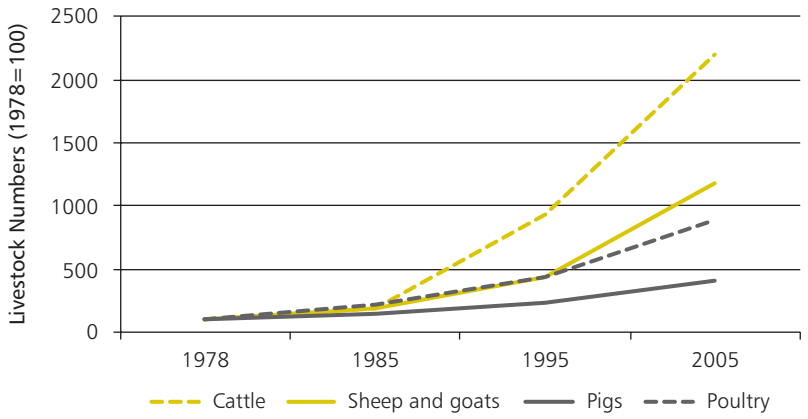
A variety of measures were included in the 11th Five-Year Plan to deal with the fertilizer management problem including (i) promoting soil testing and fertilizer formulation technologies; (ii) improving the quality of cultivable land through increased use of organic fertilizers, better soil quality monitoring programs, and adoption of water-saving agricultural techniques; (iii) enhancing farmer education; (iv) encouraging the utilization of advanced production techniques within the fertilizer production industry; and (v) tightening up regulatory supervision. These were steps in the right direction and need to be sustained into the next planning period.

Emissions from intensive animal production enterprises. A notable change in the structure of the rural economy over the past 3 decades has been the increased contribution made to the gross value of agricultural output (GVAO) by livestock production, which more than doubled its contribution from 14% in 1970 to 36% in 2006.

The growth in output value has been accompanied by phenomenal increases in livestock numbers—between 1978 and 2005, cattle numbers increased by 2,200%, sheep and goats by 1,200%, pigs by 411%, and poultry by 892% (Figure 14).

Due to the shortage of land in the PRC, much of the production of meat and dairy products is carried out in intensive animal production enterprises, which represent concentrated points of animal waste production. From an environmental point of view,

Figure 14 **Livestock Numbers in the People's Republic of China, 1978–2005 (Indexed, 1978 = 100)**



Source: Meng Q.X. and K.J. Guo. 2008. *Overview of Current Nutrient Use Efficiency in Livestock Production Systems in [the People's Republic of] China*. Beijing: China Agricultural University. p. 6.

[70] *China Economic Review* (2010); and Norse and Zhu (2004).

Table 12 **Proportion of Livestock Subsector Production from Small- and Medium-Sized Enterprises**

Type of Production	Proportion of Total Output Produced by Small- and Medium-Sized Enterprises (%)
Pigs	73
Poultry (broilers)	63
Poultry (eggs)	69
Beef cattle	82
Dairy cattle	65
Sheep and goats	73

Source: Meng Q.X. and K.J. Guo. 2008. *Overview of Current Nutrient Use Efficiency in Livestock Production Systems in [the People's Republic of] China*. Beijing: China Agricultural University.

one of the main challenges presented by the livestock sector is the predominance of small- and medium-scale producers (Table 12), which are characterized by low levels of technology and nutrient efficiency, low levels of management expertise, and low levels of organization.

The PRC's Environmental Protection Law, in theory, provides MEP with the legal authority to control discharges from intensive animal production units, but in reality, given the very large number of small- and medium-scale production units, only partial regulatory control focused on the large-scale production units is feasible. Control of the small- and medium-scale units is likely to be achieved gradually by means of a process of education through MOA.

Pesticides. The other major inputs that have played a part in the growth of the agriculture sector's output are pesticides, residues from which are not showing up in routine water quality data since they are not routinely tested for. In the early 1950s, total domestic pesticide production was only about 1,000 tons. By 1999, this had increased to 625,000 tons by which time the PRC had become the second largest producer and consumer in the world. Since then, usage is believed to have doubled to around 1 million tons per annum, of which about 0.4 million tons was exported, making the PRC the world's biggest producer, consumer, and exporter (Shanxi Petroleum and Chemistry Industry Office 2006; Yang 2007).

About 30% of the total pesticides used in the PRC are highly toxic, and the government has initiated measures to address this problem. In 2004, the government took steps to reduce the use of five high-toxicity pesticides that accounted for 25% of total pesticide application in the PRC—methamidophos, parathion, methyl parathion, monocrotophos, and dimecron—and their use was banned completely at the beginning of 2007. The 2006 Law on Agricultural Product Quality and Safety included a new standard for pesticide residue limits on food items in the PRC and a pesticide education system for farmers that will represent a major step forward in food safety. Again, the management and control of pollution due to pesticide use is a matter primarily under the control of MOA.

Approach to Water Pollution Control

At the center of the water pollution control policy landscape are "command-and-control" instruments, such as the Three Simultaneous process,[71] the application and enforcement of discharge standards, total pollutant discharge control, and the issuance of discharge permits. Taken together, these are very similar to water pollution control policies applied anywhere in the modern developed world. The key features of the current water pollution control system are as follows:

- The industry sector is the main focus;
- Water pollution control for the agriculture and urban sectors is undertaken mainly as an extension of industrial pollution control policies, which are not well suited to dealing with, for example, nonpoint sources;
- The system is heavily reliant on the government using coercive instruments such as penalties for exceedance of discharge standards;
- It has no clear guidance and direction for enterprises;
- Opportunities for participation by the general public are absent or very limited; and
- There is only limited use of economic, participatory, incentive-based, and voluntary policies.

Existing policies seek to intervene in three ways:

- **Prevention**—use of relevant policies, such as water pollution control planning at the river basin level, environmental impact assessment (EIA), the Three Simultaneous process, and total pollutant load control;
- **Process controls**—influencing the process, with discharge permits as the main vehicle; and
- **End-of-pipe policies**—including pollution levies, establishment of centralized wastewater treatment plants (WWTPs), suspension of production for enterprises that cannot comply with relevant discharge standards, or closure of enterprises that have neither the financial or technical capacity to comply.

Most of the emphasis are on end-of-pipe policies—with insufficient attention on early prevention and middle-stage management (i.e., process controls). However, this situation is gradually improving due to the increasing emphasis given on preventive measures including more effective use of the EIA system and development of river basin-based water pollution control plans.

Within this general framework for water pollution control, MEP's water pollution control strategy has focused on three important activities: (i) total pollutant

[71] The "Three Simultaneous process" is the design, construction, and operation of pollution control facilities simultaneously with the development of capital projects.

discharge control, (ii) targeted pollution control activities in key watersheds, and (iii) special campaigns.

Total pollutant discharge control

The main measures for achieving total pollutant discharge objectives (e.g., the reduction of total COD emissions by 10% during the course of the 11th Five-Year Plan) include:

- **Control at entry.** MEP rejects any proposed project that would result in the discharge of heavy metals or persistent organic pollutants (POPs) into a key lake, or nitrogen and phosphorus into a closed or semi-closed water body. In addition, environmental requirements for highly polluting industries such as iron and steel, coking, calcium carbide, copper refinery, and automobile industries have become more stringent. Proposed projects within these subsectors that do not conform to national industrial policy and environmental protection requirements will not be approved. Approval of a proposed project is not granted if: (i) the proposing enterprise has any history of failure to meet prescribed discharge targets, failure to meet total pollutant discharge control limits, or has a record of environmental violations; (ii) relevant ambient water quality standards are already being exceeded; or, (iii) the local administration fails to meet targets for eliminating production processes utilizing outdated technologies, in the case of expansion of existing enterprises.
- **Strengthening industrial pollution control.** Since 2008, all enterprises must possess a valid pollutant discharge permit, and those without the necessary permit are not allowed to operate. Enterprises not complying with their permit requirements are compelled to suspend or cease operations. Supervision of the implementation of these policy requirements was strengthened, with particular reference to key industrial enterprises that account for 65% of total COD emissions. In addition, small-scale, highly polluting, and high-energy consumption plants in the pulp and paper, brewery, chemical, textile, and dyeing industries (referred to as the "five smalls") have been phased out or shut down. Enterprises that cannot meet the discharge standards of the prescribed key pollutants within a specified period are ordered to cease operations for immediate rectification.

  Enterprises are also required to adopt measures to conserve, recycle, and reuse water. High water-consuming enterprises face mandated requirements for wastewater discharge volume. Pollution reduction and technological transformation are promoted for pulp and paper, brewing, chemical, textile, and dyeing industries. Wastewater reuse and recycling are encouraged for iron and steel, power, chemical, and coal industries. Stringent monitoring of the quantity and quality of industrial wastewater discharged into urban WWTPs is conducted. Inspections conducted in chemical enterprises located along waterways seek to identify discharges of toxic and hazardous wastes. To increase transparency regarding the operation of in-plant WWTPs, prevent pollution accidents, and improve emergency preparedness and response, monitoring data is published on a regular basis.

- **Accelerated construction of municipal WWTPs.** A mandatory target of the 11th Five-Year Plan for environmental protection required all cities to have operational WWTPs by 2010, with sufficient capacity to handle at least 70% of total urban residential wastewater flows (the target was exceeded). Supervision of the operation of municipal WWTPs was strengthened, and cities with inadequate water supplies were required to take steps to ensure the reuse and/or recycling of at least 20% of water consumed. All cities within key river basins were required to collect wastewater tariffs, if they were not doing so already. Technical standards for municipal WWTPs were recently upgraded and now require the inclusion of tertiary treatment capacity (nutrient removal) in certain cities and municipalities—a program that will be extended under the 12th Five-Year Plan.
- **Controlling rural sewage and nonpoint source pollution.** To reduce the use of chemical fertilizers and pesticides, organic and green agriculture is being promoted, along with balanced fertilizer application (i.e., the use of compound fertilizers) and integrated pest management. In certain priority control areas, livestock and poultry breeding are being banned. Livestock and poultry farms that cannot meet the relevant discharge standards for the sector within a specified time frame face closure. All concentrated rural settlements were required to have sewage treatment facilities installed by the end of June 2008 (although this target was not achieved).
- **Maintenance of safe drinking water.** Special measures were taken to strengthen water quality management and protection in certain key water supply catchment areas, including preparation of drinking water safety plans and environmental protection plans. Soil erosion, water resource restoration, and nonpoint source pollution control were strengthened. In Class I catchments, all pollutant discharges of any kind are being prohibited or eliminated. In Class II catchments, closure notices are being issued for all projects newly built or expanded since 2000, and the handling and storage of toxic and hazardous substances are being banned. Other measures in these watersheds include the development of emergency response plans, strengthening of interagency coordination, increased water quality monitoring, and in areas relying on groundwater sources, groundwater pollution surveys and development of groundwater protection plans.

Pollution control for key watersheds

Over a series of 5-year planning periods, a succession of key watersheds has been identified for special water pollution control measures, and these programs continued under the 11th Five-Year Plan. The program began during the 9th Five-Year Plan with the designation of the "three rivers and three lakes" program (the three rivers are the Huai, Hai, and Liao rivers; and the three lakes are Tai Lake, Chao Lake, and Dianchi Lake). Since then, the number of key watersheds has expanded to include the Songhua River (which was the location of a disastrous chemical spill in 2005), the Three Gorges Reservoir along the Yangtze River and its upper reaches, and the Xiaolangdi Reservoir on the Yellow River and its upper reaches (the latter two are preventative programs; all the others are restorative programs).

Most of these programs are implemented within the framework of a set of comprehensive pollution control plans. For example, the (then) State Environmental Protection Administration (SEPA) and the National Development and Reform Commission (NDRC) jointly issued the "Pollution Control Plan for the Three Gorges Reservoir and Its Upper Reaches (Revised)" (January 2008). Similarly, MEP, NDRC, MWR, and the Ministry of Housing and Urban-Rural Development (MHURD) jointly developed the "Water Pollution Control Plan for Huai, Hai, and Liao, Chao Lake, Dianchi Lake and the Upper and Middle Yellow (2006–2010)." MEP and NDRC formulated the "Master Plan for the Comprehensive Rehabilitation of the Tai Lake Basin," which was approved by the State Council in May 2008. These comprehensive plans are a step in the right direction for simultaneously addressing current problems and mitigating future problems (Box 3).

Special campaign for water pollution control

In July 2008, the PRC initiated an environmental protection enforcement campaign that involved joint action by eight central agencies, namely MEP, NDRC, the Ministry of Supervision, the Ministry of Justice, MHURD, the State Administration for Industry and Commerce, the State Administration of Work Safety, and the State Electricity Regulatory Bureau. The campaign was intended to crack down on non-compliant enterprises in drinking water supply sources and ensure that the quality of all drinking water supplies meets applicable standards. Inspection of environmental protection was conducted in 113 key cities. Long-time offenders were threatened with permanent closure and, to prevent pollution migration, outdated technologies and equipment were to be phased out and destroyed. Municipal WWTPs that cannot reach 60% of their design capacity 1 year after completion are placed on probationary status and given a fixed period to solve problems. During the probationary period, no EIAs for developments in the affected area will be approved.

4.2 Air Quality and Sources of Air Pollution

Air Quality

The increased demand for energy, growing vehicular fleet, and industrial expansion have led to serious air quality deterioration in the PRC, which, in turn, has adverse effects on human health and ecosystems. A recent study by the World Bank (2007) estimated that air pollution could be imposing annual economic costs in the PRC equivalent to as much as 1.2% of GDP based on cost-of-illness valuation and 3.8% of GDP based on willingness to pay.[72]

Less than 1% of the 500 largest cities in the PRC meet the air quality standards recommended by the World Health Organization (WHO), and 7 cities in the PRC are ranked among the 10 most polluted cities in the world.

[72] The estimate is based on the economic valuation of the lives lost prematurely and the loss of economic productivity attributable to exposure to air pollution levels of the kind being experienced in the PRC.

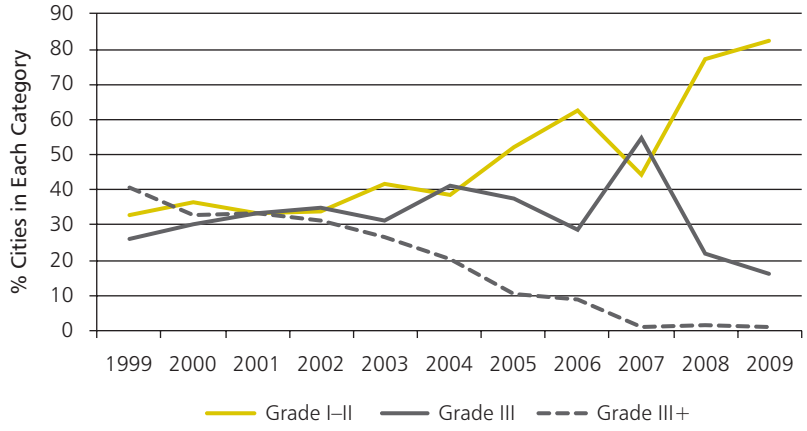
The government has been applying significant financial and administrative resources to the air pollution problem with the net effect that, over the 11-year period ending in 2009, the PRC's overall urban air quality levels have begun to improve although, as mentioned, the situation remains serious.

Air quality is measured regularly in 560 cities around the country including 113 cities that were identified in the 11th Five-Year Plan for environmental protection as priority cities for sulfur dioxide (SO_2) and general air pollution control. Three major pollutants are monitored on a routine basis: inhalable particulate matter (PM_{10}), SO_2, and nitrogen dioxide (NO_2).

The trends in ambient urban air quality over the 1999–2009 period are shown in Figure 15. The most obvious achievement is the virtual disappearance of Grade III+ conditions (i.e., pollutant concentrations that exceed the lowest category defined in the standard) in the surveyed cities over the period.

In 1999, Grade III+ was the dominant condition being experience in about 40% of the 340 cities included in the survey. By 2009, Grade III+ conditions were being measured in less than 2% of the 612 cities included in the survey. The incidence of Grade III conditions actually increased through to 2005 (from about 26% of 338 cities surveyed in 1999 to 37% of 522 cities surveyed in 2005), but decreased thereafter (to 16% of 612 cities surveyed in 2009) in response to the greatly increased regulatory and control efforts by MEP under the 11th Five-Year Plan. The incidence of Grade I and II conditions steadily increased throughout the period (from 33% in 1999 to 83% in 2009).

Figure 15 **Ambient Urban Air Quality Trends, 1999–2009**



Note: The number of cities monitored in the annual survey changed over the 1999–2009 period; 340 cities were included prior to and including 2004. After that period, the sample size increased to 522 cities in 2005, 559 in 2006, 519 in 2008, and 612 in 2009. In 2007, only the 113 "major environmental protection cities" were included in the survey, which probably accounts for the somewhat anomalous data for that year.
Source: Ministry of Environmental Protection. 2009. *[The People's Republic of] China Environmental Quality Bulletin (1999–2009).* Beijing.

These broad overall trends mask some variability between cities. Most of the improvements realized over the 1999–2009 period occurred in smaller cities with lower economic and population growth rates. In general, air pollution is found to be significantly worse in large cities than in medium and small cities; cities with populations in the range of 1–2 million people have some of the worst air pollution levels in the country. It also appears that in some parts of the country, pollutant interactions and pollutant clouds from adjacent urban and/or industrial areas combine to produce regional and subregional patches of reduced air quality. Thus, the overall environment quality at the regional level is declining, with increased occurrences of smog, haze, and acid rain.

Suspended particulates

The most visible air pollutant in the PRC is suspended particulate matter (PM_{10}). Over one-third of the monitored cities reported concentrations of PM_{10} higher than the Class II standard, which is much higher than the proportion of cities with SO_2 and NO_2 concentrations exceeding the relevant standards.

Fine particulates

SO_2 and nitrogen oxides (NO_x) emitted into the atmosphere can be transformed through chemical reactions into sulfate and nitrate particles. This form of fine particulate ($PM_{2.5}$), or particulate matter that measures 2.5 microns or less in diameters, is fine enough to enter deeply into the lungs and bloodstream and cause the most serious health problems. Regional simulations using computer models suggest that large regions of the PRC are suffering from high $PM_{2.5}$ concentrations, supporting the view that fine particulate pollution is already a severe regional environmental issue.[73] Since 21 January 2012, the Beijing Environmental Monitoring Center has begun reporting $PM_{2.5}$ data, representing a major step forward for the PRC's air pollution control efforts.[74]

Sulfur dioxide

The pollutant that most closely tracks developments in an industrializing and urbanizing economy is SO_2, which is primarily a combustion product of materials such as coal, fuel oil, gasoline, and diesel. The dominant source of SO_2 in the PRC is the thermal power industry, which accounts for around 60% of total emissions. However, residential and commercial emissions are often more significant in terms of actual local impacts due to their lower emission heights and greater proximity to residential areas.

During the 1990s, the government made considerable headway in reducing SO_2 emissions but, during the 10th Five-Year Plan (2001–2005), these efforts were reversed by the tremendous surge in economic growth—total SO_2 emissions increased by 25%, from about 20 million tons in 2000 to about 25 million tons in 2005.[75] The momentum of the SO_2 emissions continued into 2006 (when total emissions increased further to 25.9 million tons), but the trend reversed in 2007 and continued through to the end

[73] Lin and Swanson (2009), p.22.

[74] The United States started reporting on $PM_{2.5}$ in 2002 and the European Union in 2008.

[75] The government's objective for SO_2 emissions under the 10th Five-Year Plan (2001–2005) had been to reduce the amount emitted to 18 million tons.

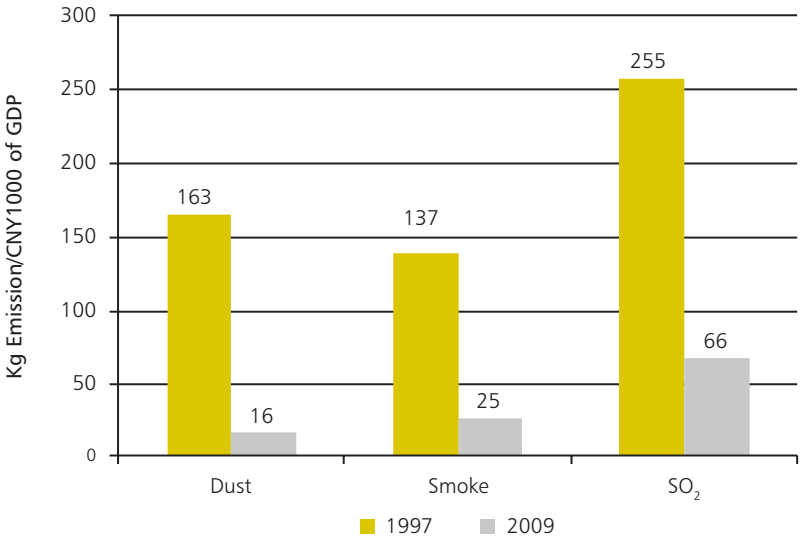
of the plan period. SO_2 emissions declined by 12.6% during the 11th Five-Year Plan period (2006–2010), and were estimated at 21.85 million tons in 2010.[76]

The downward trend of SO_2 emissions in recent years is clearly not an effect of the global economic slowdown, as the trend has been sustained well into the PRC's recovery period; rather, the decline is credited to the effectiveness of MEP's SO_2 control strategy under the 11th Five-Year Plan. Nevertheless, it is worth recalling that total SO_2 emissions at the end of the 11th Five-Year Plan were more than 20% higher than the level (18 million tons) that had been set as the target for the 10th Five-Year Plan. This illustrates the importance of relentlessly maintaining the environmental regulatory effort at all times. In a rapidly growing economy like the PRC's, every step backward on pollution control, as was experienced under the 10th Five-Year Plan, becomes increasingly difficult to compensate for in subsequent years.

Industrial air pollution emissions

The most encouraging dimension of the PRC's struggle with air pollution is the long-term decline in industrial air pollution emission intensities (i.e., the quantity of air pollutants emitted per increment of GDP), as shown in Figure 16, although the country began from a very low base.[77]

Figure 16 Changes in Air Pollutant Emission Intensities, 1997 and 2009



GDP = gross domestic product, kg = kilogram, SO_2 = sulfur dioxide.
Source: Ministry of Environmental Protection. 2008. *[The People's Republic of] China Environmental Quality Bulletin (1999–2009)*. Beijing.

[76] Accompanying SO_2 emissions control is control of mercury emissions, which come mainly from coal combustion.

[77] The PRC's industry sector at the beginning of the 1990s was remarkably inefficient in air pollution terms. Overall industry sector emission intensities were 12 times that of the United States, 26 times that of the United Kingdom, and 78 times that of Japan.

Nevertheless, the substantial upward inflection in economic growth during the past decade far outweighed the beneficial effects of these efficiency improvements. This suggests that something more than the current program of enterprise reform in the energy sector and, for SO_2 control, the installation of desulfurization facilities,[78] will be required in the future to achieve real progress in reducing total quantities of pollutant emitted and in further improvements in ambient air quality.

Acid rain

A direct consequence of the high SO_2 levels being experienced in the PRC has been an increasing incidence and severity of acid rain—i.e., precipitation that is unusually acidic due to interaction with gases such as SO_2 and NO_x. Between 2000 and 2005, monitoring by MEP detected increases in the average concentrations of sulfate and NO_3 radicals in the air of between 12% and 40%, respectively. The geographical extent of the problem has also increased quite substantially. Between 2002 and 2005, the area heavily affected by acid rain (average pH of precipitation <4.5) increased by 25% (from 4.9% of national land area to 6.1%).

In 2006, about one-third of counties in the PRC experienced significant incidences of acid rain (more than 25% of precipitation having pH <4.5). This has remained fairly steady up to the present time, notwithstanding the considerable economic growth that has occurred in the interim. This may be reflective of the positive results of the government's substantial efforts in closing down small and inefficient thermal power stations and high emission industrial enterprises.

The regions most affected by acid rain are the areas with higher rainfall, primarily south of the Yangtze River, including Chongqing, Fujian, Guizhou, Hunan, Jiangxi, and Zhejiang as well as part of provinces and cities such as Anhui, Guangdong, Guangxi, Hubei, Jiangsu, Shanghai, and Sichuan.

Indoor air quality

The PRC also faces challenges with indoor air quality, although levels are not consistently or comprehensively monitored. According to research conducted by the China Consumer's Association, formaldehyde concentration in indoor air samples exceeded relevant standards by 73% in Beijing and 79% in Hangzhou. In addition, benzene concentrations in indoor air samples were 10 times higher than acceptable standards. Furthermore, 94% of new vehicles tested for indoor air pollution had concentrations of pollutants exceeding air quality standards, and 90% of newly decorated homes have formaldehyde concentrations exceeding relevant standards.[79] In rural areas, indoor air pollution from cooking and heating poses considerable threats to household members' health.

[78] An important component of the 11th Five-Year Environmental Plan was the installation of desulfurization facilities on thermal power plants, which were built before 2004 and were violating emission standards, combined with closure or renovation of thermal power plants older than 20 years or with an installed capacity below 100 megawatts (MW). By the end of 2010, 80% of coal-fired thermal power stations in the PRC has sulfur scrubbers fitted (Zhou 2011).

[79] The PRC is not alone in not routinely monitoring indoor air quality. WHO issued (15 December 2010) its first guidelines for acceptable levels of indoor chemicals including benzene, carbon monoxide (CO), formaldehyde, naphthalene, NO_2, polycyclic aromatic hydrocarbons (PAH), radon, and tri- and tetra-chloroethylene. This may prompt more regular monitoring not only in the PRC but also elsewhere.

Sources of Air Pollution

The industry and energy production sectors are the main sources of anthropogenic air pollution emissions in the PRC. However, the rapidly growing fleet of personal vehicles is playing an increasingly important role.

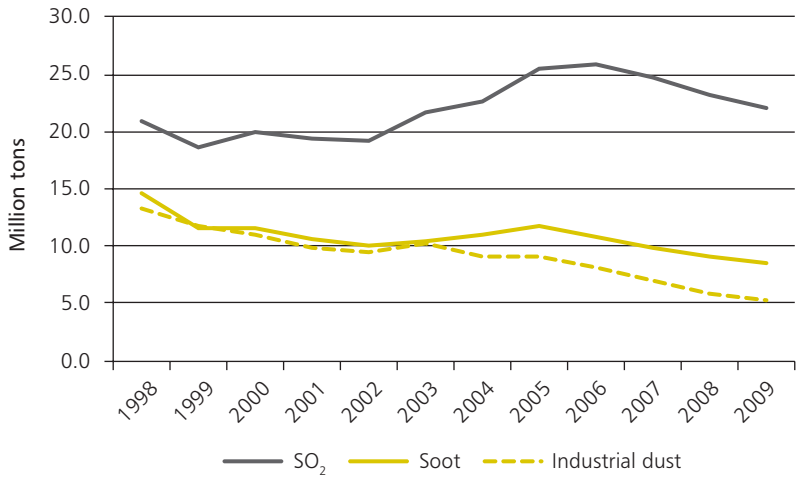
Emissions from industrial point sources

The industry and power sectors have been the backbone on which the PRC's growth and development have been built, but they have also made a significant contribution to the poor air quality situation.

Over 70% of SO_2 and dust (particulate) emissions are derived from industrial point sources (including emissions from thermal power stations). SO_2 emissions started climbing in the first part of the past decade (Figure 17) due to the rapid growth in industrial output over the period. The trend only started to reverse at the beginning of the 11th Five-Year Plan period as MEP stepped up its efforts in closing down small and inefficient enterprises and power stations, and enforcing more strictly the provisions for noncompliant sources to be brought into compliance within fixed time periods. In contrast to SO_2 emission trends, particulate emissions (soot and fugitive dust) have been on a generally declining trend.

The major sources of SO_2 emissions are the electric power industry, non-metallic mineral products industry, ferrous smelting industry, chemical manufacturing industry, and nonferrous smelting industry. Collectively, these subsectors contribute over 85% of total industrial SO_2 emissions, and their contribution is disproportionately greater than their contribution to the economic output of the industry sector. Among these major

Figure 17 **Industrial Air Emissions, 1998–2009**



SO_2 = sulfur dioxide.
Source: Ministry of Environmental Protection. Various years (1996–2009). *Environmental Statistical Yearbook.* Beijing.

sources, it is the electric power industry that makes by far the greatest contribution, accounting for around 60% of total industrial SO_2 emissions.

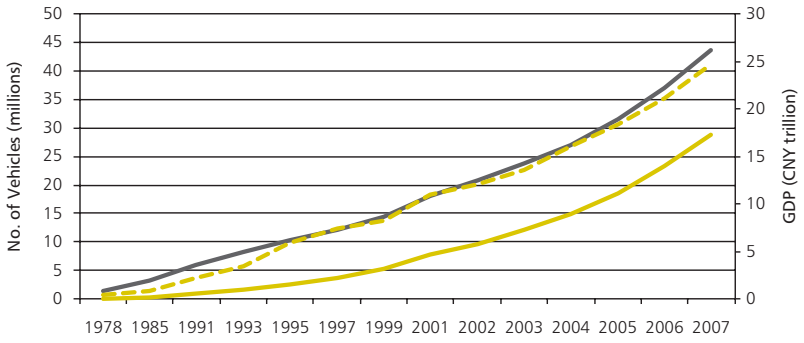
Vehicular emissions

The growth in the number of vehicles in the PRC over the past 3 decades has been little short of incredible. The number of civilian vehicles (i.e., nonmilitary, government, and privately owned vehicles) on the roads in the PRC has increased at a compound rate of 15% per annum over the past 3 decades which, essentially, has paralleled nominal GDP growth (Figure 18). The number of privately owned vehicles has grown even faster, at a compound rate of 26% per annum starting, effectively, at zero in the late 1980s. The number of civilian vehicles in the PRC in 2007 was 3,200% higher than in 1978.

Vehicles are already making a substantial contribution to air pollution due to emissions of NO_x, carbon monoxide, hydrocarbons, and fine particulates. In 2008, vehicular emissions of NO_x were estimated at 5.52 million tons, which was 34% of total NO_x emissions, while fine particulate emissions—at 0.57 million tons—were accounting for 6.4% of total fine particulate emissions.[80]

The problem of vehicular emissions is compounded by a lack of effective public transit facilities, low (but improving) motor vehicle emission standards, and slow development of automobile energy-saving and clean technologies. Limited money has been invested to support public transport infrastructure, such as high-quality interchange terminals and passenger information systems. Bus priority and bus rapid transit have been tried and sustained in only a few places, but are catching on.

Figure 18 Number of Civil and Private Vehicles and Gross Domestic Product Growth in the People's Republic of China, 1978–2007



GDP = gross domestic product.
Sources: National Bureau of Statistics. Various years. *[The People's Republic of] China Statistical Yearbook.* Beijing; Parkash, M. 2008. *Promoting Environmentally Sustainable Transport in the People's Republic of China.* Manila: ADB.

[80] Emissions increased even further between 2008 and 2009, with vehicular NO_x emissions increasing by 6.7% and particulate emissions increasing by 1.1% (Ge et al. 2010).

Impacts of Air Pollution

Of all the pollution challenges confronting the PRC, atmospheric pollution is arguably the most significant due to its impacts on human health, either through poor indoor air quality or poor ambient air quality.

Epidemiological evidence suggests that outdoor air pollution is a contributing cause of morbidity and mortality due to factors such as reduced lung function, respiratory symptoms, chronic bronchitis, cardiovascular and cerebro-vascular diseases, increased hospitalization or outpatient visits, work and school absenteeism, and premature death.[81]

Indoor air pollution has similar effects but represents a greater risk to individuals due to their prolonged exposures and the much higher pollutant concentrations that are experienced. Until relatively recently, the problem was confined mostly to the rural poor as a result of exposure to suspended particulates, relatively simple volatile organic compounds (VOCs) and carbon monoxide/dioxide due to the use of solid fuels (e.g., animal wastes, crop wastes, and others) for both heating and cooking in poorly ventilated houses. This type of "traditional" exposure is an important contributor to the fact that the PRC has the highest incidence of chronic obstructive pulmonary disease (COPD) and the highest number of deaths due to lung cancer in the world (although smoking is another key factor).

As incomes have risen and more people, particularly urban residents, have been able to afford new apartments and houses, they too are becoming exposed to more exotic forms of indoor air pollution. Such pollution could be due to the use of modern surface finishes (paints and wallpapers), decorative products (synthetic surface coverings, engineered flooring materials, etc.), and furniture (particularly products made with substantial quantities of epoxy glues and resins). There is a general lack of awareness that these materials can pose significant human health risks due to "outgassing" of VOCs (formaldehyde, benzene derivatives, etc.), many of which are suspected carcinogens or could increase the risk of allergies and related effects.

This issue is only just starting to be studied in the PRC, but data from the Beijing Chemical Substance Toxicity Identification and Test Center indicate that more than 400 acute poisoning events due to toxic architectural decoration materials occur each year in Beijing alone. Concerns have also been expressed in the PRC about links between indoor air pollution and the rising incidence of childhood leukemia.[82]

This is a completely new area for the PRC and the related standards and control policies are rather limited, as is the background research necessary to quantify the problem.

Approach to Air Pollution Control

The central instrument for air pollution control is the Law on the Prevention and Control of Atmospheric Pollution, which was first issued on 5 September 1987 and

[81] World Bank (2007), p.20.

[82] See, for example, http://news.sohu.com/20050628/n226115129.shtml, although many of the concerns being expressed may be somewhat speculative.

revised and re-issued on 29 May 1995. The law specifies a series of pollution prevention and control measures and contains regulations relating to acid rain and SO_2 control areas. These control areas were approved and delineated in 1988 and involve 175 cities covering a total area of 1.09 million km^2, or 11% of national land area.[83] Within the control areas, the government carries out structural adjustment in the energy sector by popularizing clean fuels and low-sulfur coals, and prohibiting the use of coal for domestic cooking.

The approach to air pollution control has changed over time in response to the growing seriousness of the problem. As far back as 1973, the focus was on the control of emissions from industrial point sources using a concentration-based standard. In the 1980s, the emphasis shifted toward a more integrated approach focusing on urban areas, although the standards were still concentration-based. In the 1990s, the emphasis shifted again from concentration-based control to total load control (total load being a function of both the concentration of the pollutant and the total volume of gas discharged), and from integrated urban environmental control to regional pollution control. Finally, in the 11th Five-Year Plan, greater emphasis was placed on SO_2 and acid rain control through the adoption of objective measures—to be included in the plan. The goal under the *Plan for Prevention and Control of Pollution from Acid Rain and Sulfur Dioxide* was to reduce total SO_2 emissions by 10% from its 2005 levels.[84]

The specific policies and instruments developed and issued since 2000 to underwrite these control strategies include:

- Policy on Technologies for Prevention and Control of SO_2 Emissions from Coal-Burning,
- 10th Five-Year Plan for Prevention and Control of Pollution from Acid Rain and Sulfur Dioxide in the Two Control Areas, and
- New emission standards governing coal, oil and gas-fired boilers, thermal power plants, and motor vehicles.

Some key components of the approach to improving performance and compliance include:

- **Industrial sources.** The approach combines industrial restructuring (e.g., requiring the closure of certain categories of industry or sizes of enterprises within an industrial category), and stronger enforcement of the regulatory requirement for enterprises to comply with discharge standards within a prescribed time limit. Enterprises that cannot comply with the standards, or are exceeding the allowable load, are required to restrict production and are prevented from undertaking any investments that would increase total load. Those who cannot comply within the specified time limit are theoretically required to shut down (enforcement of this requirement has been much stronger in recent years, although it is not uniform across the country).

[83] The acid rain control zone covers an area of 806,000 km^2, and the SO_2 control x-zone covers an area of 290,000 km^2.

[84] So far, the control targets have been oriented toward limiting emissions rather than ambient air quality, which has more direct relation with population exposure.

- **Thermal power industry.** Key elements of the approach include promotion and development of alternative energy; promotion of energy-saving appliances; promotion of greater use of market instruments to encourage energy conservation; shutdown of small-scale thermal power units, and making the elimination of such units a precondition for approval of new, larger-scale generating units; and installation of desulfurization facilities on new thermal generating units.
- **Mobile sources.** The primary means of control is via vehicle emission standards. The PRC's standards are quite good by international standards. The current National Standard III, which went into effect in July 2007, is equivalent to Euro III standards (which were only introduced in Europe in 2000), and Euro IV standards (which came into effect in Europe in 2005) took effect in 2010.[85] On the enforcement side, considerable investments are being made in the development of vehicle testing stations to increase capacity to periodically retest operating vehicles. Supervision and management of vehicle test organizations are also being improved to ensure compliance with correct testing procedures. In major urban areas, environmental control of gas stations is being strengthened, and monitoring of air quality on urban roads is being increased.

Positive results from the combination of these measures started showing up in ambient air quality data during the latter parts of the 11th Five-Year Plan. The results also suggest that the comprehensive approach adopted under the plan was the correct approach. However, there will be limits to how much more improvement can be gained through structural adjustment, and this will increase the pressures on the command-and-control system and perhaps also increase the need to look more seriously at the role of incentives systems, including the development and use of market-based instruments.

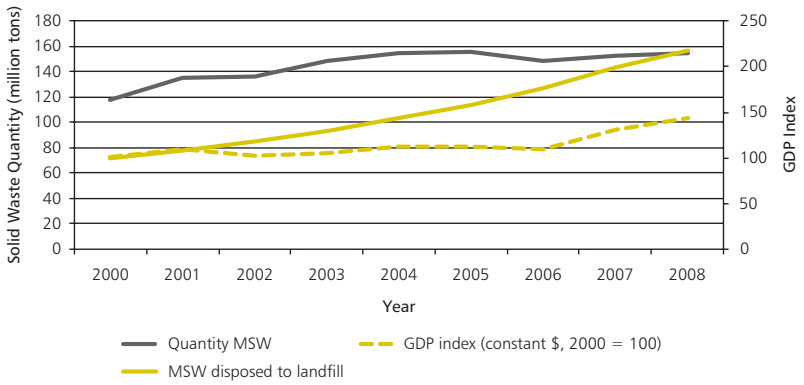
4.3 Solid Waste

Introduction

During the 1990s, the solid waste situation in the PRC was something of an afterthought on the environmental agenda but, since the 10th Five-Year Plan, it has started to move into the front rank of priority environmental problems. No country has ever experienced as large or as fast an increase in solid waste quantities as the PRC is now facing. The PRC currently produces about 25% of the world's solid waste. The quantity of industrial solid waste has been increasing at a rate of around 7% per annum, while the quantity of municipal solid waste (MSW) has been increasing at around 4% per annum.

[85] Beijing introduced the Euro IV standard on 1 January 2008 in preparation for the Olympic Games.

Figure 19 **Growth of Municipal Solid Waste Production and Gross Domestic Product, 2000–2008**



GDP = gross domestic product, MSW = municipal solid waste.
Sources: Ministry of Environmental Protection. Various years (1996–2009). *Environmental Statistical Yearbook.* Beijing; World Bank (http://data.worldbank.org).

Municipal Solid Waste

The PRC has already surpassed the United States (US) as the world's largest generator of MSW. In 2008, 154 million tons (Mt) of MSW was generated, and some estimates indicate that this could increase to a range of between 380 million tons per annum (Mtpa) and 580 Mtpa by 2030.[86] At the middle level of this range of forecast (i.e., 480 Mtpa), the PRC would be producing twice as much MSW as the US at the same time, based on current US projections. Depending on the development path the PRC chooses, these projections may be conservative.[87] Nevertheless, the growth in MSW generation so far has been significantly lower than the real rate of GDP growth, and there seems to have been a significant tapering off in growth since 2004 (Figure 19).

As the quantity of generated MSW has increased, so too has the quantity that was "safely disposed"[88]—increasing by 142% over the 2000–2008 period, from 72.6 Mt in 2000 to 103.1 Mt in 2007. However, this increase was insufficient to keep up with the quantity of MSW produced, and the proportion of MSW safely disposed remained more or less constant at around 55% (improving slightly to 62% in 2007 and 2008), which is unacceptably low and did not meet the planned objectives. This means that around 60 Mtpa of MSW are not adequately disposed of and end up on wastelands, in ponds, or in back alleys.

[86] World Bank (2005), p.15.

[87] The PRC forecasts are based on projected per capita MSW generation rates in 2030 ranging from 1.2 to 1.8 kilogram/capita/day (kg/c/d). The existing rate in the US is already around 2.1 kg/c/d. If the PRC was to proceed on the same development path that led to the development of the "throw-away society" in the US, there may be considerable "upside" potential on the projections for the PRC.

[88] The term "safely disposed" used in the statistical tables means disposed of in a landfill. However, the great majority of landfills in the PRC could not be accurately described as "sanitary landfills" and thus they are not necessarily safe from an environmental point of view.

In 2008, there were 407 active landfills in the PRC with a total waste intake capacity of 253,268 tons per day. Given that there are 652 cities in the PRC (Table 1), the gap between the number of active landfills of any kind and the number that are needed becomes apparent.

Incineration is not yet well developed as a disposal method for MSW, but it is developing rapidly from a low base. The capacity in 2003 was only 15,000 tons per day, although this was a significant increase from the previous year. Incineration is likely to be preferred in densely populated areas where land is at a premium.

Construction waste

One of the problems facing the PRC's urban waste managers is the huge quantities of construction waste being generated as a by-product of the construction boom that has been accompanying the rapid economic growth of the past decade. Construction currently accounts for about 20% of GDP, where housing construction, a subset of total construction expenditure, accounts for some 5.5% of GDP. It is estimated that the volume of construction waste generated in the PRC amounts to about one-third of the total quantity of MSW.

Large quantities of construction waste are reported to be disposed of illegally. On 1 June 2006, the Ministry of Construction issued the *Regulations on Management of Urban Construction Waste* to standardize the methods for handling construction wastes, but there remain many problems. Most construction wastes are not segregated (i.e., these are mixed in with other waste streams), which reduces recycling potential, and few cities have specialized recovery facilities for construction waste. There seems to be a thriving small-scale private sector business for recovery and recycling of valuable construction materials such as copper, reinforcing steel, and others; but it is very labor-intensive and not much attention appears to be paid to workers' health and safety.

Industrial Solid Waste

The government estimates that, in 2009, a total of 2.04 billion tons of industrial solid waste was produced in the PRC. This was about 12 times the total quantity of MSW produced and an increase of about 130% over the level of production in 2000. These wastes are typically high-volume, high-mass by-products of industrial production, such as mine tailings, slag, and coal ash; and the majority can have adverse environmental impacts if not disposed of properly. In 2009, about two-thirds (1.38 billion tons) of the industrial solid waste produced was recycled ("comprehensively utilized"), and an additional one-fourth (0.475 billion tons) was treated, leaving a total of around 0.185 billion tons that was stored and discharged.

In geographical terms, the four major industrial solid waste production areas are Chongqing, Guizhou, Shanxi, and Xinjiang Uygur Autonomous Region—together, they account for 63% of the national total. Each of these four areas produced more than 1 Mtpa of industrial solid waste. In sector terms, the four biggest producers are (i) the coal industry, (ii) the nonferrous metal mining and processing industry, (iii) the ferrous smelting industry, and (iv) the ferrous mining and processing industry. Each of

these industries generates more than 1 Mtpa of industrial solid waste and, together, they account for about 70% of the total industrial solid waste produced each year.

Hazardous waste

According to data published by MEP, the quantity of hazardous waste generated increased at an average annual rate of 7% over the 2000–2009 period. The total quantity generated in 2009 was 1.4 million tons, of which about 60% was recycled, 15% was stored, and 26% was disposed.[89] The main sources of hazardous wastes are the mining industry, chemical industry, and the ferrous and nonferrous metal industries. In addition to the regular activities of these industries, a backward mode of production, insufficient treatment equipment, and a lack of hazardous waste management ability lead to even more hazardous waste than ordinarily might be produced.

In 2004, SEPA organized a national survey of the state of hazardous and medical waste disposal facilities.[90] The survey showed that there were 512 centralized hazardous waste disposal facilities in the PRC, including 424 comprehensive utilization facilities, 79 incineration facilities, and 9 secure landfills. The combined total treatment and disposal capacity of these facilities was 5.7 Mtpa, equivalent to only about half of the total quantity of hazardous waste that, according to the statistical yearbook, was being generated at that time.

The design capacities of the three main components of the hazardous waste management system were

- comprehensive utilization—5.0 Mtpa,
- incineration—0.5 Mtpa, and
- landfill—0.15 Mtpa.

These facilities, however, were not being utilized at design capacity. In 2003, only 24% of system capacity (1.34 million tons) was being utilized, although this improved significantly to 35% (2.02 million tons) in subsequent years. The national survey identified a number of systemic problems including irrational layouts of facilities, low technical standards, inadequate pollution prevention and control, low operational efficiency, outdated incinerators, inadequate landfill capacity, and severe secondary pollution.

The National Hazardous Waste and Medical Waste Disposal Facilities Construction Plan of 2007 was developed to remedy these deficiencies; it is still under implementation and already behind schedule.

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[89] The published statistics are difficult to interpret because the total quantity of hazardous waste produced is never equivalent to the sum of the quantities "recycled," "stored," "disposed," and "emitted." The yearbooks do not explain what the terms "disposed" and "emitted" actually mean, and there seem to be varying opinions among local experts as to their meaning.

[90] The work was part of the National Construction Planning of Hazardous Waste and Medical Waste Disposal Facilities that was approved by the State Council in December 2003, in response to the severe acute respiratory syndrome (SARS) epidemic.

Electronic waste

A new and growing solid waste management challenge is the so-called "e-waste"—solid waste created by discarded surplus, and obsolete or broken electrical or electronic devices which, in many respects, is a subcategory of the hazardous waste problem. The quantities of this form of waste in the PRC are increasing rapidly as the consumer society grows. The government estimates some 350 million television sets, 130 million refrigerators, 170 million washing machines, 20 million computers, and 190 million mobile phones already in the PRC. These numbers seem large but, in a country with a population of 1.3 billion, they represent relatively low penetration rates and there is clearly potential for major increases in the near future. Most of these appliances only started to enter the mass market in the past 2 decades, and a large proportion of the current stock must be approaching the time for replacement and will require disposal. In 2003, the government projected that, within the next 10–15 years, at least 5 million televisions, 4 million refrigerators, 5 million washing machines, 5 million computers, and over 10 million mobile phones will be discarded each year. These projections seem conservative, to say the least.

The government has taken some steps to deal with the problem, beginning with the issuance of the *Administrative Measure on the Prevention and Control of Environmental Pollution Caused by Electronic Waste* (issued by SEPA, now MEP, in 2007) to standardize waste disposal procedures and to establish penalties to discourage improper disposal activities. The order covers the control of pollution from dismantling, utilization, and disposal of electronic wastes; sets out the procedures for management and supervision of the dismantling and utilization of electronic wastes, including environmental impact assessments for new projects that would produce electronic wastes; defines information disclosure requirements; and includes penalties for violation.

Solid Waste Summary

The solid waste management situation in the PRC is not yet under control. The quantity of MSW is rising rapidly and the proportion that is safely disposed (62% in 2009), while an improvement over previous years, is still not sufficient. Most of the inadequately disposed MSW are left lying exposed on unused or wasteland, or disposed of in ponds and waterways where they provide breeding grounds for pests and diseases. They also pollute the environment due to leachate or air pollution from fires.

The industrial solid waste disposal problem, in terms of annual quantities, is over 10 times larger than the MSW management problem. The proportion that is inadequately disposed (around 18%) is somewhat better than for MSW, but the consequences of poor disposal of industrial wastes, particularly hazardous wastes, are much greater because the pollutants (heavy metals, and others) are more persistent in the environment and more dangerous to human health.

5. The Climate Change Agenda

5.1 Introduction

Climate change is an issue of central significance both in the People's Republic of China (PRC) and in the world, and is being treated with great seriousness at all levels of government in the country. To reflect its importance, an entire chapter is being devoted to this subject which, in any event, is so cross-cutting that it is difficult to address in any other way. The main topics covered are (i) the PRC's contribution to global climate change and the main driving forces behind it, (ii) a review of how the PRC has been and might be affected by climate change, (iii) an outline of the PRC's strategic position on climate change and the key elements of its strategy for dealing with the issue, (iv) a discussion of the main constraints and opportunities offered by the climate change agenda, and (v) some comments on the opportunities created for the participation of the Asian Development Bank (ADB) in this important agenda.[91]

5.2 Contribution to Climate Change of the People's Republic of China

Aggregate Emissions

According to data compiled by the International Energy Agency (IEA),[92] total emissions from fossil fuel combustion in the PRC exceeded those from the United States (US) in 2007 for the first time and thus, the PRC became the world's largest greenhouse gas (GHG) emitter (Figure 20). The PRC's GHG emission trajectory since 1980 has gone through three distinct phases—(i) moderate growth (slightly higher than the US) between 1980 and 1997, (ii) leveling off between 1998 and 2002 even though economic growth continued substantially unabated, and then (iii) a rapid and substantially unprecedented burst of growth (with annual increases ranging from 11.2% to 11.9%) from 2002 to the present time.[93]

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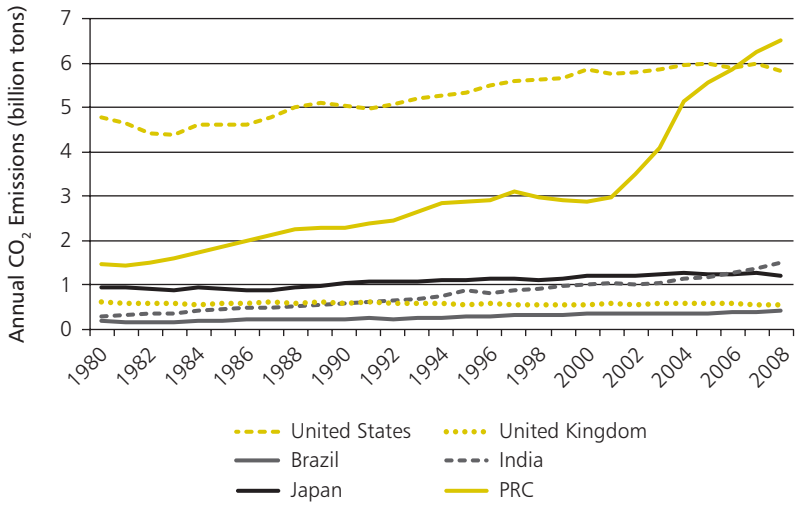
[91] This chapter is abstracted from a background study commissioned as part of the country environmental analysis (CEA) update and prepared by Professor Pan Jiahua, with assistance from Zhang Ying of the Institute of Urban and Environmental Studies of the Chinese Academy of Social Sciences (Pan and Zhang 2010).

[92] IEA (2009).

[93] Auffhammer and Carson (2008).

Figure 20 **Carbon Dioxide Emissions of the People's Republic of China (1980–2008), Compared to Selected Major Economies**



CO_2 = carbon dioxide, PRC = People's Republic of China.
Source: International Energy Agency. 2010. *World Energy Outlook 2010*. Paris: OECD/IEA.

The latest data show that the PRC's carbon dioxide (CO_2) emissions increased in 2009 by an additional 9.1%, bringing its share of global emissions to 24.2%. At the same time, US emissions decreased by 6.5%, reducing its share of global emissions to 19.1%.[94]

Per Capita Emissions

The picture in terms of per capita emissions provides a somewhat different perspective. The US is by far the world's largest per capita CO_2 producer (18.4 tons per capita in 2008, 4.2 times the global average in 2008), although the rate has declined by 24% since 1971. Per capita emissions in the PRC, on the other hand, increased by 430% over the 1971–2006 period (from 1 ton per capita in 1971 to 4.9 tons per capita in 2008). Per capita emissions also increased in Brazil and India but at much lower rates, largely due to differences in energy mix and economic structure.[95]

Cumulative Emissions

Looking at accumulated emissions since the beginning of the global industrial revolution (1850–2004), studies by the PRC's National Climate Center suggest that the global average per capita CO_2 emission was 173.5 tons.[96] The PRC's cumulative per capita

[94] BP (2010).
[95] Per capita data from IEA (2010b).
[96] Luo and Hu (2006).

emission over the same period was 68.9 tons (40% of the global average), compared to 318.7 tons (184% of the global average) for the US and 15.0 tons (8.6% of the global average) for India. The same study looked at cumulative CO_2 emissions for 13 major economies (the G8+5)[97] between 1950 and 2004 and concluded that the US accounted for 39% of the total and the PRC accounted for 11%.

Expected Future Emission Trends

The International Panel on Climate Change (IPCC) projects that, without any change in current global energy use patterns and policy measures (i.e., under the "Business-as-Usual" or BAU situation), global GHG emissions will continue to increase and, as a result, the world's average temperature will increase.[98] Global energy-related CO_2 emissions under the BAU scenario will increase by 1.6% between 2006 and 2030. The rate of increase in the US will be 0.1%, and the rate in the PRC will be 3.1%—i.e., nearly twice the global average and 30 times the US average.[99]

The main drivers behind the PRC's GHG emission patterns are the same factors driving the overall environmental agenda: (i) the rapid growth rate of the economy, (ii) the economic structure, (iii) the dominance of coal in the overall energy mix and the likelihood that this dominance will persist well into the foreseeable future, and (iv) urbanization and the somewhat related issue of changes in personal consumption patterns. Future patterns will be heavily influenced by developments associated with all these underlying drivers, as was discussed in Chapter 2.

Figure 21 shows the IPCC's longer term projection (for the period ending 2050) of the PRC's CO_2 emissions under three different scenarios:

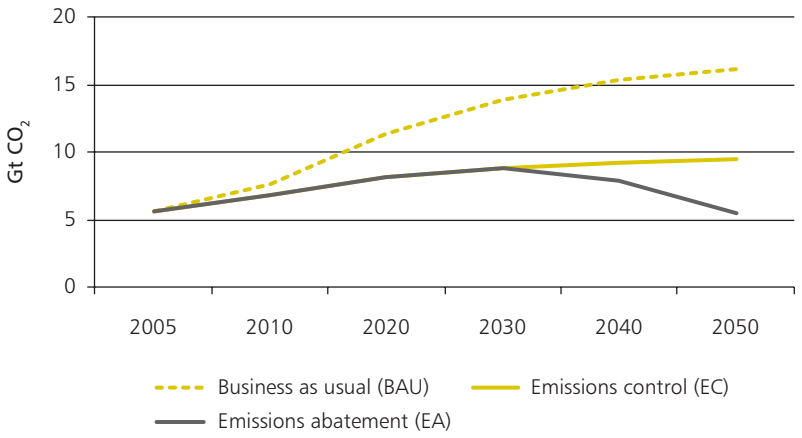
- **The BAU scenario**, in which the PRC's CO_2 emissions would reach 16.2 billion tons (or gigatons [Gt]) per annum (250% higher than 2008 emissions) and per capita emissions would be 10.9 tons (223% higher than 2008 per capita emissions);
- **An emissions control (EC) scenario**, in which annual emissions would increase to some 9.4 billion tons by 2050 (45% higher than the 2008 emission level) and per capita emissions would be 6.3 tons (128% higher than 2008 per capita emissions). The EC scenario would require the PRC to adopt advanced mitigation measures including significant improvements in energy efficiency and the development of renewable energy, although it would not be necessary to apply expensive technologies, such as carbon capture and storage (CCS), solar power generation, adoption of electric automobiles, and others on a large scale; and finally,

[97] United States, Japan, Germany, United Kingdom, France, Italy, Canada, Russian Federation, People's Republic of China, India, Brazil, South Africa, Mexico.

[98] IPCC (2007).

[99] IEA (2008).

Figure 21 **Carbon Dioxide Emissions Project in the People's Republic of China, Under Different Development Scenarios**



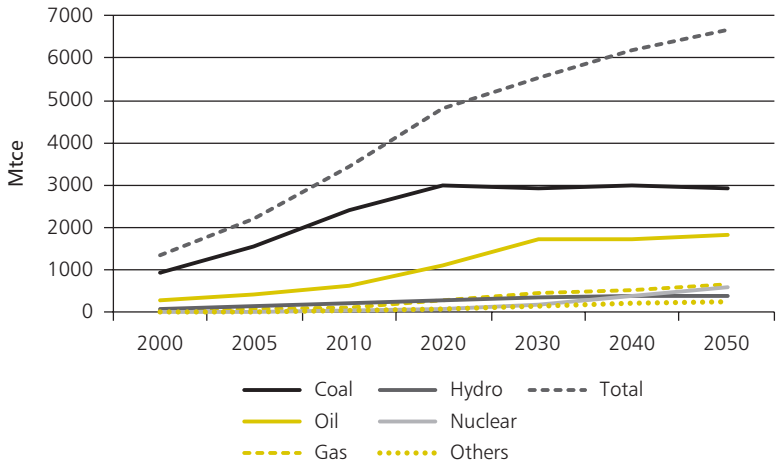
CO_2 = carbon dioxide, Gt = gigatons or billion tons.
Source: United Nations Development Programme. 2009. *Human Development Report 2009. Overcoming Barriers: Human Mobility and Development*. New York: Palgrave MacMillan.

- **An emissions abatement (EA) scenario**, under which the PRC's emissions in 2050 would decline to 5.5 billion tons at most, and per capita emissions would fall to 3.7 tons (24% lower than the 2008 per capita emission level). This scenario assumes that the government would adopt policies to ensure the widespread adoption of advanced abatement technologies including low-carbon technologies, such as electric vehicles, fourth generation nuclear power, as well as CCS. Substantial incentives to encourage new, renewable technologies, particularly wind and solar power, would also be necessary. This scenario is technologically feasible, but it will be very difficult without a large number of support measures and their effective implementation over the next few years.

Figure 22 shows the government's baseline energy consumption projections for 2000–2050. The projections provide for a more or less continuous increase in the annual rate of consumption throughout the projection period, with a slight flattening in the rate of annual increase commencing around 2020. The growth scenario for the 12th Five-Year Plan (2011–2015) is based on a rate of economic growth of 8% per annum, an energy consumption elasticity of 0.51, and a 3.7% per annum reduction in economic energy intensity.[100] Total primary energy consumption would reach 4.2 billion tons of coal equivalent (Btce) per annum, and coal would remain the dominant source (accounting for 64% of the total, equivalent to 3.8 billion tons per annum of raw coal), although the projected flattening off of consumption beginning in 2020 seems rather optimistic. In this projection, the role of the other major fossil fuel, i.e., gas, is very

[100] Since this study was conducted, the government reduced its GDP growth rate projection for the 12th Five-Year Plan to 7% per annum.

Figure 22 **Actual and Projected Total Energy Demand in the People's Republic of China, 2000–2050**



Mtce = million tons of coal equivalent.
Note: "Others" include wind, bioelectric, and biodiesel.
Source: Energy Research Institute. 2009. *[The People's Republic of] China's Low-Carbon Development Pathways by 2050: Scenario Analysis of Energy Demand and Carbon Emission.* Beijing: NDRC. September 16.

modest because the PRC has only very limited reserves of "conventional" gas. What is not included in the projections is a possible much larger role for "unconventional" gas which, as discussed in the section on The Strategic Position of the People's Republic of China on Climate Change, page 80, has the potential to play a much more significant role in the PRC's energy future than current projections suggest.

The role of nonfossil fuel sources would increase, but they will still remain relatively insignificant in the total picture (by 2015, hydropower would supply 6% of the total, nuclear 1.6%, wind 1.4%, and biomass 0.5%). Total energy demand by 2050 is projected to reach 6.7 Btce, 94% higher than the likely current (2010) demand of 3.4 Btce.

5.3 How the People's Republic of China Has Been and Might Be Affected by Climate Change

Observed Climate Changes in the People's Republic of China

Over the past 100 years, the PRC's climate has followed the same warming pattern as has been experienced around the world. The average surface temperature has increased by 0.8°C,[101] which is slightly higher than the global average of 0.74°C. Temperatures have increased more in the western, eastern, and northern parts of the country than in

[101] Qin et al. (2006).

the southern regions. Increases in winter temperature have mostly only occurred during the past 3 decades.[102] There have been no significant changes in total precipitation, but there have been obvious interregional changes. For example, annual precipitation has decreased significantly in the north, in the eastern part of the northwest, and in the northeast, with the most severe decreases being 20–40 millimeters (mm) per annum. In the south and southwest, increases in the range of 20–60 mm per annum have been observed.

The rate of sea-level rise along the PRC's coasts was 2.5 mm per annum over the past 50 years, which is also slightly higher than the global average of 2.3 mm per annum. Glaciers in the PRC have been retreating, and the trend is accelerating.

The frequency and intensity of extreme climate and/or weather events have also increased countrywide over the past 50 years. For example, significantly longer periods of heat waves have been observed in many cities, especially in the eastern and southern regions, the country's most active economic zones. The frequent heat waves caused an extensive use of air conditioning and pushed local power supply systems to the edge. The impacted areas suffered power shortages and associated brownouts and blackouts. In July 2010, most regions in the PRC experienced a historic record heat wave, and temperatures in Beijing, Hebei, and Tianjing exceeded 40°C, a record high for the decade.[103] This coincided with a new record electricity demand of 12.9 billion kilowatt-hour (kWh), an increase of 6% over the previous record reached in July 2009.

Expected Future Climate Change Trends

Based on the various assumptions regarding future atmospheric CO_2 concentrations, the IPCC has predicted that global temperature will increase by between 1.1°C and 6.4°C over the next 100 years as a result of which, average sea levels will increase by between 180 mm and 580 mm compared with the 1980–1990 average level.[104]

It is expected that temperature changes in the PRC would follow similar trends.[105] Modeling has suggested that, compared with the average temperature of the 1960–1990 period, the PRC's annual mean temperature would increase by 1.3°C–2.1°C in 2020, by 1.5°C–2.8°C in 2030, by 2.3°C–3.3°C in 2050, and by 3.9°C–6.0°C in 2100. This would represent a total increase, through to the end of the century, in the range of 2.6°C–3.9°C. Daily maximum and minimum temperatures would also rise, but the latter would rise more, thus reducing the average daily temperature range and bringing about more extreme heating events.

Mean annual precipitation would increase by 2%–3% in 2020, 5%–7% in 2050, 7%–9% in 2070, and 11%–17% in 2100, but with significant differences between regions. In the northwest, northeast, and south, precipitation will increase by 10%–25%. However,

[102] Ibid. ; NDRC (2007).
[103] Xinhua News Agency, 8 July 2010, Beijing.
[104] IPCC (2007).
[105] Qin et al. (2006); Xu et al. (2006); Xiong et al. (2008).

rainfall will decrease along the Bohai Coast and the Yangtze River Delta. The number of rain days will increase in the north, and the number of heavy rain days will increase in the south due to an increase in local heavy rainfall events.

Other researchers calculated that by the 2080s, temperatures across the entire country could increase by between 3.4°C and 4.5°C relative to 1960–1990 averages, and precipitation may change by between 9% and 17%.[106] Other studies have shown slightly different figures, but they all agree on a general warming trend and increased precipitation across the PRC in almost all seasons as the century progresses.

Impacts of Extreme Climate Events

Between 2004 and 2007, it is estimated that droughts attributable to climate change incurred an annual costs of $8 billion in the PRC, threatening food security and rural social welfare.[107] In June 2010, after the commencement of the monsoon season, south PRC was hit by severe rainstorms as a result of which water level in nearly 230 rivers exceeded flood warning levels, and water flows in over 25 rivers across the country reached historical record highs. A total of 27 provinces suffered flooding disasters and many cities were severely flooded. More than 113 million people were affected, 645,500 houses were damaged, and the estimated direct economic loss was CNY142.2 billion ($21 billion).[108] Table 13 summarizes the major climate-related disasters and their social–economic effects in the PRC over the past 100 years. As shown, the PRC is prone to climate-related disasters, even under the most benign of climatic conditions.

According to the national climate assessment report on the effects of global climate change scenarios, the PRC will face challenges due to many climate-related environmental problems in the foreseeable future. It is estimated that over the next 50 years, the rate of species extinction would be 7%–13% at least and, in some cases, could reach 60%. Under the scenario of a doubling of atmospheric CO_2, the grassland boundary would shift to the east as the climate gets drier and warmer in the north. This would result in a decrease in forest area, particularly of temperate and boreal forests, which would result in significant economic losses.

Other analysts have applied models to assess the adaptive capacity of the PRC's ecosystems in response to climate change, but the results were very variable and heavily dependent on the scenarios considered.[109] For example, one set of scenarios (Special Report on Emissions Scenarios [SRES] B2) that would produce a global temperature

[106] Xiong et al. (2008).

[107] ECA (2009).

[108] Xinhua News Agency, 22 July 2010, Beijing.

[109] Wu et al. (2006). The scenarios considered were those used in the Special Report on Emissions Scenarios (SRES) that was prepared by the IPCC in 2001 and used as background to the IPCC's Third (2001) and Fourth (2007) Assessment Reports. Scenario families contain individual scenarios with common themes. For the purposes of the current discussion, two scenario families are of particular interest: A2 and B2. The A2 scenarios reflect a somewhat divided world characterized by (i) independently operating, self-reliant nations; (ii) continuously increasing population; (iii) regionally oriented economic development; and (iv) slower and more fragmented technological changes and improvements to per capita income. The B2 scenarios reflect a similarly divided world, but one that is more ecologically friendly and is characterized by (i) continuously increasing population, but at a slower rate

Table 13 **Climate-Related Disasters and their Socioeconomic Impacts on the People's Republic of China, 1900–2010**

Form of Disaster		Number of Events	No. of People Killed	Total Affected Population (million)	Damage ($ billion)
Drought		32	3,503,534	441.27	20.11
Temperature Extreme	Cold wave	3	26	0.13	29.00
	Extreme winter conditions	2	145	77.00	21.10
	Heat wave	5	166	0.04	-
Flood	Unspecified	50	2,254,492	165.02	16.87
	Flash flood	20	2,099	89.07	4.49
	General flood	126	4,338,288	1,444.62	119.72
	Storm surge and/or coastal flood	5	391	1.00	-
Storms	Unspecified	41	2,029	39.33	1.77
	Local storm	56	1,605	160.28	4.33
	Tropical cyclone	108	169,790	227.94	41.28
Wildfire	Forest fire	5	243	0.06	0.11

Source: The Office of the United States Foreign Disaster Assistance (OFDA)/Centre for Research on the Epidemiology of Disasters (CRED) International Disaster Database. (www.em-dat.net). Data as of 12 May 2010.

increase of 3.2°C would have beneficial effects on ecosystems in the northeastern PRC, while another scenario (SRES A2), which would result in global warming of 3.9°C, would be detrimental for the same ecosystems. Assessments based on changes in the net primary productivity (NPP) of vegetation[110] suggested that the PRC ecosystems would be severely affected by climate change, with a worsening trend over time. The northern PRC and the Tibetan Plateau would be particularly vulnerable. The same authors also modeled extreme climate scenarios and concluded the ecological effects would be even worse in both the medium and long term.

Impacts on Water

Water scarcity is already a critical problem in the PRC with existing water shortages, particularly in the north, exacerbated by economic and population growth. There are various indicators that the situation could be very vulnerable to adverse effects due to climate change.[111] The PRC's Climate Vulnerability Index (CVI), which provides a quantitative assessment of human vulnerability to the impacts of global climate change on water resources, ranges from 44.0 to 51.9 on a scale of 1 to 100, indicating medium

than in A2; (ii) emphasis on local rather than global solutions to economic, social, and environmental stability; (iii) intermediate levels of economic development; and (iv) less rapid and more fragmented technological change.

[110] Wu et al. (2007). "Net Primary Productivity (NPP)" is the rate at which plants in an ecosystem produce chemical energy (mainly due to photosynthesis) surplus to the energy required to drive their energy production systems. The units of measurement are usually expressed as the mass of carbon produced per unit of area per unit of time (e.g., grams of carbon per ha per year).

[111] Lan et al. (2006).

to high vulnerability.[112] The national climate change assessment concluded that climate warming would increase the frequency of floods and droughts, further destabilizing the security of water supplies and exacerbating water shortages.[113]

Finally, the IPCC concluded, with high degree of confidence, that water supplies stored in glaciers and snow cover will decline over the next 100 years due to climate change, thus reducing water availability during warm and dry periods.[114] This would lead to a decline in runoff volume and result in severe spring droughts in the Tibetan Plateau and the autonomous regions of Xinjiang Uygur and Inner Mongolia, and 20%–40% reductions in per capita runoff in Qinghai Province and the autonomous regions of Ningxia Hui and Xinjiang Uygur by the end of the 21st century. Global warming could also increase the drying tendency in the northern PRC, and worsen existing water supply and demand conflicts. On the other hand, increased rainfall in the southern PRC and Fujian, Jiangxi, and Zhejiang provinces is anticipated over the next 50–100 years, leading to more instances of flooding.[115]

In contrast, runoff is expected to increase in the southwest, southeast, and Songhua river basins, in the northeastern PRC, and also (slightly) in the Yangtze River Basin. Runoff is expected to decrease in the Hai-Luan, Yellow, and Huai river basins, while prospects for the Liao River Basin are uncertain.[116] Table 14 provides a general summary of projected changes in runoff quantities, per capita water availability, and water supply/demand balances for each of the PRC's seven regions for both the 2050s (expected temperature increase 2°C–3°C) and the 2080s (expected temperature increase 3°C–5°C).

It is clear that the combination of human factors plus climate change will intensify water resource stresses in the PRC, unless suitable adaptation measures are adopted in the near future. To put the balance between human and climate change factors into perspective, studies of the Qinhe River, one of the most important tributaries of the Yellow River, indicated that from 1970 to 2006, the average runoff depth has declined by 84 mm, with climate change contributing 46% of the change and human activities (coal mining, artificial rainwater harvesting, industrial and agricultural water consumption, groundwater extraction, water and soil conservation, and others) accounting for 54% of the change. This clearly shows that human effects were greater than the effects due to climate change. [117] The implication is that a reduction in the adverse impacts due to human factors could offset future adverse effects due to climate change.

Food Security

Researchers have used different models to simulate the impact of climate change on the PRC's agriculture and, thus, on food security. The findings revealed similar trends and patterns under the BAU scenario and scenarios that assume no beneficial effects due to

[112] Sullivan and Huntingford (2009).
[113] Lin (2006).
[114] Bates et al. (2008)
[115] Lin (2006); Lan et al. (2006).
[116] Yang and Xu (2010).
[117] Fu et al. (2010).

Table 14 **Projections of Climate Change Impacts on Water Resources (%)**

Time Period	Parameter	Region						
		NE	N	NW	E		SW	S
					S part	N part		
2050s	MAR	(1)–2	6–8	4–5	16–21	9–12	8–11	3
	WR/capita	(14)–11	(21)–18	(26)–24	(14)–10	(7)–6	(14)–12	(29)
	Supply/ Demand Balance[a]	Balance	(2)	(3)	Balance	Balance	Balance	Balance
2080s	MAR	(4)–0	7–12	5–12	19–31	11–6	10–17	3–5
	WR/capita	(18)–14	(20)–17	(25)–21	(11)–8	(7)–5	(13)–11	(30)–29
	Supply/ Demand Balance[a]	Balance	(1)	(4)	Balance	Balance	Balance	Balance

MAR = mean annual runoff, E = east; N = north; NE = northeast, NW = northwest, S = south, SE = southeast, SW = southwest, WR/capita = water resources per capita.
[a] Negative number (in parenthesis) denotes a deficit.
Source: Xu et al. 2006. Statistical Analyses of Climate Change Scenarios over [the People's Republic of] China in the 21st Century. *Advances in Climate Change Research*. 2 (Suppl. 1). pp. 50–53.

CO_2 fertilization.[118] In general, it is expected that the PRC's agricultural productivity will decrease as temperatures rise over time.[119] However, the results are variable due to differences in data sources, the types of models used, and the assumptions made.

Table 15 shows the results of a major global study that directly linked Global Climate Model (GCM) estimates to highly detailed country climate change estimates. The study suggested that, by 2080, climate change would decrease the PRC's agricultural productivity by 7% compared with the baseline, which is lower than the predicted world productivity loss of 16%. Geographically, there would be significant variations in effects ranging from adverse to beneficial. The south central and Tibetan Plateau regions could face reductions in productivity by as much as 15% under the BAU scenario, whereas losses in the Beijing northeast region could be as low as 1.1%.

Adaptation to Climate Change in the Agriculture Sector

The PRC's food security will not be determined solely by the effects of climate change since there are so many other factors impinging on it, including

i. the loss of prime agricultural land due to the effects of urbanization;

ii. the availability and use of agricultural inputs such as fertilizer, improved varieties, and others;

[118] CO_2 fertilization is the phenomenon whereby increasing atmospheric CO_2 concentrations encourage increased plant growth which, in turn, results in the fixation of more atmospheric carbon, thus offsetting the effects of fossil fuel emissions as well as increasing agricultural productivity over what it might otherwise be. There is no doubt that this phenomenon exists, but there is some debate among experts as to the significance of the potential effect.

[119] Xiong et al. (2008); Xu et al. (2006); Lan et al. (2006).

Table 15 **Projected Climate Change and Agricultural Productivity by 2080, Business-as-Usual Scenario**

Impacts on Agricultural Productivity (%)	Without Carbon Fertilization	With Carbon Fertilization
World (output weighted)	(15.9)	(3.2)
Industrialized countries	(6.3)	7.7
Developing countries	(21.0)	(9.1)
Africa	(27.5)	(16.6)
Asia	(19.3)	(7.2)
Middle East and North Africa	(21.2)	(9.4)
Latin America	(24.3)	(12.9)
People's Republic of China	**(7.2)**	**6.8**
Beijing Northeast	*(1.1)*	*13.7*
Central	*(3.0)*	*11.5*
Northwest	*(2.7)*	*11.9*
South Central	*(14.6)*	*(1.8)*
Tibetan Plateau	*4.8*	*20.5*
Yellow Sea	*(9.3)*	*4.3*

( ) = negative.
Source: Cline, W.R. 2007. *Global Warming and Agriculture: Impact Estimates by Country*. Washington, DC: Center for Global Development and Peter G. Peterson Institute for International Economics.

iii. the responses of farmers to changes in markets for produce and the resultant effects on cropping patterns; and

iv. future government policies on issues such as water pricing, and the degree to which the government and farmers respond to changing climatic conditions by adopting climate change adaptation measures.

Notwithstanding the inherent uncertainty in the climate change projection models as they relate to agricultural output, current indications are that the projected changes are unlikely, on their own, to significantly compromise the PRC's food security over the next 80 years beyond the risks and hazards that already exist. This is due to the wide variety of factors that affect the agriculture sector. While the effect of climate change on agriculture in the PRC will depend very heavily on the type of adaptation measures adopted, it is unlikely that food production will be significantly threatened by global warming in the next 80 years.

Implications for National Economic and Spatial Planning

The effect of rainfall and temperature changes on agricultural production and the hydrological cycle have already been discussed earlier. Cropping patterns, crop yields, and water availability could potentially have important, indirect effects on both urban and industrial development.

Like many countries, the PRC's largest cities are centered mainly in the coastal regions, especially in the deltas of the Yangtze, Yellow, and Pearl rivers. Over the past 50 years, air

temperature in Shanghai has increased by 2.35°C, which was double the national average and four times the global average over the same period. The sea level at Shanghai rose by 115 mm over the past 3 decades, which was greater than the national average of 90 mm for the same period. A study of 11 coastal megacities in Asia, including Shanghai, to evaluate their vulnerability to climate change, predicted that, by 2050, the sea level in Shanghai would rise by 180 mm compared with the 1990 levels.[120] Shanghai was assessed as the fourth most vulnerable city due to its susceptibility to sea-level rise, and the second most vulnerable to climate impacts since the city is susceptible to flooding and tropical storms. In terms of potential human and economic effects, Shanghai was ranked as the second most vulnerable city due to its great population and its importance to the national economy. On the other hand, the same study ranked Shanghai as having the second highest adaptive capacity (i.e., capacity to adapt to the consequences of climate change) among the studied cities. It should be noted, however, that the adaptive capacity will vary over time and possibly have a threshold depending on the scale of the climate force.

5.4 The Strategic Position of the People's Republic of China on Climate Change

Perception of Climate Change

The government's view is that global climate change will have a profound impact on the existence and development of mankind and is a major challenge faced by all countries.[121] It is an issue that has emerged in the process of human development, and is influenced not only by natural factors but also by human activities. It is an environmental issue but, more importantly, a development one, and is linked closely to factors such as development stage, lifestyle, population size, resource endowment of countries, and the international division of labor. Therefore, climate change challenges have to be tackled in the course of development and solved through a common approach.

Overall Principles to Deal with Climate Change Issues

The government considers that the following principles need to be followed in tackling climate change:

1. ***The principle of common but differentiated responsibilities.*** Developed countries should fulfill the task of emission reduction set in the Kyoto Protocol, continue to work hard to achieve the quantitative medium-term emission reduction targets, and support the developing countries' efforts of fighting climate change. Developing countries should try to adapt to climate change and mitigate GHG emissions as much as possible, according to their

[120] WWF (2009).

[121] Speech made by the PRC's President Hu Jintao at the UN Summit on Climate Change, 22 September 2009, New York.

national conditions and with the financial and technological support from the developed countries.

2. ***Climate change cooperation must aim at mutual benefit and a win–win outcome.*** Climate change is not confined by boundary, and no country is immune from its impact.

3. ***Finance and technologies must be made available to developing countries.*** Developed countries should take responsibility for providing developing countries with new, additional, adequate, and reliable financial support since it is a joint investment in the future of mankind. Climate-friendly technologies should better serve the interests of all human beings. A government-led positive interaction mechanism must be established with enterprise participation and market operation to ensure full access of the developing countries to the climate-friendly technologies.

The Commitments of the People's Republic of China to Climate Change Mitigation

The government has made four main climate change commitments:

1. The PRC will step up efforts to conserve energy and improve energy efficiency and, more particularly, will strive to ***reduce CO_2 emissions per unit of GDP by 40%–45% by 2020 from the 2005 level.***

2. The PRC will energetically develop renewable and nuclear energy and try to ***increase the share of nonfossil fuels in the primary energy consumption to around 15% by 2020.***

3. The PRC will vigorously increase forest carbon sinks and work hard to ***increase forest area by 40 million hectares (ha) and forest reserves by 1.3 billion cubic meters (bcm) by 2020 from the 2005 levels.***

4. The PRC will spare no efforts to ***develop the green economy, low-carbon economy, and circular economy, as well as strengthen research and development (R&D) and dissemination of climate-friendly technologies.***

The IEA has stated that the policies and measures being considered by the government would bring about approximately 1 gigaton (Gt) of reductions in CO_2 emission by 2020, or 25% of the total global reductions required to stabilize global atmospheric CO_2 concentration at 450 parts per million (ppm).

The PRC further committed at the Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) at Durban, South Africa in 2011 that the PRC will join the international community in negotiating a new legal treaty applicable to all countries for setting GHG mitigation targets from 2020.

Low Carbon Transformation

The low carbon development strategy is not only a response to global climate change, but is also necessary for environmentally sustainable development and energy security. The PRC's fossil fuel situation is characterized by a lack of oil and conventional gas but a great abundance of coal. Automobile ownership in 2009 was 50 per thousand people, which is only 1/15 of the US ownership rate and 1/10 of the rates in the European Union (EU), and Japan. Nevertheless, the PRC's import of oil was already over 204 million tons in 2009, more than half of total consumption. According to a recent review, the PRC's proven reserves of oil will only support 11.3 years of consumption.[122] Global oil reserves will meet global consumption at current rate for only 42 years, if the current production and/or reserves ratio is maintained. Thus, the oil supply prospects for the PRC are not secure.

The production and/or reserves ratio for natural gas in the PRC is three times higher than oil, but would still only support 32.3 years of consumption, approximately half as much as the global average (60.4 years). However, the PRC's gas situation looks considerably different, if account is taken of the potential role of "unconventional gas" in the fossil energy mix.[123] The PRC has some of the most potentially significant unconventional gas resources in the world, and these are virtually untapped at the present time. The potential shale gas reserves alone, at around 33 trillion cubic meters, are about 10 times larger than the proven conventional gas reserves and, if fully recovered, would be sufficient to provide 400 years of supply at current gas consumption levels.

Increased use of gas as a substitute for coal has the potential to reduce both GHG emissions[124] and local and regional air pollution, including the myriad adverse environmental effects associated with coal mining. However, there are also environmental risks associated with the development of unconventional gas resources (e.g., potential ground and surface water pollution), which would need to be carefully studied and considered. The government is taking significant steps to tap into unconventional gas reserves, including increasing market access to foreign explorers and developers, and it is possible that further developments in the unconventional gas arena could significantly and beneficially affect the PRC's carbon emissions profile.

The PRC has substantial coal resources but, at the current production and/or reserves ratio, even these reserves will only support 41 years of consumption, which is less than

[122] BP (2010).

[123] Unconventional gas is gas that is tightly held in geological deposits and cannot be recovered using conventional gas recovery methods. Unconventional gas deposits include (i) tight sands gas, which was formed in sandstone or carbonate with low permeability that prevents the gas from flowing naturally; (ii) coal bed methane (CBM), which was formed in coal deposits and adsorbed by coal particles; (iii) shale gas, which was formed in fine-grained shale rock with low permeability in which gas has been adsorbed by clay particles or is held within minute pores and microfractures; and (iv) methane hydrates, which are crystalline combinations of natural gas and water formed at low temperature and high pressure in places such as under the oceans and permafrost.

[124] For example, a modern, combined cycle gas turbine power station emits 40% of the CO_2 per kWh of energy produced, as does a conventional coal-fired unit (Verrastro and Branch 2010, p.3).

one-third of the global average (144 years).[125] The PRC became a net importer of coal in 2009, even though it has the third largest coal reserves in the world.[126]

The reserve situation is constantly changing, but the government considers that it has a clear strategic interest in not relying too heavily on the global market for something as fundamental as energy. In any event, domestic coal mining has many associated adverse environmental and social impacts, which provide additional reasons for diversification of the energy base. Thus, the real question for the PRC is not whether the transformation to a lower carbon society should be made, but how to accelerate the process.

In any event, the PRC has already announced to the international community that, by 2020, per unit GDP emissions of CO_2 would be lowered by 40%–45% from the 2005 level, and nonfossil energy sources would supply 15% of primary energy consumption (an approximate 50% increase over the current situation). Together with the targets for forest carbon sinks, these are the operational targets for the PRC to achieve low-carbon growth and transformation, but they will be very hard to achieve. The first step to this path was the achievement of the objective of reducing national energy intensity by 20% during the 11th Five-Year Plan. This was achieved but with difficulty.[127] Subsequent decreases will be even more difficult.

These carbon targets are disaggregated among individual provinces and key sectors, and numerous programs have been initiated, including the low-carbon cities, low-carbon communities, low-carbon enterprises, and the "low-carbon consumption all around the society," to help meet the objectives. Already, the PRC's wind and solar power industries are growing at significantly higher rates than most developed countries.

Nevertheless, the government considers that the rate of carbon transformation has to be kept compatible with the country's development level. Reducing carbon emission intensity in the PRC is a relative target. Even if carbon emission intensity in 2020 is reduced by 45%, the PRC's GHG emissions would still increase by 60%, given the expectations on GDP growth.

Reducing the PRC's incremental CO_2 emissions (i.e., emissions per incremental unit of GDP) by 40%–45% in 15 years (2006–2020) is quite ambitious. The challenge will be particularly difficult for the PRC since it is experiencing a remarkably critical period of industrialization and urbanization.[128] However, one potentially positive factor is the

[125] The global estimates are from IEA (2008).

[126] Imports in 2009 were 0.10 billion tons. Projected net imports for 2010 are 0.17 billion tons, which will make the PRC the largest coal importer in the world. The PRC's total reserves are 114.5 billion tons, placing it third in the world after the US (238.3 billion tons) and the Russian Federation (157.0 billion tons) (BP 2010). The PRC was a net coal exporter until 2003 but the government, in the interest of energy security, has placed controls on coal exports in the form of taxes and quotas (IEA 2008).

[127] In 2010, local newspapers were filled with stories of local government officials shutting down power stations for periods ranging from days to weeks as they made desperate attempts to meet their energy efficiency targets under the five-year plan. The economic and social costs of such measures were no doubt substantial.

[128] Between 1990 and 2005, CO_2 emission intensity was reduced by 49% in the PRC (IEA 2007). Emission intensity reductions for other countries were mostly under 30% over the same period.

prospect for significant shifts in the mode of growth in the foreseeable future. The economy has been growing at 10%, on average, for the past 3 decades, and the industry sector has shifted from a labor-intensive to a capital-intensive mode of growth. In 2009, the PRC's raw steel output reached 570 million tons, while cement production totaled 1.65 million tons—both represent about 50% of global production.[129] It is difficult to imagine that either sector will be able to sustain 10% growth rates for much longer. If the experiences of the developed countries—such as the US and Germany, where growth rates in the low to medium single digits are the norm—are to be used as the bases, growth rates in the PRC must flatten out in the coming years. The target for the 12th Five-Year Plan is to average 7%, which is a step in the right direction, although as with the 11th Five-Year Plan, it might be difficult to dampen down growth that much.

Even so, the PRC has a long way to go before it can mimic the performance of the more developed economies. Key developments that will be required include (i) the efficiency level of the industry sector must improve significantly, (ii) the role of the tertiary sector must expand parallel to the increases in domestic consumption, and in the longer term, (iii) the PRC must become a predominantly service economy, like all its counterparts in the Organisation for Economic Co-operation and Development (OECD). Given such developments, and even without specific government intervention, the PRC's GHG emissions would continue to increase, but at a steadily reducing rate and certainly much lower than 10%.

Alternative Energy Development Options

The PRC is already investing heavily in the development of alternative (i.e., nonfossil) energy sources, including renewables and nuclear sources.

On **renewables**, the attraction is on very low carbon energy production, but the disadvantage is their reliance on natural resources and conditions such as hydrological resources, wind patterns and intensity, and solar radiation—all of which are likely to be more sensitive to climate change and vulnerable to damage from extreme weather events. Globally, nearly 80 gigawatts (GW) of renewable capacity were added in 2009, including 31 GW of hydro and 48 GW of non-hydro capacity. Nearly half of the global increment (37 GW) was added in the PRC, more than any other country in the world.[130] Prospects for further development of renewables in the PRC are as follows:

- **Hydroelectric power.** The PRC was the world's largest producer of hydroelectric power in 2007, and hydropower represented 14.1% of total generating capacity.[131] The IEA calculates that the PRC would need to increase hydropower capacity to 300 GW by 2020 to meet the objectives of the 450 ppm CO_2

[129] NBS (2009) and World Steel Association (2010). The PRC's share of global steel production now exceeds the combined production of the US, the EU 27, the Russian Federation, and Japan, which historically were the largest producers of steel. For 2010, annual steel production capacity in the PRC is believed to be about 740 million tons, while predicted actual production in 2010, according to some sources, might be as low as 600 million tons. This is a significant overproduction situation, which may have indirect environmental benefits as the government is ordering the shutdown of old and inefficient mills that tend to be the biggest polluters.

[130] REN21 (2009).

[131] IEA (2009).

equivalent concentration scenario. However, extreme weather events such as floods and droughts compromise the reliability of hydropower generation, making it a useful but somewhat unpredictable component of the national power production system. These characteristics significantly limit its potential contribution to the future integrated energy production system.

- **Wind power.** Wind energy is the fastest-growing form of renewable energy being developed in the PRC. In 2009 alone, the PRC added 13.8 GW of wind energy production capacity, increasing national capacity to one-third of global capacity (up from only 2% in 2004). One of the main constraints to further wind energy development is deficiencies in the grid. The PRC's wind resources are mainly located in the northern and coastal areas, where the grid construction is not well developed and the best sites are located well away from the main concentrated loads. Grid construction has lagged behind wind energy production development, and is now one of the main barriers slowing wind energy development in the PRC.
- **Solar.** In 2009, the PRC produced 40% of the world's solar photovoltaic (PV) supply and 77% of the world's solar hot water collectors. In the same year, the government launched the Golden Sun Demonstration Program to speed up solar energy development. The project calls for at least 600 megawatts (MW) of PV to be installed within 3 years, with at least 20 MW in each province. Solar thermal for water heating is commercially competitive already in the PRC and has been widely adopted throughout the country. On the negative side, solar energy production is vulnerable to climate change-induced effects, such as variability introduced by seasonal changes and cloud cover, making the energy supply from solar energy highly variable and potentially subject to long-term declines due to decreases in global solar radiation. Anthropogenic sources of aerosols can also decrease average solar radiation, especially on a regional or localized basis. The relationship between the climate-forcing effect of GHGs and aerosols is complex, and extensive research is needed to bridge the knowledge gap on this topic.

The other form of alternative energy that has a potentially important role to play is **nuclear energy**. It is difficult to see how the government will achieve its objective of increasing the share of nonfossil fuels to 15% of total energy consumption by 2020 without significant development of nuclear power which, in 2010, only accounted for 1.0% of total energy consumption (installed capacity was 10 GW). Currently, there are 13 nuclear power stations in operation on the mainland, with more than 25 under construction. The 12th Five-Year Plan includes provision for the development of an additional 40 GW of nuclear power capacity (i.e., a 400% increase over 2010 capacity), and longer-term plans could increase total nuclear capacity to at least 400 GW by 2050. However, all such plans were put on hold due to the nuclear incident at Japan's Fukushima–Daiichi power station complex in March 2011. The State Council immediately announced that it would suspend approvals for new nuclear power stations and conduct comprehensive safety checks of all nuclear projects, including those under construction.

Most observers expect that the nuclear program will resume after completion of the necessary reviews since the Japanese nuclear power sector is mainly based on 2nd generation technology, whereas most existing and planned developments in the PRC are based on 3rd and 4th generation technologies, which are inherently safer and more reliable. Nevertheless, the effect of the review on the scale of future nuclear power development plans is very hard to predict. Even under the most positive review outcomes, however, there are several factors that limit nuclear power development potential in the PRC. First, the PRC has only limited domestic supplies of uranium and is reliant on foreign suppliers, most significantly, Australia, Canada, and some Central Asian countries. These countries have strong economic relationships with the PRC; nevertheless, there is an associated political risk that has to be considered. Second, and as the incidents at Fukushima–Daiichi in March 2011 confirm, there are significant real and perceived public safety risks associated with nuclear power generation. These can be offset by the development of very strong safety cultures among owners, operators, and regulators, but these can take a long time to develop. This safety culture is still developing in the PRC, and considerably more work is required on personnel training and development at all levels. Third, the problem of nuclear waste disposal has not yet been fully resolved in the PRC. The current strategy is based on underground disposal in remote areas, but the potential long-term effects are not fully understood. Fourth, nuclear power development is very capital intensive, which raises significant questions regarding investment risk.

In summary, it is clear that alternative energy sources, such as renewables and nuclear, will all play more important roles in the future energy mix. But each option has its own risks and shortcomings. The government's objective of meeting 15% of energy demand by 2020 from alternative energy sources is very ambitious and will be difficult to achieve. It is extremely difficult to see it being exceeded to any significant degree. Thus, the role of fossil fuels, in particular coal, is likely to continue to be dominant for at least the next 15 years, and major efforts will be required to deal with the associated climatic consequences. One important caveat to that scenario relates to the potential role of unconventional gas in the overall energy mix and the degree to which it might prove to be a complete substitute for coal. The PRC has very substantial reserves of unconventional gas, but the true potential will only be identified after more work is done on recovery technologies, pricing policies, and environmental safeguards.

Beyond the fuel mix, the issue of carbon capture and storage will require serious consideration and, in fact, is an essential part of an emissions control strategy post-2030. However, this expensive technology has yet to be demonstrated at a commercial scale and is not an option that will be available in the short- to medium-term future.

5.5 Climate Change Strategies under the 12th Five-Year Plan (2011–2015)

The State Council established the National Leading Group on Climate Change (NLGCC) in June 2007, led by Premier Wen Jiabao and with 27 member agencies. The role of the NLGCC is to:

i. devise national climate change strategies, directions, and measures;

ii. unify national actions on climate change;

iii. research international cooperation and negotiation processes; and

iv. coordinate solutions on key issues in responding to climate change.

In 2008, the National Development and Reform Commission (NDRC) set up the Department of Climate Change to be the lead body in charge of climate change and related social development issues. It is responsible for analyzing the social and economic impacts of climate change; formulating strategies, plans, and policies on climate change; undertaking works directly related to the UNFCCC negotiations; and coordinating international cooperation and capacity building. Following this institutional change, many local governments formed divisions of climate change under their local NDRCs to assume responsibilities related to climate issues. A total of 27 provinces have developed local climate change mitigation and adaptation action plans to guide climate change management in accordance with the reality of local economic development conditions and natural resources availability.

In the document "[the People's Republic of] China's Nationally Appropriate Mitigation Actions (NAMAs) under the Copenhagen Accord," the government pledged to (i) lower its CO_2 emissions per unit of GDP by 40%–45% by 2020 compared to the 2005 level, (ii) increase the share of nonfossil fuels in primary energy consumption to around 15% by 2020, and (iii) increase forest coverage by 40 million ha and forest stock volume by 1.3 bcm by 2020 from the 2005 levels. These domestic mitigation actions are voluntary in nature and will be implemented in accordance with the principles and provisions of the UNFCCC. The PRC's mitigation actions are projected to reduce emissions by 8.5%, compared to the BAU scenario in 2020, with total emission savings of 11.4 Gt of CO_2 equivalent.

It is expected that the 40%–45% carbon intensity reduction target will be allocated to all provinces and different enterprises, but how to do so is still under consideration. Whatever the allocation approaches would be, getting all stakeholders involved in the discussions and actions is critical to the successful implementation of the emission reduction plan. Moreover, like the 20% energy intensity reduction target regulated in the 11th Five-Year Plan, the carbon intensity reduction target is anticipated to be clearly addressed in both the 12th and 13th five-year plans. Furthermore, there should be a certain space in relevant regulations and policies to define CO_2 as a pollutant.

5.6 Barriers

The government has been pushing the low-carbon economy and has extremely ambitious plans but, first, it will have to overcome a number of significant barriers as follows:

i. Lack of long-term strategy and/or planning and no systematic approaches to deal with climate issues;

ii. Poor and fragmented coordination among national, regional, and local decision makers, and among authorities and different sectors on the policies issued weakens the power of the legal system;

iii. Climate policies do not specify the measures, instruments, or approaches that local governments can follow on how to reach the climate goals, such as institutional arrangements, financial supports, information sharing, and other specific actions needed to achieve the targets; and

iv. There are no monitoring, reporting, and enforcing mechanisms designed for the policy implementation, and no systems to track the effectiveness of the policies after placing them into practices.

Currently, most climate policy focuses on command-and-control instruments. Experiences from 3 decades of pollution control work in the PRC show that this approach is too narrow; a much broader range of approaches will be required and more economic instruments need to be used. For example, there is an urgent need to pilot market-based mechanisms, such as carbon taxes, for effectively managing the climate issue. Introduction of a carbon tax would have potentially significant macroeconomic effects, and would have to be very carefully considered and introduced. But there is ample evidence from other countries that such economic instruments (e.g., air pollutant cap and trade systems) can provide very economically efficient solutions to emission control problems. Factors to be considered when introducing such a system include whether or not the tax should be revenue neutral (government revenue has been increasing at twice the rate of GDP in recent years, which would support revenue neutrality), and whether or not to use revenues for specific, related purposes—e.g., R&D on clean technologies, provision of subsidies for renewable energy, investments in climate change funds for disaster and risk relief, provision of financial assistance to help disadvantaged people access basic energy services and adapt to the negative impacts of climate change, and encourage low-carbon lifestyles.

A much closer connection should also be established between GHG emission reduction policies and other environmental emission control policies, particularly air emission control policies. GHGs and air pollutants often stem from the same sources, which create the potential to generate co-benefits by addressing climate change and air pollution simultaneously rather than independently, as they are at present. An example of a co-benefits policy would be to achieve a low-carbon, low-sulfur economy that would produce air quality benefits and climate change benefits more efficiently than achieving one or the other. Measures that could be taken to support a co-benefits strategy would include:

- R&D of co-control policies and targets, such as energy intensity and sulfur dioxide (SO_2) emission control targets;
- Incorporation of energy and/or GHG intensity targets into the existing environmental performance evaluation system, and implementation of such at the local level;

- Specification of relevant energy requirements for publicly procured goods and services; and/or
- Limitations on trade and export of carbon- and sulfur-intensive goods.

5.7 Role of the Asian Development Bank

ADB has just completed its first Climate Change Implementation Plan for the East Asia Region, including the PRC. The current country partnership strategy aims to reduce energy intensity and coal dependency in the PRC, focusing on six areas: (i) energy efficiency and conservation; (ii) alternative energy—e.g., solar, wind, biomass, and hydropower; (iii) clean coal technologies; (iv) urban environment improvement; (v) methane capture from coal mines; and (vi) regional cooperation in energy use.

These focus areas need to be maintained moving into the next five-year plan, although more effort is needed to mainstream climate change concerns into all aspects of assistance including

i. giving a prominent place to energy efficiency;
ii. developing successful carbon market projects;
iii. increasing support to climate change adaptation to reduce climate vulnerability and negative impacts;
iv. coordinating water-related infrastructure construction to mitigate current and future impacts of climate change;
v. investing in food security and livelihood improvement;
vi. strengthening disaster risk management;
vii. promoting carbon sequestration by terrestrial ecosystems (soil, biomass, and forestry);
viii. changing the balance of support from intercity roads to alternative low-carbon transport modes (such as inland waterways and railways) and creating sustainable urban transport; and
ix. cooperating in regional initiatives targeted at regional climate change challenges.

It must be remembered that there are considerable interconnectivities between the climate change agenda and the pollution control agenda. Some GHGs (e.g., nitrous oxide [N_2O] and perfluorocompounds [PFCs]) are also air pollutants, while other GHGs (e.g., CO_2, methane [CH_4]) are produced by the same sources that produce conventional air pollutants. Thus, within the broader environmental agenda, there are many opportunities to produce environmental and climate change co-benefits through carefully thought-out policy and investment interventions.

At the same time, there can also be contradictions between GHG reduction and pollution control. For example, end-of-pipe air and water pollution control technologies are

generally energy-intensive and the higher the standard of treatment required, the greater the energy consumption. Thus, a policy to move toward generally higher standards of water pollution control (as is proposed under the 12th Five-Year Plan) will have significant economic, energy, and GHG emission consequences.

Closer cooperation and coordination is needed between climate change tasks and pollution control work in the PRC to maximize co-benefits opportunities and minimize contradictions. This might be an area of opportunity for ADB through the underwriting of appropriate research, studies, conferences, and possibly even investment projects.

6. Policy, Institutional, and Fiscal Frameworks for Environmental Protection

6.1 Introduction

Ten years ago, as the People's Republic of China (PRC) prepared for the 10th Five-Year Plan (2001–2005), the main criticisms of its environmental work were that environmental protection was taking second place to economic development; the State Environmental Protection Administration (SEPA), now the Ministry of Environmental Protection (MEP), was too weak and under-resourced; and the environmental agenda was insufficiently mainstreamed.

There was a serious deterioration of environmental quality during the 10th Five-Year Plan, as a result of which nine of the 20 mandatory targets under the Environmental Plan were not met, thereby, suggesting that previous criticisms of the government's environmental approach were justified.

By the time that preparation had commenced for the 11th Five-Year Plan (2006–2010), it was already apparent that several important shifts were taking place in the government's thinking on the environment–development nexus. It was notable that Premier Wen Jiabao participated in the Sixth National Conference on Environmental Protection held in Beijing in 2006, prior to finalizing the 11th Five-Year Plan, and announced certain shifts in the government's approach to environmental protection, which would be reflected in the 11th and succeeding five-year plans. Subsequent events during the 11th Five-Year Plan showed that the government was quite serious in these intentions; some potentially important changes were made in the strategic framework for growth and development, and in the institutional and legal frameworks for environmental protection.

This chapter outlines the key elements of the government's approach to environmental protection with particular emphasis on the role of MEP and important changes and improvements made to the policy and institutional frameworks during the 11th Five-Year Plan.

6.2 Strategic Framework and the "Three Shifts"

The Sixth National Conference on Environmental Protection that was held in Beijing on 17–18 April 2006 was the venue for an announcement by Premier Wen Jiabao that

the government intended to place more emphasis on the quality, rather than just the quantity, of growth with the aim of building a "harmonious, resource-efficient and environment-friendly society" as an essential state policy. As a result, the government intended to follow three new policy directions, or to make "three shifts" in policy, as follows:

i. Shift from the previous approach that laid greater stress on economic growth and less stress on environmental protection to a new approach that pays equal attention to environmental protection and economic growth;

ii. Shift from environmental protection lagging behind economic development (i.e., dealing only with the consequences of economic development) to environmental protection that is synchronized with economic development (i.e., where environmental considerations would influence a priori decisions on economic development); and

iii. Shift from mainly using administrative means to protect the environment to a more comprehensive approach using legal, economic, technical, and administrative means to resolve environmental problems.

An important and tangible manifestation of these shifts occurred in 2007. At the 17th National Congress of the Chinese Communist Party, "ecological civilization construction" was, for the first time, identified as a key element for "building a well-off society in an all-around way," thus providing an important theoretical and practical thesis for exploring new approaches to environmental protection and striking a better balance between economic growth and environmental protection.

6.3 The Institutional Framework for Environmental Management and Protection

The Environment and Natural Resources Protection Committee of the Standing Committee of the National People's Congress

Under the 1982 Constitution, the National People's Congress (NPC) is the highest organ of state power. The NPC has the authority to enact all "basic laws,"[132] to supervise the implementation of the laws, and to make amendments to the Constitution. However, since the full NPC meets only once a year, most lawmaking activity is actually conducted by the NPC's Standing Committee that has approximately 155 members and meets every 2 months. The Standing Committee is authorized to interpret the Constitution, pass laws other than basic laws, interpret laws, and supervise the work of the other principal organs of government including, most notably, the State Council, the Supreme People's Procurate, and the Supreme People's Court.[133]

[132] Although not defined, a "basic (or fundamental) law" is generally understood to be any statute that is likely to have a fundamental effect on the whole society.

[133] Tanner (1994).

The NPC has also established nine specialized committees to facilitate its work, one of which is the Environment and Natural Resources Protection Committee (ENRPC) that was created in 1993. At present, the ENRPC has 28 members and its responsibilities are as follows:

i. To review bills pertaining to the environment that are delivered from the NPC and its Standing Committee;

ii. To submit relevant bills to the NPC and its Standing Committee;

iii. To review administrative regulations, relevant government documents, and local laws that are transferred from the NPC and its Standing Committee;

iv. To vet or check bills for compliance with provisions of the Constitution and national laws;

v. To deliberate questions about bills transferred from the NPC and its Standing Committee;

vi. To receive answers from the administration; and

vii. To investigate and supervise the implementation of environmental laws.

The ENRPC plays an important role in

i. formulating proposals for new laws and regulations for consideration by the NPC;

ii. pushing new environmental initiatives through the Standing Committee for subsequent consideration by the NPC;

iii. negotiating with ministries and other powerful interests who might oppose new environmental initiatives;

iv. mobilizing support for new initiatives through strategies such as soliciting public opinions on draft laws; and

v. commissioning investigations (in association with MEP, for example) of environmental problems.

Ministry of Environmental Protection

Background

MEP's progenitor was the Environmental Protection Bureau (EPB), which was formed in 1975 as a department of the National Basic Construction Commission (NBCC).[134] The EPB was created as a direct result of the State Council's First National Conference on Environmental Protection, soon after the United Nations Conference on the Human Environment, held in Stockholm in June 1972.

As a result of major institutional reforms instituted by the government in 1988, the EPB was separated from the NBCC, renamed the National Environmental Protection

[134] NBCC was the predecessor of today's Ministry of Housing and Urban-Rural Development.

Bureau (NEPB), and made a deputy ministerial level institution reporting directly to the State Council. In 1992, the NEPB was renamed the National Environmental Protection Administration (NEPA), but its deputy ministerial rank remained unchanged.

In 1998, during another round of government reforms and reflecting the increasing concern within the government about the state of the national environment, NEPA was elevated to full ministry rank under the State Council (although it did not become a member of the State Council) and renamed the State Environmental Protection Administration (SEPA). At that time, SEPA's functional orientation was defined rather narrowly as supervision of law enforcement covering pollution prevention and control, ecological protection, and nuclear safety supervision and control.[135]

Creation of the Ministry of Environmental Protection

The next and most recent institutional change was carried out pursuant to the "Plan on Reform of State Council Organs" that was approved by the First Plenary Session of the 11th National People's Congress in 2008. As part of this process, SEPA was renamed the Ministry of Environmental Protection (MEP) and upgraded to the level of a full ministry with a seat on the State Council. This measure can be seen as a concrete action that is consistent with the first two of the "three shifts"—namely, (i) giving equal attention to growth and the environment, and (ii) taking a proactive approach to environmental issues. It also placed MEP in a position to provide an environmental perspective on important questions of national policy at the time that these are being considered by the State Council, rather than after they had been decided upon, as had previously been the case. Nevertheless, the net effect of MEP's elevation was not to change its jurisdiction to any significant degree, but to improve its previously "weak" administrative position.

The "Plan on Reform of State Council Organs" and the associated "Circular of the State Council Concerning Organizational Structure" (GF (2008) No.11) assigned MEP the responsibility to "strengthen environmental management and the guidance, coordination, and supervision functions of ecological protection, and fulfill national pollution reduction targets and environmental supervision responsibility." This represented a substantial broadening of MEP's mandate when compared to that of its predecessor, SEPA.

The State Council assigned MEP 12 specific responsibilities, four of which relate to establishing institutions for environmental protection, developing environmental research and technologies, conducting international environmental cooperation, and carrying out environmental communication and education programs. The remaining eight responsibilities are related to the supervision (monitoring and oversight) and management of environmental protection activities, and they are as follows:

i. Supervision and management of major environmental issues (Article 2);

ii. Supervision and implementation of total emission (load) control and the waste discharge permit system (Article 3);

[135] The nuclear regulatory function was a new responsibility as of 1998 and has been retained by MEP to the present time. However, evaluation of this function is beyond the scope of this report.

iii. Supervision of fixed-assets investment in the environmental protection area (Article 4);

iv. Conduct of environmental impact assessments (EIA) on major economic and technological policies, development plans, and economic development programs (Article 5);

v. Supervision and management of environmental pollution control (Article 6);

vi. Supervision of ecological protection work (Article 7);

vii. Supervision and management of nuclear safety (Article 8); and

viii. Environmental monitoring (Article 9).

In terms of internal structure, the positions of Ministerial Chief Engineer and Nuclear Safety Chief Engineer were created, along with three new departments—namely, the Department of Total Pollution Emission Control, the Department of Environmental Monitoring, and the Department of Education and Communications. As a result, MEP now has 14 departments that comprise 80 divisions.

MEP's manpower was also increased, and now has 368 staff (80 more than the former SEPA), and about 1,700 staff in its affiliated research institutions or semi-managerial offices. Although this represents a significant increase over the staffing levels of 10 years ago, it still compares rather poorly with counterparts in such countries as the United States (US), Germany, and Japan (Table 16), considering the PRC's total land area and population size. However, when making such comparisons, it equally needs to be remembered that the bureaucracies of few, if any other, countries are structured quite the same as the PRC's very broadly based administrative pyramid. All state-level agencies in the PRC are small in comparison to their counterparts in other comparable countries, largely because the PRC is so highly decentralized in terms of fiscal expenditures.[136] Nevertheless, given the range of its responsibilities, MEP's staffing level, even by the PRC standards, seems inadequate; a former vice-director of SEPA is reported to have said that MEP needs 700–800 personnel to do its job properly.[137]

MEP's main responsibility is to coordinate and resolve major environmental problems. Pursuant to that objective, it was given some additional authority to supervise inter-department coordination on environmental matters, although the ambiguous relations between the numerous departments responsible for the environment remain somewhat

[136] The level of fiscal decentralization can be illustrated by the distribution of staff and expenditures. On the overall distribution of staff, it has been estimated that total direct public sector employment in the PRC is about 8 million (these are the people directly employed in government departments at all levels—it does not include the estimated 25 million additional people employed in "public service units," which are not in the government but are controlled by it). Of these 8 million, only about 50,000 (0.6%) are employed at the central level (Wong 2010). By way of comparison, the Federal Executive Branch of the US government employed 2.7 million people as of 2010 (US Office of Management and Budget, http://www.whitehouse.gov/omb). On the distribution of expenditures, 77% of all government expenditures in the PRC are disbursed by subnational levels of government (Wong 2007, p.2 and p.10). This very high level of fiscal decentralization exceeds that of countries such as the US (56%), Sweden (44%), and Germany (19%). The only OECD country that is more fiscally decentralized than the PRC is New Zealand (89% of all government disbursements made by subnational governments) (OECD 2009).

[137] "Still more than one hundred staff are needed for the new MEP," in Chengdu Shangbao, 13 March 2009, quoted in Ran (2009), p.53.

Table 16 **Employees and Budgets of the Ministries of Environment in Selected Countries**

Country	Name of Institution	Employees (No.)	Budget
United States	Environmental Protection Agency	17,354	$10.5 billion
Germany	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	2,000 (870 in HQ)	€550 million ($720 million)
Republic of Korea	Ministry of Environment	1,596 (472 in the Ministry + 1,124 in affiliated entities)	W3.6 billion ($3 million)
Japan	Ministry of Environment	1,134	$20 billion
France	Ministry for the Protection of Nature and the Environment	2,531	€21 million ($28 million)

HQ = headquarters.
Sources: Ma, Z. 2009. Strengthening [the People's Republic of] China's Environmental Protection Administrative System: Analysis and Recommendations. Unpublished report prepared for the World Bank, Washington, DC; relevant websites.

unresolved. There remain many contradictions and inconsistencies between MEP's procedures and the procedures of other ministries whose work impinges on MEP's responsibilities, and there is still much administrative reconciliation work required to remedy these problems, as discussed below.

Strengthening environmental law enforcement

Steps to strengthen environmental law enforcement began even before the government announced the "three shifts." For example, in 2003, SEPA established the Environmental Supervision Bureau and solid steps were taken to better professionalize the whole supervisory system. Following SEPA's lead, the inspection departments and/or divisions of all lower-level environmental bureaus changed their names to "environmental supervision" departments and/or divisions. Various measures were taken to standardize operations; for example, all inspectors were required to wear uniforms, carry appropriate identification cards, and be equipped with field monitoring devices appropriate to the grade of their department. There are now 2,954 environmental supervision departments and/or divisions at all levels employing a total of 57,000 inspection staff, which is about one-third of all environmental staff at all levels, representing quite a high level of commitment to the enforcement function.

During the 11th Five-Year Plan period, MEP, in cooperation with nine other departments, launched a series of five campaigns, entitled "Countrywide Special Environmental Protection Action to Punish Enterprises that Violate Law and Discharge Pollutants and Safeguard the Masses' Health." The selected priorities on which the campaigns focused on include (i) compliance of high pollution, high-energy consumption and resource-based industries; (ii) compliance of iron and steel and arsenic-related industries; (iii) supervision and inspection of drinking water source protection zones; (iv) inspection of urban wastewater treatment plants for compliance with discharge standards; and (v) operation of landfill sites.

In 2009 alone, MEP reports that 2.42 million person days (roughly equivalent to 9,270 person years) were spent on these inspection campaigns and more than 980,000

enterprise inspections were carried out, representing a significant proportion of the total number of industrial enterprises in the PRC.[138] As a result of these campaigns, over 10,000 environmental violations were recorded and investigated, and 2,587 cases were identified for further action. As a result of the latter, 744 enterprises were closed down, 841 enterprises were ordered to stop production while problems were being rectified, 810 enterprises were ordered to make treatment improvements within a prescribed time limit, and 119 persons were prosecuted for breaches of the law.[139]

Regional supervisions centers

Strengthening the environmental inspectorate was the first part of a strategy to improve the effectiveness of environmental enforcement. The second part, commencing in 2006, was the establishment of a network of regional supervision centers (RSCs). These were intended to strengthen SEPA's capacity to supervise the regulatory performance of subnational levels of government (provinces, counties, and others) as part of the environmental supervision and management system of "national supervision, local monitoring and management, and enterprise responsibility,"[140] as well as deal with some issues (e.g., transboundary issues) that were proving difficult to manage. The RSC concept has some similarities to the regional offices of the US Environmental Protection Agency (EPA).

Under the PRC system, each level of government is responsible for applying relevant environmental laws and regulations (at its own level) and guiding its environmental supervision teams (at the lower levels). The concept is shown schematically in Figure 23, which also shows where the regional supervision centers fit into the hierarchy.

An environmental department and/or bureau at any level has a dual and sometimes conflicting set of obligations, such as

- a "horizontal" allegiance to its own level of government, which employs its staff, provides much of its budget, and may not necessarily put environmental protection at the top of its list of priorities; and
- a "vertical" and, essentially, technical responsibility to environmental departments and/or bureaus higher in the government structure and, ultimately, to MEP to enforce relevant environmental rules and regulations and maintain certain standards.

A common criticism of this layered administrative system is that effectiveness tends to break down at lower levels due to the often irreconcilable nature of the horizontal/

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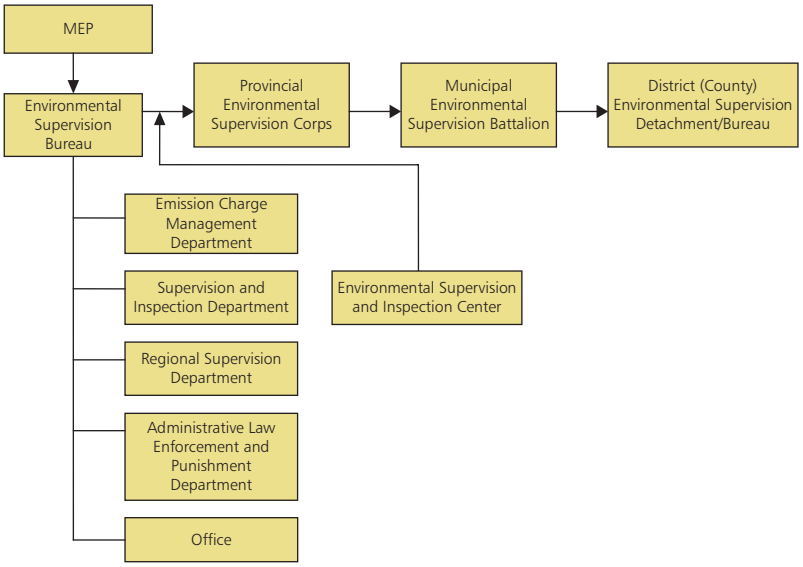
[138] According to the Second National Economic Census conducted by the National Bureau of Statistics in 2008, a total of 2.3 million licensed secondary industry establishments existed in the PRC as of 31 December 2008, of which 1,859,000 were manufacturing enterprises. While there is no one-to-one relationship between the number of manufacturing enterprises counted in the Bureau of Statistics census and the number of enterprises that are subject to the pollution control laws, it seems reasonable to conclude that the inspection campaign in 2009 might have covered between one-third and one-half of all industrial enterprises in the PRC (assuming that every enterprise inspection was of a different enterprise).

[139] The number of sanctions and penalties imposed are numerically large but proportionally (i.e., to the total number of enterprises inspected) very small.

[140] The paradigm is that the national level sets the rules and supervises implementation, the local agencies monitor and manage the performance of the responsible parties, and individual enterprises comply with the rules.

Figure 23 **Schematic Diagram of the Environmental Supervision System in the People's Republic of China**



MEP = Ministry of Environmental Protection.
Source: ADB

vertical conflict. When such breakdowns occur, the horizontal obligations tend to be favored at the expense of the vertical responsibility, and thus, reduce the effectiveness of the regulatory system. This problem is of major significance given the distribution of staff resources in the national regulatory system; as previously discussed, the overwhelming majority of human resources are located at the lower levels of government, particularly at the municipal and county levels. Clearly, the system as a whole cannot be effective unless the lower levels are effective.

In 2006, (then) SEPA was authorized to create six RSCs (South, Southwest, North, Northeast, Northwest, and East) with the specific intention of strengthening the effectiveness of the vertical aspect of environmental management and control.[141] The RSCs are agencies of MEP, are not answerable to lower-level governments, and have the following seven basic functions:

i. Supervise and inspect the local execution of national environmental policies, laws, regulations, and standards;

ii. Supervise and inspect major environmental pollution incidents and cases of ecological damage;

iii. Supervise and inspect emergency responses and responses to major environmental incidents;

[141] At the same time as the environmental RSCs were being established, MEP also established five regional nuclear and radiation safety supervision centers as part of its nuclear regulatory responsibilities, which are not a focus of this report.

iv. Supervise and inspect the supervision and management of major pollution sources and construction projects approved at the national level, as well as the implementation of the Three Simultaneous policy at such locations;[142]

v. Supervise and inspect the environmental law enforcement for national-level nature reserves and national ecological function protection zones;

vi. Assist and coordinate local environmental protection departments to resolve trans-provincial and major regional environmental disputes; and

vii. Accept and coordinate the inspections and resolution of complaints regarding trans-provincial regional and trans-basin environmental pollution and ecological damage cases.

The RSCs are being developed in three stages during which time they will gradually build their capacity to carry out supervision, investigation, and management. The stages are as follows:

- **Supervision** (Phase I) will involve the supervision of local governments' implementation of environmental protection laws and regulations, and national arrangement of environmental protection in pollution prevention and ecological conservation;
- **Investigation** (Phase II) will involve the investigation of violations of environmental protection laws by individual enterprises, organization of emergency response to environmental incidents, and coordination of trans-regional environmental disputes; and
- **Management** (Phase III) will involve the assessment of regional environmental capacity, approval of environmental impact assessments, checking the implementation of the Three Simultaneous policy, allocation of environmental protection funds, and implementation of environmental protection projects.

It is expected that the regional offices will become fully staffed at the end of Phase II, at which time, 876 staff will be working in these offices. Moreover, a lot of work needs to be done for the RSCs to perform their designated roles in the environmental protection system. It is understood that some provincial environmental departments are thinking of establishing their own regional supervision offices to improve their ability to regulate affairs in their own provinces. There will be a need to ensure that these different programs do not create confusion.

Changes in the reporting relationships of sub-municipal environmental bureaus

To supplement the efforts to solve the horizontal/vertical problem through the establishment of the RSCs, the government also introduced structural reforms that essentially transferred the staff, funds, assets, and management of all environmental protection bureaus below the municipal level to the municipal government.

[142] Article 26 of the Environmental Protection Law requires that facilities for the prevention and control of pollution at a construction project must be designed, built, and commissioned at the same time as (i.e., simultaneously with) the principal part of the project. This is the Three Simultaneous policy.

It remains to be seen whether this initiative went far enough, but it represents an important step in the right direction. Many would argue that the main responsibility for environmental regulation and enforcement should be at the provincial level, and that lower-level governments should only have responsibility for low-level environmental enforcement (e.g., nuisance issues such as noise and odors, and regulation of very small-scale industrial enterprises).

Environmental capacity building

Finally, the State Council agreed to invest significant funds under the 11th Five-Year Plan for environmental capacity building as shown in Table 17.

The Judicial System

The third shift in the government's development policy envisaged a switch toward a more comprehensive approach to protecting the environment using legal, economic, and technical means as well administrative channels to resolve environmental problems. Clearly, the judicial system will be very important in the pursuit of this policy. However, progress so far on this dimension has been less substantial than those of the administrative and technical aspects.

Table 17 **Environmental Capacity Building under the 11th Five-Year Plan (2006–2010)**

Item	Details
Components	15 construction tasks and 50 construction projects including installation of automatic pollution source monitoring and reporting systems, and facilities and equipment to strengthen environmental supervision and enforcement.
Budget	CNY14.96 billion. Of this, CNY7.85 billion (52%) was provided by the central government, CNY2.75 billion (18%) was local (province, county, municipality) counterpart funding, CNY3.96 billion (26%) was contributed by beneficiary enterprises, and CNY403 million (4%) was a grant from the central government.
Physical progress	**Automatic source monitoring:** 324 provincial, prefecture, and municipal-level monitoring and control centers constructed; automatic monitoring and control equipment installed at 7,225 wastewater discharge outlets and 5,472 waste gas emission outlets of 10,279 major monitored and controlled enterprises (as a result of which 85% of all national-controlled major pollution enterprises had automatic monitoring and control equipment). **Environmental law enforcement supervision:** 41% of provincial-level environmental supervision stations reached the Grade 1 standard and 2,085 vehicles, instruments, and devices were purchased; 44% of prefecture and municipal-level environmental supervision stations reached the Grade 2 standard and 14,921 vehicles, instruments, and devices were purchased; 29% of district- and county-level environmental supervision stations reached the Grade 2 standard and 37,190 vehicles, instruments, and devices were purchased. The checking capacity of 6 national-level environmental supervision and law enforcement institutions was enhanced and 507 sets of evidence collecting, office and communication equipment, 34 law enforcement vehicles, and 6 mobile monitoring vehicles for pollution sources (including on-vehicle instruments) were procured.

Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

The judicial system in general

The PRC's judicial system consists of the Supreme People's Court, the local people's courts, and specialized people's courts. The local people's courts include the higher people's courts, covering all provinces, autonomous regions, and municipalities directly under the central government; the intermediate people's courts whose jurisdictions are districts and municipalities; and the basic people's courts in counties, cities, and municipal districts. The specialized people's courts include, among others, the Military Court, Maritime Court, Railway Transport Court, Forestry Court, Petroleum Court, Land Reclamation Court, and the Youth Court. All people's courts are answerable to the People's Congress at the corresponding level, as well as to the Standing Committee of that Congress. All people's courts function under the supervision of the people's courts at higher levels.

Environment courts

Environmental disputes are generally decided in the people's courts. However, beginning in 1989, certain districts or municipalities have established specialized environment courts to deal with particular environmental issues. So far, 11 environment courts have been established.

During the 1980s and 1990s, the number of environmental disputes recorded in government statistics remained fairly constant at about 100,000 per annum. But over the past decade, it started to increase significantly until, by 2005, it had risen to nearly 700,000.[143] The number of environmental lawsuits filed in the people's courts also increased over the same period at a rate of 25% per annum.

Most of these disputes were not resolved through litigation or court proceedings, but resolved through the intervention of administrative agencies by "administrative determination" procedures. It is estimated that, presently, only about 3% of all environmental disputes are brought to court. Environmental cases adjudicated by the courts have covered just about every form of legal proceeding including criminal, civil, and administrative cases, and have been heard not only before the corresponding divisions of the people's courts but also by specialized courts such as the Maritime Court, Forestry Court, and Railway Transport Court.

Most criminal cases concern crimes relating to resources, such as illegal tree felling. The number of criminal cases for impairing protection of the environment is quite small. Civil cases mainly include (i) disputes over infringement of rights, such as those involving environmental pollution; (ii) maritime disputes, including those involving compensation for marine pollution; and (iii) disputes over property rights and ownership in connection with environmental pollution charges. Administrative cases mainly include complaints against specific actions by administrative agencies responsible for environmental supervision.

As the complexity and economic consequences of environmental disputes increase, it is expected that the number of environmental disputes that are brought to court, rather

[143] Lin et al. (2009), p.5.

than resolved by administrative means, will increase from the current rate of 3% to 10% over the next 5 years. This is likely to require expansion of the specialized environment court system. However, for this to occur, several obstacles will need to be overcome:

- **Lack of training of most judges in environmental law.** Very few of the PRC's 190,000 judges have specialized environmental training. Environmental law courses have entered the curriculum of some law schools only recently, and most schools do not make them mandatory.
- **Difficulties in enforcing court orders in environmental cases.** It is common for the losing parties in lawsuits to refuse to implement the remedies ordered by the court, and for local governments to refuse to help the court in applying remedies. This can be a particular problem in cases involving discharges of wastes by enterprises, where local governments are reluctant to force actions that may result in unemployment and/or loss of tax revenues.
- **Weak regulatory support.** The regulatory framework has been slow in developing the legal basis for court actions. The Environmental Protection Law (Trial) of 1979 made it clear that those who seriously pollute the environment would be criminally liable. However, articles relating to environmental criminal offenses were not completed until 1997. Principles and policies on the burden of proof and the presentation of environmental monitoring data were not enacted until 2004. Of the 3,400 judicial interpretations that the Supreme People's Court has promulgated so far, only 18 or 0.5% pertain to environmental cases.

Conclusion

In the long run, a fully functioning and effective legal system for environmental protection will be an essential pillar of the administrative and regulatory system. This is to provide an independent and impartial venue for adjudicating disputes between those who regulate, those who are regulated, and those whose lives are affected by environmental issues. Over the past 3 decades, the PRC has made great strides in creating the administrative and regulatory structure for environmental management, but progress in constructing the environmental judicial system is less advanced and more work needs to be done.

Several types of environment courts have been established in a few areas across the country, but they will not be sufficient to handle the rapidly increasing number of environmental disputes that develop into court cases. In addition, the environmental judicial system is not fully formed conceptually, such that so much still needs to be done in piloting and testing alternative structures and approaches. At the same time, a great deal of work will be required in strengthening training in environmental law for both the judiciary and the legal professions—e.g., there is a clear role here for university law schools, but the government (through MEP) could also start working on curriculum development and related matters. Finally, as the role of the environment courts increases, some of the drafting weaknesses inherent in existing laws and regulations will become apparent, and there will be a need for continuous revision and strengthening of the legal and regulatory instruments to increase clarity and precision.

The Environmental Roles of Agencies other than the Ministry of Environmental Protection

Although MEP has overall responsibility for the unified supervision and management of environmental protection nationwide, a number of other important national government agencies are also given the role of oversight for environmental protection activities of certain specific environmental media. For example:

- The National Development and Reform Commission (NDRC) develops the overall economic plans for the country, including environmental strategies and plans;
- The Ministry of Finance (MOF) reviews and approves foreign loans and domestic financial allocations related to environmental projects and programs;
- The Ministry of Housing and Urban–Rural Development (MHURD) handles urban environmental issues, especially the development of environmental infrastructure systems such as water supply, wastewater treatment, and solid waste management;
- The State Forestry Administration (SFA) is responsible for forest protection, reforestation, and wildlife management, and leads in biodiversity protection through the parks and nature reserves that fall under its authority;
- The Ministry of Water Resources (MWR) controls soil erosion and groundwater quality, and carries out watershed management outside the urban areas;
- The China Meteorological Administration is responsible for regional air quality management and also takes part in the climate change negotiations;
- The Ministry of Agriculture manages agricultural chemicals, aquatic nature reserves, agricultural biodiversity, and grasslands management. It also regulates township and village enterprises;
- The Ministry of Land Resources is responsible for land use planning, mineral and marine resources management, and land rehabilitation. It is also responsible for mapping and cadastral (land ownership) management;
- The Ministry of Communications shares responsibility with MEP on vehicle emissions control, the implementation of which falls on the Public Security Bureau;
- The Ministry of Health monitors the quality of drinking water and the incidence of water-related diseases;
- The Ministry of Science and Technology is the leading body in the development of environmental science and technology. It coordinates various environmental research programs throughout the country, including cooperation with international partners; and
- The State Oceanographic Administration (SOA) is responsible for managing coastal and marine waters, including marine biodiversity conservation.

These divided responsibilities, in many respects, are a direct result of the wording of parts of the Environmental Protection Law (EPL) of 1989. Article 7 of the EPL creates the authority for a "competent department of environmental protection administration" under the State Council to take responsibility for the unified "supervision and management" of the environmental protection work of the entire nation. This "competent department" is MEP.

However, and in apparent contradiction to this provision, Article 7 also authorizes certain other state departments to undertake supervision and management of certain matters relating to pollution control and natural resources protection. In particular, Article 7 authorizes the following departments to "conduct supervision and management of the prevention and control of environmental pollution" (most of these departments no longer exist but the functions still do). These are the State Administrative Department of Marine Affairs; the Harbor Superintendency Administration; the Fisheries Administration; the Environmental Protection Department of the Armed Forces; and the administrative departments of the Public Security, Transportation, Railways and Civil Aviation. Article 7 also authorizes certain departments to "conduct supervision and management of the protection of natural resources" in accordance with relevant laws, including the Departments of Land, Minerals, Forestry, Agriculture, and Water Conservancy.

The problem of divided responsibilities is one of the factors most frequently cited by experts as undermining MEP's effectiveness. The problem is compounded by the fact that the hierarchy and relationship between the EPL and other laws that have overlapping or related objectives are very unclear. In principle, as the basic and comprehensive law for environmental protection in the PRC, the provisions of the EPL ought to override and govern the provisions of any and all other laws impinging on or relating to the protection and improvement of the people's environment. However, there is no statement in the EPL to that effect. As a concrete example of the resulting contradiction, the Marine Environmental Protection Law (MEPL), which was enacted after the EPL, is treated as a law of equal force to the EPL rather than being subject to it. A recent manifestation of the effect of these legal conflicts was SOA's announcement, in March 2011, of its intention to draft a national standard limiting pollutant discharges into the sea.[144] SOA's plan is not inconsistent with the authorities assigned to it under Article 7 of the EPL, but it is a clear infringement of MEP's pollution control authority.

These problems of overlapping responsibilities and lack of legal clarity are very complex, and many suggestions have been made on how to resolve them. However, it seems that the necessary first step should be a comprehensive redrafting of the EPL to directly address these issues by specifying, among other things, that

- MEP is the sole "competent department" for the unified supervision and management of the environmental protection work of the entire nation, and that the work of other departments must be consistent with and approved by MEP; and
- in the event of conflict with other laws, the provisions of the EPL prevail.

[144] *China Daily*. 2011. National standard to help clean up coastal pollution. 25 March (http://english.peopledaily.com.cn/90001/90776/90882/7330711.html).

There are many other reasons for amending and redrafting the EPL. It was enacted in 1989, which was a time that bears little, if any relationship to conditions in a country that is now the second biggest economy in the world, where the private sector has a significant economic role to play, and where public interests and expectations about environmental quality are completely different. The law is very short (the English version is only 12-pages long), vague (the definitions section defines only one term, "environment"), and has not kept up with legal and institutional developments in the environment sector (e.g., the Water Pollution Prevention and Control Law is a far more explicit and prescriptive piece of legislation than the EPL) or the country at large.

6.4 Changes in Laws, Regulations, and Related Instruments

New and Amended Laws, Regulations, and Rules

There was a considerable amount of regulatory activity during the 11th Five-Year Plan period. More laws were passed and/or amended, in addition to the substantial body of environmental laws, regulations, and rules that were already in place. Table 18 highlights some of the major developments.

More Comprehensive Approach to Environmental Management

A key concept embodied in the "three shifts" was the idea of taking a more strategic approach to the national environmental problem that was more comprehensive than previous efforts. This approach would maintain the necessity of regulating pollution at the enterprise level but, at the same time, would look beyond the individual enterprise to consider the entire economy (i.e., not just the industrial economy). This approach would then address environmental problems at a macro level through strategies such as improving resource and energy use efficiency, promoting a recycling economy, and improving public awareness. This approach also includes the creation of economic instruments to influence the behavior of economic actors as well as voluntary instruments that would encourage the adoption of more environmentally sustainable approaches. It also involves the development of procedures to evaluate the environmental effects of plans and programs through the process referred to as strategic environmental assessment. Key features of these initiatives are outlined in the following sections.

Measures to influence the economic development mode and industrial structure

Relevant laws promulgated in recent years, including the Law on Promotion of Cleaner Production (2002), the Renewable Energy Law (2005), and the Circular Economy Promotion Law (2009), have all been aimed at influencing the structure of the economy by changing the incentive frameworks. MEP has also issued the "Comprehensive Directory for Environmental Protection," which defines "admittance conditions" for resource-based industries with high pollution potential and/or high energy consumption. The objective was to clearly define the minimum standards to be met by any new entrants to these industries.

Table 18 **Main Laws for Natural Resources and Environmental Management Approved since 2006**

Type of Instrument	Title
Laws	Law on Conserving Energy (28 October 2007) Law on Water Pollution Prevention and Control (originally passed on 11 May 1984, amended in 1996, and amended again in 2008) Circular Economy Promotion Law (29 August 2008) Renewable Energy Law (26 December 2009) Law on Island Protection (26 December 2009)
Regulations	Regulation on the Bio-safety Management of Pathogenic Microbe Labs (8 March 2006) Regulation on National General Survey of Pollution Sources (9 October 2007) Regulations for Management of Recycling Disposal of Waste Electric and Electronic Products (20 August 2008) Regulations on Plan Environmental Impact Assessment (12 August 2009) Regulations on the Prevention of Sea Environmental Pollution by Ship (2 September 2009) Management Rules for Ozone Depleting Substances (24 March 2010) Measures on Environmental Management of New Chemical Substances (15 October 2010)
Departmental Rules	Measures for Compliant Reporting on Environment (24 June 2006) Measures for the Administration of Environmental Statistics (26 October 2006) Measures for the Supervision and Inspection of National Nature Reserves (26 October 2006) Measures for Environmental Administrative Reconsideration and Response (27 December 2006) Measures for the Disclosure of Environmental Information (Trial Implementation) (11 April 2007) Measures for the Administration of Environmental Surveillance (25 July 2007) Administrative Measures for the Prevention and Control of Environmental Pollution by Electronic Waste (7 September 2007) Administrative Measures for the Examination and Approval of the Export of Hazardous Wastes (25 December 2007) Classification of Construction Project Lists for EIAs (15 August 2008) Provisions for the Grading and Approval of EIA Documents of Construction Projects (11 December 2008) Administrative Measures for the Filing of Local Environmental Quality Standards and Pollutant Emission Standards (30 December 2009) Measures for the Administrative Penalties for Environmental Protection (30 December 2009)

EIA = environmental impact assessment.
Source: Ma, Z. 2009. Strengthening [the People's Republic of] China's Environmental Protection Administrative System: Analysis and Recommendations. Unpublished report prepared for the World Bank, Washington, DC.

Economic instruments

Over a period of years but particularly during the 11th Five-Year Plan period, a series of economic instruments have been developed to try and influence the environmental sustainability of the national economic system culminating with (then) SEPA's announcement, in 2007, of a suite of seven economic policies that were to be introduced on a trial basis, namely:

1. **Introducing environmental tax.** It was proposed to levy taxes on or to provide tax credits or rebates to organizations and individuals in accordance with their development, utilization, pollution, damage to, or protection of environmental resources. Preferential tax policies would also be developed to reward environment-friendly behavior. In addition, a direct pollution discharge-based tax and an indirect pollution-based product environmental tax would be developed. This was not done during the 11th Five-Year Plan, but is again on the agenda of the 12th Five-Year Plan.

2. **Reforming pollution levies.** The government will increase wastewater and solid waste treatment charges, take account of environmental protection factors in resource price reform, and push energy saving and discharge reduction through economic instruments such as pricing and charging.

3. **Promoting ecological compensation (eco-compensation).** The PRC government is advocating the use of eco-compensation mechanisms to help resolve key environmental problems in the country (see section on Fiscal Dimensions of Environmental Management, page 112), and it is expected that the government during the 12th Five-Year Plan period will develop a specific policy framework for the application of eco-compensation approaches and possibly also a draft law.

4. **Designing and piloting a tradable permit system.** The tradable permit system will utilize market forces to improve environmental protection, optimize environmental capacity resource allocation, reduce total pollution control cost, and mobilize polluters' enthusiasm for pollution abatement.

5. **Introducing green trade policy.** In response to increasing green trade barriers from developed countries, the PRC must change its development model of solely pursuing quantity growth while ignoring resource restriction and environmental capacity. The PRC must balance the benefits of import and export trade with domestic and overseas environmental protection.

6. **Introducing green insurance.** The most common type of "green insurance" being considered in the PRC is environmental pollution liability insurance. This is seen as potentially beneficial for two reasons: first, the insurance company compensates victims of sudden pollution accidents and reduces pressure on government and enterprises; second, the market mechanism enhances the supervision of enterprises' pollution discharge.

7. **Making capital markets green.** The government proposes to implement a "green credit" program through an indirect financing channel, which will provide loan support or grant preferential interest rates to environmentally friendly enterprises or institutions. In addition, the government will restrict loan volume and impose higher interest rates on investments and working capital on new development of highly polluting enterprises. The government will also consider developing a set of green security policies, including restricting access to capital markets, subsequent fund restriction, and exemplary de-listing for "high-pollution and high-energy consumption" enterprises.

Information disclosure and public participation

In 2008, the State Council made provisions for the range and model of government information disclosure at all levels in the "Provisions on the Disclosure of Government Information in [the People's Republic of] China." Information to be disclosed includes all information that

- involves vital interests of citizens, legal persons, or other organizations;
- reflects institutional establishment, functions, and work procedures of own administrative organ; and
- should be actively disclosed according to laws, regulations, and related national regulations.

Modes of disclosure include government bulletins, government websites, news releases, conferences, newspapers and periodicals, radio broadcasts, and television programs that are widely available to the public.[145]

Public awareness of environmental issues has been growing fast in the past decades. To encourage public participation and enhance transparency in environmental management, specific methods are detailed in the "Interim Measures for Hearing the Administrative License in Respect of Environmental Protection" and the "Temporary Measures of the Public Participation in Environmental Impact Assessment" issued in 2004 and 2006, respectively. These measures provide detailed regulations for the scope, procedure, and organizational system to encourage public participation.

Voluntary instruments

Environmental management system (ISO 14000). In 1997, the State Bureau of Quality and Technical Supervision introduced the ISO 14000 system (a set of international quality assurance standards for environmental management) as the national standard, and introduced a certification inspection system administered by a national certifying agency and an auditor. When the system was first introduced, the adoption rate, as in other countries, was quite slow (only 27 enterprises received ISO 14001 certification during the first year), but it has since picked up speed and now more than 12,000 enterprises are ISO 14000 certified. Nevertheless, this represents only a small fraction of the 1.86 million manufacturing enterprises in the PRC.

Clean production audits. The "clean production" concept was first introduced to the PRC by MEP's predecessor, NEPA, in 1990.[146] Since then, MEP has consistently supported the clean production agenda by supporting demonstration projects, training, capacity building, and policy suggestions at the factory level. So far, 21 clean production centers have been established and over 5,000 enterprises in chemical, light, electric

[145] While implementation of the requirements for access to environmental information varies widely across jurisdictions (Natural Resources Defense Council, *Breaking the Ice on Open Environmental Information: 2008 Pollution Information Transparency Index*), there is evidence of improvements over time in some areas.

[146] Clean production is any practice which eliminates at source the use or formation of hazardous substances either (i) through the substitution of alternative, non-hazardous chemicals in the production process, or (ii) through product or process redesigns that eliminate the need to use hazardous substances, or prevent or minimize the release of hazardous substances into the environment.

power, coal, machinery, and building material industries have passed clean production audits. Again, the level of penetration is small, but it has been steadily growing.

Eco-labeling. "Eco-labeling" is intended to help guide national procurement policies and promote green product development. To date, eco-labels have been authorized for 21,000 products produced by more than 1,100 enterprises. The approved products fall under 56 main categories, including household appliances, convenience goods, textile products, and architectural decorative materials. The value of eco-labeled products sold in 2008 exceeded CNY90 billion ($14.3 billion).

Strategic Environmental Assessment

It has long been understood by environmental experts in the PRC, and in international circles, that an alternative to conventional EIA—which is a procedure that permits environmental analysis of proposed projects with well-defined time and space—needs to be developed to permit environmental assessment of policies, plans, and/or programs (often referred to as PPP) as a means of promoting "environmentally sustainable development." This will ensure that the environmental consequences of proposed PPPs are taken into account at the time that the policies, plans, and/or programs are being formulated and considered, rather than after these have been implemented.

One of the approaches that has been developed to deal with this question is the so-called strategic environmental assessment (SEA), described as a series of "analytical and participatory approaches that aim to integrate environmental considerations into policies, plans, and programs, and evaluate the inter-linkages with economic and social considerations."[147] SEA has been widely adopted in as many as 50 countries, although the utility of the process has been somewhat variable.

The PRC's Law on Environmental Impact Assessment, which became effective in 2003, explicitly provides for the application of a form of SEA insofar as the law repeatedly refers to the application of environmental assessment to both "plans" and "construction projects." Chapter II of the said law relates to "Environmental Impact Assessment on Plans."

The law actually does not use the term "SEA" although it explicitly provides for the EIA procedure to be applied to various spatial and sector-specific plans at both national and provincial levels. Spatial plans cover land use plans and plans for the development and utilization of river basins and coastal areas. Sector plans cover plans for the development of industry, agriculture, animal husbandry, forestry, energy, water conservancy, transport, urban construction, tourism, and natural resources development. The law does not yet apply to policies or large regional development plans.[148]

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[147] OECD (2006a), p.17.

[148] The following discussion has relied substantially on a recent review of SEA implementation in the Southeast Asian region (Dusik and Xie 2009, pp.23–24).

The law provides that spatial plans can only be approved if they include chapters relating to environmental assessment or separate EIAs, which must be prepared during the plan's drafting and submitted together with the plan to a relevant authority for examination and approval. No public consultation is required, no solicitation for comments from relevant authorities is required, nor are there any specific requirements as to aspects that should be covered in the EIA.

The provisions governing EIA for sector plans (or "special plans" as they are referred to in the law) are considerably more rigorous. The law specifies the aspects that need to be covered (including an analysis of the environmental impacts that might occur if the plan or program is implemented, specification of mitigation measures, and conclusions and recommendations). More importantly, the law requires that consultations be undertaken with interested institutions, experts, and the general public on the draft plan prior to its submission for approval. The finalized drafts of sector plans and their respective plan EIA reports must be submitted for review by the environmental protection department or other designated authority. The agency conducting the review must convene a review panel with representatives from the relevant departments and environmental experts. The designated authority is required to consider in its decision making both the conclusions of the EIA report and the review inputs.

MEP has drafted a series of relevant regulations, although their applications are still on a trial basis. They include Technical Guidelines for Plan EIA, Scope of the Plans to Prepare the Environmental Impact Statements, and Scope of the Plans to Prepare the Environmental Impact Chapters or Statements.

A lot of activity has been undertaken, with the help of donors, in the development and delivery of SEA training courses and methodologies. In 2006, SEPA established a nationwide program of SEA pilots and experimental applications. So far, this program has focused on the SEAs of general development plans and special plans, including the plan for developing key industries in the area surrounding the Three Gorges reservoir.

A recent review of the practical applications of SEA at the provincial level concluded that most EIAs for plans are prepared too late to effectively influence the planning process, and the reports tend to be too broad in their coverage rather than focusing on key strategic issues relevant to the particular plan.[149] Clearly, there is an opening for further work on capacity building, pilot studies, and institutional development.

International Cooperation and the Global Environment

So far, the PRC has concluded or signed 12 categories of more than 50 international environmental conventions, such as the Convention on Biological Diversity, the International Convention to Combat Desertification, the Framework Convention on

[149] Yunnan Environmental Protection Bureau and Swedish International Development Agency (SIDA) (2009).

Climate Change, the Convention on Wetlands, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora. [150]

Stockholm Convention

The Stockholm Convention came into effect in the PRC on 11 November 2004. A National Coordination Group composed of 14 national agencies and institutions, with MEP as head organization, was set up; and the National Implementation Program was developed and submitted to the Secretariat of the Convention. Under the Convention, the PRC completed the phasing out of 9 kinds of pesticide persistent organic pollutants (POPs); conducted national investigation and assessment of POPs; refined policies, regulations, standards, and guidelines relevant to POPs; carried out demonstrations on alternatives of relevant pesticide, reduction of and disposal of polychlorinated biphenyls (PCBs); and organized diversified activities to raise public awareness.

Rotterdam Convention

The Rotterdam Convention came into effect in the PRC on 20 June 2005. Under the Convention, the PRC, among others, established the Chemical Registration Center that is responsible for the technical review of import and export of chemicals; released the List of Toxic Chemicals Banned or Severely Restricted in Import and Export, and adjusted the List in line with the Convention; and conducted export registration of five kinds of high-toxicity organophosphate pesticides subject to phasing out in a given period of time.

Montreal Protocol

On 10–14 July 2006, the 49th session of the Executive Committee for the Montreal Protocol approved the PRC's application to export chlorofluorocarbons (CFCs) for Article 2 countries without the export restrictions under the Agreement on Accelerated Phase out of CFC. As of 1 July 2007, the production and consumption of CFCs and halons in the PRC ceased, in accordance with and in advance of the country's obligations under the Montreal Protocol.

The 54th session of the Executive Committee of the Multilateral Fund for the Montreal Protocol approved the PRC's Hydrochlorofluorocarbons (HCFC) Phase out Management Plan Guide, worked out the medium-term planning for the 3-year operational plan in 2008–2010, and approved the 2008 plan for two industrial plans already under execution.

Convention on Biological Diversity

In 2008, the PRC completed the "Study on the Capacity Building of Implementation Institutions for the Convention on Biological Diversity." MEP also jointly organized an International Workshop on Biodiversity and Climate Change, in collaboration with the NDRC, the European Union (EU), and the United Nations Development Programme (UNDP), which was held on 6–7 March 2008 in Beijing.

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[150] The following discussion relates only to international environmental agreements. MEP is also the PRC's nuclear regulatory authority, in which capacity it has also entered into a wide range of international agreements; but these are not covered in this report.

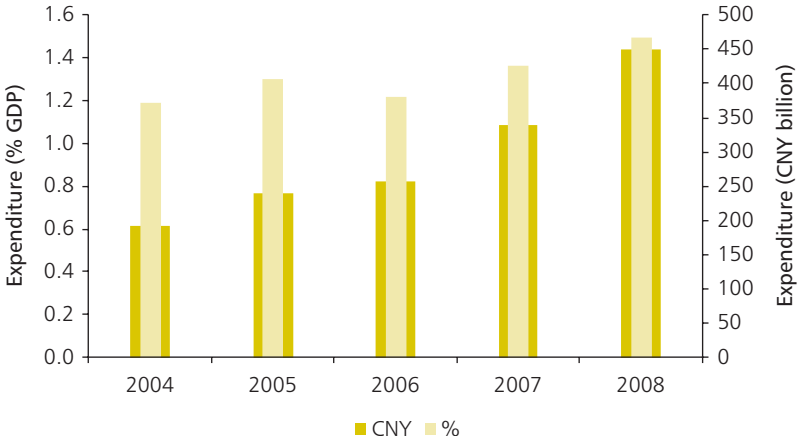
The PRC's "Biodiversity Protection Strategy and Action Plan" was revised in 2009 to cover the 2010–2030 period. The plan identified 35 new priority protection areas; set out the PRC's strategy, policies, and guiding principles for biodiversity protection during the planning period; outlined near-, medium- and long-term strategic objectives and tasks; and identified protection priority fields, priority actions, priority projects, and safeguard measures for related work. By the end of 2009, more than 60,000 species of organisms and hundreds of thousands of copies of germplasm resources had been catalogued while the national biological species resource database platform had been established. Biodiversity evaluation pilot work had been done in 16 provinces, autonomous regions, and municipalities directly under the central government, and a preliminary national biodiversity assessment system had been established.

6.5 Fiscal Dimensions of Environmental Management

Scale of Environmental Expenditures

An essential element of the government's environmental strategy during the 11th Five-Year Plan was to increase financing for environmental protection work, and it was successful in this regard. The PRC's National Bureau of Statistics (NBS) reports annually on "estimated investments in the treatment of environmental pollution" and, as shown in Figure 24, these increased progressively until they reached 1.5% of gross domestic product (GDP) in 2008 (equivalent to CNY449 billion or $71.3 billion). In absolute terms, the level of investment increased steadily throughout the period—by 75% over the level in 2006 (the first year of the 11th Five-Year Plan), and by 88% over 2005 (the last year of the previous five-year plan).

Figure 24 Investments in the Treatment of Environmental Pollution, 2004–2008



GDP = gross domestic product.
Source: National Bureau of Statistics. 2009. *[The People's Republic of] China Statistical Yearbook*. Beijing. Item 11–47.

However, as a measure of environmental protection expenditures in their broadest sense, the NBS data on environmental investments are somewhat limited for several reasons: (i) they are rather narrow in scope,[151] (ii) they represent a mixture of actual and estimated government and private sector expenditures,[152] and (iii) they provide no clear measure of what resources the government itself is spending on its environmental program.

In 2005, as part of a scheme to strengthen environmental expenditures, the government created a budgetary line item, Item 211: "environmental protection," to better track government's environmental expenditures at all levels. Item 211 covers the government's environmental expenditures within 14 different categories regardless of which ministry or department makes them.[153] Governments at all levels were instructed not only to explicitly account for environmental expenditures in their budgets but also to increase them every year. The accounting scheme is still at an introductory stage, and many lower-level governments are apparently not yet reporting expenditures against Item 211. But this represents an important initiative, and the data recording will no doubt improve over time.

During the first 3 years (2007–2009) for which data were available, expenditures under Item 211 increased by 94%—from CNY99.6 billion ($15.8 billion) in 2007 (0.4% of GDP and 2.0% of total reported government expenditure) to CNY193.4 billion ($30.7 billion) in 2009 (0.6% of GDP and 2.5% of total reported government expenditure). It will be noted that expenditures under Item 211 are only about one-third of the "treatment of environmental pollution" expenditures recorded by the NBS, although Item 211 includes a much wider range of environmental work.

Table 19 shows partially itemized expenditures under Item 211 for 2008 and 2009 (the only years and categories for which data could be obtained).

As shown, expenditures under pollution control were the largest (55% of the total in 2009), followed by investments in ecological improvement (32% in 2009), and energy conservation (13% in 2009). It should be noted, however, that 16% of the disbursements within the pollution control category are actually re-circulated pollution discharge fees rather than incremental government expenditures.

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[151] The only expenditures accounted for are those for urban environmental improvement (including gas supply and central heating, drainage works, landscaping, and sanitation), industrial pollution control (i.e., treatment systems on existing enterprises), and subsidies for installation of pollution control systems on new projects as part of the Three Simultaneous process. The estimates do not include the substantial sums of money invested in other environmental programs administered by MEP, or investments in environmental programs administered by other agencies such as the SFA (Sloping Land Conversion Program, the Natural Forest Protection Program, or investments in ecological protection, to name just a few).

[152] The NBS acknowledges that the data recorded in this statistical category (Item 11–47 in the NBS's statistical database) are only estimates, and they include expenditures by both the government and enterprises. The expenditures by enterprises are self-reported and unverified.

[153] The 14 forms of environmental expenditure are (i) environmental administration, (ii) environmental monitoring and supervision, (iii) pollution control, (iv) ecological protection, (v) activities under the Natural Forest Protection Program (NFPP), (vi) reforestation of cultivated land (basically the Sloping Land Conversion Program or SLCP), (vii) desertification control, (viii) conversion of cropland to pasture, (ix) conversion of cropland to improve pasture, (x) energy conservation, (xi) pollutant emission reduction, (xii) renewable energy investment, (xiii) energy management, and (xiv) comprehensive utilization expenditures.

Table 19 **Expenditures under Item 211 for 2008 and 2009** (CNY billion)

Expenditure Categories		Expenditure (% total) 2008	2009	% Change 2008/09
Pollution	Pollution control	80.90 (56%)	106.90 (55%)	+32
Ecological	Reforesting cultivated land	30.68 (21%)	43.83 (23%)	+43
	Natural Forest Protection Program	8.17 (6%)	8.06 (4%)	–1
	Ecological protection	3.35 (2%)	5.37 (3%)	+60
	Replacing cropland with pasture	1.96 (1%)	3.66 (2%)	+87
Energy	Renewable energy	4.48 (3%)	5.90 (3%)	+32
	Energy saving	15.56 (11%)	19.70 (10%)	+27
Total: Item 211		**145.14 (100%)**	**193.40 (100%)**	**+33**

Source: Ma, Z. 2011. [The People's Republic of] China's Fiscal Expenditure for Environmental Protection. Thematic paper for the Country Environmental Analysis Update. p.22.

Environmental Special Funds

One of the features of the PRC's fiscal system following reforms carried out in 1994 is that, while a large share of total government revenue (about 55%) is collected by the central government, most government spending (77% in 2007) is done by governments below the national level (Table 20). As previously mentioned, this is a very high level of fiscal decentralization as compared to other comparable countries.

In the environment sector, one of the implications of this decentralized expenditure arrangement is that a significant share of the funds for subnational environmental expenditures come in the form of transfers from the central government to subnational levels of government, most of which are earmarked (i.e., can only be used for purposes designated by the central government). One of the main vehicles for transferring budgetary resources for environmental expenditures from the central to lower-level governments is through a series of Special Funds for Environmental Protection.

There are two sources of central special fund for environmental protection—(i) infrastructure investment funds administered by the NDRC, and (ii) financial special funds administered by MOF. In 2008, there were 11 special funds administered through the NDRC, providing total resources of CNY11.3 billion ($1.8 billion), and seven special funds administered through MOF providing total resources of CNY16.4 billion ($2.6 billion)—this was increased to 12 funds in 2009. The range and objectives of the funds are extremely broad and somewhat confusing. It will also be noted that the total amount delivered through these funds is only about 20% of the total environmental expenditures.

Table 20 **Revenues Collected and Disbursements Made by Level of Government, 2007**

Level of Government	Revenues Collected (% of total)	Expenditures Made (% of total)
Central	54	23
Province	12	18
Municipality	15	22
County	14	32
Township	5	5

Source: Wong, C. 2010. Paying for the Harmonious Society: Why [the People's Republic of] China Needs Intergovernmental Fiscal Reform. Unpublished paper presented at the Asian Development Bank. 10 August.

Table 21 provides details of the funds that are presently administered through MOF, in collaboration with MEP.[154] It will be noted that there was a significant increase in the number of special funds during the 11th Five-Year Plan.

Financing through environmental special funds is subject to two types of problems—the first is systemic to the whole system of local government financing in the PRC, and the second is specific to environmental special funds. Together, these problems may be seriously jeopardizing the efficacy and sustainability of the programs.

Systemic problems

1. The funds, for the most part, only provide money for capital investment and, in any event, do not cover 100% of the capital costs of the equipment and infrastructure being financed. A certain level of counterpart funding by the beneficiary government is required, as in virtually all central government funding programs. Local governments, particularly subprovincial governments and governments in poorer and more backward parts of the country, tend to be chronically short of operational funds due to systemic shortcomings in the PRC's fiscal system. This frequently means that participating governments have to borrow money to meet their counterpart funding obligations.[155] This also tends to focus the attention of local governments on investments that will produce revenues in the short- to medium-term (to provide revenue to pay off the loans), rather than on investments that are needed to solve the problem at hand;[156] and

2. The special funds do not contribute toward the costs of operating and maintaining the equipment and infrastructure procured under the various programs, raising serious questions as to the sustainability of many of the

[154] These are just the funds administered by MEP. Other ministries have established similar earmarked funds for other environmental purposes. Examples would be the transfers made through the SFA to fund its major national initiatives such as the NFPP, the SLCP, and so on.

[155] Technically, subnational governments are forbidden to borrow in capital markets, but they get around this prohibition by borrowing through intermediaries, such as local government-owned enterprises or special purpose investment vehicles.

[156] A recent comprehensive review of the government's track record in the cleanup of lakes and wetlands in the PRC, sponsored by ADB, identified this factor as one of the major reasons for the consistent failure of such programs (Zhang et al. 2008). Similar problems have been identified with programs such as the Sloping Land Conversion Program (Xu et al. 2004).

Table 21 **Summary of Special Funds for Environmental Protection Administered through the Ministry of Finance**

Name of Fund	Date of Creation	Scope and Emphasis
Special Fund for Nature Reserves	2001	Financing for the establishment of national level NRs with typical ecological features and important research value in the central and western PRC; for NRs with good basic conditions, good management, and significant conservation value; for strengthening the management of weak national NRs.
Special Fund for Livestock Pollution Control	2003	Promotion of comprehensive utilization and pollution control for livestock and aquaculture enterprises. Focus areas: major livestock production provinces in the western PRC, regions with large livestock pollution loads, regions with relative shortage of central government funding for livestock pollution prevention, regions with good rural environmental management.
Central Fund of Environmental Protection	2004	Environmental monitoring and capacity building, centralized drinking water source protection activities, regional environmental security, new socialist countryside environmental protection projects, financing of new technology for pollution control, and other projects determined by MEP and MOF according to central government's policy.
Special Fund of Renewable Energy Development	2006	Emphasis on supporting promising alternative energy approaches for building heating and cooling, power generation, and development of alternative renewable energy including bioethanol and biodiesel.
Central Fund of Major Pollutants Emission Reduction	2007	Support and promotion for the monitoring and enforcement of major pollutant reduction investments, including the provision of rewards for enterprises and regions with significant achievements in reducing major pollutant emission.
Special Fund of Basin Water Pollution Control in Three Rivers, Three Lakes, and Songhua River	2007	WWTP construction and associated pipeline network construction; construction of advanced industrial wastewater treatment facilities and cleaner production systems; regional pollution control projects (pollution control in drinking water source, urban water comprehensive treatment, etc); other water pollution control projects.
Central Government Incentive Funds to Eliminate Backward Production Capacity	2007	Technology upgrades in 13 industry sectors: electricity, iron, steel, electrolytic aluminum, iron alloy, calcium carbide, coke, cement, glass, paper, alcohol, monosodium glutamate, citric acid.
Special Subsidies for Production and Use of Renewable and Energy-saving Building Materials	2008	Subsidized loans for expanding production capacity in the production of renewable energy-saving building materials, awards for the promotion of renewable energy use, underwriting for R&D of related technical standards, other expenditures on production and use of renewable building materials approved by MOF.
Central Fund of Rural Environmental Protection	2008	Rural drinking water source protection, rural sewage and waste treatment, livestock pollution treatment, treatment of historical mining pollution in rural areas, rural NPS pollution control.

continued on next page

Table 7 *continued*

Name of Fund	Date of Creation	Scope and Emphasis
Special Fund of Heavy Metal Pollution Control	2009	Support for the comprehensive improvement of pollution sources, rehabilitation of historical heavy metal pollution problems, model projects for pollution restoration and capacity building for heavy metal pollution monitoring.
Special Subsidies for Promotion of Energy Efficient Products	2009	Subsidies for the development of high-efficiency, energy-saving products; supervision and inspection, standards, information management; education and training.

MEP = Ministry of Environmental Protection, MOF = Ministry of Finance, NPS = nonpoint source, NR = nature reserve, PRC = People's Republic of China, R&D = research and development, WWTP = wastewater treatment plant.
Source: Ma, Z. 2011. [The People's Republic of] China's Fiscal Expenditure for Environmental Protection. Thematic paper for the Country Environmental Analysis Update. pp.53–55.

investments, particularly in the poorer and more backward parts of the country where the environmental needs are greatest and local government finances are most seriously constrained.

These deficiencies are not unique to environmental funding programs; they are systemic problems that compromise the ability of local governments throughout the country to carry out the onerous and comprehensive responsibilities placed upon them, which include not only environmental protection but also education, social security, and public health, among others. There has been considerable debate and discussion within the PRC and among local and foreign experts on the difficulties that these systemic fiscal problems are creating for the delivery of social services at the local level.[157] Various measures have already been taken to address the problem and a great deal more needs to be done, not least being a complete overhaul of the tax system and the system of expenditure assignments so that national progress is less reliant on the effectiveness of the lowest level of government which, in general, has the least capacity. What has not yet been sufficiently acknowledged is that these fiscal problems are also creating serious problems for the sustainability of the very substantial investments that the government is making in environmental protection and management, thus increasing the urgency for the sort of broad fiscal reform that is being advocated by many.

Specific problems

In addition to these systemic problems, there are certain additional problems that are specific to the system of Special Funds for Environmental Protection that may be compromising potential benefits. These are as follows:

1. The system is extremely complex and has the appearance of being somewhat arbitrary. That is, whenever a new environment crisis or issue arises, a new fund is created. The system appears to lack coherence and strategic focus, and this may be compromising the effectiveness of the overall environmental program.

[157] For example, see Lou and Wang (2008), Wong (2007), and Wong (2010).

2. There may be a problem relating to lack of "ownership" at lower levels, at least with some programs. The investment programs are being pushed down from the center, while local officials may have other priorities and may not have much interest in seeing that the funds are wisely spent.
3. The wide variety of funds available, the differing eligibility criteria, and the fact that they are jointly managed create very cumbersome application and assessment procedures, which slow down disbursements and may disadvantage governments in the poorer and more backward parts of the country who may be less skilled in navigating the bureaucratic system.
4. It is not clear that the fund managers provide much assistance to local governments in designing programs, formulating funding proposals, or managing programs once the funds have been approved. The municipalities and counties most in need of the funding may be the least capable of accessing it.[158]
5. The size of the funds is very small compared to the scale of the problems being addressed.

Setting aside the steps that will be necessary to reform the entire system of government financing, which is beyond the scope of this report, measures that have been recommended to reform the system of Environmental Specials Funds include the following:

1. Integrate the "extra-budgetary" environmental special funds into the central government budget to provide more stability, predictability, and better use of the funds (e.g., not just for capital investment but for activities such as capacity building and training), although this would have to be accompanied by the development of a more structured and institutionalized system of planning, budgeting, management, and supervision.
2. Provide greater certainty and predictability for funding through the consolidated and integrated environmental special fund by providing annual replenishments as a fixed percentage of total central government revenues.
3. It has been suggested that a "national environmental protection investment corporation" be established to recycle pollution discharge fees back into environmental infrastructure investments, supplemented by earmarked receipts from existing national taxes that are of an environmental nature (e.g., urban maintenance and construction tax, certain parts of the value-added tax, the resources tax, and others), or impose new or increased taxes of an environmental nature.[159]
4. The proposal review and monitoring systems need to be significantly strengthened to ensure that maximum environmental benefits are achieved.

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[158] This is certainly a problem expressed by provincial and lower-level governments with regard to government programs promoting the concept of "eco-compensation." The eco-compensation concept is very broad and somewhat vague. The central government is providing funding but local governments appear to be left on their own to figure out what the concept means and how to operationalize it.

[159] There appears to be considerable opportunities within the PRC to increase taxes on sources of carbon emissions, such as coal and oil production and importation (Stern and Hussain 2008, pp.34–35).

Eco-Compensation: A New Financial Initiative

In recent years, the PRC has been witness to a growing number of national- and provincial-level innovations in environmental policy under the broad heading of "eco-compensation," with this concept representing a potentially important new direction in the evolving environmental policy framework. These various programs have sought to improve environmental management outcomes by using fiscal transfers or direct payments between key stakeholders to align the social and private costs and benefits of environmental protection. Such mechanisms have included the following (Zhang et al., 2010a and 2010b):

- Direct payments from the government to individual and community-level suppliers of ecosystem services to ensure and improve ecosystem service provision;
- Compensation to households, communities, or regional governments for regulatory takings associated with environmental policy (e.g., the creation of protected areas or restricted development zones for conservation, and the associated introduction of land use restrictions or requirements);
- Creation of clear, fair, lateral cooperation, and financial transfers between regional or administrative levels of government to ensure and improve ecosystem services;
- The adjustment or introduction of fees, levies, taxes, tax reductions, or subsidies on resource uses to increase funding and/or incentives for conservation, environmental management, and/or restoration;
- Increased financial transfers from upper- to lower-level governments to better fund environmental management; and
- Compensation to regions, especially in the PRC's less-developed western region, for past and current extractive and environmentally damaging resource uses.

The term "eco-compensation" first appeared in the *Notice Regarding the Confirmation of NEPA's Ecological Environment Compensation Fee Pilots*, issued by the National Environmental Protection Agency in 1993 (NEPA 1993). This "eco-compensation" fee was used by environmental agencies to both strengthen their administrative power and better finance environmental rehabilitation and protection. During the time it was levied (1993–2002), only government environmental agencies and the environmental community (e.g., academics, researchers, and others) saw the need for an eco-compensation policy (Zhang et al. 2010a and 2010b). Beginning in 1999, however, this began to change.

The year 1999 witnessed the launch of the Sloping Land Conversion Program (SLCP), the largest afforestation payment for ecological services program in the world. The SLCP expanded quickly, starting out with around 300,000 hectares of enrolled cropland across three pilot provinces in 1999 and growing to 7.2 million hectares by the end of 2003, by which time it was being implemented in more than 2,000 counties across 25 provinces in the PRC (Xu et al. 2002; Uchida, Xu, and Rozelle 2005; Xu et al. 2010). The sheer scale of the program—estimated by some to be one of the most pervasive programs

in the rural PRC[160]—generated significant momentum and capacity building at local levels. Combined with its relatively new and innovative approach of directly contracting rural households as key stewards of ecological services, it became a powerful catalyst for local, provincial, and national environmental policy innovations. These included a growing range of programs targeting watershed ecological services, such as experiments in compensated water use rights transfers and fiscal transfer programs aimed at improving the financing for and rational and transparent apportioning of the costs and benefits of watershed protection and forest conservation (Bennett 2009).

As a result of these developments, domestic policy makers and experts became increasingly aware of the concept of payments for ecological services (PES), and so enthusiasm for eco-compensation gradually spread across sectors (e.g., water and finance) and at levels of government, with each of these different actors developing their own definition of the term (Zhang et al. 2010a and 2010b). This reached the national government by 2005, when the State Council issued, for the first time, the principles for developing eco-compensation mechanisms (Document No. 39: *State Council Decision Regarding Using the Scientific Development View to Strengthen Environmental Protection*). This document stated that the government "…should improve eco-compensation policy, and develop eco-compensation mechanisms as quickly as possible" (State Council 2005). The PRC's 11th Five-Year Plan (2006–2010) called for innovation in environmental policy and the development of eco-compensation pilots. The plan also called for policy makers to quicken the pace of development of eco-compensation mechanisms, to develop intra-regional and watershed-related eco-compensation mechanisms, and to resolve funding issues regarding conservation.

In response, MEP issued its own *Guiding Opinions on the Development of Eco-compensation Pilot Work* targeting four main areas of focus for the development of eco-compensation pilots—(i) nature reserves; (ii) key ecological function zones (e.g., grasslands, wetlands, and forest areas); (iii) mineral development areas; and (iv) watersheds. MEP also set out five fundamental principles for developing eco-compensation policies and mechanisms (MEP 2007) as follows:

1. Those who develop and exploit resources should also protect the environment, those who destroy the environment should repair it, those who benefit from it should subsidize it, and those who pollute should pay.
2. Responsibility, right, and power are synonymous.
3. "Win–win" development should be achieved by jointly realizing public construction of the environment and public benefit.
4. Government guidance should be combined with market regulation, wherein funding source diversification and greater harnessing of market forces are encouraged.
5. Adapt central policy to local conditions and energetically innovate.

[160] Zhang et al. (2006) finds in a survey of investment projects during 1998–2003 in 2,459 sample villages across 6 provinces in the PRC that the Conversion of Cropland to Forest and Grassland (CCFG) is the third most common project being implemented at the village level, behind roads and bridges, and irrigation investments.

More recently, the *2007 State Council Work Outline* has called for "…deepening product pricing and emissions fee reforms for key natural resources, perfecting a resource taxation system, and improving a paid mineral resource use system; quickening the development of eco-compensation mechanisms." The revised Water Pollution Prevention and Control Law (WPPCL) of 2008 also included wording that would enable the use of financial transfers and payments to underwrite watershed protection works in drinking water source protection areas; and in river, lake, and reservoir upper watershed water environment and ecological protection areas.

Finally, in 2009, at the Second Plenary Session of the 11th National People's Congress, both President Hu Jintao and Premier Wen Jiabao made clear statements reiterating that the PRC will develop a "sound system of paid use of (mineral/natural) resources" and "eco-compensation mechanisms" (Zhang et al. 2010a and 2010b). As a result of these developments, the NDRC has been made responsible for developing a national "eco-compensation" policy framework, and it is expected that the 12th Five-Year Plan will incorporate this and possibly also a draft law.

To support this work, the NDRC, MEP, Ningxia Provincial Government, and ADB hosted the "International Conference on Payments for Ecological Services" in Ningxia Hui Autonomous Region on 6–7 September 2009, which was attended by about 500 provincial and central government representatives from 13 provinces and central ministries, as well as a range of international experts on payments for ecosystem services and conservation policy. A second conference was held in Ya'an, Sichuan Province in October 2010, and a third conference was held in Jiangxi Province in November 2011. A fourth conference to be held in 2012 is likely to concentrate on the potential role of the private sector in eco-compensation.

These conferences have been intended to clarify the eco-compensation concept and provide opportunities for governments from different levels to exchange experiences to better operationalize the concept. Some of the key findings from the first conference were as follows: [161]

- The NDRC and MEP need to work to clarify the concept of eco-compensation as a basis for a national policy and legal framework. Its broad use to date, which has encompassed a wide range of different policies and program types, has led to confusion among lower-level governments that are trying to operationalize it.
- While eco-compensation has the potential to become a useful and powerful environmental policy tool, it is not a "magic pill" that will solve all of the PRC's environmental management problems. Other initiatives are also needed to effectively address these problems, including clarification of ambiguous property rights over ecosystem services, the development of better methods to promote interagency and interregional cooperation, and the improved enforcement of existing environmental regulations.

[161] Zhang et al. (2010a and 2010b).

- The eco-compensation concept offers a way to spearhead a more general approach toward greater incorporation of incentive-based and outcome-based mechanisms into environmental policy to improve outcomes and reduce the costs of conservation and environmental protection. The promotion of market-based instruments for pollution control would be one example.
- Eco-compensation experiments being piloted across the PRC rely too heavily on the valuation of ecosystem services by decree or by the application of mathematical algorithms, with insufficient use of price discovery mechanisms, such as auctions or negotiations. Greater use of price discovery mechanisms could help to improve program cost-effectiveness, reduce adverse welfare impacts of programs by ensuring that program payments fully compensate for the opportunity costs of participation, and better identify the real costs of environmental management.
- More work needs to be done to develop legal and policy frameworks to allow eco-compensation to be effective, including clarification of property rights and mechanisms for effective coordination and cooperation between different regions, levels of government, and government agencies.
- Insufficient work has been done to promote private sector participation in ecosystem service markets. Such participation would help unlock a wider range of funding sources for conservation, and allow the participation of a broader array of economic actors to protect and improve ecological and environmental resources.
- The government needs to carefully consider how, and when, poverty reduction goals can be effectively incorporated into eco-compensation policies and programs. In some cases, these two goals can be effectively combined in a common policy instrument. In other cases, however, it might be more effective to create complementary policies that separately target these goals.

Overall, the eco-compensation concept has the potential to become a useful tool for dealing with certain types of environmental externalities, particularly in rural areas. Local governments are clearly enthusiastic about experimenting with direct payment and fiscal transfer "eco-compensation" programs as a means to try to resolve intractable environmental management problems. However, much work remains to be done to clarify and operationalize the concept, and central organs such as the NDRC and MEP and affiliated research institutes and universities will likely need to provide active leadership in working with lower-level governments to develop pilots and eventually scale this up to landscape and regional levels.

6.6 Conclusion

The PRC's recent record in the promotion and elaboration of the policy and institutional frameworks for environmentally sustainable development has been significant. Many of the criticisms on the administrative and regulatory frameworks that were made at the

beginning of the 10th Five-Year Plan have been responded to quite positively. The "three shifts" in the strategic framework for environmental protection provide a solid basis for moving forward into the 12th Five-Year Plan, even if the shift in the structure of the economy that will be necessary to address long-standing systemic issues has not yet made sufficient progress.

MEP has also recognized the need to refocus on the basic task of pollution control and, to this end, has been taking effective steps to increase regulatory effectiveness through training and capacity building, strengthening the ambient environmental monitoring system, and expanding the range of pollutants monitored on a regular basis. The government has been investing substantial sums of money into the environment sector, not only through programs administered by MEP but through other agencies such as the SFA, MHURD, MWR, and others. These investments will be doubled in volume under the 12th Five-Year Plan.

The discussion on expenditures highlights the next major issue to be addressed—reform of the fiscal expenditure system. This is an issue that impinges on both the environmental agenda and the social agenda, including health, education and welfare. Major reform of environmental fiscal expenditures (EFP) should be a priority under the 12th Five-Year Plan and beyond. Key issues to be addressed should include the following:

- Mainstream EFPs into public financial reform,
- Overcome policy gaps and weaknesses,
- Increase emphasis on program-based rather than crisis-oriented decision making and disbursement,
- Provide a better balance between centralized and decentralized implementation to allow better adaptation of program components to suit local circumstances,
- Provide a better range of funding options and conditionalities, and
- Resolve disparities between regions, local governments, and sectors.

7. Strategic Framework for Environmental Protection

7.1 Introduction

This chapter deals with the strategic dimensions of environmental management in the People's Republic of China (PRC). It first discusses work that the Ministry of Environmental Protection (MEP) has done to look beyond the 5-year planning cycle, and as far ahead as 2050, to identify the challenges that will need to be addressed to meet the government's objective of building an environment-friendly and resource-efficient society. It then summarizes achievements under the 11th Five-Year Environmental Plan and the objectives under the 12th Five-Year Plan.

7.2 Macro-Environmental Strategy of the Ministry of Environmental Protection

One of the important activities approved by the State Council for inclusion in the 11th Five-Year Environmental Plan was the development of a macro-level national environmental strategy to support the government's new orientation of building an "environment-friendly and resource-efficient society." The scope of this exercise would extend beyond the framework of traditional 5-year planning activities, and looking forward as far as 2050 so as to provide a more comprehensive framework of what needs to be done to achieve the government's environmentally sustainable development objectives. The idea is that, having established such a forward-looking framework, it should be possible to structure the components of successive five-year plans to keep the country moving toward its long-term goal.

The Macro Strategic Research Report on the PRC's Environment was carried out between 2007 and 2009 by the Chinese Academy of Engineering and MEP. The final report comprised a main report and 29 thematic reports compiled by over 50 academicians and 600 specialists in a wide variety of fields as environmental protection, economy, sociology, trade, law, technology, and diplomacy.[162] The strategy report evaluated the present state of the environment and likely future development trends, and then identified a series of priority strategies that should be adopted to ensure a more environmentally sustainable future.

[162] The report was publicly released on 17 April 2011.

Present State of the Environment and Prospects for the Future

The present state of the environment is discussed in Chapters 2 and 3 of this country environmental analysis (CEA), the contents of which closely approximate those of the Macro Strategic Research Report on the PRC's Environment. In essence, the study concluded that, while some improvements in several indicators are made each year, the situation in general is not yet under control, and it is unlikely that truly comprehensive improvements in ambient environmental quality will be achieved until 2030.[163]

The prospects for the foreseeable future are that environmental pressures will continue to grow due to the following:

- Continuing growth of per capita consumption as the income level continues to increase which suggests that the consumption of natural resources will continue to increase at very rapid rates;
- The likelihood that the industry sector, particularly the heavy industry sector, will continue to play a prominent role as a driver of growth, and thus industrial point source air and water pollutant emissions will continue to rise even as regulatory effectiveness continues to improve;
- The continued dominant role of the coal-fired thermal power subsector (notwithstanding the rapid expansion of the use of renewables and nuclear energy that is already occurring and is likely to continue to grow into the future) will further add to regional air pollution problems and national greenhouse gas (GHG) emissions. The study projected that power sector growth would continue at 70%–80% of the rate of growth of gross domestic product (GDP) over the next 20 years; and
- Urbanization will and must continue as a necessary driver of economic growth, with the urbanization rate expected to reach 60%, or over 850 million people, by 2020, and with much of the growth occurring in small-sized cities and larger towns, few of which have adequate urban environmental infrastructure.

There were some differences of opinion as to what these factors would imply in terms of the prospects for environmental quality—indefinite straight line deterioration, some continued deterioration followed by a reversal leading to gradual improvement in environmental quality, or a leveling off either now or at some time in the not too distant future.

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[163] It should be noted that there is a wide range of opinion among local experts as to what the available monitoring data actually mean. For example, many of the routine monitoring data suggest that, in recent years, many measures of environmental quality are on an improving trend. However, many experts believe that the existing monitoring indicators are not adequately reflecting real environmental quality due to gaps in the monitoring networks and insufficient sampling frequency, gaps in the emission sources monitored (e.g., nonpoint sources are not included in the national estimate of COD emissions), and inadequate accounting of certain forms of pollutant emission (e.g., particulate matter with diameter of 2.5 micrometers or less [$PM_{2.5}$]) in the monitoring program. It is feared that these factors, if combined, may result in significant underestimation of the gravity of the environmental situation. The environmental analysis summarized in Chapters 2 and 3 of this report is based on the data reported by MEP and essentially takes the official data at face value.

Strategic Implications

Notwithstanding the differences of opinion as to future prospects, there was agreement that a strategic shift in the approach to environmental management will be required, as follows:

i. Widen the focus of pollution control to cover soil contamination, in addition to the traditional air and water pollution control, while the range of pollutants monitored and controlled needs to be expanded significantly;

ii. Expand the focus of regulatory effort to include the environmental management of rural areas (particularly nonpoint water pollution control), in addition to the two existing focal areas of industrial point source control and urban environmental management; and

iii. Broaden the scale at which environmental planning and management is carried out—from the individual enterprise or urban area level, as at present, to larger scales such as regions or river basins. This is to deal with the ever increasing complexity and interaction of environmental management problems, as in the case of water pollution, the interaction of point and nonpoint pollution sources combined with issues on water use and water allocations as they affect the feasibility of maintaining environmental flows.

Eight specific measures were identified that would need to be taken to achieve acceptable environmental conditions within the planning period. They are as follows:

i. Strengthen the development of the environmental legal system and pay more attention to ecological conservation in national laws and regulations.

ii. Strengthen environmental administration and improve coordination. In the short term and at the central level, functional overlaps and fragmented responsibilities need to be reduced. More implementation responsibility should be delegated to lower levels while, at the same time, lower level capacity needs to be strengthened. In the medium term, MEP wants to integrate and absorb ecological conservation functions of relevant ministries and commissions of the State Council so that a single department would be responsible for the supervision and management of all environmental affairs and ecological conservation throughout the country.

iii. Strengthen environmental supervision and the environmental law enforcement system.

iv. Improve the environmental fiscal system and increase investments in environmental protection. The main objective would be to get a better alignment of fiscal resources and administrative responsibilities for environmental management. MEP wants to encourage the application of funds from many sources (e.g., local governments, state-owned enterprises, and the private sector) for environmental protection through better incentive policies. The overall objective is to ensure that the growth of environmental protection investment outpaces GDP growth.

v. Improve environmental economic policy through the development of a "green taxation system," the application of taxes on pollutant emissions including carbon dioxide (CO_2), and other related initiatives such as tax deductions to offset investments in pollution control equipment, increased resource rent taxes, and taxes on luxury goods and "one-time consumer goods." Other recommended financial actions include promotion of the eco-compensation concept, taking increased account of environmental factors in the fiscal transfer system, improvements to the system for compensating firms for the shutdown of energy-inefficient and/or highly polluting enterprises, promotion of environmental labeling, expansion of the government's green procurement program, and development of a pollution liability insurance system.

vi. Develop an ecological zoning system as a basis for managing and regulating land use and development.

vii. Strengthen environmental science and technology, enhance capacity building including environmental monitoring and investigation of pollution sources, and enhance environmental emergency warning and response systems.

viii. Strengthen environmental information dissemination and public participation.

Even if the road map laid out in the study is fully implemented, it will require about 2 decades to fully rein in rampant pollution and rapid ecological degradation, and prevent the loss of valuable species. This is a sobering, but not at all unrealistic, expectation that highlights the challenge posed by the PRC's current mode of development.

According to this study, if the aforementioned measures were adopted, emissions of major pollutants should be considerably reduced by 2020, and environmental safety should be effectively guaranteed. By 2030, the aggregate emissions of all pollutants should be significantly reduced, and the overall environmental quality should be greatly improved. By 2050, the environmental quality should match the people's high quality of life as well as the country's status as a modern and powerful country.[164]

As will be discussed in the two succeeding sections—i.e., section 7.3 on the 11th Five-Year Plan, and section 7.4 on the Environmental Strategy for the 12th Five-Year Plan—many elements of the strategic road map are included, at least to some degree, in the 11th and 12th five-year plans and their associated environment sector plans. There remain significant gaps in the agenda but, at least, the strategic framework has been defined, and some progress on implementation is being made.

7.3 The 11th Five-Year Plan (2006–2010)

This section briefly outlines the main components of the 11th Five-Year Plan that had a bearing on the environmental agenda and the particular provisions of the 11th

[164] *People's Daily Online* (2011).

Five-Year Environmental Plan. The discussion focuses mainly on identifying the main objectives and comparing these with actual achievements. Overall, it is concluded that the environmental outcome of the 11th Five-Year Plan, as reflected by the mandatory objective indicators, was a significant improvement over the performance under the 10th Five-Year Plan. This section concludes with a list of key reasons underlying the success of the environmental plan for the 11th Five-Year Plan.

Table 22 outlines the main macroeconomic assumptions that underpinned the plan, (which have an important bearing on the achievability of the environmental objectives) and compares these with what actually happened. The most obvious underestimations were the average GDP growth rate and total growth, with the latter exceeding the assumed quantum of growth by more than 50%, complicating the environmental management task quite significantly.

Table 22 **Macroeconomic Assumptions for the 11th Five-Year Plan Period** (%)

Item	Assumption	Actual (2010)
Population increase 2006–2010	4	2.5
Growth in total economy	40	70.0
Annual average GDP increase	7.5	11.2

GDP = gross domestic product.
Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

Quantitative and Qualitative Environmental Objectives

The plan includes both qualitative and quantitative objectives. The key quantitative objectives under the 11th Five-Year Environmental Plan and the actual outcomes are listed in Table 23.

Overall, the environmental performance under the 11th Five-Year Plan (11 out of 13 targets achieved) was a significant improvement over that under the 10th Five-Year Plan (9 out of 20 quantitative targets achieved). The achievement is made more significant by the fact that the economic growth environment was so much more substantial than had been assumed in the plan.

The achievement in terms of reduction in sulfur dioxide (SO_2) emissions exceeded the target (representing a 10% reduction from the 25 million tons of emissions in 2005), which contrasts the results of the 10th Five-Year Plan, where SO_2 emissions increased by 28% rather than reduced by 10% as had been planned. The achievement under the 11th Five-Year Plan reflects the combined effects of the government's efforts in closing down small-scale and inefficient industrial and thermal power production facilities, and the installation of desulfurization facilities on the remaining power stations.[165] The achievement is particularly notable in light of the greater economic growth that was

[165] By the end of 2010, more than 80% of thermal power stations in the PRC had been fitted with sulfur scrubbers.

Table 23 **Primary Environmental Objectives and Achievements under the 11th Five-Year Plan (2006–2010)**

	Goal	Plan	Result
1	SO_2 reduction (million tons)	22.95	21.85
2	COD reduction (million tons)	12.70	12.38
3	Ratio of recycled industrial solid wastes	> 60%	69.0%
4	Ratio of urban sewage treatment (secondary)	> 70%	75.25%
5	Ratio of sanitary disposal of urban solid wastes	> 60%	71.4%
6	Ratio of village environmental improvement	> 20%	Basically reached the indicator
7	**Ratio of state-level nature reserves meeting national standards**	**> 25%**	**11.8%**
8	**Ratio of the water supply sources in key cities meeting national standards (in volume)**	**> 80%**	**73%**
9	Ratio of sections of surface water bodies monitored by state-level monitoring stations having water quality below Level V	< 22%	18.4%
10	Ratio of sections of the seven largest rivers having water quality better than Level III	> 43%	57.3%
11	Ratio of coastal areas having water quality better than Level II	> 70%	72.9%
12	Ratio of key cities having air quality better than Level II for more than 292 days	> 75%	95.6%
13	Ratio of effective annual exposure to radiation for residents living adjacent to nuclear power plants lower than the threshold of national standard	< 10%	9%

COD = chemical oxygen demand, SO_2 = sulfur dioxide.
Note: Unmet objectives are in **bold**.
Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

experienced during the plan period and the huge economic stimulus that the government applied to maintain growth in the aftermath of the global financial crisis. However, it is worth remembering that the 2010 SO_2 emission level is still 21% higher than the target that was set (18 million tons) for the end of the 10th Five-Year Plan. This highlights the difficulty of reversing SO_2 emission trends in the face of continued strong economic growth and the continuing dominant position of heavy industry in the overall economy. The overall SO_2 emission intensity of the economy as a whole was reduced by more than 30% but, clearly, this is not sufficient to get the PRC where it needs to go in terms of SO_2 emissions.

Another notable success was the increase in the construction of municipal wastewater treatment capacity and the resultant decrease in point source chemical oxygen demand (COD) emissions. The objective was to provide treatment capacity equivalent to 70% or more of urban wastewater flows, whereas the achievement was over 75%, as a result of the construction of 50 million tons per day of additional treatment capacity. This represented a huge increase over the rate at the end of the 10th Five-Year Plan (37.4%) and an even more significant increase over the level at the beginning of the 10th Five-Year Plan period (18.5%). The government took steps to provide supplementary funds to extend sewage collection networks at the same time that treatment capacities were being upgraded. Failure to invest in collection networks has been a problem in

the past that led to underutilization of installed capacity. It is believed that the current utilization rates are significantly higher than in the past, although data to verify this could not be located.

The 11th Five-Year Plan also included a plethora of qualitative environmental objectives, the more important of which are summarized in Table 24. As with the quantitative objectives, the general picture for the qualitative objectives was positive and, once again, particularly so in light of the intense economic growth experienced over the period. Nevertheless, improvements in ambient air and water quality would best be described as moderate.

Other Objectives with Environmental Consequences

Some sector plans, other than the environmental plan, include objectives that have a direct or indirect bearing on environmental quality. Table 25 lists some of these objectives and their respective outcomes. Most of the targets were met. The most significant shortcomings, from a pollution control point of view, were related to wastewater treatment capacity in provincial capital cities and the proportion of water functional zones meeting the relevant water quality standards.

Environmental Capacity Building Programs

A major environmental initiative under the 11th Five-Year Plan was the range of investments to materially improve the national environmental monitoring system, emergency preparedness, and analytical capacity at county and lower levels, as shown in Table 26.

Overview of Environmental Results of the 11th Five-Year Plan

The PRC's environmental performance during the 11th Five-Year Plan showed major improvements from that of the 10th Five-Year Plan. Some of the highlights included the following:

- Continued progress on reforestation that is not only nationally but also globally significant;
- Some encouraging signs that land degradation is being reversed or, at least, the deteriorating trends have been stopped;
- Air and water pollution control was improved significantly when compared to what was achieved during the 10th Five-Year Plan. There were significant reductions in SO_2 emissions and COD discharges, and these are being reflected in noticeable improvements in ambient air quality and possibly also water quality in some areas (although water quality data are more difficult to interpret and are perhaps less reliable than air quality data);
- There has been a clear drop in industrial pollution discharge intensity due to a combination of factors, including increased pressure by MEP to shut

Table 24 **Key Qualitative Objectives under the 11th Five-Year Plan (2006–2010)**

Objective	Result
Discharges of major pollutants will be effectively controlled.	• Total COD emission was 12.78 Mt and total SO_2 emission was 22.14 Mt, down by 10% and 13%, respectively, compared with 2005 levels.
Pollution intensity of major sectors will be reduced significantly.	• SO_2 emission intensity dropped by 53% (from 13.9 kg/CNY10,000 of GDP in 2005 to 6.5 kg/CNY10,000 of GDP in 2008). • COD intensity dropped by 51% (from 7.72 kg/CNY10,000 of GDP in 2005 to 3.75 kg/CNY10,000 of GDP in 2008).
Air quality of key cities, the sources for urban water supply, the quality of rural drinking water, the quality of surface water across the country, and the water quality of coastal waters will improve.	• Air quality in 113 major environmental protection cities improved to some extent. The proportion of cities with Grade I air quality was 0.9%, Grade II was 66.4%, and Grade III was 32.7%. • The proportion of surface water monitoring sections with water quality at Grades I–III was 57.3%, and proportion worse than Grade V was 18.4%, up by 16.3% and 7.7%, respectively, compared with 2005 levels. • An estimated 73% of the 397 centralized drinking water source areas that were monitored reached the required water quality standard.
Grassland degradation will be controlled, areas for soil erosion control and ecological rehabilitation will expand, and the state of the environment in mining areas will significantly improve.	• By the end of 2009, the desertified land area was 2.62 million km^2 and the sandified land area was 1.73 million km^2. Both represented reductions of 0.5% over the preceding 5 years. • The 7th NFRI indicated that forest coverage increased to 20.4%.
Over-extraction and pollution of groundwater will slow down.	• Water quality monitoring result of 641 wells in eight provinces showed that only 2.3% of wells had Class I/II water (suitable for drinking without treatment), 24% had Class III water (suitable for drinking after treatment, and for industrial and agricultural uses), while 74% had Class IV/V water. It is not clear if the planning objective was reached.
Ecological functions of major protected areas and nature reserves will be stabilized.	• "National Ecological Function Regionalization" and "Outline of National Ecologically Fragile Zones Protection Plan" were promulgated, and preliminary work for the construction of important ecological function regions was initiated. • By the end of 2009, there were 2,541 nature reserves in the PRC, with a total area of 147 million ha or 14.7% of national land area (excluding Hong Kong, China; Macao, China, and Taipei,China).

COD = chemical oxygen demand, GDP = gross domestic product, ha = hectare, kg = kilogram, km^2 = square kilometer, Mt = million ton, NFRI = National Forest Resource Inventory, SO_2 = sulfur dioxide.
Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

down enterprises with outdated technology, improved process control, and improved end-of-pipe treatment in heavily polluting industry sectors such as cement, thermal power, iron and steel, pulp and paper, and chemicals. These achievements resulted from more effective enforcement and substantial government financial assistance to enterprises to underwrite technological and waste treatment upgrades; and

Table 25 Other Objectives and Achievements of Environmental Relevance under the 11th Five-Year Plan (2006–2010)

	Indicator (Responsible Agency)	Plan	Result
1	% reduction in energy consumption per CNY10,000 of GDP (NDRC)	18%	19.1%
2	% reduction in total pollution loadings (MEP)	10%	14.29% (SO_2) 12.45% (COD)
3	**% of protected areas in total land mass (MEP/SFA)**	**> 16%**	**14.7%**
4	% of recycling of industrial wastewater (MEP)	> 80%	85%
5	% of reuse of industrial solid wastes (MEP)	> 60%	67%
6	% of urban garbage with sanitary disposal in total volume (MHURD)	> 60%	71.39%
7	**% of secondary wastewater treatment for provincial capital cities (MHURD)**	**> 80%**	**75.25%**
8	% of secondary wastewater treatment for prefecture-level cities (MHURD)	> 60%	75.25%
9	Increased capacity of sanitary urban solid waste disposal (t/d) (MHURD)	200,000	286,165
10	Increased capacity of sanitary urban night soil disposal (1,000 tons) (MHURD)	21	Basically reached the indicator
11	Additional rural residents having access to safe drinking water (million) (MWR)	100	200.86
12	Area of land suffering from soil erosion (MWR)	34%	Basically reached the indicator
13	**% of water functional zones meeting applicable water quality standards (MWR)**	**60%**	**46.9%**
14	% of urban water supply sources meeting applicable water quality standards (MWR)	> 95%	97%
15	Forest cover (SFA)	20%	20.36%
16	Rehabilitation of desertified land (million ha) (SFA)	7.33	Basically reached the indicator
17	**Total number of nature reserves (MEP/SFA)**	**2,800**	**2,538**
18	Total area of nature reserves (million ha) (MEP/SFA)	125	149
19	Total number of wetland reserves (SFA)	523	550
20	% of natural wetlands under effective protection (SFA)	> 50%	Basically reached the indicator
21	No. of counties to be covered by pest monitoring network (MOA)	50%	Basically reached the indicator
22	% of animal wastes of animal farms above certain scale with comprehensive treatment in total number (MEP/MOA)	> 40%	Basically reached the indicator

COD = chemical oxygen demand, GDP = gross domestic product, ha = hectare, MEP = Ministry of Environmental Protection, MHURD = Ministry of Housing and Urban–Rural Development, MOA = Ministry of Agriculture, MWR = Ministry of Water Resources, NDRC = National Development and Reform Commission, SFA = State Forestry Administration, SO_2 = sulfur dioxide, t/d = tons per day.

Note: Figures in **bold** represent targets that were not achieved.

Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

Table 26 **Capacity Building Programs for the 11th Five-Year Plan Period**

Plan	Result
National Ambient Air Quality Monitoring • Complete the establishment of the automatic air quality monitoring network at the prefecture level. • Establish air quality monitoring stations, air quality baseline monitoring stations, and air quality verification stations in rural areas. • Complete the establishment of the national acid precipitation monitoring network and the sandstorm monitoring network.	A total of 125 air quality monitoring points, 31 automatic rural air monitoring systems, 263 urban air monitoring systems, and 69 sandstorm monitoring points either have been newly built, are being built, or have been basically completed.
National Ambient Water Quality Monitoring • Build 50 new surface water automatic monitoring stations, focusing on real-time monitoring and accident early-warning capacity for river mouths and trans-provincial and international rivers; and conduct capacity building in seven marine stations.	A total of 26 automatic surface monitoring systems, 241 automatic pollution source monitoring centers, and 118 emergency monitoring vehicles with instruments and devices were provided and/or established.
Conventional Monitoring in the National Ambient Environmental Monitoring Network • Strengthen the capacity for conventional monitoring of surface water, water supply source, solid wastes, soil, ecology, noise, and coastal zones; and data quality assurance.	In total, 36 automatic radiation environment monitoring stations were built; and 332 land monitoring points, 108 water monitoring sections, 175 soil monitoring points, 84 electromagnetic radiation quality and pollution points, and 28 nuclear safety early-warning points were established in the PRC.
National Ambient Radioactivity Monitoring • Establish 100 state-controlled atmospheric radioactivity automatic monitoring stations and 10 monitoring systems for discharges from nuclear facilities.	A total of 73 continuous automatic monitoring stations have been completed and 93 prefecture-level cities were equipped with at least one portable radiation monitoring device each.
Environmental Emergency Preparedness Monitoring • Equip provinces with water and air emergency response vehicles and nuclear radioactivity emergency monitoring equipment for real-time monitoring of ambient environmental radioactivity surrounding major nuclear facilities. • Equip key cities with integrated water, air, and radioactivity monitoring vehicles.	The 94 major environmental protection cities are equipped with more than one set of emergency monitoring instrument for water and air environment, and 118 emergency monitoring cars. Compared with the planning target, 90.38% of the task is finished.
Basic Environmental Monitoring at the County Level • Equip environmental laboratories with standard equipment, to enable 90%, 80%, and 60% of the county-level environmental monitoring stations in eastern, central, and western provinces, respectively, meet the national standards.	The standard reaching progress of monitoring capacity lags behind. Conventional monitoring capacity up-to-standard rate of monitoring stations is only 35.29% at provincial, 23.06% at prefecture, and 16.94% at district and county level; up-to-standard construction of environmental monitoring stations in some provinces has basically reached the planned target; while up-to-standard construction of environmental monitoring stations in most provinces lags behind.

continued on next page

Table 26 *continued*

Plan	Result
Automated Monitoring of Key Pollution Sources	
• National key pollution sources equipped with automated monitoring systems. • Establish monitoring and supervision centers at the national, provincial, and municipal levels and integrate them via the internet. • Improve the capacity of 244 municipal monitoring stations to monitor pollution sources.	Some 306 pollution source monitoring centers were built and 13,000 major enterprises were automatically monitored. In 2009, the emission up-to-standard rate of wastewater was 78%, and 73% for waste gases from national key pollution sources.
Basic Infrastructure for Environmental Management	
• Improve basic infrastructure and working conditions of environmental protection agencies. • Establish key laboratories for environmental research and technological applications. • Establish national environmental protection information platform.	Key laboratories such as the Chinese Research Academy of Environmental Sciences and the South China Institute of Environmental Science were built; construction of 4 out of 7 subcenters in the Phase I Project of the National Environmental Dioxin Monitoring Center has been basically completed; 3 hazardous waste disposal technology and engineering R&D centers are under reconstruction and expansion.

PRC = People's Republic of China, R&D = research and development.
Source: Chinese Academy of Environmental Planning. 2010. State of the Environment. Unpublished report prepared as background paper to the Country Environmental Analysis. Beijing.

- There have been huge investments to develop municipal wastewater treatment capacity as well as to develop sanitary landfills for municipal solid waste disposal, although it has proved harder to close the gaps between the quantities of urban wastes produced and the quantities treated due to the rapid urbanization growth.

What is most remarkable about these achievements is that they were realized within a macroeconomic framework that, as discussed in Chapter 2, was not conducive to achieving environmentally sustainable development, despite the government's clearly stated objective, at the commencement of the 11th Five-Year Plan, to build a "harmonious, resource-efficient and environment-friendly society" as an essential state policy. The economy continued its pursuit of growth through "vast inputs of capital and labor" into developments that are not always economically optimal or technologically efficient and are perpetuating an economy that is over-reliant on a "high pollution, high growth" model of development, and overly dependent on secondary industry.[166] In the meantime, the services sector, which offers the clearest way forward toward a resource-efficient and environment-friendly society, remained underdeveloped and, perhaps even, moribund in recent years.

This strategy had effects far beyond the environmental agenda. As observed in a recent ADB publication, "Excessive reliance on investment, exports, and industrial development has created structural imbalances that jeopardize future growth. These include (i) declining total factor productivity levels resulting from overinvestment and

[166] Lou and Wang (2008), p.7.

excess capacity in key industries; (ii) labor surpluses owing to the capital-intensive nature of the growth model; (iii) widening income inequality and regional disparities due to the geographical bias of export-oriented industry; (iv) high savings that constrain consumption and downplay the role of domestic demand as a source of growth; and (v) an allocation of resources that undermined the development of services, particularly the provision of social services."[167]

The adverse environmental consequences of the current mode of economic growth and development are real and significant. MEP has been annually calculating the PRC's "pollution-adjusted GDP" or "green GDP" since 2003 as a means for keeping track of this cost in terms of air and water pollution. Its most recent estimate (for 2008) was based on pollution damage estimates from 600 cities across the country. MEP estimated that the national cost of pollution damage is equivalent to between 3.9% of GDP (when calculated on a human resources basis) and 6% of GDP (when calculated on a "willingness-to-pay" methodology).

A recent and far more wide-ranging estimate, prepared by a large team of experts from the Chinese Academy of Sciences (CAS), took account not only of air and water pollution, but also of land degradation and loss of resources due to activities such as mining and non-sustainable forestry operations. CAS estimated that, in 2005, the PRC's resource and environmental costs (including resource consumption, ecological degradation, and environmental pollution) amounted to 13.5% of GDP.[168] This cost far exceeded those of France, Germany, Japan, United Kingdom (UK), United States (US), and other developed economies when calculated on the same basis. It was slightly higher than countries such as Australia and Canada (whose environmental costs are elevated due to their large, extractive industries sectors), and on par with countries such as Ghana, Mexico, and Pakistan. CAS analysts concluded that their cost estimate reflected "the features of high capital input, high resources/energy consumption, high pollution, low output, and low efficiency of the PRC's economic growth."

Given this macroeconomic framework, the most remarkable feature of the PRC's environmental performance during the 11th Five-Year Plan is the significant environmental achievements that were realized, let alone the widespread progress on many fronts as summarized above and discussed in more detail in Chapters 3 and 4. These achievements are the result, not of a significant change of economic course, but of a wide range of advances that the government has made in the legal and regulatory environment, and very substantial investments in pollution control and environmental improvement. These were combined with a significant improvement in the government's understanding of the importance of the environmental agenda as evidenced by the elevation of the State Environmental Protection Administration (SEPA), now MEP, to the level of a full ministry, and MEP's steadily improving effectiveness as an environmental policy and regulatory institution.

[167] ADB (2010), p.4
[168] CAS (2009).

The prospects for the environmental agenda under the 12th Five-Year Plan, and beyond to 2020, will depend substantially on the structure of the economy, particularly the balance between the secondary and tertiary sectors and the role of large-scale, capital-intensive industries within the industry sector.

The global crisis makes rebalancing of the PRC's economy under the 12th Five-Year Plan even more urgent since it is becoming apparent that recovery in the PRC's major export markets in the US and Europe may be slow. The PRC needs more growth from domestic demand to maintain growth in the face of subdued international demand and that relative prices need to change, notably those of energy, land, water, natural resources, and capital to ensure that future growth is achieved with less adverse impact on the environment.

Reasons for the Success of the 11th Five-Year Environmental Plan

Given the unfavorable macroeconomic and structural conditions for an environmentally sustainable development in the PRC, the question arises: what accounted for the positive environmental achievements during the 11th Five-Year Plan when compared to the 10th Five-Year Plan?

Several factors seem to have been important and these are as follows:

- **Failure of the 10th Five-Year Environmental Plan.** The environmental plan was the only sector plan for the 10th five-year period not to have achieved its objectives. This came as a wake-up call to the government that fed a determination not to repeat the experience in the subsequent plan. Some of the factors that contributed to the failure of the 10th Five-Year Environmental Plan were

    (i) inadequate attention of local (subprovincial) governments to environmental protection,

    (ii) over-heated economy,

    (iii) low resource efficiency in the economy,

    (iv) ineffective regulatory framework combined with weak supervision and enforcement,

    (v) lack of cross-sector coordination, and

    (vi) inadequate financing of environmental infrastructure combined with an ineffective fiscal system.

    Items (i), (iii), (iv), (v) and (vi)—the last two only partially—were explicitly addressed under the 11th Five-Year Plan.

- **Change in national development strategy.** A key strategic component of the 11th Five-Year Plan was the government's decision to place more emphasis on the quality of growth, rather than just the quantity of growth through the "three shifts," as discussed in Section 6.2, pages 91–92. These strategic objectives were not fully realized during the 11th Five-Year Plan, although some progress was

made. Nevertheless, the mere fact that the government had recognized that "ecological civilization construction" was a key element for "building a well-off society in an all-around way" was a significant step forward and consistent with long-held opinions of both domestic and international environment experts that a broad-based, economy-wide approach needs to be taken to overcome environmental challenges.

- **Increased investment.** There was a significant increase in investment in environmental infrastructure during the 11th Five-Year Plan. The planned amount (CNY1.53 trillion or $242.9 billion) represented an 80% increase over the 10th Five-Year Plan, while the actual amount (CNY1.4 trillion or $222.2 billion) was 65% higher. Investments were made in capital equipment—most notably, municipal wastewater treatment plants (WWTPs) and industrial desulfurization equipment—and in capacity-building, including procurement of better environmental monitoring and enforcement equipment and facilities for environmental protection departments. The huge increase in investment is the main reason behind the significant achievements realized in municipal wastewater treatment capacity and SO_2 reductions in both the power and industry sectors. There is still considerable room for further investment in municipal wastewater treatment capacity, which presently has the capacity to treat 75% of estimated flows, and even more investments will be required to upgrade many treatment plants from Class 2 to Class 1a or 1b, as planned under the 12th Five-Year Plan. However, control of SO_2 pollutants in the power and industry sectors may be nearing, or has already reached, its threshold.[169]

- **Greater focus.** A criticism of previous environmental plans was that they were too ambitious and were trying to achieve too many disparate goals, many of which were outside the direct control of MEP. The 11th Five-Year Environmental Plan was considerably more focused, as indicated by the reduced number of objective indicators included in the plan (13 indicators) as compared to the 10th Five-Year Plan (20 indicators). This sharper focus was supported by a significant increase in financial resources, and the two measures taken together seem to have significantly improved the plan's effectiveness.

- **Strengthened accountability and enforcement.** Several measures were taken in this regard. Responsibility for achieving the plan's objectives was delegated downward with decentralized accountability. MEP commenced the establishment of pollution reduction agreements with the provincial governments making the provincial leaders accountable for their pollution management. In 2006, six regional supervision centers were established, with support from ADB's TA on Institutional Development of SEPA's Regional Supervision Centers (TA 4741-PRC), to provide increased oversight of the environmental performance of subnational governments. Compliance monitoring of industrial enterprises was stepped up through a series of five

[169] Private and foreign investments have become a significant complement to the public investment in environmental infrastructure. For instance, the water supply and wastewater treatment sectors attract a tremendous amount of capital from the private sector in the 11th Five-Year Plan. On the other hand, private participation in these sectors remains controversial and a number of barriers such as pricing, and lack of benchmarking system and fair competition exist.

campaigns entitled "Countrywide Special Environmental Protection Action to Punish Enterprises that Violate Law and Discharge Pollutants and Safeguard the Masses' Health." The campaigns focused on (i) compliance of high-pollution, high-energy consumption and resource-based industries; (ii) compliance of iron, steel, and arsenic-related industries; (iii) supervision and inspection of drinking water source protection zones; (iv) inspection of urban WWTPs for compliance with discharge standards; and (v) operation of landfill sites.

7.4 Environmental Strategy for the 12th Five-Year Plan (2011–2015)

The 12th Five-Year Plan (2011–2015)

The 12th Five-Year Plan (2011–2015) was released on 5 March 2011. The plan is designed to rein in economic growth to some degree, make further efforts to restructure the economy, and pay prominent attention to the issues of the environment and climate change. Some of the key macroeconomic objectives that will directly impinge on the environmental agenda include:

- **GDP growth:** An average of 7% per annum;
- **Increased service sector growth**: Value-added of service sector to increase to 47% of GDP, a 4% increase over 2010; and
- **Urbanization:** Urbanization rate to reach 51.5% by 2015, an increase of 4%.[170]

The main objectives with direct environmental consequence include:[171]

- Decrease SO_2 and chemical oxygen demand COD by 8% by 2015;[172]
- Commence regulating emissions of two new key pollutants (nitrogen oxide [NO_x] in air and ammonia nitrogen [NH_3–N] in water) and reduce emissions by 10% by 2015;
- Decrease energy intensity of the overall economy by 16% by 2015;
- Increase nonfossil energy as a proportion of primary energy (currently 8.9%) to 11.4%;
- Decrease water intensity of the overall economy by 30%; and
- Increase forest coverage to 21.7% and forest stock by 600 million cubic meter (Mm^3).

[170] This is very slightly higher than the "moderate" (50.8%) urbanization growth scenario discussed in Section 2.5 and shown in Table 2, page 14. It is substantially lower than rates being advocated by proponents of a rapid urbanization policy.

[171] Not all of these are included in the plan. Some objectives were included in an announcement by officials around the time the 12th Five-Year Plan was released.

[172] The 8% SO_2 reduction objective is equivalent to a total emission of 20.1 Mt, which is 11% higher than the 19 Mt target that was the objective for the end of the 10th Five-Year Plan.

The Environmental Plan

On 15 December 2011, the State Council officially released the 12th Five-Year Plan on Environmental Protection. The key objectives of this environmental plan are to (i) strengthen and expand total emission control of pollutants, (ii) further improve people's living quality and standards by enhancing environmental management and strengthening protection of drinking water sources, (iii) promote green development with environmental protection, and (iv) broaden efforts to address international environmental issues such as climate change. The draft plan could reasonably be described as a continuation of the more balanced development approach that had some success under the 11th Five-Year Plan, combined with some augmentations to address new and emerging issues. It is also noted that the environmental plan addresses many of the priority issues identified in the macro-environmental strategy discussed in Section 7.2 on Macro-Environmental Strategy of the Ministry of Environmental Protection (pages 124–127).

Expansion of the total emission control program

It is increasingly apparent that the past, narrow focus on SO_2 and COD emission control needs to be broadened, and this will be done during the 12th Five-Year Plan by the inclusion of the pollutants NH_3–N in water and NO_x in air in the total emission control program. In 2008, 19% of national surface water control sections were Grade V+ with regard to NH_3–N, and the overall average concentration for all monitored sections was 1.9 milligrams per liter (mg/l), which is close to Grade V. Thus, NH_3–N has replaced COD as the leading cause of degraded surface water quality in the PRC and clearly deserves specific attention.

On NO_x in air, concentrations have been increasing continuously. The eastern PRC and the Pearl River Delta are experiencing extensive nitrogen dioxide (NO_2) pollution, and total atmospheric NO_2 load is growing rapidly. At the same time, atmospheric NO_x concentrations are rising and, according to acid rain monitoring data, the nitrate (NO_3)/sulfate (SO_4) equivalent concentration ratio has been rising since 1999.

The quantitative objective is expected to be a 10% reduction in both pollutants (NH_3–N in water and NO_x in air) by 2015, and the control measures are expected to include structural emission source reduction (i.e., closing down small-scale and inefficient enterprises) as well as management measures (improved process controls and emission controls).

Under the water pollution control program, construction of WWTPs will be accelerated, with particular emphasis on the central west regions, underdeveloped cities, and county-level cities. Consistent with the objective to control NH_3–N emissions, upgrading and reconstruction work of existing WWTPs will be supported to bring all city and county WWTPs in major watersheds up to Class 1B standards. WWTPs in the major capital cities and major prefectures, in major watersheds, or where the assimilative capacity of the receiving water body is restricted, will be upgraded to meet the 1A standard. The increased standards are directed at emission control of nitrogen (N) and phosphorus (P). The differences in performance standards between Class 2, Class 1B, and Class 1A are very significant as shown in the following table (all values in mg/l):

	WWTP Performance Standard		
Parameter	Class 2	Class 1B	Class 1A
COD	100	60	50
Total N	No standard	20	15
Total P	3	1	0.5

It is expected that a total of 20 million tons per day (Mt/d) of WWTP capacity will be upgraded and reconstructed during the 12th Five-Year Plan. The incremental capital and operating costs associated with this initiative are likely to be very substantial, and are likely to exacerbate the fiscal difficulties being experienced by subprovincial governments and increase the pressure for fiscal reform.[173] As this new capacity is developed, the sludge disposal problem—already a significant challenge—will grow and will also require additional investment.

Key elements of the atmospheric pollution control program will include (i) continuation and improvement of the thermal power desulfurization policy; (ii) strict control of SO_2 emissions from newly constructed power plants; (iii) continued phaseout of low-efficiency/high-energy consumption/heavy-pollution small thermal power units; and (iv) strengthening of the SO_2 controls for major industries including iron and steel, nonferrous metals, building materials, and chemical and petrochemical industries. These programs will be extended to cover NO_x control. Emission standards for thermal power plants will be strengthened, whereas high-emission thermal power units will be closed down or their operations suspended while control improvements are being undertaken. Existing coal-fired boilers will be renovated to adopt low NO_x combustion technologies, NO_x emissions from thermal power plants will be strictly controlled, and NO_x control for motor vehicles will be stepped up.

Increased attention to environmental quality of life

Environmental protection has been listed in the top five issues affecting people's well-being ahead of public security, education, and medical care. These environmental rights include the right to drink clean water, breathe clean air, and eat safe food. At the moment, these rights are not being safeguarded equally across the nation. Environmental standards are not being revised frequently enough to keep up with developing conditions, the range of pollution indicators being monitored is insufficiently broad, and both ambient and discharge standards, on the whole, are insufficiently stringent.

The following programs will be implemented under the general category of improving environmental quality of life:

- **Heavy metal pollution prevention and control.** By 2015, emissions of heavy metals in the major pollution prevention and control zones will be reduced by 15% compared to the levels in 2007 while, elsewhere, there shall be no increase. The proposed means for meeting the objectives will be increased

[173] A study done of WWTP upgrading costs in Harbin suggested that the capital cost of a Class 1B WWTP is 20% higher than a Class 2 plant, and the operating cost is 15% higher. The capital cost for a Class 1A WWTP is 43% higher than for a Class 2 plant, and the operating cost is 65% higher (Wang and Huppes 2010).

environmental supervision of priority sources listed in the environmental plan and strict application of the principle of "treatment within a prescribed time limit." The plan will also identify enterprises or projects considered to have no potential to comply, and they will be closed down or ordered to suspend operation. The plan also includes provisions requiring compulsory cleaner production audits of selected enterprises as a basis for reaching the cleaner production standard.

- **Increased drinking water source protection.** Increased attention will be paid to protecting and maintaining water quality in drinking water source areas through a combination of

  (i) **increased prevention** by application of total discharge control through the environmental impact assessment (EIA) process, the issuance of pollution discharge permits, and enforcement of restrictions on establishment of certain types of industries;

  (ii) **increased supervision** through strict enforcement of laws and regulations on the protection of drinking water source areas, strengthening control of construction activities, and tighter investigation and control of illegal discharges and catchment destruction; and

  (iii) **enhanced monitoring and early warning** through the use of remote sensing systems and related measures.

- **Establishment of a Joint Prevention and Control System for Atmospheric Pollution in the Three Regions (Beijing–Tianjin–Hebei, Yangtze River Delta, Pearl River Delta).** The major pollutants to be covered are SO_2, NO_x, fine particulates, and volatile organic compounds (VOCs); and the major industries to get attention are thermal power stations, iron and steel, nonferrous metal, petrochemical, cement, and chemical industries assessed as having major effects on regional air quality. Regional air quality monitoring systems will be expanded and improved, and municipal governments will be required to develop air quality improvement plans according to certain criteria. For example, cities that cannot meet the Grade II standard will be required to develop a plan of action to come into compliance. Where the Grade II standard is being met, cities will be required to develop air quality maintenance plans that will prevent their falling out of compliance as a result of future development. MEP will cooperate with the relevant regions and sectors to identify and publicize the list of major enterprises, carry out joint law enforcement inspections for regional atmospheric environmental assessment, and ensure that noncompliant enterprises are brought into compliance.

- **Strengthen work on soil contamination.** The main objectives are to strengthen the national database on soil contamination, strengthen capacity, and strengthen the legal and regulatory frameworks. The scope of work will include

  (i) completing a nationwide survey of soil contamination;

  (ii) capacity building and gradual establishment of a national, three-level (national, provincial, and municipal) monitoring system, along with

a system that periodically publishes information on national and regional soil environmental quality data;

(iii) developing and strengthening of laws, regulations, and standards for the prevention and control of soil contamination; and

(iv) undertaking experimental and demonstration work to remedy contaminated soils, to assess the effects of using wastewater and sewage sludge for irrigation, and other related topics.

- **Strengthen rural environmental protection.** A series of measures will be implemented to support the dissemination and adoption of environmentally sustainable agriculture, and help control agricultural nonpoint source (NPS) pollution including

(i) increasing the dissemination of information on the use of soil testing and compound fertilizers in the main grain production regions and major watersheds;

(ii) promoting the use of integrated pest management, biological pesticides, and high-efficiency, low-toxicity, and less-persistent pesticides, as well as information on the safe handling and storage of agrochemicals;

(iii) encouraging crop production structural readjustment and pattern optimization to encourage the planting of crops that need less fertilizer and have more environmental benefit; and

(iv) extending environmental monitoring, supervision, and control and/or treatment systems to rural areas.

Increased environmental protection and promotion of green development

A major effort will be made under the 12th Five-Year Plan to promote "green development" and fundamentally change the macroeconomic structure to promote increased resource use efficiency. There will be two main aspects to the program—(i) increasing green innovation of traditional industries, and (ii) supporting the development of new and greener industries.

- **Increase green innovation of traditional industries.** A wide range of complementary measures is planned that includes the following:

(i) Strictly control environment-related industrial entry, control pollution from the source, and strictly restrict the development of high-energy consuming and high-pollution industries by improving the linkage between plan EIA and project EIA;

(ii) Make total pollutant indicators the precondition for examining and approving project EIAs and the necessary condition for examining plan EIAs to promote the implementation of pollution emission reduction tasks;

(iii) Accelerate the elimination of outmoded and inefficient production capacity, publish lists of pre-eliminated, production-restricted, and

import-restricted products and technologies as guidelines to influence future industrial development;

(iv) Establish a compensation mechanism for the elimination of backward production capacity and to encourage heavy-pollution enterprises to exit on their own initiative;

(v) Establish a system for publicizing enterprises with backward production capacity to be phased out. Announce the enterprises, production lines, and production capacities closed down and eliminated during examination to keep the public informed and encourage their participation in supervising compliance;

(vi) Plan and construct several ecological industrial parks to demonstrate the concept of the recycling economy in the major regions and major industries including iron and steel, nonferrous metal, electric power, chemical, building materials, and mechanical industries;

(vii) Comprehensively implement cleaner production (CP) and support enterprises to carry out CP audits; and

(viii) Increase CP project investments and adopt CP technologies.

- **Accelerate the development of the environmental protection industry.** The main objectives are to actively increase investment in environmental protection, and construct major and important environmental protection projects (e.g., comprehensive resource utilization, environmental prevention and control, and ecological protection) to provide impetus for further development of the environmental protection industry.

  Economic measures to be applied will include (i) increases in wastewater and solid waste treatment charges; (ii) improved preferential taxation policies for energy saving, environmental protection, and comprehensive resource utilization; and (iii) provision of support for fund raising by eligible energy-saving and environmental protection enterprises (e.g., stock market listings and issuing bonds). Financial support will also be provided to accelerate technology innovation in key and generic technologies such as comprehensive pollution treatment, recycling technologies, and ecological protection.

Increased attention to international environmental problems

The main driving forces behind this component of the environmental plan are the GHG reduction commitments that the PRC has committed to achieve by 2020, and the recognition that international scrutiny of compliance with international environmental agreements is continually strengthening.

For the GHG emission reduction objectives, the following activities will be undertaken:

- Establish a long-term mechanism for emission reduction of GHGs;
- Develop an emission inventory of major GHGs like CO_2, including an emission statistical system;

- Investigate the inclusion of indicators for mitigating and addressing climate change into the EIA indicator system;
- Enhance GHG monitoring and strengthen mitigation planning and design;
- Increase the ecosystem's carbon-absorbing capacity through additional plantings and management measures;
- Carry out studies on the synergetic control of GHGs and local air pollutants emissions to more cost effectively achieve climate change mitigation and environmental protection; and
- Select major industries and regions to carry out low-carbon economy experimental demonstrations (low-carbon technological innovation, low-carbon product certification, and low-carbon community development).

The main initiatives to strengthening compliance with international environmental agreements include the following:

- Strengthen the ozone depleting substances (ODS) management system, including (i) developing a total process management system for monitoring ODS production, use, sales, import and export, and recovery and disposal; and (ii) strengthening ODS elimination work by using industrial restructuring as the main elimination mode, and completing the elimination tasks at all time points specified in the convention;
- In accordance with the requirements of the PRC's "National Implementation Plan for the Stockholm Convention," control dioxin emissions from major industries and in regions, resolve the high-risk persistent organic pollutants (POPs) waste and contaminated sites, and promote POPs elimination, reduction, and control;
- Protect biodiversity, enhance capacity building for biospecies and genetic resources protection, and choose several priority regions to carry out experimental work for biodiversity protection; and
- Strictly control international trade and transboundary movement of hazardous chemicals and wastes.

Recommendations for Striving Toward an Environmentally Sustainable Future

The prospects for the environmental agenda under the 12th Five-Year Plan and beyond to 2020 will depend substantially on the structure of the economy, particularly the balance between the secondary and tertiary sectors and the role of large-scale, capital-intensive industries. The 11th Five-Year Plan had called for a change of course and promoted an environment-friendly and resource-efficient society, but not much success was realized.

Restructuring the economy is likely to be a slow process, as it will be difficult to overcome the considerable momentum behind the current mode of growth, which includes the

local "rush to growth" urbanization approach, the overdependence on administrative measures to manage the environment, and the weak coordination across line ministries and across regional and local governments.

As the government strives toward green growth for the 12th Five-Year Plan and the environmentally sustainable future, it should keep in mind the following recommendations:

Removal of disincentives and change in the course of growth patterns

- **Restructuring economic and fiscal system to reflect the environmental externality.** Economic growth should be redirected from its overdependence on manufacturing for exports toward the services sector, which depends on domestic demand. Essential to this shift is the price reform of resources, such as water, land, energy, mineral and extractive resources (particularly coal), and capital to reflect such factors as scarcity and environmental externalities associated with resource consumption.

  Pollution charges should be raised to levels above the marginal costs of pollution control, and taxation and pricing measures should be implemented to encourage companies to adopt pollution control measures and to deter heavy resource consumption and environmental pollution. Levies could be charged on chemical and petrochemical products to set up a super fund to clean up chemically contaminated soils. Feed-in tariffs could be used to offer cost-based compensation to renewable energy producers, and a renewable energy surcharge could be levied on thermal power and placed in a super fund to subsidize the development of renewable energy supply.

  To remove disincentives and growth patterns that undermine environmental sustainability, fiscal reform should accompany economic restructuring. Since the fiscal reforms of the mid-1990s, subnational, particularly subprovincial, governments have been caught in an ever-tightening squeeze between the cost of implementing their health, education, welfare, and environmental obligations and the very limited revenue sources available to them. They are increasingly reliant on revenues from property development and loans contracted through "investment vehicles" that were established to bypass restrictions on their ability to issue bonds. In terms of environmental investment, this tends to focus local governments' attention on investments that will produce short- to medium-term revenues rather than on investments that are needed to solve the environmental problems at hand but may not generate revenue. Some trial programs are already being undertaken to assess the feasibility of introducing natural resources taxes (e.g., in Xinjiang Uygur Autonomous Region) and property taxes. These programs need to be expedited and expanded.

- **Adopting a more programmatic approach to environmental investment and enhancing investment efficiency.** Much of the PRC's environmental investment is made through special campaigns that are often hastily conceived and implemented to respond to environmental incidents or emergencies. This approach is inefficient, too "top–down," and extremely unpredictable in the

medium to long term. A more programmatic approach to environmental investment is needed, with (i) timetables that spread across 5-year planning periods, (ii) increased flexibility for subnational governments to adapt programs to suit local conditions, and (iii) higher levels of grant financing for investments with significant externalities.

While substantial amount of money has been invested in protecting the environment, the effectiveness and efficiency of the investments remain largely unknown. To improve the efficiency of public resources, more solid cost-effectiveness and/or cost–benefit analyses of the investment should be conducted ex ante as well as ex post. Policymaking for future environmental investments should increasingly be based on the accumulated knowledge of the cost-effectiveness and/or costs and benefits of the available alternatives.

- **Focusing on the quality of urban development.** With continued urbanization fast becoming a pillar of future economic development, significant improvements are needed in the planning and management of urban development. At present, a "wild west" quality to urban development is prevalent, which has much to do with the administrative hierarchy and the incentive systems that govern the behavior of local government officials. These incentive systems create a "rush to growth," regardless of whether the economics are favorable, and lead to a proliferation of urban infrastructure that may not always be needed. Thus, too much attention is being paid to the quantity instead of the quality of urban development. The government needs to (i) sustain and extend its financial commitment to the development of essential urban environmental infrastructure, (ii) look seriously at the incentive structure governing the work of municipal governments to improve its efficiency, and (iii) provide a much better guidance and rewards system in the implementation of an environmentally sustainable urban development, which makes efficient use of scarce land and other natural resources and maximizes the application of reduce–reuse–recycle strategies.

Expanded use of market-based instruments to control pollution

Overreliance on administrative measures has resulted in many problems, not the least being fraudulent reporting. In addition, coercive closure of enterprises to meet arbitrary targets may infringe on the rights and interests of enterprises and leave a trail of social side effects and grievances. More reliance needs to be placed on market-based instruments.

- **Introducing water quality trading early to reduce nonpoint source pollution.** The emerging great pollution control challenge is the NPS pollution. It is very important to introduce the market-based mechanisms as an adjunct to the command-and-control approach to NPS pollution control. The majority of nutrient pollution originates from NPSs, principally agricultural sources. Water quality trading programs that allow point-to-nonpoint trades may become mechanisms for leveraging point-source regulatory requirements to generate reductions from unregulated NPSs. More than 70% of active water quality trading programs in the world allow trades between point and nonpoint sources. ADB has recently supported MEP in designing water quality trading

programs in Tai Lake and Chao Lake. These experiments need to be expedited and replicated to other areas.

- **Developing environmental service markets that attract the private sector.** The government, in particular through the work of MEP and the National Development and Reform Commission, is advocating the application of eco-compensation principles to solve certain intractable environmental problems such as catchment protection, rehabilitation of degraded watershed, and other dimensions of natural resources conservation. However, an overly large public sector presence as buyer of environmental services risks crowding out the private sector. In developing a national eco-compensation policy framework, the government needs to (i) think carefully about how its role can evolve from being the main buyer of environmental services to more of an "enabler" that encourages private sector participation, and (ii) establish regulatory requirements that can create markets (such as having to offset the impacts of projects on biodiversity or watershed services).

Legal reform to clarify responsibilities and encourage cooperation

The Environmental Protection Law (EPL) needs to be revised to make it up-to-date and relevant to the 21st century. The legal reform should address two fundamental issues: (i) rights and authorities over environmental protection; and (ii) coordination between jurisdictions and institutions.

- **Clarifying rights and authorities to improve environmental governance.** The government should clarify and strengthen the EPL on rights and responsibilities over environmental protection work, which would include designating responsibility for ensuring environmental quality. Rights and authorities determine the key actors and stakeholders of environmental protection work and will provide the foundation for successful environmental governance.

  Revisions are required to:

  (i) establish MEP as the sole "competent department" tasked with the unified supervision and management of the environmental protection work of the entire nation, and that the environmental work of other departments must be consistent with and approved by MEP;

  (ii) confirm that, in the event of conflict with other laws, the provisions of the EPL prevail; and

  (iii) create unambiguous authority for inspectors from MEP and its subnational counterparts to enter and inspect enterprises and other locations that are, or are believed to be, sources of pollution.

- **Encouraging coordination between jurisdictions through legal reform.** Provinces, municipalities, and counties, while competing with each other on economic growth, often "race to the bottom"[174] in environmental surveillance.

[174] The phrase "race to the bottom" is a socioeconomic concept that occurs between nations or within a nation (such as between states, provinces, or counties). When competition becomes fierce between nations (or levels of government)

The problem is further aggravated by the fact that ecological boundaries are rarely matched with political boundaries, which encourages local governments to "leave the problem to the neighbors." Given the range of central and provincial government ministries, and departments with different and sometimes overlapping responsibilities for environmental protection, the EPL amendment should develop frameworks for cross-provincial coordination and cooperation.

over a particular area of trade and production, there is an increased incentive to dismantle or eliminate currently existing regulatory standards, such as environmental safeguards.

8. Implications for the Country Partnership Strategy

8.1 Introduction

Between 1986—when the People's Republic of China (PRC) joined the Asian Development Bank (ADB)—and the end of 2011, the PRC received a total of $24.86 billion in sovereign loans, $3.0 billion in nonsovereign assistance, and $380.0 million in technical assistance (TA) grants from ADB, making it ADB's second largest borrower and its largest client for private sector financing. In spite of its growing economic strength and amidst speculation that the need for development assistance will soon disappear, the PRC remains one of ADB's most important clients—total approved assistance in 2011 was $1.79 billion, including $1.56 billion worth of loans (sovereign and non-sovereign) and $23 million in TA grants.

The relationship between ADB and the PRC is much more than a one-way association as the PRC, in addition to borrowing money from ADB, has also been making financial contributions to support ADB initiatives. For example, in 2005, the PRC contributed $30 million to the Asian Development Fund (ADF)[175] with an additional $35 million in 2008. The PRC also established the $20 million PRC Regional Cooperation and Poverty Reduction Fund, becoming the first developing member country (DMC) to set up such a fund with an international development agency.

ADB's Country Partnership Strategy (CPS) covered the period 2008–2010, and is being replaced by the new CPS (2011–2015). The CPS (2011–2015) recognizes the PRC's transformation, through 3 decades of successful reforms, into the world's second largest economy, the country's swift transition from a low-income to middle-income country, and its growing economic strength and international status. It also reflects the PRC's increasing role in reforming the international financial architecture, promoting regional and global public goods, sharing knowledge, and providing development assistance both bilaterally as well as through multilateral finance institutions. In the pursuit to reach the high-income status, the PRC needs a more determined stance toward inclusive growth and environmental sustainability to secure long-term growth and facilitate the middle-income transition.

The current CPS is based on a number of key principles: (i) aligning with the priorities of the 12th Five-Year Plan that intersect with those of the ADB Strategy 2020;

[175] Established in 1973, the ADF is a multilateral source of concessional assistance dedicated exclusively to the needs of the region. The ADF is designed to provide loans on concessional terms and grants to ADB's DMCs that have low incomes per capita and limited debt-repayment capacity. Activities supported by the ADF promote poverty reduction and improvements in the quality of life in the poorer countries of Asia and the Pacific.

(ii) focusing on value addition through knowledge sharing, innovation, and capacity development to enhance demonstration effects and be responsive to the needs of a large and dynamic middle-income country; (iii) incorporating lessons from ADB's operational experiences; and (iv) focusing on ADB's core areas of competence and country-specific comparative advantages.

In line with the above principles, ADB programming for the current CPS focuses on three pillars: (i) inclusive growth; (ii) environmentally sustainable growth; and (iii) regional cooperation and integration. Inclusive growth to foster balanced and equitable development will be supported by promoting integrated rural and urban development in ways that expand livelihood opportunities for the poor. Improving access to microfinance and small- and medium-sized enterprise (SME) finance, and management of natural resources that also helps to boost rural livelihoods, will be the main goal of rural development support. In urban areas, ADB will assist the development of small- and medium-sized cities in less developed regions through promotion of low-carbon development, integrated urban planning, and comprehensive provision of municipal and social services. Improved transport connectivity will help boost access to employment and essential services. Support for the PRC's twinning initiatives (whereby more prosperous provinces and municipalities provide assistance to less developed interior regions), fiscal reform, and municipal bond market development are also integral parts of the inclusive growth strategy. Further, regionally balanced development will be promoted by continuing to focus operations on the interior regions.

Support to environmentally sustainable growth will be achieved by further greening the portfolio and mainstreaming climate change considerations into future operations. ADB will, in particular, support the government's efforts to foster a cleaner and more sustainable growth process by (i) strengthening capacity of environmental management, and pilot testing cutting-edge clean energy and energy efficiency technologies; (ii) supporting the development of low-carbon transport systems, particularly in public transport; (iii) strengthening protection and sustainable use of land, water, and forest resources; (iv) helping to develop model livable and low-carbon cities; and (v) promoting the development and institutionalization of green financing instruments.

The regional orientation of the country program will be further strengthened to complement ADB's support for regional cooperation programs, particularly the Central Asia Regional Economic Cooperation (CAREC) and the Greater Mekong Subregion (GMS) programs. ADB, in this context, will continue to work closely with the government to support regional cooperation and integration through country projects and TA, with a focus on transport connectivity and trade facilitation to promote economic corridors and development of corridor cities to foster regionally inclusive development. ADB will also strengthen capacity and strategy development support for government agencies and provinces and autonomous regions involved in the CAREC and GMS programs. Support for regional cooperation and integration will in turn continue to reinforce the country program, particularly in its efforts to address regional disparities in the PRC and provide regional perspectives on national development issues. Further, ADB will

strengthen efforts to promote knowledge sharing between the PRC and other DMCs for expanded South-South cooperation.

The preparation of the CPS and the country environmental analysis (CEA) has been an interactive process. The CEA has provided useful inputs into the development of the CPS, while the analysis for the CPS has served to guide the development of the CEA. Following this introductory section, this chapter proceeds with the analysis of ADB's lending and non-lending programs in the PRC from an environmental perspective. It then examines the opportunities and challenges of private sector participation in ADB's environmental projects, followed by a discussion of the environmental assistance programs of other major donors active in the PRC, with the view of building synergy and complementarity. The ensuing section provides a comparison of ADB and PRC environmental safeguard systems to guide the application of the Safeguard Policy Statement (2009) in the PRC and promote the use of international best practices. The chapter concludes with a comprehensive package of recommendations on ADB interventions in the PRC to achieve the CPS objective of environmentally sustainable growth.

8.2 Asian Development Bank's Assistance Program

Overall Lending and Technical Assistance

ADB provides assistance to the PRC through lending and TA in four major sectors:

i. agriculture, environment, and natural resources sectors under the Environment, Natural Resources, and Agriculture Division (EAER) of ADB's East Asia Department (EARD);

ii. urban and social sectors under EARD's Urban and Social Sectors Division (EASS) (but only the urban development component of EASS's work will be discussed in this report);

iii. energy sector under EARD's Energy Division (EAEN); and

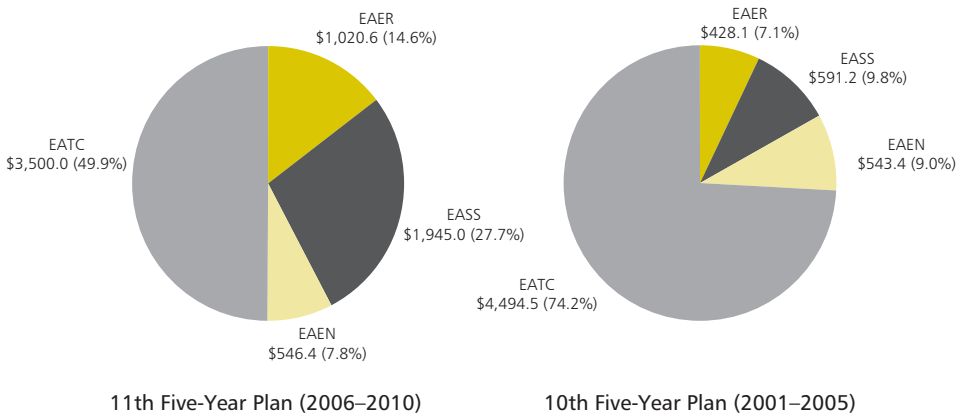
iv. transport sector under EARD's Transport Division (EATC). [176]

Figure 25 compares the sector distribution of ADB lending during the 10th and 11th five-year plan periods.

During the 11th Five-Year Plan, transport accounted for the largest share (50% of total lending by value); followed by urban (28%); environment, natural resources, and agriculture (15%); and energy (8%). The percentage share of lending to the transport sector declined significantly between the 10th and 11th five-year plans (from 74% to

[176] It should be pointed out that the sector division in ADB is increasingly becoming indistinguishable, and many projects, as by design, are multisector and inter-sector in nature. For example, projects undertaken by the Environment, Natural Resources, and Agriculture Division (EAER) have included urban sewage treatment components, which are urban sector issues. Conversely, projects undertaken by the Urban and Social Sectors Division (EASS) have covered integrated water resources management.

Figure 25 **Sector Distribution of ADB Lending by Value, 10th and 11th Five-Year Plan Periods**



EAER = Environment, Natural Resources, and Agriculture Division of ADB's East Asia Department (EARD), EAEN = EARD's Energy Division, EASS = EARD's Urban and Social Sectors Division, EATC = EARD's Transport Division.
Source: ADB

50%). However, the decrease was picked up by the urban and social sectors (which increased from 10% to 28%) and the environment, natural resources, and agriculture sectors (which increased from 7% to 15%). The share of the energy sector remained almost constant. This reallocation of resources was consistent with one of the main recommendations of the first CEA for the PRC (ADB 2007).

The distribution of TA financed during the 11th Five-Year Plan was dominated by EAER (39%) and EAEN (28%), followed by the EATC (19%) and EASS (14%).

Environment, Natural Resources, and Agriculture

Assistance volumes

The 11th Five-Year Plan portfolio comprises 12 loans valued at $1.02 billion (Table 27). Water resources management accounted for the largest share (51%), followed by comprehensive agriculture development (25%), land resources management (14%), rural energy (6%), and forestry (4%).

The TA portfolio (Table 28) comprises 19 activities valued at $14.05 million. Similar to the lending program, water resources management accounted for the largest share (42%). The balance of resources among the remaining subsectors is as follows: land resources management (25%), comprehensive agriculture development (19%), rural energy (9%), and environmental policy and regulation (4%).

Urban and Social Development

The following discussion relates solely to the urban sector work of EASS.

Table 27 **Environment, Natural Resources, and Agriculture Lending by Project, 11th Five-Year Plan (2006–2010)**

Subsector	Project Title	ADB Contribution ($ million)	Year of Approval
Water	Hunan Flood Management Sector	200.0	2006
	Integrated Ecosystem and Water Resource Management in Baiyangdian Lake	100.0	2008
	Qingdao Water Resources Management	45.0	2008
	Guiyang Integrated Water Resources Management (Sector)	150.0	2009
	Risk Mitigation and Strengthening of Endangered Reservoirs in Shandong Province	29.8	2010
Forestry	Jiangxi Sustainable Forest Ecosystem Development	40.0	2010
Land	Ningxia Integrated Ecosystem and Agricultural Development	100.0	2008
	Shaanxi Qinling Biodiversity Conservation	40.0	2009
Rural energy	Integrated Renewable Biomass Energy Development	66.1	2010
Comprehensive agriculture development	Henan Sustainable Agriculture and Productivity Improvement	66.7	2007
	Dryland Sustainable Agriculture	83.0	2008
	Shanxi Integrated Agriculture Development	100.0	2009
	Total	**1,020.6**	

Source: ADB

Portfolio

The urban development portfolio comprises 18 loans valued at $1.95 billion projects (Table 29).[177] The portfolio has a very strong integrated, multi-sector approach to urban environmental improvement, with support being provided for urban transport, water supply, drainage, municipal wastewater, sewage sludge and solid waste management, central heating, environmental rehabilitation, and disaster management. Pollution prevention and water quality control are increasingly taking a basin-wide approach, and adoption of clean and efficient urban utility technologies are being promoted. The geographical focus favored the western provinces, with increased attention to meeting the urban infrastructure needs of third-tier cities, fourth-tier cities, and towns, which are the urban areas most lacking in both financial and human resources to deal with continuing urbanization.

The range of topics covered by the TA program (Table 30) reflected the significance of urban management problems being confronted, with a sizeable share being allocated for wastewater, and sludge and solid waste management (40%), followed by sustainable urbanization (24%), climate change and resource recovery (17%), water pollution control (13%), and private sector participation (6%).

[177] All of EASS's urban sector investments are multi-sector in nature, so the table does not classify projects by subsector.

Table 28 **Environment, Natural Resources, and Agriculture Technical Assistance by Project, 11th Five-Year Plan (2006–2010)**

Subsector	Activity Title	ADB Contribution ($ million)	Year of Approval
Water	Strengthening Flood Management Sustainability in Hunan	0.56	2006
	Strengthening Water Resources Management in Guiyang	0.80	2006
	Capacity Building for Integrated Ecosystem Management in Ningxia Hui Autonomous Region	0.60	2007
	Implementing the National Flood Management Strategy	0.50	2007
	River Basin Water Resources Allocation and Management Policy	0.75	2008
	National Guidelines for Eco-compensation in River Basins	0.80	2008
	Enabling the Protection of Jiaozhou Bay Water Quality	0.75	2008
	Effective Reservoir Utilization for Integrated Water Resources Management	0.50	2010
	Strengthening Participatory Irrigation Management and Project Management Capacity in Qinghai Province	0.70	2010
Land	Strategy for Drought Management	0.63	2009
	Management and Policy to Combat Land Degradation	2.93	2009
Rural energy	National Strategy for Rural Biomass Renewable Energy Development	0.40	2006
	National Strategies for Environmental Management and Energy Conservation	0.90	2007
Comprehensive agriculture development	Strengthening the Capacity of Sanmenxia Municipality Government	0.40	2007
	Policy Study on Government Public Expenditures in Agricultural Production	1.00	2009
	Study on Eco-compensation Regulations	0.50	2010
	Provincial Development Strategies for Provinces in Central People's Republic of China Focused on Rural Development	0.80	2010
Environmental policy and regulation	Strengthening Enforcement of Environmental Laws and Regulations	0.30	2009
	Country Environmental Analysis	0.23	2009
	Total	**14.05**	

Source: ADB

Table 29 Urban and Social Development Lending by Project, 11th Five-Year Plan (2006–2010)

Project Title	ADB Contribution ($ million)	Year of Approval
Shandong Hai River Basin Pollution Control	80.0	2006
Guangxi Nanning Urban Environmental Upgrading	100.0	2006
Wuhan Wastewater and Stormwater Management	100.0	2006
Nanjing Qinhuai River Environmental Improvement	100.0	2006
Anhui Hefei Urban Environment Improvement	150.0	2007
Jilin Urban Environmental Improvement	100.0	2007
Kunming Qingshuihai Water Supply	80.0	2007
Gansu Baiyin Urban Development	80.0	2008
Xinjiang Municipal Infrastructure and Environmental Improvement	105.0	2008
Songhua River Basin Water Pollution Control and Management	200.0	2008
Guangxi Wuzhou Urban Development	100.0	2008
Xinjiang Urban Transport and Environmental Improvement	100.0	2009
Liaoning Small Cities and Towns Development Demonstration Sector	100.0	2009
Hebei Small Cities and Towns Development Demonstration Sector	100.0	2009
Shanxi Small Cities and Towns Development Demonstration Sector	100.0	2009
Wuhan Urban Environmental Improvement	100.0	2010
Chongqing Urban–Rural Infrastructure Development Demonstration	100.0	2010
Guangxi Southwestern Cities Development	150.0	2010
Total	**1,945.0**	

Source: ADB

Table 30 Urban Development Technical Assistance by Project, 11th Five-Year Plan (2006–2010)

Subsector	Activity Title	ADB Contribution ($ million)	Year of Approval
Sustainable urbanization	ADB–PRC Knowledge Hub on Sustainable Urbanization	0.23	2009
	Development of Indicators and Monitoring Systems for Environmentally Livable Cities in the People's Republic of China	0.12	2009
	Establishing a Regional Knowledge Hub for Sustainable Urban Development	0.23	2010
	Policy Study on Strategic Options for Urbanization	0.60	2010
Water pollution control	Policy Study on Market-Based Instruments for Water Pollution Control	0.50	2007
	Preliminary Survey and Assessment for Initiating Interventions on Zhangye Wetlands Protection and Rehabilitation in Heihe River Basin	0.15	2009
Wastewater, sludge and solid waste management	Urban Wastewater and Solid Waste Management for Small Cities and Towns	1.00	2007
	Urban Wastewater Reuse and Sludge Utilization Policy Study	1.00	2008

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Table 30 *continued*

Subsector	Activity Title	ADB Contribution ($ million)	Year of Approval
Climate change and resource recovery	Increasing the Climate Change Resilience of Urban Water Infrastructure: Case Study of the PRC	0.15	2009
	Strengthening Capacity to Address Climate Change for Small- and Medium-Sized City Development	0.50	2010
	Resource-Efficient Towns Development in Xinjiang Altay Area	0.20	2010
Private sector participation	Supporting the Establishment of the Jilin Province Urban Infrastructure Management Company (JPUIMC)	0.15	2010
	Assessment of Private Sector's Environmental Information Disclosure and Management in the PRC	0.12	2010
	Total	**4.94**	

Source: ADB.

Table 31 Energy Sector Lending by Project, 11th Five-Year Plan (2006–2010)

Subsector	Project Title	ADB Contribution ($ million)	Year of Approval
Energy efficiency	IMAR Environment Improvement I	120.0	2006
	MFF: Guangdong Energy Efficiency and Environment Improvement Investment Program—Tranche 1	35.0	2008
	MFF: Guangdong Energy Efficiency and Environment Improvement Investment Program—Tranche 2	22.1	2009
	IMAR Environment Improvement II	150.0	2010
Renewable energy	Gansu Heihe Rural Hydropower–Erlongshan Hydropower	22.0	2006
	Gansu Heihe Rural Hydropower Development Investment Program—Dagushan Hydropower	28.0	2008
	Hebei Zhangbei Wind Power	34.3	2009
Clean coal technology	Tianjin IGCC Power Plant Project	135.0	2010
	Total	**546.4**	

IMAR = Inner Mongolia Autonomous Region, MFF = Multitranche Financing Facility, IGCC = Integrated Gasification Combined Cycle
Source: ADB.

Table 32 **Energy Sector Technical Assistance by Project, 11th Five-Year Plan (2006–2010)**

Subsector	Activity Title	ADB Contribution ($ million)	Year of Approval
Energy efficiency	Promoting Resource Conservation and Energy Efficiency	0.40	2007
	Utilization of Foreign Capitals to Promote Energy Conservation, and Energy Efficiency Power Generation Scheduling	1.50	2008
	Energy Efficiency Improvements in IMAR	0.50	2009
Alternative energy	Gansu Rural Clean Energy Development	0.80	2007
	Utilization of Renewable Shallow-Ground Geo-Energy	0.15	2007
	Development of Biomass Power in Rural Areas	0.60	2007
	Concentrating Solar Thermal Power Development	1.00	2009
	Recycling Waste Coal for Power Generation	0.50	2009
Clean coal technology	Tianjin Integrated Gasification Combined Cycle Capacity Development	0.20	2008
Climate change mitigation	Support for Establishing CDM Fund	0.60	2006
	CDM Capacity Development	0.80	2008
	REG: Carbon Dioxide Capture and Storage Demonstration	0.50	2009
	Carbon Dioxide Capture and Storage Demonstration	1.25	2009
	Developing a Low-Carbon Economy in Yunnan	0.40	2009
Coal mine safety	Coal Mine Safety Study	0.66	2006
	Total	**9.86**	

CDM = clean development mechanism, IMAR = Inner Mongolia Autonomous Region, REG = regional project.
Source: ADB

Energy

Portfolio

The energy development lending program is shown in Table 31. After almost 10 years of transition, ADB appears to have found effective niches in the energy sector although, with only eight projects and a volume of $546.4 million, the program remains very small. Interventions responded well to the PRC's priorities of energy conservation and pollution reduction. About 60% of the loan portfolio was directed at energy efficiency improvement, 15% on renewable energy, and 25% on demonstrating clean coal technology, which is an essential area of development if the PRC is to meet its greenhouse gas (GHG) emission control objectives.

The TA program in the energy sector (Table 32) is very diverse, covering a wide range of environmentally significant energy topics including energy efficiency (24%), alternative

Table 33 **Transport Sector Lending by Project, 11th Five-Year Plan (2006–2010)**

Subsector	Project Title	ADB Contribution ($ million)	Year of Approval
Road	Heilongjiang Road Network Development	200.0	2006
	Southern Gansu Roads Development	300.0	2006
	Eastern Sichuan Roads Development	200.0	2007
	Western Guangxi Roads Development	300.0	2007
	Xinjiang Regional Road Improvement (Korla–Kuqa Section)	150.0	2007
	Central Yunnan Roads Development	200.0	2008
	Anhui Integrated Transport Sector Improvement	200.0	2009
	Yunnan Integrated Road Network Development	250.0	2010
	Second Heilongjiang Road Network Development	200.0	2010
Railway	Taiyuan–Zhongwei Railway	300.0	2006
	Lanzhou–Chongqing Railway Development	300.0	2008
	Chongqing–Lichuan Railway Development	150.0	2008
Railway safety	Railway Safety Enhancement	100.0	2007
	Railway Energy Efficiency and Safety Enhancement (Tranche 1)	300.0	2009
	Railway Energy Efficiency and Safety Enhancement (Tranche 2)	100.0	2010
Sustainable urban transport	Lanzhou Sustainable Urban Transport	150.0	2009
	Xinjiang Urban Transport and Environmental Improvement	100.0	2009
	Total	**3,500.0**	

Source: ADB

Table 34 **Transport Sector Technical Assistance by Project, 11th Five-Year Plan (2006–2010)**

Subsector	Activity Title	ADB Contribution ($ million)	Year of Approval
Transport efficiency	Managing Railway Passenger Operations More Efficiently	0.60	2006
	Resource Optimization in the Road Sector	0.40	2006
	Resource Optimization in the Road Sector (Supplementary)	0.20	2006
	Enhancing the Competitiveness and Efficiency of Railway Passenger Operations	0.50	2008
	Transport Efficiency through Logistics Development Policy Study	0.50	2008
	Capacity Development for Railway Track Maintenance	0.40	2010
Financing	Asset-Backed Securitization for Expressway Financing and Corporate Debt Restructuring in Yunnan Province	0.15	2008
	Financing Road Construction and Maintenance after Fuel Tax Reform	0.23	2009
	Financing Road Construction and Maintenance after Fuel Tax Reform (Phase 2)	0.45	2010

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Table 34 *continued*

Subsector	Activity Title	ADB Contribution ($ million)	Year of Approval
Safety and information systems	Railway Emergency Management System Study	0.50	2007
	Transport Information System	0.40	2007
	Improving Road Safety through the Application of Intelligent Transport Systems	0.50	2009
Sustainable rural transport	Sustainable Rural Transport Services	0.40	2006
	Community-based Rural Road Maintenance by Women Ethnic Minority Groups in Western Yunnan	0.20	2010
Energy efficiency	Railway Sector Energy Efficiency Strategy	0.80	2008
	Institutional and Capacity Development	0.60	2009
	Total	**6.83**	

Source: ADB

energy (31%), clean coal technology (2%), climate change mitigation (36%), and occupational health and safety including coal mine safety (7%).

Transport

Portfolio

The lending portfolio comprises 17 projects, with loans valued at $3.5 billion (Table 33). The portfolio has a strong focus on the road (57%) and railway (21%) subsectors, and mainly in the western and northeastern parts of the country where the infrastructure demand remains strong. New lending areas opened up in railway safety (14%) and sustainable urban transport (7%). Interventions in urban transport may have a programming overlap with EASS but, with proper coordination, synergy and complementarity could be achieved.

The TA program (Table 34) is quite diverse, covering topics such as transport efficiency (38%), energy efficiency (20%), safety and information systems (20%), financing (12%), and sustainable rural transport services (9%), which are highly aligned with the domestic priorities.

8.3 Private Sector Participation in ADB's Environmental Projects

One of the key strategic thrusts of the current CPS is to provide support for the creation of an environment conducive to private sector development by promoting public–private partnerships in infrastructure finance and helping to strengthen the development of the finance sector. To do this, the proposed measure was to increase private sector operations and to raise local currency resources through yuan-denominated

bonds. Opportunities were seen in the infrastructure and energy sectors by promoting innovative contractual and financial structures to encourage private sector participation, enhance management expertise, and improve corporate governance. ADB also planned to promote commercialization, privatization, and public–private partnerships by assisting technology and management transfer to local entities currently owned by the public sector through acquisition, rehabilitation, or expansion projects.

No systematic evaluation of the success of this program has yet been completed, although there have been some successful cases. One was the Fuzhou Water Supply and Wastewater Treatment Project, which has led to the awarding of two wastewater treatment plants (WWTPs) to private sector companies. As a follow-up to the Nanjing Qinhuai River Environmental Improvement Project,[178] ADB provided technical assistance to build the capacity for a corporate utility bond issue to fund water and environment sector projects in Nanjing.[179] The bond issue in Nanjing, in the amount of CNY2 billion, has received approval from the National Development and Reform Commission (NDRC) and will be the first public–private partnership to address future urban infrastructure investment needs. Private sector participation was also successfully applied in the clean development mechanism (CDM)-related initiatives under the Kyoto Protocol and existing carbon credit markets, sponsored mainly by private sector developers.

In general, the private sector in the PRC still faces many constraints, such as unclear private property rights, barriers to market entry, high taxation for domestic private enterprises, lack of transparency, and inadequate access to financial services. There is a strong need for assistance to strengthen private sector participation in environmental projects. In view of ADB's efforts to promote private sector operations and innovative public–private partnerships, the CEA team recommends for ADB to identify the factors contributing to the successful cases and replicate the successes in future environmental projects, especially the operation of waste treatment facilities, which more often than not run into financial and management problems. Other public–private investments of an environmental nature with likely considerable demand include clean energy, urban solid waste management including incinerators, recycling of mining wastes, and energy efficiency improvements.

There may also be opportunities for ADB to underwrite pilot programs to increase private sector participation in eco-compensation activities. This would be a new area for the PRC and the best way to proceed would be through very small-scale activities, perhaps financed in the form of technical assistance, to test ideas with willing counterparts (e.g., county or township governments, or perhaps a public utility or a private firm dependent on the maintenance of environmental quality for continued operations).

[178] ADB. 2006. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Nanjing Qinhuai River Environmental Improvement Project.* Manila.

[179] ADB. 2005. *Technical Assistance to the People's Republic of China for Nanjing Water Utility Long-Term Capital Finance in Commercial Markets* (Cofinanced by the Cooperation Fund for the Water Sector). Manila (TA 4604-PRC).

8.4 Environmental Assistance of Other Donors

Donors other than ADB, which are active in the PRC, include the World Bank Group, the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), the European Union, Australia, Germany, Italy, and the United Kingdom (UK). In recent years, previously important bilateral donors such as Canada, Sweden, and Japan have significantly reduced their assistance programs due to the PRC's improving economic situation. The UK's bilateral assistance program ended in March 2011.

The World Bank Group

The World Bank Group's Country Partnership Strategy, covering the 2006–2010 period, focused on five thematic areas, as follows:

i. Helping to integrate the PRC into the world economy by deepening its participation in multilateral economic institutions, reducing internal and external barriers to trade and investment, and contributing to its overseas development efforts;

ii. Reducing poverty, inequality, and social exclusion by promoting balanced urbanization, sustaining rural livelihoods, and expanding access to basic social and infrastructure services, particularly in rural areas;

iii. Managing resource scarcity and environmental challenges by reducing air pollution, conserving water resources, optimizing energy use, improving land administration and management, and observing international environmental conventions;

iv. Deepening financial intermediation by expanding access to financial services, developing capital markets, managing systemic risks, and maintaining financial stability; and

v. Improving public and market institutions, improving competitiveness, reforming public sector units, and rationalizing intergovernmental fiscal relations.

Over the 5-year period ending 2010, the World Bank lent a total of $7.5 billion to the PRC with the following sector distribution:

Transport	:	44.0%
Water, sanitation, and flood protection	:	26.5%
Energy and mining	:	10.5%
Agriculture	:	7.3%
Public administration and law	:	4.1%
Health and social services	:	3.1%
Education	:	1.8%
Finance	:	1.7%
Industry and trade	:	0.8%

United Nations Development Programme

UNDP is the United Nation's global development network and focuses mainly on technical assistance and institutional development. Since beginning operations in the PRC in 1979, UNDP has completed over 900 field projects ranging from agriculture to industry, energy, public health, poverty alleviation, economic restructuring, and many more. UNDP's main counterpart is the China International Center for Economic and Technical Exchanges (CICETE), under the Ministry of Commerce. UNDP manages financial resources from various sources in support of its development efforts in the PRC. These resources include UNDP Core funding, resources mobilized from the PRC government and other donors to the PRC, resources from global trust funds such as GEF and the Montreal Protocol, and funds from the private sector. In 2001–2005, UNDP mobilized more than $250 million for its program in the PRC.

UNDP has just agreed with the government on a new country program covering the 2011–2015 period, which has the following four main components:

i. Poverty eradication and achievement of internationally agreed development goals, including the Millennium Development Goals (MDGs);

ii. Democratic governance;

iii. Gender equality and the empowerment of women; and

iv. Environmentally sustainable development.

The aim is to mobilize a total of $422 million of resources, of which $32 million would be UNDP regular resources and $390 million would be leveraged from partners.

European Union

The European Union's (EU) Country Strategy Paper 2007–2013 for the PRC has the following three main objectives:

i. To provide support for the PRC's reform program in selected areas where EU experience can provide added value;

ii. To assist the PRC's efforts to address global concerns over the environment, energy, and climate change; and

iii. To provide support for human resources development.

The indicative budget is €330 million, of which about 30% is earmarked for environmentally sustainable development programs. Environmental issues covered include biodiversity, climate change, waste management, water and air pollution, vehicle emissions, environmental indicators, sustainable consumption and production, and environmental impact assessment. Particularly notable programs during the 11th Five-Year Plan included the Natural Forest Protection Program (€22.5 million) to test and demonstrate a range of options for sustainable management of natural forests at the community level, and the Energy/Environment Program (€20 million), which provided technical assistance on energy policy, energy efficiency, and renewable energy.

Australia

The country program (2006–2010) of the Australian Agency for International Development (AusAID) concentrated on building capacity in the governance, environment, and health sectors. The objectives are as follows:

i. To support the PRC's policy reform agenda and build capacity in the areas of governance, environment, and health;

ii. To promote Australia–PRC institutional linkages; and

iii. To work collaboratively with the PRC to strengthen the regional capacity.

The Australia China Environment Development Partnership (ACEDP) works with four ministries to help the PRC improve its environmental protection and natural resources management, particularly in relation to water. Bilateral expenditure in the PRC in 2009–2010 was A$7.35 million, which accounted for about 30% of the bilateral program.

More particularly, AusAID has provided support for the China Council for International Cooperation on Environment and Development (CCICED), coordinated a high-level bilateral dialogue on water policy, and is promoting the establishment of a long-term relationship between the Yellow River Conservancy Commission and the Murray Darling Basin Authority. Water resources management is likely to continue to be a central component of the program, but there is potential to expand the range of issues to include matters of common interest.

Germany

The main agent of German assistance is the Deutsche Gesellschaft für Internationale Zusammenarbeit GMbH (GIZ), which operates in the PRC in fields where Germany has unique experience and comparative advantages. Priority areas include sustainable economic development and environmental policy and energy management. Projects cover urban environmental management, enterprise pollution control, energy efficiency improvement and renewable energy development, forest protection, sustainable agriculture, nature reserve management, climate change, and biodiversity protection.

Italy

Italy first became a donor to the PRC in 2000, and its development cooperation program has grown substantially since that time. As of 2009, 82 environmental projects have been or are being implemented. By the end of 2005, the total contribution from the Italian government amounted to €170 million. Priorities covered energy efficiency, cleaner and renewable energy, implementation of international conventions, air quality monitoring, urban sustainable development and eco-buildings, waste recycling, sustainable transportation, integrated water resources management, ecological conservation and desertification control, sustainable agriculture, and capacity building.

United Kingdom

As earlier mentioned, the UK's bilateral assistance program in the PRC closed in March 2011. The focus in the future will be on establishing a strategic partnership with the PRC that benefits the UK, the PRC, and other developing countries. It is likely that a Global Development Partnerships Program will be established for work on issues of global development significance with middle-income countries.

Conclusion

It may be concluded that the scope and size of bilateral assistance programs in the PRC is declining as its continued economic growth moves it out of the range of economic and social characteristics that most donors use to focus assistance programs and make best use of their scarce resources. The World Bank will continue to be a major partner for large-scale investment programs, but its capacity to deliver grant-based technical assistance is somewhat limited. The UNDP will continue to be an important source of technical assistance for capacity building and related activities. ADB will continue to occupy a unique position for its loan-based investment funds plus grant-based technical assistance resources that it has to offer.

8.5 Policy and Institutional Issues: Environmental Impact Assessment

In July 2009, ADB approved the Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS builds upon the three previous safeguard policies on the environment (2002), involuntary resettlement (1995), and Indigenous Peoples (1998), and brings them into a consolidated policy framework that enhances effectiveness and relevance. The objectives of the SPS are (i) to avoid, or to minimize, and mitigate adverse project impacts on the environment and on affected people; and (ii) to help borrowers strengthen their safeguard systems and develop the capacity to manage environmental and social risks. To achieve the second objective, the SPS includes provisions on the use of country safeguard systems under certain circumstance, and call for long-term partnership program among donor agencies under the framework of the Paris Declaration and the Accra Agenda for Action.

ADB's Environment Policy (2002) was developed to prevent or mitigate adverse environmental impacts of projects supported by ADB, and thus reduce its risk of inadvertently doing environmental harm through its development assistance activities. Other international development assistance agencies, such as the World Bank and bilateral agencies, have fairly similar policies for similar reasons and, somewhat belatedly, even private sector financial institutions have adopted a similar approach through the so-called "Equator Principles."[180]

[180] The "Equator Principles" were developed to ensure that projects financed by signatories to the Principles (Equator Principle Financial Institutions or EPFIs) would be implemented in a manner that is socially responsible and reflects sound environmental management practices. Source: http://www.equator-principles.com/principles.shtml.

The environment policy was originally formulated at a time when many of ADB's client countries, including the PRC, either had no environmental protection policies or had policies that were considerably less stringent than the standards that ADB required. With regard to the PRC, this has changed considerably since the PRC has a functioning and, generally, improving environmental impact assessment (EIA) system that includes provisions for information disclosure, public consultation, and even for quite advanced forms of environmental assessment such as strategic EIA. The quality and effectiveness of EIAs are highly variable across the country, although the Ministry of Environmental Protection (MEP) is taking steps to address this issue.

The SPS is a set of aspirational principles based on international best practices. It contains additional environmental requirements and represents a significant strengthening of ADB's safeguards procedures. In comparison, the EIA system of the PRC is for the most part composed of technical requirements that respond to specific needs. An attempt is made in Table 35 to provide a summary of some of the issues arising from the SPS implementation. While the SPS is more demanding than the 2002 Environment Policy, it provides for the opportunity to assist the PRC achieving higher levels of environmental and social due diligence, assessment and mitigation of development impacts, responding to the rising standards and expectations of the PRC citizens, particularly in the wealthier eastern parts of the country.

Table 35 illustrates that the PRC's country systems are not yet ready to substitute for ADB's internal equivalents and provide ADB with the confidence that they adequately protect ADB's investments against possible environmental and/or social risks. The SPS provides a number of opportunities to further develop local capacity. SPS implementation in ADB-supported projects would also assist in progressively closing the gaps between domestic and international best practices, in such areas as associated and existing facilities, cumulative and induced impacts, depth and effectiveness of public participation, supervision during construction, and post-EIA follow-up. ADB is already maximizing the use of local experts and consultants during project processing. These experts and consultants carry out background studies and prepare preliminary drafts of reports while using experienced international experts as advisers to help local counterparts define the scope of work required, review their work as these are being carried out, and help structure and edit the final reports to ensure that they meet ADB standards.

ADB is working with the World Bank and other international financial institutions (IFIs) on consolidating its approaches.[181] The use of the SPS is expected to continuously strengthen the PRC's country systems and gradually narrow the gap with international best practices, both on policy and implementation levels.

[181] In July 2010, ADB's Board of Directors approved a $5-million regional technical assistance for Strengthening and Use of Country Safeguards Systems (TA 7566-REG), which is open to all DMCs. The main outputs of the subprojects under this TA project include (i) equivalency assessment and capacity assessment of country safeguards systems, (ii) improved safeguard-related legal and/or regulatory reform, (iii) implementation of capacity development, (iv) South–South cooperation (twinning programs), and (v) improved environmental and social management systems for private sector companies. For environment, the regional TA for the most part proposed the strengthening of country safeguards systems.

Table 35 **Summary of Issues Arising from the Implementation of the Safeguard Policy Statement in the People's Republic of China**

Principles of International Best Practices (As espoused by ADB's SPS)	The PRC Regulatory or Specific Technical Requirements/Standards	Implementation/Delivery of the PRC Technical Requirements
Use of a scoping process to determine the appropriate extent and scope of environmental assessment to be carried out.	Scoping is required in the PRC environmental impact assessment (EIA) guidelines to determine the issues of critical concern to be addressed in the EIA.	Projects are screened for classes of EIAs to be prepared; "assessment factors" are screened to determine the extent and scope of assessment.
Geographical scope: Area of influence	The PRC regulatory requirements are more elaborate. For example, the *Technical Guideline on Atmospheric Impact Assessment (HJ 2.2-2008)* stipulates that the assessment boundary is defined as (i) for a point source, the area with a radius of $D_{10\%}$ (distance of a pollutant reaching 10% of its concentration from the emission source) but not shorter than 5 kilometers; and (ii) for a linear source, 200 meters from the center of the emission source. The *Technical Guideline on Noise Impact Assessment (HJ 2.4-2009)* stipulates that (i) for a stationary source, the area of assessment should cover 200 meters from the border of the facility but should extend to the minimum distance that can meet the applicable ambient noise standard; and (ii) for roads, the area of assessment should cover 200 meters from the center of the road but extending to the minimum distance that can meet the applicable ambient noise standard. Both guidelines refer to sensitive receptors.	The requirement is applied in practice.
Coverage of potential direct, indirect, cumulative, and induced impacts.	The PRC regulatory requirements are compatible with ADB environmental safeguard requirement. For example, the *Technical Guideline of Ecological Impact Assessment (HJ 19-1997)* requires that the assessment should cover negative as well as positive impacts, reversible and irreversible impacts, short-term and long-term impacts, one-time and cumulative impacts, explicit and implicit impacts, local and regional impacts.	While the regulatory requirement is in place, the assessment of indirect, cumulative, and induced impacts is often not present nor consistent across EIAs.
	A particular strength of the PRC EIA system is the regulatory requirement for "Plan EIA." EIA of development plans and programs is required in the *EIA Law* of 2003, but it was not enforced until the release of the PRC *Regulation on Plan EIA*, which was proclaimed in 2009. The *Technical Guideline on Plan EEA (HJ/T 130-2003)* and the *Technical Guideline on EIA of Development Zones (HJ/T 131-2003)* cover, in one way or another, cumulative, induced, and indirect impacts.	Plan EIA is a separate process from a project-specific EIA, providing guidance on safeguard issues.

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Table 35 *continued*

Principles of International Best Practices (As espoused by ADB's SPS)	The PRC Regulatory or Specific Technical Requirements/Standards	Implementation/Delivery of the PRC Technical Requirements
Coverage of impacts on the physical, biological, socioeconomic (including livelihoods, occupational health and safety, vulnerable groups, and gender issues), and physical cultural resources. Also assess potential transboundary and global impacts, including climate change.	The regulations require assessment of physical, biological, and ecological impacts, as well as socioeconomic impacts, including agriculture and land use, transport, public heath, historical and cultural relic sites, and valued landscape (e.g., protected areas, scenic and tourist areas, resort areas, hot springs, and political and cultural facilities). The assessment of occupational health and safety, vulnerable groups and gender issues, transboundary and global issues are not required.	While the regulatory requirement is in place, health impact assessment is often not present nor consistent across EIAs. Assessment of occupational health and safety, vulnerable groups and gender issues, transboundary and global issues are normally not undertaken.
Examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts, and document the rationale for selecting the particular alternative proposed. Also consider the "no project" alternative.	Analysis of alternatives (including the "no project" alternative) is not required.	In practice, the alternatives may be assessed in the EIA, feasibility study report (FSR), soil erosion plan, or water permit; but the scope is often limited. The "no development" alternative would not normally be assessed.
Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and enhance positive impacts by means of environmental planning and management.	Impact avoidance, minimization, and compensation (offset) are regulatory requirements in the PRC.	The regulatory requirements are applied but within limited scope.
Prepare an environmental management plan (EMP) that includes the proposed mitigation measures, environmental monitoring and reporting requirements, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators. Key considerations for EMP preparation include mitigation of potential adverse impacts to the level of no significant harm to third parties, and the "polluter pays" principle.	Environmental monitoring and reporting are not required in an EIA. The PRC environmental protection regulations require an "environmental audit upon project completion" and regular compliance monitoring by the local environmental protection bureau (EPB) of emissions and discharges once the project becomes operational.	EMP is prepared in practice for each EIA. Cost estimates for mitigation measures (or "environmental protection investment" in the PRC EIA reports) are done. EIAs usually do not have provisions for environmental monitoring, supervision, and reporting, as well as institutional arrangements, capacity-building measures, implementation schedule, and performance indicators.

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Table 35 *continued*

Principles of International Best Practices (As espoused by ADB's SPS)	The PRC Regulatory or Specific Technical Requirements/Standards	Implementation/Delivery of the PRC Technical Requirements
Carry out meaningful consultation with project-affected people and facilitate their informed participation. Ensure women's participation in consultation. Involve stakeholders, including affected people and concerned nongovernment organizations, early in the project preparation process and ensure that their views and concerns are made known to and understood by decision makers and taken into account. Continue consultations with stakeholders throughout project implementation as necessary to address issues related to environmental assessment. Establish a grievance redress mechanism to receive and facilitate resolution of the affected people's concerns and grievances regarding the project's environmental performance.	Information disclosure and public consultations are required. The *Interim Guideline on Public Participation in EIA (2006)* stipulates the information disclosure and public participation requirements.	Information disclosure is undertaken (one week from signing of the EIA contract, and first draft of the EIA). Both internet and public posters are used. Public consultations are usually done through questionnaire surveys, and the results are reported in the EIAs. But the scope and depth are often not meaningful to identify public concerns. Grievance redress mechanism is usually not included in the EIA.
Implement the EMP and monitor its effectiveness. Document monitoring results, including the development and implementation of corrective actions, and disclose monitoring reports.	Environmental monitoring and reporting are not required in an EIA. Ambient compliance monitoring system is in place. However, the system of monitoring by polluters and the verification of the depth of their monitoring are yet to be put in place.	Compliance monitoring by EPBs through their monitoring stations is in place.
Do not implement project activities in areas of critical habitats, unless (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated. If a project is located within a legally protected area, implement additional programs to promote and enhance the conservation aims of the protected area.	The PRC regulations contain certain specific requirements.	While the regulatory requirements are applied, there is a lack of consistency in actual practice.

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Table 35 *continued*

Principles of International Best Practices (As espoused by ADB's SPS)	The PRC Regulatory or Specific Technical Requirements/Standards	Implementation/Delivery of the PRC Technical Requirements
In an area of natural habitats, there must be no significant conversion or degradation, unless (i) alternatives are not available, (ii) the overall benefits from the project substantially outweigh the environmental costs, and (iii) any conversion or degradation is appropriately mitigated. Use a precautionary approach to the use, development, and management of renewable natural resources.	The PRC regulations specify similar requirements.	There is a lack of consistency in the application of the requirements.
Apply pollution prevention and control technologies and practices consistent with international good practices as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety (EHS) Guidelines. Adopt cleaner production processes and good energy efficiency practices.	Pollution prevention and control are part of the PRC regulations. EIAs are required to report on energy conservation and emission reductions.	While the EIA's emphases are on pollution prevention and control and energy efficiency, health and safety aspects remain weak.
Avoid the use of hazardous materials subject to international bans or phaseouts.	This is covered in the PRC regulations, specifically the *Technical Specifications on Identification of Hazardous Wastes (HJ/T 298-2007)*. There is a series of hazardous wastes disposal standards. In particular, health risks related to asbestos and asbestos-containing materials (ACM) are increasingly recognized as issues in ADB projects, especially related to deconstruction of old facilities such as factories and heating boilers. In the National List of Hazardous Wastes released jointly by MEP and the NDRC, asbestos-containing wastes are prescribed as hazardous wastes (code HW36). But wastes from mining and manufacturing industries only are listed. Asbestos-containing wastes from deconstruction of old facilities are not on the list.	The application is inconsistent across EIAs. Health risks related to ACM are rarely covered in EIAs in the PRC.

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Table 35 *continued*

Principles of International Best Practices (As espoused by ADB's SPS)	The PRC Regulatory or Specific Technical Requirements/Standards	Implementation/Delivery of the PRC Technical Requirements
Purchase, use, and manage pesticides based on integrated pest management approaches; and reduce reliance on synthetic chemical pesticides.	This is covered in the PRC regulations, specifically the *Technical Guideline on Environmental Safety Application of Pesticides (HJ 556-2010)*.	The regulatory requirement is applied, although inconsistently.
Provide workers with safe and healthy working conditions; and prevent accidents, injuries, and disease.	Workers' health and safety are not part of the PRC EIA regulations, but it is a regulatory requirement in the PRC.	Workers' health and safety are normally not covered in the PRC EIAs.
Establish preventive and emergency preparedness and response measures to avoid, and where avoidance is not possible, to minimize, adverse impacts and risks to the health and safety of local communities.	The PRC has stringent requirement for regulatory emergency, including environmental emergency, preparedness, and response, but they are not part of the EIA regulations.	Emergency preparedness and response are not covered in EIAs.
Conserve physical cultural resources and avoid destroying or damaging them by using field-based surveys that employ qualified and experienced experts during environmental assessment. Provide for the use of "chance find" procedures that include a pre-approved management and conservation approach for materials that may be discovered during project implementation.	The PRC has regulations for the protection of physical cultural resources. The EIA regulations also require the assessment of impacts on valued landscape (including, e.g., protected areas, scenic and tourist areas, resort areas, hot springs, and political and cultural facilities).	Sensitive receptors for physical cultural resources are required to be identified and impacts assessed. However, implementation is weak due to loose enforcement and low capacities of local governments.
Assessment of associated facilities	The PRC regulations do not have the provision for the assessment of associated facilities.	EIAs do not contain assessment of associated facilities.
Assessment of existing facilities	The *General Technical Guideline on EIA (HJ 2.1-2011)* requires the consideration of (i) the combined pollution effects of the environmental baseline, and existing projects and projects under construction; and (ii) the allocated quotas of nationally prescribed major pollutants (COD, SO_2, NO_x, NH_3-N, TN, TP) in the project area.	Existing projects are described in the EIA as existing pollution sources and treated as part of the environmental baseline. Projects under construction or proposed are seldom described or considered in the EIA. The quota system for the nationally prescribed major pollutants is in place. The proponent is required to apply for quotas for the proposed project on a prior basis. The EIA is required to discuss the quota allocations for the project area, and to assess if the emissions and discharges of proposed project are within the allocated quotas for the project and for the project area.

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Table 35 *continued*

Principles of International Best Practices (As espoused by ADB's SPS)	The PRC Regulatory or Specific Technical Requirements/Standards	Implementation/Delivery of the PRC Technical Requirements
SPS is a set of aspirational principles assuming their full implementation.	The PRC system is, for the most part, a set of specific technical requirements, responding to identified specific needs.	The ability of the PRC system to deliver on its technical requirements is affected by the still low enforcement levels and its environmental management issues, including various mandates of the cities, provinces, state and river basins, their complex relationship with MEP's central and local agencies, the overlap of responsibilities of different ministries, the often conflicting technical assessments by different ministries/authorities based on varying assumptions/goals, the lack/beginning of licensing system, and the lack of process control and troubleshooting approach to managing environmental utilities, etc.

ADB = Asian Development Bank, COD = chemical oxygen demand, MEP = Ministry of Environmental Protection, NDRC = National Development and Reform Commission, NH_3–N = ammonia nitrogen, NO_x = oxides of nitrogen, PRC = People's Republic of China, SO_2 = sulfur dioxide, SPS = Safeguard Policy Statement, TN = total nitrogen, TP = total phosphorus.
Source: ADB.

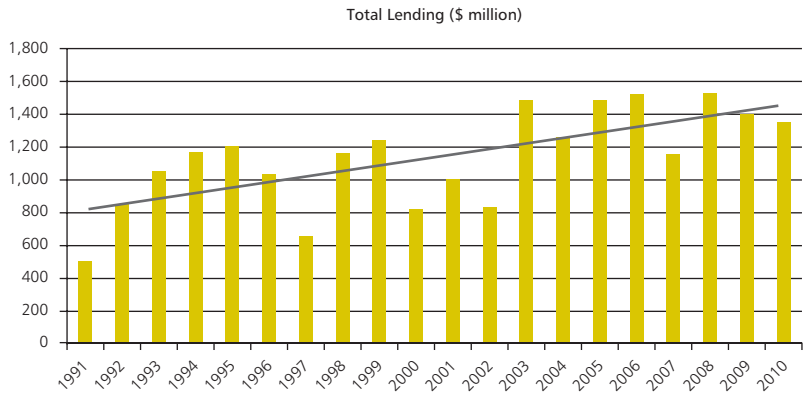
8.6 Assessment of ADB Performance in the People's Republic of China

In 2003, the government and the two multilateral banks—ADB and the World Bank—agreed that each bank would have an annual lending between $1.0 billion and $1.5 billion. ADB's annual lending since 2003 has met the lending target (Figure 26).

During the 11th Five-Year Plan, ADB continued to restructure its program for maximum alignment with the PRC priorities. This restructuring took place in two dimensions:

- **Inter-sectorally**, the share of transport sector lending, in terms of dollar amount, declined from 74% of the portfolio during the 10th Five-Year Plan to 50%. The decrease was taken up by the urban and social sectors, which increased from 10% to 28%, and by the environment, natural resources, and agriculture sector with an increase from 7% to 15%. To a large extent, these changes reflected the evolving priorities of the government. Between the opening of the PRC's first international standard expressway in 1988 (the 18.2-kilometer long Shanghai–Jiading Expressway) and the beginning of the 11th Five-Year Plan, the total length of operational expressways in the PRC—a major subsector of ADB lending—had increased to 40,000 kilometers (km). Similarly, the total length of operational railways, another major sector of ADB lending, reached 75,000 km. Clearly, the PRC was in much less need of assistance building expressways and railways. The new issues it was confronting were urbanization, agricultural and rural development, and natural resource management, and these were reflected in ADB's investment program.
- **Intra-sectorally**, the lending priorities for each of the four sectors for the 11th Five-Year Plan also showed changes consistent with the government's strategy of building an "environment-friendly and resource-efficient society" with

Figure 26 **ADB Lending, 1991–2010**



Source: ADB.

the top priorities being energy conservation and emission reduction. In the transport sector, ADB programming moved from construction to maintenance, traffic safety, and energy efficiency improvement. In the energy sector, greater emphasis was placed on energy efficiency, emission reduction, and coal-bed and coal-mine methane. For the urban and social sector, lending on urban wastewater and solid waste management, environmental rehabilitation, disaster mitigation, and regional cooperation gained prominence. For the agriculture, environment, and natural resources sector, lending priorities covered comprehensive agriculture development, rural water supply, irrigation, biomass utilization, rural energy, wetland and forest ecosystem protection and rehabilitation, and integrated water resources management.

While the lending program was notably responsive to the government's changing priorities and needs during the 11th Five-Year Plan, the TA program, in terms of volume, was less significant. In the rapidly changing development environment in the PRC, the value of knowledge transfer, which the TA program delivers, is arguably increased. During the 11th Five-Year Plan, the size of ADB's non-project preparatory technical assistance (non-PPTA) actually improved, representing a reversal of the decline that occurred between the 9th and 10th five-year plans (Table 36).

Although the total dollar amount is small, a TA project has the potential to generate significant value-added in terms of promoting needed policy reforms and generating needed knowledge products relevant to the government's priority development objectives. With most of the bilateral development agencies phasing out or planning to phase out of the PRC and the World Bank having limited access to grant-based TA resources, ADB is the only international agency likely to be able to deliver significant TA resources in the future. In this context, it is essential that the growing trend in TA volume experienced during the 11th Five-Year Plan period be sustained.

Table 36 **Non-Project Preparatory Technical Assistance Delivered during the 9th, 10th, and 11th Five-Year Plans**

	Planning Period		
	9th (1996–2000)	10th (2001–2005)	11th (2006–2010)
Number of non-PPTA (% change)	99	92 (–7%)	102 (11%)
Total value (million) (% change)	$63.6	$50.8 (–20%)	$62.6 (23%)
Average annual value (million) (% change)	$12.7	$10.2 (–20%)	$12.5 (23%)

PPTA = project preparatory technical assistance.
Source: ADB.

8.7 Strategic Directions of the People's Republic of China and Possible Areas of ADB Assistance

As the PRC economy continues to expand, the need for foreign currency will become less obvious than the need for advanced technologies and management skills. Moreover, the fast-expanding private sector has gradually taken over the commercial sectors where there are vast opportunities for profits, and has moved into some public infrastructure sectors where the potential for profits has begun to emerge (e.g., urban sewage treatment). This raises the question whether ADB should continue to finance the types of conventional income-generating projects, in competition with the private sector, or reorient its lending toward low- or non-income-generating environmental and social services areas. The latter reorientation, together with the continued provision of knowledge products that respond to the priority policy and capacity building needs of the country, would enhance ADB's relevance and value-added to the economic and social development of the PRC.

The enhancement of ADB's relevance and value-added to the fast-evolving economic and social situation rests with being (i) responsive to the priority needs of the PRC for building a harmonious, resource-efficient, and environment-friendly society; (ii) innovative to mobilize financing for non-income-generating and low-income-generating environmental and social services; (iii) catalytic to lead the way for downstream private sector investments; and (iv) demonstrative for replication, including the use of ADB funds to demonstrate the effectiveness and efficiency of using public funds on environmental and social services.

ADB will align its support closely with the objectives of the 12th Five-Year Plan as well as with ADB's environmental policy. The environmental challenges facing the PRC cut across the sector categories through which ADB designs and delivers its country program. Because of this crosscutting nature, the best approach to the environmental agenda is by embedding consideration of environmental issues into the various sector programs—an approach that is being successfully followed in the current country partnership strategy and should be continued into the next. Chapters 2, 3, and 4 established that, although environmental performance under the 11th Five-Year Plan was a considerable improvement over the 10th Five-Year Plan, the current environmental situation is not satisfactory and the environmental challenges will continue to be formidable under the 12th and subsequent five-year plans. The main factors defining the nature of the environmental challenges will be (i) the macroeconomic structure, which is likely to change only slowly and thus remain a major impediment to an environmentally sustainable development; (ii) the structure of the energy sector, which is likely to be dominated by coal for the foreseeable future; (iii) the continuing pressure of urban development, which will be unavoidable and for which new and innovative approaches need to be developed to provide a better balance between continued expansion and the environmental quality; (iv) the declining quality of the rural environment, ranging from the chronic problem of the overuse of agrochemicals to pollution; and (v) the degradation of water, forest, and land resources, which threatens local livelihoods and the ecological security of the country.

Chapter 5 discussed the climate change agenda and outlined the government's approach and plans for addressing climate change. The government is serious about its climate change agenda, and all the leading agencies are working to incorporate this agenda into the plans and strategies. It has to be said, however, that some of the government's objectives, particularly the energy mix, are very ambitious and may be very difficult to achieve.[182] Climate change will be a crosscutting issue that should be considered throughout ADB's assistance program.

Chapter 6 outlined the considerable advances to improving the policy and institutional frameworks for an environmentally sustainable development during the last two five-year plans, noting that this is an ongoing work and further advances are needed in the 12th and subsequent five-year plans to meet the continuing challenges. The issue of the fiscal dimensions of environmental protection is a means of adding to the sense of urgency that should be felt about fiscal reform in the PRC. ADB is already supporting the reform agenda through technical assistance and studies, but more can be done.

Chapter 7 outlined the strategic framework for environmental protection. As a result of work commissioned during the 11th Five-Year Plan, MEP has articulated a long-term, macro-environmental strategy that sets out and prioritizes the main issues that will need to be addressed if the PRC is to see a comprehensive improvement in environmental quality by 2030. Work has already begun on many of the priority issues, and the agenda will be pushed further forward during the 12th Five-Year Plan. Overall, the environmental strategy for the 12th Five-Year Plan represents a continuation of the strategy that produced successful results during the 11th Five-Year Plan, combined with a widening of the range of environmental indicators being addressed and the increased use of regional and sector approaches to deal with certain environmental issues.

All of the above represent issues that cut across the sector structure to ADB's country partnership program. Below are suggestions on how these issues can be taken into account in the four main sector programs and related knowledge sharing.

Environment, Natural Resources, and Agriculture

ADB has been active and thus accumulated considerable experience in a wide range of subsector areas including sustainable forestry development, biodiversity preservation, eco-tourism development, wetland protection, water pollution reduction and lake restoration, land degradation prevention, and integrated agricultural development. While ADB will continue to provide financial and technical assistance to these projects in the PRC, there are a few areas to be highlighted where ADB can make potentially high value addition.

[182] The recent emergence of "unconventional gas" as a potentially significant fossil fuel resource that could offer both GHG and air quality benefits is a reminder that the climate change agenda is constantly shifting and needs to be the subject of continual review.

Continued support for the eco-compensation agenda

The NDRC, MEP, and ADB have already established a productive working relationship to help turn the broad and all-encompassing idea of "eco-compensation" into something tangible and operational. Three international conferences have been organized. The conferences provided a platform for subnational governments, who are trying to operationalize the eco-compensation concept, to discuss the practical problems they are encountering so that these experiences can be incorporated into the Eco-Compensation Ordinance that is presently being drafted, and into the design of future projects. In addition, ADB is already investing in pilot programs to operationalize some eco-compensation concepts through projects such as the Guiyang Integrated Water Resources Management Project (Loan No. 2573) and the Yancheng Wetlands Protection Project (Loan No. 2838). ADB needs to maintain its financial support to the NDRC and MEP for the completion of the knowledge generation program and publication of the results. It then needs to follow up by identifying possible pilot projects designed to operationalize some of the eco-compensation concepts being discussed, in consideration of the government priorities for the 12th Five-Year Plan including transfer payments for the protection of key ecological function regions and drinking water supply sources, establishment of a national ecological compensation fund, implementation of a sustainable development reserve fund for resource-based industries, and introduction of market-based ecological compensation mechanisms.

Small-scale TAs to test innovative ideas with willing counterparts, with respect to market-based instruments, private sector participation, public–private partnerships and community co-management in protected areas, catchment protection and rehabilitation, ecological flows and transboundary pollution, are worth pursuing. In addition to investments, there will also be opportunities for capacity building and training (especially for lower levels), for the preparation of technical manuals, and the development of knowledge centers.

Support to rural environmental protection and rural energy with emphasis on management of animal wastes

Demonstrating appropriate (practical, affordable, and culturally sensitive) technologies and approaches to managing consumption of resources, use of agrochemicals, agricultural wastes and household wastes provides an opportunity to simultaneously make contributions to the public health and environment. Among the top priorities of lending and non-lending interventions are integrated approaches to agricultural pollution through the introduction of Environmental Farm Planning, environmental planning at the village and township levels in combination with building the socialist new countryside program, water efficient agriculture, integrated pest management, and balanced fertilizer application.

ADB could continue to provide support for the installation of small-scale, household-level biogas digesters and for the development of large-scale biogas digesters at medium- and large-scale livestock enterprises which continue to be government priorities, but it needs to ensure that its participation will promote innovation. One of the main areas for development and innovation will be through environmentally sustainable

management and disposal of digester sludges, particularly from medium- and large-scale enterprises. There may also be opportunities to work with the Ministry of Agriculture (MOA) to promote environmentally sustainable practices among small- and medium-scale specialized household animal production enterprises. Opportunities could include training and extension for the design and construction of environmentally sustainable animal housing units, and farmers' education. Other related activities that might provide opportunities include crop residue utilization, support for energy-saving stoves, support for energy crop development, and community-, institution- and household-based rural solar and wind energy.

ADB could also support MOA's efforts to strengthen fertilizer management through activities such as (i) promotion of soil testing and fertilizer formulation technologies, (ii) improved quality of cultivatable land including promotion of the use of organic fertilizers, (iii) improved soil quality monitoring programs and the use of water-saving agricultural techniques, (iv) increased farmers' education, (v) encouragement of the adoption of advanced production techniques within the fertilizer production industry, and (vi) tightening up regulatory supervision. The way to support this agenda is by mainstreaming these strategies into rural development projects, as opportunities arise. Environmental Farm Planning and rural environmental planning with respect to safe disposal of household wastes could also be piloted.

Soil contamination

MEP plans to carry out a national soil contamination survey during the 12th Five-Year Plan period. ADB may be able to provide TA resources to assist in the planning and design of a national survey to ensure that adequate account is taken of international standards and experiences, and for the development of training and awareness programs. There may be downstream opportunities to provide implementation support for the procurement of vehicles and equipment for the survey and for demonstration methods for remediating contaminated soil using techniques such as aeration, bio-remediation, phyto-remediation, and other technologies.

Providing support to MEP for further development of the National Environmental Information Center may also be considered. MEP has already commenced a program to build analytical capacity at provincial, county, and township levels, and this program is likely to continue throughout the 12th Five-Year Plan period. There will be potentially significant TA needs on issues such as environmental data analysis, prediction, policy impact assessment, quality assurance and quality control procedures, and related matters.

Food safety and green agriculture

There is already a local demand for green food, and it is reasonable to expect that this will increase as incomes rise and living standards improve. The greatest barrier lies in how to connect the green farmers with the markets, and how to create trust among consumers that "green-labeled" products are really green. The State Environmental Protection Administration (SEPA), and subsequently MEP, has been a strong advocate of the concept of "green food" in the PRC; and MOA has been operating a "green food" labeling system since 1990, which has been described as "one of the most successful

eco-labeling programs in the world" (Giovannucci 2005, p.3). Thus far, ADB has not really made much effort to push MOA's green food agenda through lending projects, thus missing an opportunity to support an ongoing government program that, by all accounts, seems to have been very successful and one that supports the government's efforts to improve the rural environment.

ADB could play a useful supporting role by considering opportunities to promote green food production and participating in MOA's green food labeling program through rural lending projects. Supporting activities could include creating links to the green food labeling program, training and capacity building, and even the acquisition of suitable technology and training for certification and localized input production, where conditions are suitable. Under certain circumstances, it may also be possible to promote the development of mutually beneficial partnerships between farmers and private firms. Moreover, green food is not only about production and labeling, but also markets and sales which are dominated by counterfeit products. Opportunities exist to expand food safety and green agriculture from production and labeling to marketing and sales.

Climate adaptation and carbon sequestration in agriculture and natural resources sectors

ADB will continue to promote a climate-resilient development in agriculture, water, and other vulnerable sectors. Disaster risk management will be incorporated into national development plans and country partnership strategies. The design of all agriculture and natural resources management projects needs to consider climate change adaptation possibilities, and wherever suitable, projects will include relevant components in some shape or form. Assistance will be provided to policy studies and to the demonstration of structural and nonstructural measures to combat climate change in agriculture. Financial resources will be continuously channeled to climate-proofing projects, such as drought management, flood protection and management, integrated water resources management, and wetlands protection.

Given terrestrial ecosystems' (soil, biomass, and forestry) carbon capture and sequestration functions, ADB will increase its support in sustainable forest management and conservation, agricultural land use improvements, grassland management, and integrated ecosystem-based land degradation prevention, thereby helping the PRC secure people's livelihoods while achieving carbon sequestration.

Environmental and climate change "co-benefits"

There are considerable interconnectivities between the climate change agenda and the pollution control agenda. Some GHGs—such as nitrous oxide (N_2O) and perflourocomponds (PFCs)—are also air pollutants, while other GHGs—such as carbon dioxide (CO_2) and methane (CH_4)—are produced by the same sources that produce conventional air pollutants. Thus, there are many opportunities within the broader environmental agenda that produce environmental and climate change "co-benefits" through carefully thought-out policy and investment interventions. ADB may explore these opportunities through the underwriting of appropriate research, studies, conferences, and possibly even investment projects.

The PRC has been experimenting with water and air pollution emissions trading since the late 1980s. To promote carbon trading in the PRC as a cost-effective means to reduce carbon emissions, ADB may support a study, jointly with the NDRC and MEP, to review the current status of the existing environmental exchange platforms and trading programs. The study can draw valuable lessons for developing carbon trading programs in the PRC.

Urban Development

The present approach to urban and social development already has a very strong urban environmental improvement character, with support being provided to a wide range of initiatives in urban transport, water supply, drainage, sanitation, solid waste management, central heating, environmental rehabilitation, and disaster prevention. However, as the program moves forward, certain aspects of the agenda need to be emphasized. For example, urban wastewater reuse will be promoted in the 12th Five-Year Plan, and there will be an opportunity for ADB to get involved in studies and projects supporting urban wastewater reuse.

Fiscal dimensions of urban development

As discussed in Chapter 6, the reform of the fiscal system is an essential element needed to underwrite national development. ADB can help by continuing to finance studies on the subject and by participating in ongoing reform efforts. For example, it has been announced that Shanghai and Chongqing will soon commence a pilot program to levy a property tax on owner–occupiers of land as a means of curbing property speculation and to reduce local government reliance on land auctions as a source of income.[183] Depending on the success of these experiments, a variety of training and TA needs could ensue in areas such as land and property valuation, data management, and others.

The decision to upgrade significantly the wastewater treatment plant (WWTP) standards in certain cities under the 12th Five-Year Plan will be enormously expensive and add to the problems that municipal governments are already experiencing in funding operation and maintenance of sewage treatment infrastructure. There will be an opportunity for studies to be conducted to help (i) refine the policy, (ii) develop analytical approaches to assess whether upgrading the standard is the best or only solution to discharge problems in all circumstances, and (iii) identify alternative treatment options that may be more cost-effective. This policy will also result in significant increases in sludge production and heighten the need for further research and investment in disposal and recycling operations.

The promotion and marketing of reclaimed water in urban areas have the potential to mitigate the problem that municipal governments are experiencing in funding the operation and maintenance of wastewater treatment infrastructure, and this will be supported under the 12th Five-Year Plan. Again, this will create an opportunity for ADB to get involved in studies and projects aimed at promoting wastewater reuse.

[183] *New York Times.* 2011. [The People's Republic of] China to Allow Select Cities to Impose Property Taxes. 27 January.

ADB has already underwritten a study on the use of market-based instruments for water pollution control (Chinese Academy of Environmental Planning 2011). The next stage should be piloting and demonstration of some of the recommended mechanisms in selected cities in the Tai Lake watershed. The application of eco-compensation approaches in urban settings could be considered, for example, to protect urban water supply sources. Efforts like this might be employed in medium- and small-sized cities, which may be more interested in new ideas but do not have the planning and implementation capacity of the larger cities.

There may also be opportunities to apply the eco-compensation concept to the provision of urban environmental services. The objective would be to adjust relations among the stakeholders in urban environmental protection on the basis of service values, cost of ecological conservation, opportunity cost, and via government and market mechanisms.

Urban planning

This agenda should be pursued through a combination of technical assistance, studies, and investments to turn new planning concepts into reality. The possibilities under the urban planning agenda will depend, to a large degree, on the findings and conclusions of the *Policy Study on Strategic Options for Urbanization* (TA-7533 PRC), which is still ongoing.

One of the keys to improved urban planning is to increase focus on "improving urban livability." From the environmental perspective, this may include the following:

- **Land-efficient urbanization.** The present urbanization pattern has not given much consideration to the efficient use of land, thereby exacerbating the alarming reduction in prime arable land that has been occurring in recent years. Studies are required to highlight what is driving the present inefficient approach, and what changes are needed to improve development density without compromising urban environment quality.
- **Integrated urbanism.** Working with small city administrations and relevant local research institutes, what is needed to realize the objectives of an "integrated urbanism" that incorporates the concepts of liveable, human-centered, low-carbon, and climate-resilient development? How can this be equated with other urban development objectives such as the provision of appropriate services, equality of access to services, environmental sustainability, heritage conservation, appropriate technology, energy efficiency, efficient transport, and regional integration?
- **Comprehensive approach to urban air pollution control.** What planning strategies can be applied to control urban air emissions, including transport planning, open space provisions, lot development standards, and others?

Solid waste and sludge management

Given the scale of the solid waste management problem in the PRC and the prospects for future increases, attention should be given to dealing with the challenge where circumstances permit. Some of the main opportunities for improvement that might

be studied, piloted, and/or implemented under urban development projects include the following:

- Support for the construction of solid waste treatment, reuse and disposal systems, and improved waste collection systems;
- Support for methane capture and utilization at municipal landfills;
- Support for recycling programs including study on market-based instruments in promoting utilization of sewage sludge;
- Strategic planning and investments for the treatment and beneficial use of sewage sludge;[184]
- Management of construction, demolition waste, and hazardous wastes including asbestos and "e-wastes;"
- Promotion of environmentally sound closure of polluting factories and support for the decontamination and rehabilitation of these "brownfields;" and
- Support for capacity building at local level to identify, manage, and monitor toxic and hazardous wastes.

Consideration may also be given to providing material support for the toxic and hazardous waste monitoring components of MEP's ongoing program for the development of a solid waste center to build solid waste management capacity on a national basis. The work commenced in 2008 and has 31 subprograms. It includes the development and management of a national database to track imports, exports, and the transformation of toxic and hazardous wastes into less hazardous forms. MEP may need to look for technical support for the following:

- Development of an online database;
- Development of emergency management procedures for toxic and hazardous wastes;
- Monitoring of trading in hazardous wastes;
- Strengthening interconnection between all four levels of government;
- Development of data analysis and decision-support systems;
- Application of new technologies; and
- Establishment of 2–5 city-level pilot sites.

Pursuing low-carbon and climate-resilient urbanization

Future support for urban sector should mainstream the climate change agenda by incorporating the concept of low-carbon urbanization through the (i) introduction of energy-efficient urban transport systems, (ii) waste minimization and reuse, (iii) promotion of low-carbon approaches to sewage sludge management, (iv) promotion of green building technology, and (v) use of renewable energy. At the same time, support

[184] A study on sewage sludge treatment and beneficial utilization is currently being finalized (TA 7083-PRC).

should be provided for climate change adaptation through the use of natural and artificial wetlands for storm water retention, rainwater harvest and reuse for northern cities, promotion of urban wastewater reuse, permeable road surfaces (especially for nonmotorized lanes and sidewalks), structural and nonstructural measures for climate-resilient urban drainage and flood control, and disaster prevention. For coastal cities that are particularly vulnerable, ADB should support risk assessment and adaptation studies.

ADB can also assist with the formulation of criteria and standards for measuring urban carbon intensity and climate resilience. Specific opportunities include the following:

- Support through project design of a customized approach to climate vulnerability and climate adaptation, allowing for the introduction of climate proofing with the various scenarios of urban economic and population growth planning, and promoting the synergy of climate change adaptation and disaster risk reduction;
- Promoting the application of advanced technologies (e.g., use of natural and artificial wetlands for storm water retention, rainwater harvest and reuse for northern cities, and promotion of urban wastewater reuse) for climate adaptation;
- Support for investments in alternative energy development (solar and wind), carbon sequestration, and low-carbon sewage sludge management; and
- Training and technical assistance to strengthen capacity in small- and medium-sized cities to address climate change.

Energy

Given the government's ambitious climate change objectives, the need for innovation in the energy sector is likely to assume even greater importance in the 12th and subsequent five-year plans. In addition, the revised Energy Conservation Law, which became effective in 2008, has added to the importance of the energy conservation agenda in the PRC. The role of ADB will be to encourage and participate in first-of-a-kind innovative projects, wherever possible. The scope of the program will depend on the outcome of ongoing climate change negotiations, which have the potential to provide large, concessional financing support. The key elements of the energy sector strategy are likely to include the following:

- Improving energy efficiency and promoting resource conservation;
- Developing cleaner and renewable energy sources;
- Promoting the commercialization of energy utilities and developing market-based instruments; and
- Promoting cleaner production and clean energy technologies.

Many elements will be mainstreamed through other sector programs (e.g., increased efficiency of urban heating systems through urban sector programs). From an environmental point of view, there would be particular opportunities.

Energy efficiency and emission reductions

The existing ADB program already includes a substantial portfolio of technical assistance and lending to support energy efficiency improvements (e.g., TA on Energy Efficiency and Resource Conservation, and loans to develop energy-efficient power plants in Guangdong and energy conservation and emission reduction in Shandong). These programs should be continued to support the phaseout of small-scale and inefficient power plants and their replacement by larger and more efficient units, a program that will be continued into the 12th Five-Year Plan.

There should also be opportunities in industrial energy efficiency upgrades, including changes in production technology and processes that may be tied in with the promotion of clean production initiatives. Similarly, there is considerable potential for studying and promoting improvements in the energy efficiency of municipal infrastructure, such as street lighting, pumps for water and sewage systems, optimizing pipe designs and sizes, and the development of uniform standards.

Renewable energy

The announced target of 15% energy from renewables by 2020 will require early demonstrations of new low-cost, low-risk but high-impact renewable energy technologies. ADB is already heavily engaged in this through a sequence of rural biomass energy projects, clean energy (hydropower) development in Gansu Province, and the development of wind farms. Technical assistance is already underway on renewable energy for poverty reduction (including corn stalk gasification) and the development of shale geo-energy production systems, which may lead to investment opportunities. Studies will also be needed on "smart-grid" options to connect wind and solar generators into the national grid and accommodate the fluctuating supplies.

Clean coal technologies, coal mine methane, and coal bed methane

Clean coal technologies will be a high priority to match energy security with environmental sustainability. Business-as-usual coal usage without advanced clean coal technologies will undermine the government's carbon-intensity reduction target. Technical assistance on carbon capture and storage (CCS) is already underway, and this may lead to future investment opportunities. Studies are also underway on waste coal utilization, which may lead to investment.

Coal mine methane (CMM) provides large climate change benefits by capturing methane and, at the same time, improves coal mine safety. ADB is already financing the development of the world's largest CMM-based power plant in Shanxi Province. There may be potential for further studies and investments to develop the concept further by combining CMM with ventilation air methane (VAM).

Support for development of unconventional gas reserves

Technology for accessing and recovering unconventional gas reserves has developed significantly in recent years and may offer great opportunities for the PRC to considerably increase the role of gas in the overall energy mix. Technology development is likely to be spearheaded by the large state-owned enterprises and, possibly, by international firms. However, many policy questions will also be raised, such as the following:

i. How will unconventional gas development impact the PRC's future energy scenarios and what effect will this have on overall GHG emissions?

ii. How will coal and unconventional gas developments in the PRC compare in terms of GHG emissions, pollutant (air and water) emissions, regional environmental quality, and water source protection?

iii. What pricing and policy initiatives will be required to ensure that unconventional gas substitutes for coal?

ADB is uniquely well-positioned to assist the government in addressing and resolving these questions.

Transport

Transport sector development in the PRC will have critical implications for both the environmental and climate change agenda. If the PRC goes even halfway toward the United States in terms of car ownership, the country will be faced with an untenable environmental situation. There is a need for a change in the incentives structures (e.g., taxation reform, development of incentives for production, and use of more fuel-efficient cars) and development of alternatives to private cars (e.g., public transport including commuter rail in cities where topographical conditions are right) through both investments and improvements in urban planning. Some of the key elements of support for environmentally sustainable transport sector development in the PRC should include at least some of the following elements.

Support for institutional and policy reforms

Support should be provided for an administrative reform that would ultimately lead to the creation of a single Ministry for Transportation that is responsible for all transport modes. The creation of a national transport fund may be considered to underwrite national sustainable transport development and direct funds to areas of critical needs, such as urban public transport, rural road construction and maintenance, and the development of sustainable transport technology, transport for the disadvantaged, and safer bicycle and pedestrian ways.

Policy and planning studies should likewise look at improving the incentive frameworks and changes in the taxation system (e.g., replacing the existing taxes on sales of cars as a source of road improvement funds with a fuel tax) that would encourage increased energy use efficiency and dampen increases in demand for cars.

Investments to promote environmentally friendly modal shifts

This would mainly involve investments in railways and inland waterways development, both of which offer the potential for significant improvements in transport efficiency. Railway investments might provide support for the construction of high speed passenger rails services, urban rail transit, and heavy freight transportation corridors, particularly in the western regions and for coal transportation. Funding for inland waterways needs to be put on a more stable basis, the legal framework needs to be improved, and better

inter-department coordination needs to be achieved to overcome problems relating to water conservation and hydroelectric power generation.

Improved integration of transport and urban planning

Transport needs are not adequately taken into account in urban planning in the PRC, and there is an opportunity for ADB to push this agenda through the provision of technical assistance and to support innovation through urban sector investments. Land use and infrastructure have a huge role in determining mobility needs—by developing an urban structure that provides all kinds of services locally for inhabitants, less transport will be needed. Mobility choices, like good access to public transport, are easier to achieve when integrated planning is the norm. Such planning would take into account the rational use of corridor resources, strengthen the planning and construction of intermodal terminals and hubs, and realize coordinated development between transport modes.

Technical assistance could be supported to develop modern urban mobility management concepts and provide guidelines for the design of new cities and develop existing ones. Important objectives would be to get transit-oriented development measures (e.g., multiple-mode transport corridors) included in urban master plans, to strategically shift urban plans to reduce overexploitation of central urban areas and minimize urban sprawl, to make provision for public transport and nonmotorized vehicle use, and to give first priority to public transit.

Knowledge support to sustainable transportation development

Technical assistance could be provided to underwrite the preparation of strategic environmental assessments for policies, plans, and programs relating to transport sector development as a means to develop cost-efficient and benefit-sustainable transport systems. Technical assistance could also be provided to study the costs and benefits of current vehicle fuel consumption standards in the light of national climate change and air pollution control objectives, and recommend possible acceleration of current plans to tighten standards.

Studies could be supported to develop policies for the research, popularization, and use of clean alternative energies, including strategies for phasing in their use (e.g., using them first in buses and government vehicles), and encourage the development of high-efficiency vehicles including formulation of policies to focus on the introduction, research, and industrialization of the hybrid synergy drive.

Further ideas might include the (i) development of an effective alternative to CDM for the transport sector, (ii) collaboration on the proposed ADB-GEF ASCUDA low-carbon urban transport program, (iii) development of models of comprehensive transport sector coordination to realize the full potential of low-carbon transport, (iv) study of the effects of pricing on transport carbon emissions, (v) pilot project for the introduction of congestion/pricing, and (vi) information sharing on climate adaptation measures for transport projects.

Supporting Knowledge Sharing, Capacity Building, and Policy Reforms

Experiences from the PRC, where environmental management practices have rapidly advanced in recent years, could offer valuable lessons for other developing member countries (DMCs). Developing and sharing knowledge on environmental management practices and innovations will have an increasing role in the partnership between ADB and the PRC. The potential areas that could benefit other DMCs are (i) practices of eco-compensation and payments for ecological services; (ii) urban wastewater management; (iii) rural biomass renewable energy development; and (iv) low-carbon emissions technologies.

ADB will provide assistance in capacity building and training, with focus on officials and stakeholders at the local level in the following areas associated with the environment: (i) eco-compensation in the preservation of natural resources and provision of urban environmental services including preparation of technical manuals and establishment of knowledge centers; (ii) development of the National Environmental Information Center and building analytical capability related to environmental data analysis, prediction, policy impact assessment, quality assurance and quality control procedures, and other relevant matters; (iii) solid waste management, in particular identifying, managing, and monitoring toxic and hazardous wastes; and (iv) addressing climate change in small- and medium-sized cities.

More importantly, ADB and the PRC government agencies may work together on studying important policy issues and push forward policy reforms for better environmental protection, which can be used as good examples for other DMCs to follow. The potential areas for policy studies include (i) reform of the fiscal system which is an essential element underwriting urban development; (ii) sewage standards upgrading and benchmarking system for wastewater and solid waste treatment; (iii) greater use of market-based instruments, including eco-compensation and water quality trading, for water pollution control; (iv) improving urban planning focused on "urban livability" including land-efficient urbanization, integrated urbanism, and comprehensive approaches to urban air pollution; (v) improvements in the incentive frameworks, and changes in the taxation system (e.g., replacement of existing taxes on sales of cars with a fuel tax) to promote sustainable transportation development; (vi) strategic environmental assessments for policies, plans, and programs relating to transport sector development; (vii) cost-effective or cost–benefit analysis of environmental policies, programs, and interventions, such as current vehicle fuel consumption standards, in the light of national climate change and air pollution control objectives; (viii) structural and non-structural measures to combat climate change in agriculture; and (ix) regional cooperation on low-carbon economy.

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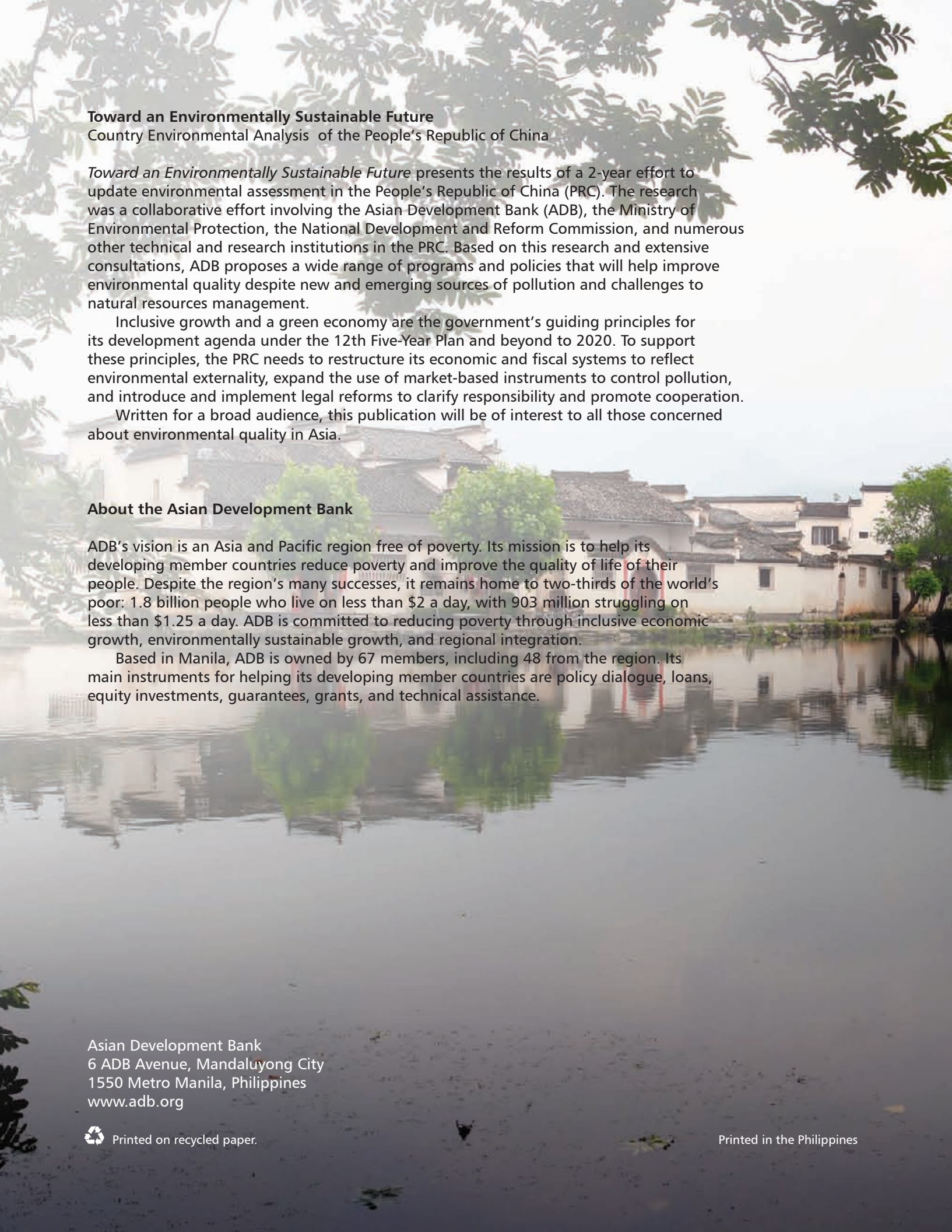

Toward an Environmentally Sustainable Future
Country Environmental Analysis of the People's Republic of China

Toward an Environmentally Sustainable Future presents the results of a 2-year effort to update environmental assessment in the People's Republic of China (PRC). The research was a collaborative effort involving the Asian Development Bank (ADB), the Ministry of Environmental Protection, the National Development and Reform Commission, and numerous other technical and research institutions in the PRC. Based on this research and extensive consultations, ADB proposes a wide range of programs and policies that will help improve environmental quality despite new and emerging sources of pollution and challenges to natural resources management.

Inclusive growth and a green economy are the government's guiding principles for its development agenda under the 12th Five-Year Plan and beyond to 2020. To support these principles, the PRC needs to restructure its economic and fiscal systems to reflect environmental externality, expand the use of market-based instruments to control pollution, and introduce and implement legal reforms to clarify responsibility and promote cooperation.

Written for a broad audience, this publication will be of interest to all those concerned about environmental quality in Asia.

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