

CHINA: Air, Land, and Water

China: Air, Land, and Water presents the results of a two-year effort to reassess the environmental situation in China. The research was a collaborative effort involving the World Bank, the China State Environmental Protection Administration, and a wide range of other technical and research institutions within China. Based on this research and extensive consultations, the World Bank 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 resource management.

In the past 20 years, China's economic output has consistently grown faster than the rate of degradation. In order to continue this successful trend, China needs to balance environmental protection with continued industrialization, urbanization, and improved agricultural productivity.

Written for a broad audience, this book will be of interest to all those concerned about environmental quality in Asia. A CD-ROM, which is included, provides background research and additional technical detail.

"During the 1990s, China achieved great progress in the fields of environment protection and economic and social development; however, we face increasingly complex challenges in the new century. "China: Air, Land, and Water" provides rich, insightful and comprehensive policy recommendations for both the Chinese Government and the international community to support and promote sustainable development in China.

Everyone who wants to understand China's environment and development policies should read this report thoroughly."

—Qu Geping
Chairman of the Environmental Protection and Resource
Conservation Committee of the National People's Congress



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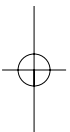
CHINA

Air, Land, and Water

environmental priorities
for a new millennium

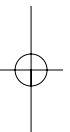
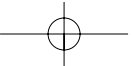
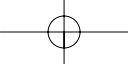


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CHINA: AIR, LAND, AND WATER

environmental
priorities for a
new millennium



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Currency Name = Renminbi (RMB)

Currency Unit = Yuan (Y)

1 Yuan = 100 fen

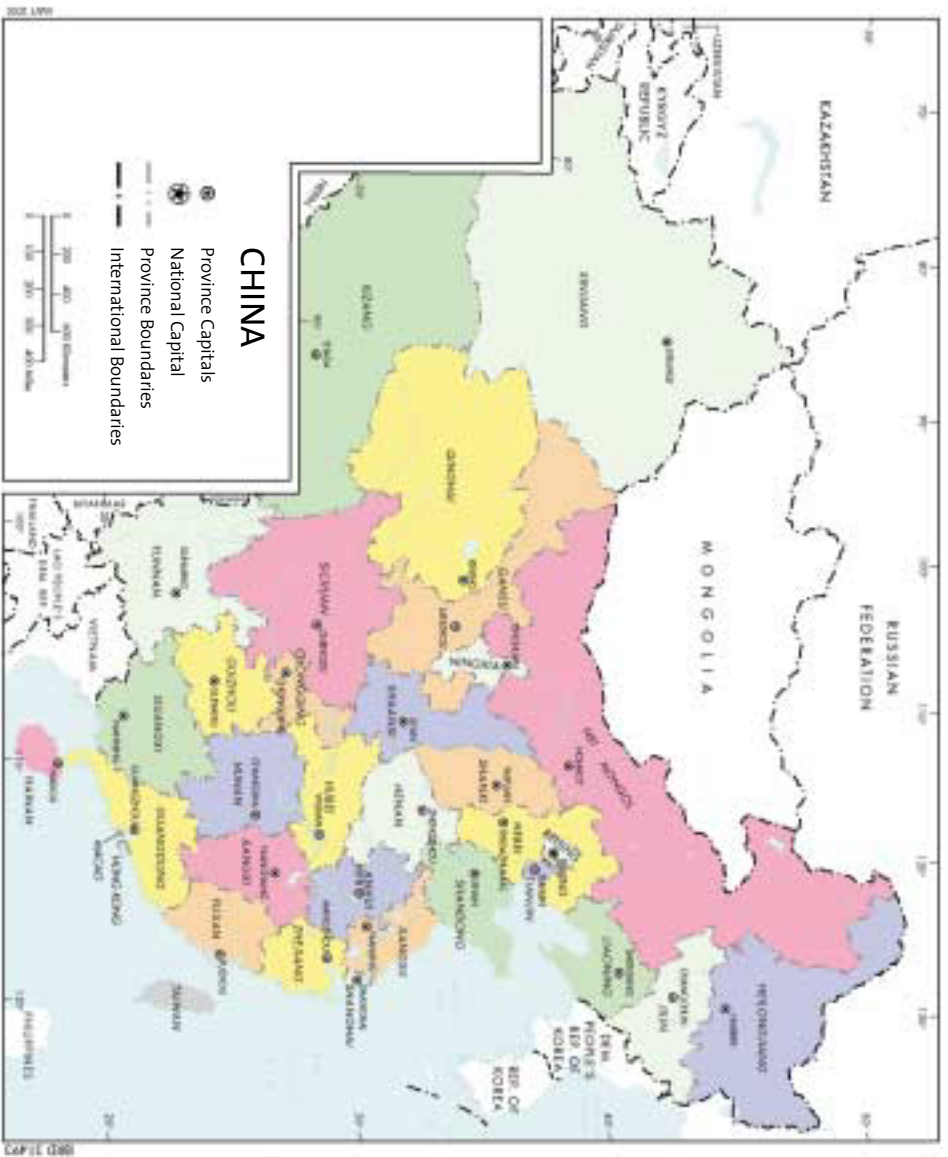
Y 1.00 = \$0.12

\$ 1.00 = Y 8.28

Abbreviations and Acronyms

ADB	Asian Development Bank	GHG	Greenhouse Gas
Bcm	Billion cubic meters	GIOV	Gross Industrial Output Value
BHC	Benzene hexafluoride	GVAO	Gross Value of Agricultural Output
BOD	Biological Oxygen Demand	HRS	Household Responsibility System
CAF	Chinese Academy of Forestry	IBRD	International Bank for Reconstruction and Development
CAOE	County and Above County-Owned Enterprise	ICAMA	Institute for Control of Agro-chemicals
CAS	Chinese Academy of Sciences	IDA	International Development Association
CCAP	Chinese Center for Agricultural Policy	IPM	Integrated Pest Management
CDM	Clean Development Mechanism	ISO	International Standards Organization
CITES	Convention on International Trade in Endangered Species	IUCN	International Union for Conservation of Nature
CO	Carbon monoxide	IRBM	Integrated River Basin Management
CO ₂	Carbon dioxide	Kg/ha	Kilogram per hectare
COD	Chemical Oxygen Demand	Km ²	Square kilometer
CP	Cleaner Production	l/c/d	Liters per capita per day
CRAES	China Research Academy of Environmental Sciences	LGPR	Leading Group on Poverty Reduction
DDT	Dichloro diphenyl trichloro ethane	m ³	Cubic meter
EA	Environmental Assessment	MFMP	Multilateral Fund for the Montreal Protocol
EIA	Environmental Impact Assessment	mg/l	Milligram per liter
EMP	Environmental Management Plan	MOA	Ministry of Agriculture
EPB	Environmental Protection Bureau	MOF	Ministry of Finance
EPO	Environmental Protection Office	MOFTEC	Ministry of Foreign Trade and Economic Cooperation
FGD	Flue gas desulfurization	MURCEP	Ministry of Urban and Rural Construction and Environmental Protection
FYP	Five Year Plan	MWR	Ministry of Water Resources
g	Gram	MWWTP	Municipal Waste Water Treatment Plant
GDP	Gross Domestic Product		
GEF	Global Environment Facility		

NAAQS	National Ambient Air Quality Standard	SEPA	State Environmental Protection Administration
NAP	Non-Agricultural Population	SEPC	State Environmental Protection Commission
NEPA	National Environmental Protection Agency	SETC	State Economic and Trade Commission
NEPB	National Environmental Protection Bureau	SLA	State Land Administration
NFPP	National Forest Protection Program	SOE	State Owned Enterprise
NGO	Non-Governmental Organization	SO ₂	Sulfur dioxide
NO _x	Nitrogen oxides	SPH	Specialized Production Household
OC	Organochlorines	SSB	State Statistical Bureau
ODP	Ozone Depleting Potential	TA	Technical Assistance
ODS	Ozone Depleting Substances	TOR	Terms of Reference
OECD	Organization for Economic Co-operation and Development	TSP	Total Suspended Particulates
OP	Organophosphates	TWAP	Trade Waste Acceptance Policy
Pb	Lead	TVIE	Township and Village Industrial Enterprise
PLF	Pollution Levy Fee	UNDP	United Nations Development Program
PM ₁₀	Particulate matter with a diameter of less than 10 microns	UNEP	United Nations Environment Program
POPs	Persistent Organic Pollutants	UNIDO	United Nations Industrial Development Organization
PPS	Plant Protection Stations	US	United States of America
PRCEE	Policy Research Center for Environment and Economics	WHO	World Health Organization
QA	Quality Assessment	WLS	Working Level Standard
QC	Quality Control	WTO	World Trade Organization
RBC	River Basin Commission	3-H	Huai, Hai, and Huang rivers
RMB	Renminbi	(µg)	Microgram
SDPC	State Development Planning Commission		
SEIA	Strategic Environmental Impact Assessment		



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Foreword

This report represents a further chapter in the successful and creative dialogue between the World Bank and the People's Republic of China about how to both promote economic growth and protect China's environment.

In 1992, the Bank and the National Environmental Protection Agency (NEPA) collaborated to produce an environmental strategy paper for China (World Bank 1992), which was crucial in the development of a multiyear World Bank program of environmental assistance to help the government address priority problems. The Bank's program was substantially delivered, and the government implemented many of the strategy's policy recommendations.

At the beginning of 1999, when I was serving as Director for Environment and Social Development within the Bank's East Asia and Pacific Region, I asked Environment Minister Xie Zhenhua whether the time had come to update that earlier study. He concurred. We were fortunate in securing the generous and timely financial support of the Government of Norway. The work that we set in motion was continued through the good offices of Minister Xie, Vice Minister Zhu Guangyao, and my successor, Mr. Zafar Ecevit, who was responsible for the original 1992 strategy paper.

The objectives of the update included reassessing the environmental situation in China and using this analysis to chart a course for improving environmental quality in China in the coming decade, particularly over the period covered by the government's 10th Five-Year-Plan. The team achieved these objectives. More importantly, they did so through collaboration with a large team of colleagues in China who are directly engaged in the day-to-day struggle to achieve environmentally sustainable development and have first-hand knowledge of the situation and challenges on the ground.

The Bank is building on the experience of client countries such as China in developing a new corporate environment strategy that will transfer good practices among countries and improve and better integrate environmental considerations into the Bank's core mission of poverty alleviation. Preparing this report has provided us and other countries with an opportunity to learn from China's practical experience. In return, we hope that we have been able to transfer some of our own experiences from elsewhere in the world to help China on the road to sustainable development.

Kristalina Georgieva
Director
World Bank Environment Department

Acknowledgments

This report is the result of a collaborative research effort by the staff of the World Bank, the Policy Research Center for Environment and Economics (PRCEE) of the China State Environmental Protection Administration (SEPA), and the Chinese Research Academy of Environmental Sciences (CRAES). A wide range of other technical and research institutions within China also participated in this effort, including the China National Environmental Monitoring Center (CNEMC), the Center for Chinese Agricultural Policy (CCAP) of the Chinese Academy of Science (CAS), the Chinese Research and Development Center for Combating Desertification at the Chinese Academy of Forestry (CAF), and staff of the World Wildlife Fund China Program Office, the Grassland Management Division of the Livestock and Husbandry Bureau of the Ministry of Agriculture, the Wetland Resources Monitoring Center of the State Forestry Administration, and the Institute of Geographic Science and Natural Resources Research of the CAS. Case studies were prepared by Professors Chen Jining and Hao Jiming of Tsinghua University and Zang Yuxiang, former deputy director general of SEPA's Pollution Control Department. All of the technical papers prepared by these collaborating institutions are included as annexes to this report (see attached CD-ROM).

The Bank's team was comprised of staff within the Environment and Social Development Division of the East Asia and Pacific Region, which is directed by Zafer Ecevit. The report was written by Robert Crooks (Task Manager), Jostein Nygard, Zhang Qingfeng, and Liu Feng, with the assistance of Jia Lanqing and Li Guo. Indra G. Raja provided secretarial assistance. The team reviewed the general literature and all technical reports commissioned for the study. In addition, they conducted extensive discussions with relevant government agencies in China, other donors, and NGOs.

As part of the research process, three workshops were held in Beijing. The first, in April 2000, included representatives from government agencies and foreign donors; the second, in July 2000, included representatives from government agencies; and the third, in February 2001, included representatives from government agencies, foreign donors, and NGOs. Government agencies attending the workshops included SEPA, the State Development Planning Commission, the State Economic and Trade Commission, and the State Forestry Administration, as well as the Ministries of Agriculture; Construction; Finance; Foreign Trade and Economic Cooperation; Land Resources; and Science and Technology. From the United Nations, the workshops included representatives from the United Nations Development Program and the United Nations Industrial Development

Organization. From foreign governments, there were representatives from Australia, Canada, the European Union, Germany, Italy, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States. NGOs included Environment Defense, Global Village, The Nature Conservancy, and Wetlands International. We are grateful for the many comments and observations provided by all those who attended the workshops.

The preparation team would particularly like to acknowledge its great debt to the staff of SEPA's Foreign Economic Cooperation Office for their organizational and administrative assistance throughout the study. In particular, the team would like to acknowledge the work of Messrs. Lu Huangsheng, Liu Yi, Liu Chunyu, Luo Gaolai, Xiao Xuezhi and Wang Xin, and Mmes. Zhou Guomei and Yu Lan.

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The report was edited by Robert Livemash (consultant). Beatrice del Monte (Studio Spark, Washington DC) did the design and managed the desktopping. Production was supervised by Nicola Marrian and Thaisa Ysonde Tiglao (External Affairs Department, World Bank). Photos have been provided by the World Bank Photo Library and Curt Carnemark, Dan Miller, and SEPA.

Finally, we would like to express our deepest gratitude to the Government of Norway, which provided the funds to carry out the study and publish the findings.

Executive Summary

During the 1990s, China continued its remarkable transformation, moving from a command or planned economy to a market-based and increasingly less-planned economy, and from a predominantly agricultural economy to a mixed economy with substantial industrial and service sectors. Perhaps most importantly, China dramatically reduced the social, economic, and human cost of poverty by halving the number of people living under the poverty line.

China is now a very different place than it was in 1992, when the World Bank formulated and published its last environment strategy (World Bank 1992). The range and significance of environmental issues have increased. An updated environment strategy for China was needed to take account of these changes, to assess how they are affecting the environmental agenda, and to identify environmental management strategies and priorities.

This updated strategy is based on research underwritten by the Government of Norway through a generous technical assistance grant. It was a collaborative effort, involving the staff of the World Bank, the State Environmental Protection Administration (SEPA), and a wide range of universities and other research institutes who are working on environmental management problems in China. Although researched and discussed collaboratively, the recommended strategy and the contents of the report are solely the responsibility of the World Bank.

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The report does not cover every environmental issue in China. We focused on the main generic issues—land, water, air, and related topics such as environmental administration—expected to be addressed in SEPA's 10th Five-Year-Plan (FYPP) for Environmental Protection. The 10th FYPP covers the period 2001-06, and commenced preparation at about the same time as this Strategy. Thus, this report does not discuss nuclear environmental management or biosafety (genetic engineering), which were two new responsibilities assigned to SEPA following the government reorganization of 1998. Nor does it address solid waste management or the management and disposal of toxic and hazardous wastes, which are important issues in China, but at the time this work was initiated were not frontline thematic issues expected to be addressed in the 10th FYPP.

Current Environmental Conditions

China has done many things right in the environmental area over the past decade, including large-scale afforestation and massive investments to reduce air and water pollution. But in many respects, economic growth in China is overwhelming investment in conservation and environmental protection. Land degradation is worsening; natural forests are declining; biodiversity resources are under stress; water quality is deteriorating

in most areas and new threats are developing, such as discharges from intensive livestock operations; and the explosive growth of motor vehicles presents a significant new problem in air pollution control.

LAND, FORESTS, AND BIODIVERSITY

Much of the weight of growth and development in China is falling on its land systems. As a result, land degradation is widespread and increasing. China has some of the worst water erosion problems in the world: the highest ratio of actual to potential desertified land in the world; and rapidly degrading grasslands. These problems are doubly serious, since the worst of them tend to be concentrated in areas that support China's poorest and most vulnerable people. In addition, some of China's best cultivated land is being lost to expanding urban and industrial areas and a developing network of roads and railways.

The state of China's forests presents a mixed picture. There is little doubt that China has successfully turned the tide of deforestation after its huge investments in plantation and shelterbelt development. This was an unprecedented achievement for a country that, in terms of population distribution, is still predominantly agrarian. On the other hand, China's natural forests have been in a continuous state of decline for 50 years, and there are no signs that the corner on sustainable management of natural forests has been turned.

Finally, almost all of China's unique and globally significant biodiversity resources are under stress. Many species in China are seriously threatened. Up to one fifth are now endangered, and nearly one fourth of the species listed in the Convention on International Trade in Endangered Species (CITES) are found in China. Both figures are disproportionately high. A substantial national system of nature reserves, which started from nothing in 1956, has been developed to improve biodiversity protection. In general, however, the system is underfinanced, overextended, and patchy in its coverage.

The government is well aware of these problems and has devoted considerable financial and other resources to address them. So far, however, these efforts have not produced the results that are needed, and new approaches are required.

WATER

Water availability and quality continued to be a critical problem throughout the 1990s, particularly in northern China, and the issue is likely to worsen over the next decade. Water quality in rivers, lakes, and groundwater will continue to deteriorate in many, if not most, areas. In addition to industrial wastewater pollution control, which was the prime concern of the 1990s, the next decade will require decisive action on the growing problems of municipal wastewater discharges and agricultural or "nonpoint"

sources, notably including emissions from intensive livestock production units. The combined effects of these problems will be felt most acutely in the rivers north of the Yangtze, where water quality is already severely degraded.

There are technical dimensions to these problems that are outlined in this report and need to be addressed. But these will not be sufficient to solve the problem. Progress also is needed on the administrative and regulatory level: on economic factors impinging on water use and efficiency; and on the development of new decisionmaking procedures, which can equitably resolve the often-conflicting claims on water resources made by different entities.

Air

Air quality control was a major and largely successful focus of government attention during the 1990s. National emissions of major air pollutants, such as sulfur dioxide (SO_2) and particulate matter, have declined since 1996. But new issues are emerging. Emissions from motor vehicles, which were not an issue at the start of the 1990s, have worsened considerably in major cities, and private vehicle ownership is only starting to spread. Indoor air pollution resulting from household consumption of solid fuels still poses potentially high health risks to most rural households and many urban households. The economy's continued reliance on

coal and oil suggests that efforts to mitigate acid deposition and carbon dioxide emissions will get tougher in the future, as demands for both forms of energy continue to increase significantly. Fundamental improvements in air quality and in mitigating carbon dioxide emissions will require, in the short term, substantial reductions in coal consumption by small and dispersed end users, and, in the long term, a significant reduction in the economy's reliance on coal.

ENVIRONMENTAL MANAGEMENT AND REGULATION

China's repertoire of environmental laws, regulations, and standards is quite comprehensive and has been continuously updated and expanded to improve effectiveness and cover emerging issues. Among comparable developing nations, China is unquestionably in the front rank, but it cannot become complacent. The demands it faces are unprecedented and it cannot settle for being among the best in its class. It needs to measure its performance against the best OECD countries in the world. By this standard, it still has a long way to go. It has to work harder on legal and administrative measures, on getting the fundamentals of development policy right, and on human resources development. Most importantly, it has to move the concept of environmentally sustainable development onto the front page of all policy documents.

The Challenge for the New Millennium

There are three cross-cutting issues that keep recurring throughout the analysis. These issues characterize the environmental management challenge over the next decade:

- First, the environmental agenda is becoming so complex and large that it cannot be adequately managed by one agency—SEPA and its counterparts at lower levels—working on its own. Effective solutions will require the combined and coordinated efforts of many different branches of government and the rethinking of many development policies. This is particularly true with regard to natural resources management, or the “green” environmental agenda, which emerged as an increasingly critical issue over the last decade. Much of the environmental degradation in China can be attributed to implementation of policies that were either directly inimical to environmentally sustainable development, or inadvertently had the same effect. New development concepts need to be applied that provide a better balance between development and environmental protection, take account of the nonfinancial benefits of natural resources, and incorporate the views of community groups whose welfare is most closely associated with those resources.
- Second, the systemic fiscal and budgetary problems facing the country as a whole are making it difficult for environmental institutions to do their work. There is a growing gap between assigned responsibilities and the resources provided to carry out those responsibilities. This applies not only to environmental protection agencies, but also to other ministries and units within them, including the agricultural research services, agricultural extension services, nature reserve management units within the State Forestry Administration, and so on. This issue is of particular importance in the context of continued market reform, where the government’s fundamental role as a “steward and protector of the national estate” needs to be strengthened to offset the inability of market-based systems to deal with environmental and social externalities. Of course, this is a problem that extends far beyond the question of environmental management and protection, but it provides one more reason for continued aggressive reform of government tax and financial management procedures.
- Third, the government has to continue to diversify the approaches it takes and the environmental tools it uses to provide a better fit between the solutions developed and the problems being experienced in different parts of the country. The “one-size-fits-all” approach, as exemplified by various mass environmental campaigns,

played a useful role in the past, but is proving increasingly inadequate to meet current demands. The concept of developing many tools to deal with many problems is particularly relevant for the management of natural resources, where greater attention needs to be paid to addressing the underlying causes of problems, not just their symptoms.

STRATEGIC PRIORITIES

To meet future challenges, the government's main strategic priority should be to revise development policy to improve the fit between economic and social development and environmental sustainability. It made several moves in this direction during the 1990s, but the intentions expressed in broad policy instruments are not being adequately translated into concrete action on the ground. The challenge for the new millennium is to correct that problem, and deliver on environmentally sustainable development. To do this, concrete actions are required in three main areas:

- The institutional arrangements for dealing with environmental issues
- The instruments applied to achieve environmental objectives
- The investments made to underwrite the environmental program.

Institutions. The new and developing environmental challenge, as already recognized by both the government and SEPA in particular, is to promote environmentally sustainable development of China's natural resources. Making progress will require the full attention of government and coordinated efforts by all relevant agencies, which in turn will require changes in the ways that all relevant institutions of government approach their work. Priority tasks include:

- **Mainstreaming.** Government agencies, particularly those concerned with economic and/or spatial planning and natural resources management, need to adjust their policies and objectives to incorporate the concept of environmentally sustainable development into their development objectives and programs.
- **Cross-sectoral coordination.** Most sustainable natural resources management issues cut across normal lines of administrative responsibility. China needs to find a way to coordinate the work of different agencies, reduce overlaps and contradictions, maximize synergies, and adjudicate disputes. An effective coordinating function has to be established that (a) is located at a suitably high—beyond ministerial—level; (b) is provided with sufficient resources, most notably an effective secretariat, to allow it to pursue an active agenda; and (c) can effectively resolve interdepartmental deadlocks.

■ Reform the approach to biodiversity conservation. Given the importance of China's biodiversity resources and the level of threat they are facing, an important priority is to significantly strengthen the approach to biodiversity protection and management. A central element should be establishment of an independent, state-level "Nature Reserves Service" to manage nature reserves of national and global significance and become a center of excellence for nature reserve management. There are many other things that need to be done on biodiversity conservation, but this is the key.

■ Push forward with integrated river basin management in water-scarce regions. There is a wide acceptance among technical experts that a more integrated, river-basin approach is required to sustainably manage water resources in the most heavily conflicted catchments, which are mostly in north China. But no significant progress is being made toward achieving that objective. This situation needs to be corrected. The government should create new and separate river basin management institutions, whose governance structure makes adequate provision for effective participation of key stakeholders—including provincial governments—in their decisionmaking processes.

The institutional situation governing the basic work of pollution management and control is much better, but there are several things that need to be done to increase effectiveness, including:

■ Increase EPB capacities and effectiveness, with particular emphasis at the local level. Technical capacity and resources made available to EPBs, particularly at the lower levels such as counties and townships, need to be significantly increased. At the same time, more effort is required to resolve contradictions between horizontal and vertical responsibilities at all levels. Options available include (a) delegating more regulatory authority to provinces and municipalities and away from counties; and/or (b) increasing supervision of lower levels by higher levels through performance audits and public reporting; and/or (c) developing a regional structure for SEPA, along the lines of the People's Bank of China, to strengthen supervision by the state.

■ Strengthen the legal system. An essential pillar of the approach should be development of a strong body of environmental law backed up by an impartial judiciary to interpret the laws and adjudicate legal and regulatory disputes. Given the numerous conceptual, social, and technical dimensions, the task will not be simple, but it should be a priority.

■ Continue to promote public participation in environmental decisionmaking. One of the strongest elements of SEPA's environmental strategy has been its work on public participation, public dissemination of environmental information, and environmental education at all levels. This work has to continue, with emphasis on extending the environmental constituency beyond wealthier urban areas in the east.

Instruments. China already has many of the basic policies and instruments necessary to achieve a high level of effectiveness in the management and control of point-source pollution. Main priorities for the future should be:

■ A new approach for point-source pollution control. New approaches have to be developed to deal with the growing number and diversity of point-source discharges and to eliminate some contradictions in the existing system, particularly in relation to the pollution levy fee system. This report advocates adoption of a permitting system under which all significant point sources of pollution, regardless of who owns them, must secure a permit or license to operate, and must pay an administrative fee to cover the costs of issuing the permit. A schedule of graduated and increasingly punitive fines for breach of permit conditions would also be required.

■ Keep working on supplementary control strategies. Command and control instruments played a key role in determining industrial pollution trends during the 1990s. On their own, however, they may not be sufficient to meet future challenges, particularly those due to the effects of changing industrial ownership patterns. Work has to continue on development of the three other pillars of the control strategy: economic, voluntary, and public disclosure instruments.

Command and control strategies will not provide an answer to natural resources management problems; a much more comprehensive approach will be required. It needs to be based on a clear understanding of the underlying causes of problems and the creation of incentive frameworks to encourage sustainable development of natural resources.

■ Continue price reform for environmental improvement. Reform of resource pricing, particularly energy and water, has to be continued, broadened, and accelerated, so as to allow prices to reflect scarcity and environmental externalities and to increase the price-responsiveness of demand.

■ Strengthen the focus on the poverty/land degradation connection. Chinese researchers have established a clear geographical link between rural poverty and rural land degradation, and it is also likely that there are causal links. China has an extremely

effective poverty alleviation program implemented through the Leading Group on Poverty Reduction (LGPR), and many of the program components target underlying causes of rural land degradation. Institutions concerned with “ecological environmental” issues need to get more engaged in the LGPR program, and identify ways of working collaboratively to increase its environmental benefits.

■ Re-orient natural resources development policies. The degraded state of natural resources in China is a result of development policies that focused on maximizing output at the least cost to the rest of the economy. Policy needs to focus on promoting production levels consistent with the long-term maintenance of the resources in question. Policy needs to be based on relevant research, which should be increased and made more cross-disciplinary to ensure that adequate account is taken of both the social and ecological dimensions of natural resources management.

Investments. The work on institutional and policy development provides the framework for environmental improvement, but investment is the driving force that achieves results. Certain steps are needed to increase the impact of environmental investments:

■ Keep focused on priority issues. The range of environmental responsibilities assigned to SEPA and the EPPBs is expanding at a far greater rate than their staff and finan-

cial resources, running the risk of dissipating their energies over too broad a range of issues and reducing their effectiveness. EPPBs need to maintain their focus on pollution management and control, but they have to be careful and selective in identifying their role when expanding into the “green” or eco-environmental agenda. Priority should be given to monitoring and reporting to government on the state of the natural environment, and assessing and reporting on the implications of proposed government policies on the state of the environment.

■ Increase environmental expenditures in real terms. The projected environmental investment for the 10th FYP is about 1.3 percent of GDP. This needs to be increased, probably to around 2 percent of GDP on air and water pollution control through 2020, and much greater allocations need to be made for basic capacity building.

■ Improve the effectiveness of investments in ecological construction and conservation. The government is allocating substantial resources to “ecological construction” work, but their effectiveness could be substantially improved by placing more emphasis on addressing the underlying social and economic causes of land degradation, and less on treating the symptoms.

■ More and smarter investments in urban environmental infrastructure. Financial commitments for construction of basic sewerage and solid waste management infrastructure have to be significantly increased to meet the challenge of increased urbanization. But investment also has to get “smarter.” For example, municipal sewage treatment standards need to be adapted to local circumstances, rather than being based on a single, national standard. There also may be opportunities to develop industrial estates with centralized wastewater collection and treatment, which could provide cost-efficient solutions to the growing problem of small- and medium-sized enterprises with high water pollution emissions.

■ Less haste and more thought on environmental improvement programs. The effectiveness of many environmental improvement programs can be improved by (a) spending more time and resources on feasibility studies; (b) paying more attention to the cost effectiveness of investment; (c) reducing emphasis on investments in physical capital, and increasing investments in human capital development; and (d) avoiding the temptation to broaden the agenda before priority problems are solved.

THE ROLE OF DONORS

The environmental challenge under the 10th FYP will be substantial, as will the government’s need for technical and financial assistance. The World Bank and other foreign donors could significantly enhance their contribution by focusing assistance on the three main strategic priorities discussed above, within the following framework:

■ Enhance donor coordination. The government and donors need to increase work to eliminate redundancies, reduce overlaps, and better match donor participation to their respective strengths in areas such as loans; grants; technical partnerships and collaborative arrangements; technical strengths and experience; program size; and administrative procedures.

■ Donors should take more account of the government’s five-year environmental planning priorities. The government’s five-year plans provide clear guidance on domestic priorities over the planning period. All donors need to take much more explicit account of these plans in setting their priorities and identifying assistance opportunities.

■ Increased use of collaborative approaches. An integrated approach to environmental problems often requires a variety of assistance needs, which may extend beyond the vehicles available to any particular donor. In such circumstances, collaborative approaches between different donors may

provide a way forward, provided that the potentially formidable administrative difficulties can be overcome.

- Increase role and use of technical partnerships. This could be an area in which bilateral donors would have a distinct comparative advantage. Areas for beneficial partnerships include (a) further development of environmental instruments such as EIA and Strategic EIA; (b) integrated river basin management; (c) nature reserve management and protection; (d) sustainable agricultural land management; and (e) general technical training.

- Private sector participation. Another new and developing area, which may be of particular interest to bilateral agencies, relates to private sector participation in environmental management and control. In addition to development of environmental infrastructure, the private sector could also make a contribution in education and training, technology transfer, policy formulation, and public awareness.

- Role of NGOs. Environmental NGOs are just starting to develop in China. As interest in and awareness of environmental issues increase, their role can be expected to increase substantially in the future. This is another area in which foreign donors could play a role through training and technical assistance, brokering partnerships with external NGOs, and provision of material support.

All foreign institutions interested in the environment and development agenda in China have a role to play in helping to underwrite the huge investments needed to meet environmental challenges in China. But their aggregate contribution will always be small in relation to the need. Based on the review underlying this report, and taking account of the government's environmental strategy for the 10th FYP, investments likely to be of particular environmental value include (a) rural development projects that combine poverty alleviation with environmental protection and/or sustainable natural resources management, with particular emphasis on grassland areas, hilly and mountainous areas, and priority areas under the "Three Regions" policy; (b) urban pollution control and environmental management, including support for sustainable development of urban environmental infrastructure, as well as increased private investments in specific investment projects; (c) biodiversity conservation and development of new approaches that integrate rural development with biodiversity conservation; and (d) development of new approaches to management of wastes from small-scale rural enterprises by, for example, establishment of industrial development zones with centralized waste collection and treatment.



1 Economic Growth and the Environment



During the roughly two-decade period from 1978 to 1998, China's gross domestic product grew at an average annual rate of about 9.6 percent. This was about four times faster than high-income countries, which as a group grew in the 2.2-2.4 percent range annually during the same period. This growth was accompanied by a variety of political, economic, demographic, and environmental changes. For example:

- The structure of the economy changed. China changed from a planned and essentially supply-driven economy to a much more market oriented and demand-driven economy. Industrial output is now more diversified, and most industrial growth is being generated by non-state enterprises, which currently contribute about three fourths of gross industrial output value.
- The rural sector changed. Farmers are increasingly responding to consumer demand rather than state production plans and, as a result, output has been diversifying significantly. At the same time, the sector declined as a source of employment and in terms of its relative economic contribution.

- Poverty declined dramatically. The population living under the government's poverty line dropped from about 260 million in 1978 to about 42 million—5 percent of the rural population—by the end of 1998.

- Population continued to grow. It reached about 1.27 billion in 2000, which was substantially higher than any other nation in the world, although the fertility rate dropped below the replacement level. Because of the large number of women of childbearing age in the population, the total population is expected to grow to about 1.48 billion by 2025, but will level off rapidly thereafter.

- Pressure on natural resources increased. China's large population and increasing per capita consumption increased the pressure on all of its natural resources, but particularly land. In 1997, the amount of cropland per 1,000 people was estimated at 109 hectares, which was a 7 percent decline from 1987 and only about 42 percent of the world average.

- Environmental awareness and protection improved. China's environmental protection capacity grew during this period, but at the same time environmental problems became more complex and often expressed themselves at a larger scale.

These changes, and particularly the trend toward a mixed, demand-driven economy, have substantial implications for the nature of the environmental agenda and the options

available to deal with it. The agenda is being particularly affected by changes in (a) industrial structure; (b) urbanization; and, (c) rural development, including changes in agricultural production and the continuing problem of rural poverty. The net effect of these changes is to widen the agenda and make it increasingly more difficult for the government to achieve its environmental objectives.

Changing Industrial Structure

Changes in China's industrial structure have had major impacts on industrial pollution and the regulatory environment. Three trends are particularly significant:

- First, the role of non-state enterprises, which dominated industrial expansion during the last 15 years, increased significantly, while the role of state-owned enterprises declined.
- Second, growth has been uneven among various industrial sub-sectors, with some of the most polluting industries experiencing relative contractions. This structural reform made a notable contribution to industrial pollution control.
- Third, the switch to a more competitive, demand-driven industrial sector is resulting in increased earnings retention and re-investment. This is increasing techno-

logical innovation and resource use efficiency, allowing more industrial growth to be achieved at less environmental cost.

While these trends in general have been beneficial environmentally, they have also increased the regulatory challenge.

GROWTH OF NON-STATE ENTERPRISES

Non-state industrial enterprises (see Box 1.1) dominated industrial growth in China over the past 20 years. In the last decade alone, these enterprises accounted for about 90 percent of growth in gross industrial output value (GIOV). They now account for about 72 percent of GIOV, compared to 45 percent in 1990 and only 14 percent in 1980.

Prior to 1996, pollution from TVIEs was largely unregulated. Between 1990 and 1995, they increased their combined pollutant emissions by about 120 percent, while emissions from SOEs actually declined by 9 percent. In 1996, the central government adopted drastic new pollution control measures for TVIEs, and launched a national campaign to close down some 72,000 highly polluting TVIEs in 15 sub-sectors. About 65,000 were actually shut down. Some 20 to 30 percent restarted, either illegally or after bringing their enterprises into compliance with relevant discharge standards. Even so, there is little doubt that the program had a major impact on total industrial wastewater emissions.¹ The fact that such drastic action had

to be taken is a reflection of the difficulty that environmental protection bureaus have been encountering in controlling this sector of the industrial economy.

UNEVEN GROWTH IN INDUSTRIAL SUB-SECTORS

Changes in industrial structure have reduced industrial pollution intensity per unit of output value and narrowed the primary sources of industrial pollution. Many industrial sub-sectors that are important sources of intractable pollution (such as machinery, textiles, pulp and paper, refining, and smelting) have been growing at rates significantly lower than the all-industrial average. At the same time, less-polluting industries (such as electronics, communications, and household appliances) have been growing at proportionately higher rates. Not all the “new” industries are without pollution problems,² but growth and development seem to be favoring industries that tend to use fewer raw materials and tend to produce less pollution per unit of output. Figure 1.1, which compares indexed trends in GIOV with indexed emissions of three pollutants (chemical oxygen demand, sulfur dioxide, and soot) during the 1989-99 period, shows that industrial pollution loads increased at much lower rates than industrial output, and actually declined after 1995. Some of the observed effects are due to increased regulatory effectiveness, but there is little doubt that industrial restructuring also played an important role.

Box 1.1 Industrial Terminology in China

The discussion of the industrial sector in this report distinguishes between two basic industrial groupings: (1) County and Above Owned Enterprises (CAOEs); and (2) Town and Village Industrial Enterprises (TVIEs). Up to 1998, environmental statistical data discriminated between these two categories, although the distinction has mainly been eliminated.

The distinction is partly historical: TVIEs were originally commune-based industrial enterprises and were administered through the Ministry of Agriculture. But it also reflects differences in the institutional, legal, and other factors that used to govern their operation. For example, different—partly less stringent—pollution control targets were set for TVIEs in the 9th Five Year Plan.

The CAOIE industrial grouping comprises State-Owned Enterprises (SOEs) and collectively owned enterprises at the county level and above. In 1999, this grouping comprised approximately 61,300 SOEs and (nominally) 1,045,000 collectively owned enterprises.

In the same year, the TVIE grouping included about 6.7 million industrial enterprises, of which 615,000 were collectively owned enterprises at the township and village levels. The remainder were household cooperatives and individual enterprises.

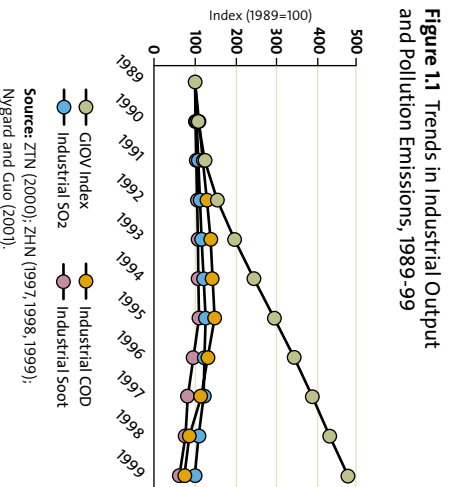


Figure 1.1 Trends in Industrial Output and Pollution Emissions, 1989-99

Industrial restructuring also has narrowed the primary sources of industrial pollution. As of 1998, just eight industrial sub-sectors were discharging about 85 percent of all industrial pollution.³ In several cases, these sub-sectors are also making only modest contributions to GIOV. For example, the pulp and paper sector generated about 46 percent of industrial chemical oxygen demand, but only 1.8 percent of GIOV. The industrial structure still is tilted toward relatively polluting upstream manufacturing,⁴ but as industrial reform continues, the share of downstream, less polluting, and high value-added manufacturing is expected to increase.

TECHNOLOGICAL PROGRESS

To stay competitive, industrial firms are finding it increasingly necessary to retain earnings and invest in new and improved technology. One of the most important environmental

consequences of this trend has been an improvement in resource use efficiency within the industrial sector. For example, over the last 10 years, industrial energy intensity declined by 50 percent. More efficient technology is estimated to account for about one third of the improvement. However, there is still considerably more room for improvement. By upgrading technologies in power generation and in several major industrial energy activities to industrialized-country levels, it has been estimated that China could cut 20 percent of its projected coal consumption.

There is even more potential for improvement in industrial water use efficiency, which has traditionally been very low in China, partly due to low water prices. Oft-quoted examples include the chemical and paper manufacturing sectors, which are the leading water-polluting industries in China.⁵ In some areas, particularly north China, increased water scarcity is leading to increased prices and an increased interest on the part of enterprises in water-saving technology and other clean production (CP) strategies.

RESTRUCTURING AND INDUSTRIAL POLLUTION CONTROL

These dramatic changes in ownership structure, sectoral structure, product mix, and technological innovation are creating many new challenges for government regulation of the industrial sector.

Traditionally, China's industrial pollution regulation focused on medium and large enterprises that were for the most part owned or controlled by county-level and above governments and were the core of the centrally planned economy. Because these were government enterprises, it was possible to exercise an element of control over them by administrative or non-regulatory means. The 1990s saw continued improvements in pollution control at medium and large enterprises, and administrative measures were an important factor influencing this trend. Growing awareness of pollution problems from TVIEs prompted a serious crackdown on small enterprises in 1996-97, and this produced a measurable reduction in emissions from this sub-sector. However, this was only achieved through the use of "extra-regulatory" methods—the campaign to shut down 15 kinds of small enterprises. This was socially disruptive, and did not really provide an acceptable basis for a long-term approach. As the industrial sector becomes even more dominated by private firms, administrative measures will become progressively less effective, and "extra-regulatory" campaigns will become unacceptably disruptive. In this context, one of the main challenges for the future will be to significantly strengthen regulatory effectiveness, so as to maximize the benefits of the laws and regulations already in place. At the same time, more work needs to

be done on supplementary approaches, including economic incentives, voluntary instruments, and public participation.

Urbanization and the Environment

China's urban population is vast and growing rapidly. The current "official" urban population of 400 million people—30 percent of the population—is roughly equal to the total population of Western Europe. Each year during the 1990s, it grew by about 10 million people, equivalent to the population of Greece. Impressive as they are, these data understate the situation. Most analysts agree that the actual urban population is much larger—about 455 million, or 36 percent of the total population.⁶

The official statistics indicate that the most dramatic increases in urbanization during the 1990s occurred in medium-sized and smaller cities, which are generally less well-equipped with financial and human resources to deal with rapid growth or its environmental consequences (see Table 1.1). However, closer examination shows that an even greater challenge may be developing at an administrative level below the city; that is, in the "administrative towns." These increased in number from about 10,000 in 1991 to more than 17,000 in 1999.⁷

Table 1.1 Urban Growth, 1991-99

	1991	1999
Number of designated cities of which:	479	667
–Super large (>2 million)	9	13
–Very large (1-2 million)	22	24
–Large (0.5-1 million)	30	49
–Medium (0.2-0.5 million)	121	216
–Small (<0.2 million)	297	365
Number of administrative townsa	10,000	17,341

Note: ^a Administrative towns refers to the urbanized part of the administrative unit known as a township and are analogous to a county seat within a county. Townships are the lowest level of government administration.

Source: ZTN (1992 and 2000); ZCJTN (1999).

The State Development Planning Commission (SDPC) hopes to maintain urbanization growth rates at 0.5-1.0 percent per annum during the period of the 10th Five Year Plan. Based on recent experience, this may be low. Nevertheless, even if the SDPC's projections are correct, there will still be a substantial increase in urbanization over the next 10 years. The demand for urban environmental infrastructure, already high, will increase accordingly. This will represent another significant environmental challenge for the government.

URBAN ENVIRONMENTAL QUALITY

Priority environmental issues in China's urban areas include air pollution, municipal wastewater treatment, solid waste management, and urban encroachment on arable land.

Air pollution. The most prominent urban environmental problem in China is air pollution, particularly fine-particulate pollution, which is generated mostly by burning fossil fuels. China has been successful in promoting the use of gaseous fuels in urban residential and commercial sectors, especially in large cities. As a result, concentrations of SO₂ and TSP in many cities have declined significantly.

Motor vehicle emissions are growing rapidly as an urban air pollution issue. Unlike the other urban issues, it was not even foreseen at the beginning of the 1990s. As shown in Table 1.3, during the 1990s the number of motor vehicles increased significantly. The biggest increases were in privately owned passenger vehicles and motorcycles, which were a rarity in the early 1990s. China is only

Table 1.2 Wastewater Flows and COD Loads, 1991 and 1999

Wastewater Source	Flow (million cubic meters)		COD Load (million tons)	
	1991	1999	1991	1999
Industrial	27,089	19,730	10.4	6.9
Municipal	10,020	20,377	4.0	7.0
National Total	37,108	40,107	14.4	13.9

Source: ZTN (1992 and 2000)

at the very beginning of its development as a privately mobile society. Given current industrial development policies, there is likely to be continued explosive growth in personal vehicle ownership and associated environmental problems in the foreseeable future. The environmental consequences of this growth are amplified by the fact that vehicles in China produce higher emissions than in other countries. For example, it is estimated that an average motor vehicle in Beijing emits four times as much carbon monoxide (CO) and seven times as much nitrogen oxide (NO_x) as an average vehicle in Tokyo. One positive note is the government's rapid and successful phaseout of lead in gasoline. The four-year program, which started in 1997, has eliminated a major public health hazard.

Table 1.3 Average Annual Increases in Registered Civilian Motor Vehicles, 1990-99

Vehicle category	Avg. Growth Rate (%)
Passenger vehicles:	19
Privately owned	33
Other ownership	14
Trucks	7
Privately owned	17
Other ownership	4
Specialty vehicles	7
Passenger Vehicles & Trucks	12
Motorcycles	26

Source: ZTN (2000)

Wastewater. During the 1990s, a significant switch occurred in the balance of wastewater flows and COD loads between industrial and

municipal sources (see Table 1.2). Industrial wastewater flows and loads declined significantly, while municipal flows and loads increased. In 1999, municipal wastewater flows and COD loads exceeded total industrial flows and loads for the first time. The treatment rates and treatment efficiencies of municipal wastewater are only a fraction of industrial rates, largely because of the inability of urban governments to keep pace with growth. These trends are likely to grow significantly in the foreseeable future, and city managers can expect that the difficulties they are currently experiencing with sewage collection and treatment demand will increase significantly.

Urban encroachment. Between 1987 and 1995, nearly 1 million hectares of cultivated land were lost due to urban infrastructure development and expansion. This represented about 20 percent of all cultivated land lost or converted during the period. About one fourth of the total was located in the eastern parts of the country, where urban economic growth has been booming. These losses are particularly serious because much of the land near urban areas is highly productive agricultural land, well served with water, and located close to major markets. Much of this land was replaced by newly developed land in other parts of China, but it was generally of lower quality, had less access to water, and was located much further away from the main domestic markets. As urbanization increases, the problems of maintaining a cultivated land base will worsen considerably.

URBAN GROWTH: PRIORITY ISSUES

The scale and speed of urban renewal and expansion in China is unprecedented. About half of all residential and commercial buildings in urban areas were built in the past 10 years, and the urban building stock is expected to double again in the next 10 to 15 years.

Some planners believe that the urbanization rate should increase to around 40 percent by 2015 from the current actual rate of 36 percent. This would bring the total urban population to about 670 million. This tremendous growth will significantly increase the challenge of urban environmental management. A further challenge in urban environmental management is that a substantial amount of urban growth is occurring at levels below official cities, where there is virtually no capacity to deal with planning problems.

Substantial investments will be required to improve urban environmental quality. Priorities include extension of sewers and increases in wastewater treatment capacity, fuel switching, water and energy conservation, and mass transit systems. The financing and the cost-effectiveness of these investments will to a large extent depend on the transparency and market-driven nature of the pricing of urban environmental services, energy, and other infrastructure services. Prices need to strike a balance between the incentive for users to reduce demand and the

incentive for suppliers to maintain adequate services. Many prices presently set for urban services do the opposite.

Increased investment will be necessary but not sufficient to meet the challenge. Improved planning, increased sectoral integration, and increased human resources development all have equally important parts to play. Environmental master plans provide a good way for cities to systematically analyze their environmental problems and seek cost-effective solutions, but few Chinese cities have them. There is an urgent need for all Chinese cities to make environmental provisions an integral part of their urban development plans, including zoning restrictions, requirements for sewer connection or alternative wastewater disposal methods, controls on sprawl, open space provisions, and so on.

Municipal or county environmental protection bureaus have been primarily dealing with industrial pollution problems, and are not well prepared and positioned to tackle the multi-dimensional, cross-sectoral urban environmental issues. They tend not to participate in municipal planning, which is carried out by planning departments, and as a result the role of prevention is minimized. Urban environmental problems tend to be addressed retrospectively and only when they become serious. Environmental agencies need to increase their participation in the urban planning process and increase the emphasis on minimization and avoidance.

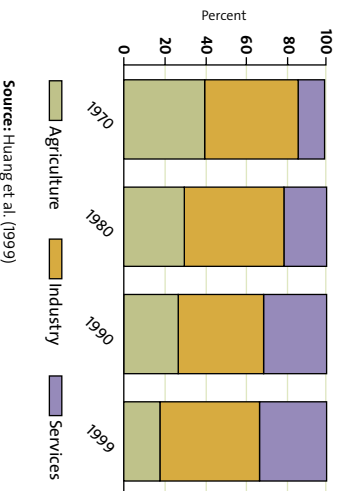
Agriculture, Poverty, and Natural Resources Management

In a country such as China, where even today the majority of the population lives in rural areas, the state of the rural environment—that is, of the land, the life that is dependent on the land, and the water that flows from the land—is substantially influenced by the state of the rural economy. As the rural economy changes, so too do the natural resources management issues that have to be addressed.

CHANGING PATTERNS OF AGRICULTURAL PRODUCTION

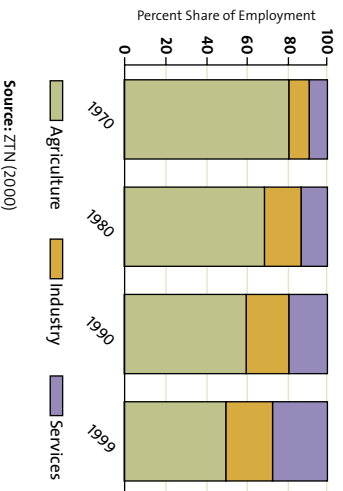
Of all the sectors that are changing in the Chinese economy, agriculture is changing the most. Its economic contribution is declining in relative terms, as is its role as a source of employment (see Figures 1.2 and 1.3). At the same time, farmers are increas-

Figure 1.2 Sectoral Contributions to GDP, 1970-99



Source: Huang et al. (1999)

Figure 1.3 Sectoral Contributions to Employment, 1970-99

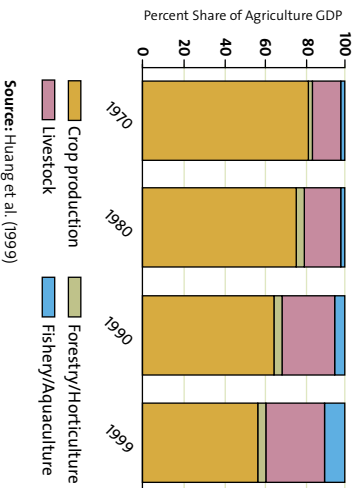


Source: ZTN (2000)

ingly being freed from direction by the state and permitted to respond to consumer demand, which is changing the structure of agricultural output. Production of crops has been declining, while the livestock, fish, and horticulture sectors have been increasing (see Figure 1.4).

These changes have many environmental implications, some of which are positive and others negative. On the positive side,

Figure 1.4 Structure of Agricultural Production, 1970-99



Source: Huang et al. (1999)

diversification out of grain crop production could reduce land development pressures; in many cases, conversion to cropland in the last 30 years has been a source of considerable land degradation, in part because much of this land is only marginally suitable for cultivation. It could also reduce irrigation demands, since much of the diversification is occurring in eastern China, where irrigation is most developed and water-use conflicts are most acute. Fertilizer demands and the adverse effects associated with their misuse may also be moderated, since grain producers are the biggest consumers of fertilizer. They are also the most prone to over-apply fertilizer, thus contributing to eutrophication problems, which are particularly severe in eastern China.

Diversification also poses two potentially significant adverse environmental consequences: (a) increased production of horticultural products and cash crops such as vegetables tend to be associated with increases in pesticide applications, particularly the more hazardous types; and (b) increased livestock production can result in increased emissions of organic pollutants.

China may already be the largest producer and consumer of pesticides in the world.⁸ There are many reports that farmers are overusing them and are unaware of the health risks associated with their use. There are also reports of substantial local production of and trade in banned and environmentally hazardous pesticides. Increased production and

domestic consumption of pesticides will not only represent an increasing risk to the health and safety of farmers using them, but elevated pesticide residues in food products could act as a barrier to entry to important export markets for high-quality food.

Livestock is another rapidly growing part of the rural economy, and this trend will continue as domestic incomes and consumption of meat products rise. The bulk of increased production, particularly pork, will be met by medium- and large-scale intensive animal production operations, which are potentially significant water pollution sources. Projections summarized in Chapter 3 suggest that, within the foreseeable future, their significance could be comparable to the current combined impact of industrial and municipal water pollution sources. This matter will present a major challenge to environmental protection agencies and relevant units of the Ministry of Agriculture.

POVERTY AND NATURAL RESOURCES MANAGEMENT

As the poverty problem retreated during the 1990s, it became increasingly caught up with the issue of land degradation. Of the roughly 42 million people still living under the government's poverty line, the great majority are living in rural areas that are particularly susceptible to land degradation, which is unquestionably the major rural environmental issue confronting the country today. In the central and eastern regions of

the country, there is a high degree of overlap between ecologically sensitive land and counties with high poverty rates. Similarly, there are concentrations of poor people in the grassland provinces of western China that are prone to desertification.⁹

In some respects, there is a circular relationship between poverty and natural resource degradation. Part of the reason that the people are poor is because their land is of poor quality, and/or the climate is variable and subject to extremes. These are the same features that make the landscape susceptible to degradation. The farmers' problems are compounded by remoteness and lack of access to government services, infrastructure, markets, and credit. Their lives are risky, and they lack confidence in their ability to access markets. In turn, this makes them unwilling to diversify production away from basic staples, principally grain or small livestock. Thus, even when they have the knowledge and ability to diversify production, they may be reluctant to take the risk. Under such heavily constrained circumstances, it is not surprising that many poor farmers attempt to increase their incomes by making use of the only production factors available to them either freely or at low cost: (a) unutilized or underutilized land, which is likely to be even more degraded than the land they are already using; and (b) their labor, which has low opportunity cost because of the shortage or complete absence of off-farm employment opportuni-

ties. Poor land resources thus lead to poverty, which leads to further degradation of land resources, which leads to increased poverty.

Land degradation in China is serious and appears to be worsening on most fronts in spite of strenuous government efforts to combat it. A coordinated attack on land degradation needs to be a central theme in the government's strategy. Past strategies will not be sufficient; new approaches need to be developed. The close connection between rural poverty and land degradation may provide a way forward. An important component of the strategy could be the poverty alleviation campaign spearheaded by the Leading Group on Poverty Reduction (LGPR), since it attacks the underlying causes of poverty, which ultimately are also important causes of land degradation.

Lessons for the New Millennium

The issues discussed above will be elaborated in succeeding chapters, but there are some general conclusions that can be drawn from the last 10 years' experience that are useful in thinking about how to confront the new environmental challenges.

When China's economy took off two decades ago, three emerging conditions changed the character of growth and subsequent environmental impacts. First, the economic system was set on a reforming path to increase its

⁹ Economic Growth and the Environment 11

responsiveness to market mechanisms. Second, the country opened up to international trade, knowledge, and norms. Third, a nascent environmental protection system was put in place and slowly but progressively increased in strength. The first two factors contributed to the spectacular economic growth of the last 20 years, while the third helped prevent environmental conditions from deteriorating even more than they have.

It would be easy to be pessimistic about China's environmental prospects over the next 10 years. The scale of expected growth and development, the complexity of issues to be addressed, and the already over-stressed state of the environment present an intimidating prospect. But there is also considerable room for optimism. Political and public awareness of environmental degradation is already high and increasing. A solid framework of environmental laws and regulations has been put in place, and there is little doubt about the government's capacity to deal with complex management problems. While it is not yet true that China has won the battle against industrial pollution, it has created many of the preconditions for success and is definitely making progress. Emissions of several major pollutants, such as COD and particulate matter, have been stabilized or even reduced during a period of strong output growth. Statistics and analysis show that economic growth and market reforms have continuously reduced the pollution intensity of Chinese industries, and there is com-

elling evidence that strengthened pollution management has increased incentives for industrial pollution control.

In short, there has been an encouraging convergence of events governing industrial pollution, which provides considerable reason for confidence about future prospects on that front. At the same time, however, other dimensions of the environmental agenda are emerging. Urban environmental management is now a huge challenge, notwithstanding the government's massive investments in environmental infrastructure. The deteriorating state of the natural environment is not only impinging on the health of the rural economy, but is also intruding into the lives of the urban community through dust storms and other indirect effects. In this context, the challenge for the next 10 years will be how to maintain the momentum on industrial pollution control and broaden the attack to cover emerging environmental issues without undermining the economic growth that has provided the motivation and space to address environmental problems in the first place.

Meeting that challenge will require more than the best efforts of SEPA and its counterparts at lower levels. This is a challenge that requires the attention and coordinated efforts of all relevant branches of government to achieve much better integration between economic and environmental policies. Economic policies and institutions need to be designed to provide the right incentives to protect the environment. Environmental

management needs to focus on the full cycle of any economic activity, not just waste disposal. The integration of economic and environmental policies is a two-way street. Economic policies and institutions need to be reformed to improve or introduce environmental signals that are received by different economic actors. Environmental policies and institutions also need to be reformed to harness the efficiency of the market and the synergistic opportunities offered by growth.

The problem of achieving economy-environment integration in China is compounded by the growing assertiveness of local governments and their unwillingness to be bound by environmental constraints in the rush for growth. This is a transitional problem, as evidenced by the increasing attention paid to environmental issues by governments in the eastern provinces, but the government needs to push the pace of transition through education, incentives, and peer group pressure.

These are difficult concepts to put into operation, and no country can legitimately claim to have fully succeeded, although many are trying. China will have to work out an approach suited to its own situation, but it is already clear that a key element in the solution will be to develop a mechanism to better integrate economic and environmental policies and to coordinate the efforts of different agencies.¹⁰

The following chapters of this report explore the detailed dimensions of the environmental challenge in relation to the management of land, water, and air, and to environmental administration. In the concluding chapter, we return again to the issue of a crosscutting environmental strategy, and discuss further how the concepts mentioned above could be put into action.

Notes

1. The impact on air emissions may not have been so significant (see Figure 1.1).
2. One of the industries favored by structural reform is leather tanning, which is a serious source of pollution.
3. They are mining (covering coal, ferrous and nonferrous metals and non-metal minerals), electricity generation, non-metal mineral production (including cement and brick making), chemical production, food processing and manufacturing, pulp and paper production, textiles, and ferrous smelting and processing.
4. Statistics show that the value added by the Chinese manufacturing sector is derived as follows: 36 percent from light manufacturing, 32 percent from raw material manufacturing, and 32 percent from downstream processing and assembly. The average contribution of these sub-sectors in the USA, Japan, and France/Germany is 30 percent, 26 percent, and 44 percent, respectively (CASS 2000).
5. For example, coal-based ammonia production technology, which accounts for over 75 percent of China's ammonia production, uses 500-1,000 tons of water per ton of ammonia, compared with only 12 tons of water in natural gas-based processes. Chinese paper mills require 200 to 400 tons of water to produce 1 ton of paper product, while state-of-the-art mills in industrialized countries use as little as 60 tons per ton. Over 80 percent of China's caustic soda, a major industrial raw material, is produced through the diaphragm process, which is both energy-intensive and highly water polluting. The membrane process, a relatively new but mature technology, requires 30 percent less energy; eliminates additives such as asbestos, lead, or heavy metals; and can cut wastewater volume by a factor of 15.

6. This includes (a) the "non-agricultural population" of China's 667 designated cities, which is the narrowest definition of urban population (they total about 380 million people and constitute the "official" urban population); (b) unregistered urban residents (mainly migrant workers); and (c) people living in "peri-urban" towns, that is, towns that have been swallowed up by expanding urban areas but are not yet counted as being part of the city.

7. The total population of China's 17,341 administrative towns in 1999 was about 116 million people, of whom about 48.8 million were registered as non-agricultural population (NAP). There are an additional 15 million people classified as NAP living in what the Ministry of Construction classifies as "town concentrations" (i.e. informal urban areas within townships, which have no formal administrative structure). All of the NAP of both organized towns and town concentrations could reasonably be considered as urban population. Together, they represent about 16 percent of the "urban" population currently registered as living in designated cities.

8. Domestic production in 1997 is estimated to have been on the order of 450,000 tons of active ingredients, which was the second highest in the world at the time. If previous growth trends were sustained in subsequent years, China would now be the biggest producer in the world (Huang et al. 2000). About 93 percent of domestic production is consumed locally.

9. The proportion of the rural population living below the government's poverty line (1996) in the major grassland provinces is as follows: Tibet—10 percent; Inner Mongolia—9.3 percent; Xinjiang—27.4 percent; Qinghai—17.7 percent; Sichuan—7 percent; Gansu—22.7 percent; and Yunnan—22.9 percent. These are all well above the national average of 6.3 percent. Xinjiang is notable for being the only province in the country where poverty increased over the 1988-96 period: the percentage of poor rural households in Xinjiang increased from 8.8 percent to 27.4 percent. (World Bank 2000).

10. The concept of environmentally sustainable development has already been incorporated into the national planning process. The Sustainable Development Strategy was formulated in 1997 and has been developed further for the 10th Five Year Plan. It is intended to achieve a harmonious balance between population, resources, and the environment, but most of the focus is on setting targets. Further work is needed to address the underlying complexities of economic and environmental integration and move the economy toward these ambitious targets.



2 Land Resources



China's growth and development is having a significant impact on its land systems. Partly as a result, land degradation is widespread and increasing.

This chapter summarizes recent trends in the main observable results of land degradation, including water erosion, desertification, and salinization. It then considers trends in the status and management of the three main terrestrial land systems: cultivated lands, grasslands, and forests. Together, these systems cover about 82 percent of the national area.¹ The chapter also discusses the management and protection of China's considerable biodiversity resources. The concluding section outlines the main recommendations for addressing these issues.

The State of Land Degradation

China is prone to land degradation, and particularly erosion, due to its climate and geography. In part because of China's rapid growth over the last 30 years, there is little

doubt that the problem has accelerated. China is now considered one of the most seriously eroded countries in the world (Huang 2000).

Based on an analysis of satellite images, the Chinese Academy of Sciences estimates that in the early 1990s some 375 million hectares—nearly 40 percent of the country—was affected by moderate to severe erosion.² The biggest problems are water and wind erosion, followed by salinization.

WATER EROSION

Over the 20-year period from 1975 to 1996, the total area of land moderately to severely affected by water erosion increased by an estimated 20 to 30 percent, which is equivalent to an annual rate of increase of about 2 percent.³

In the extended Loess Plateau region, which is the most susceptible to water erosion in the nation, increases were less than a quarter of the national average (Figure 2.1). This suggests that the government's massive erosion control campaign on the Loess Plateau is succeeding and, more generally, that the water erosion problem can be beaten given the right combination of control strategies.

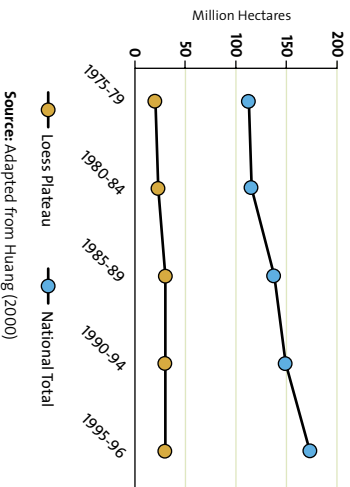


Figure 2.1 Trends in Land Moderately to Severely Affected By Water Erosion, 1975-96

Source: Adapted from Huang (2000)

Apart from the erosion on the Loess Plateau, most observed erosion is believed to be taking place on marginal cultivated land and “barren lands,” which does not threaten the productivity of China’s prime cultivated land resources. The main immediate victims are the generally poor farmers who are forced to cultivate the poorer quality areas. Water erosion also has significant off-site effects, including reducing the hydraulic capacity of important river systems.

DESERTIFICATION

An estimated 331 million hectares—roughly a third of China’s total area—is prone to desertification.⁴ Of this total, desertification is actually occurring on about 262 million hectares. This is believed to be the highest ratio of actual-to-potential desertification of any country in the world. The problem is mainly restricted to just five provinces/autonomous regions: Xinjiang (42 percent of

the national total), Inner Mongolia (34 percent), Gansu (9 percent), Tibet (7 percent), and Qinghai (5 percent).

Data on which to assess desertification trends at the national level are rather limited. They suggest that desertification has been worsening progressively over the last 50 years, and the rate may have accelerated during both the 1980s and the 1990s.

There are two main geographical areas where significant desertification is occurring: (1) the agro-pastoral transitional zone in northern China, predominantly in Inner Mongolia but extending into five other provinces to some degree; and, (2) areas surrounding agricultural oases on the internally draining river systems of northwestern China, predominantly in Xinjiang and Gansu provinces.

The worst and most intractable problems are occurring in the agro-pastoral zone in northern China. In this area, there is little doubt that the most significant contributor to desertification over the last 50 years was excessive land reclamation during the 1960s and 1970s, combined with an excessive build-up in livestock numbers in the 1960s. Both were driven by the government’s drive for food self-sufficiency. Generally, it appears that the desertification trend throughout the region has progressively worsened through the 1980s and possibly into the 1990s, notwithstanding government control efforts in the late 1980s and 1990s.

SALINIZATION

Salinization is mainly a problem associated with poorly designed and/or managed irrigation development in arid and semiarid zones. Salinization is also a natural phenomenon; there are vast areas of natural salt pans in western China.

The area of salinized land is estimated at 82 to 100 million hectares, including about 7–8 million hectares in areas of cultivated land. According to data compiled by the Ministry of Water Resources, the area of salinized cultivated land increased by about 10 percent over the 20 year-period ending in 1996, but the rate declined quite noticeably during the late 1980s and into the 1990s.

Most of the salinized cultivated land in China is located in three geographical regions: the North (30 percent of the total), the Extended Loess Plateau (26 percent), and the Northeast (16 percent). Of these, the area of major national significance is the North, which includes the north China Plain and the provinces of Beijing, Tianjin, Hebei, and Shandong.

The government has developed and implemented a range of programs to control salinization and reclaim salinized land through investments in improved irrigation and drainage, improved irrigation management, and altered cropping patterns. The program has been very successful, with consistent net gains since 1988 due to simultaneous progress in both the prevention of saliniza-

tion and remediation. Several factors are contributing to this success, including (a) the direct and obvious link between salinization and production losses, which makes farmers aware of the problem and probably more receptive to advice on what they can do to control it; (b) the fact that engineers in the Water Resources bureaus understand the causes of the problem and techniques for avoiding and/or remediating it; (c) the combined impact of focusing on both reducing the extent of new salinization and remediating already salinized areas; and (d) the substantial financial resources applied to the problem. The last point is a necessary component of the control strategy, but experience with other problems suggests that money alone is not sufficient to solve the problem. The other elements also need to be in place.

Management Issues in the Main Land Systems

Key land management issues in China include losses of cultivated land, grassland degradation, the declining state of natural forests, and increasing threats to biodiversity resources. The causes are many, but there is little doubt that the government's natural resource management policies have been an important contributing factor.

CULTIVATED LANDS

The net reduction of cultivated land is directly linked to the government's national food security concerns. The available data⁵ suggest that from 1987 to 1995 the area of cultivated land in China declined. As shown in Table 2.1, the total net decline over that period was about 1.7 million hectares, including about 3.1 million hectares in gains and 4.8 million hectares in losses of cultivated land.

Losses. Of the 4.8 million hectares in losses, about 60 percent was due to conversion of land from cultivation to other forms of

primary production, most notably horticulture, forestry, grassland, and fishponds (see Table 2.2). These changes are mainly a result of agricultural restructuring, including farmers' greater exposure to the market and greater freedom to make their own production decisions, but also partly to conversions promoted under government environmental programs. They do not represent absolute losses of cultivated land. It is at least arguable, from an environmental point of view, that some conversions may be beneficial, particularly if the converted land is marginal for food production.

Table 2.1 Additions and Losses of Cultivated Land, 1987-95

Year	Total (1,000 Ha)	Increase (1,000 Ha)	Decrease (1,000 Ha)	Net Change (1,000 Ha)
1987	132,835	372	676	-304
1988	132,530	388	417	-29
1989	132,501	446	346	+100
1990	132,601	425	448	-23
1991	132,578	412	707	-295
1992	132,283	302	625	-323
1993	131,960	347	785	-438
1994	131,522	389	798	-409
1995	131,113	—	—	—
Total	—	3,088	4,804	-1,722

Source: Adapted from Heilig (1999)

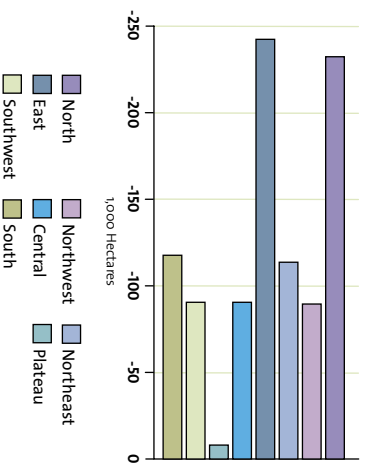
Table 2.2 Reductions in Cultivated Land by Cause, 1987-95

Source of Reduction	Area (1,000 HA)
Loss due to Construction	979
Loss Due to Conversion for:	
Horticulture	1,218
Forestry	965
Grassland	552
Aquaculture	232
Total Conversion	2,967
Loss Due to Flood/Drought/etc.	865
Total Reduction	4,804

Note: losses are cumulative for the period.

Source: Adapted from Heilig (1999)

About 20 percent of cultivated land lost over the 1987-95 period was due to the effects of infrastructure and urban construction, particularly in the North and East regions (see Figure 2.2). This is a direct reflection of the massive metropolitan area developing in the lower Yangtze Basin between Shanghai and Nanjing, and also from extension of the Beijing/Tianjin urban area. The land in the lower Yangtze is some of the most inherently productive agricultural land in China, is well served with water, and is located close to major urban markets. Its loss represents a real and substantive loss to agriculture.

Figure 2.2 Cultivated Land Losses Due to Construction, 1987-95

Source: Huang et al. (1999)

Finally, about 0.8 million hectares of cultivated land were lost due to natural disasters, including floods, fires, erosion, and desertification. Losses such as erosion and desertification are more or less absolute, while others such as floods may only be transitory.

Additions. The major source of new cultivated land was land reclamation (see Table 2.3), which accounted for about 2.2 million hectares (70 percent) of all new cultivated land, much of it in the arid and semiarid areas of the Northwest region (see Figure 2.3). Some of this new cultivated land was developed at considerable environmental cost. For example, about 224,000 hectares was reclaimed in Inner Mongolia; at least some of this reclamation was not successful and resulted in significant loss of high quality grasslands. Another 267,000 hectares was reclaimed in Heilongjiang. Much of this was

located in the “Three Rivers (Sanjiang) Plain” area, an internationally significant wetland. The largest area of reclamation was in Xinjiang (317,000 hectares), and much of this was located in the Tarim Basin. The increased water demands generated by some of this reclaimed land have been blamed by local experts for deterioration of the so-called “Green Corridor” on the lower reaches of the Tarim River.

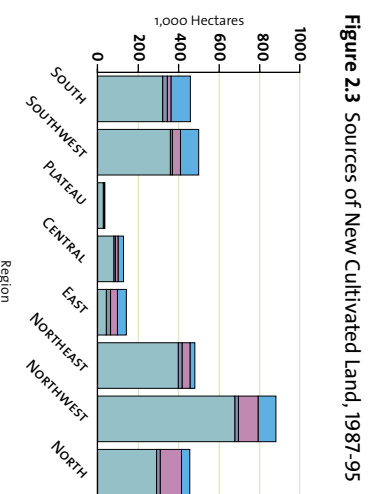
Table 2.3 Net Increases in Cultivated Land by Cause, 1987-95

Source of Increase	Area (1,000 HA)
Reclamation	2,197
Drainage	118
Rehabilitation	349
Conversion	414
Total	3,082

Note: Increases are cumulative for the period.

Source: Adapted from Helling (1999)

Drainage was an important source of increased cultivated land in the East statistical region, and it too had some adverse environmental consequences. The largest area drained was in Guangdong Province (16,400 hectares), and it is believed that much of this was at the expense of coastal wetlands in and around the Pearl River estuary. The next largest area of drainage was in Jilin Province (14,700 hectares), which may also have involved coastal wetlands.



Note: Totals are cumulative for the period.

Source: Adapted from Helling (1999)

GRASSLANDS

Grasslands cover about 40 percent (400 million hectares) of China's land area, making China second only to Australia in the extent of its grassland resources. The majority of the grasslands are found in only a few provinces or autonomous regions. The most important are Tibet, Inner Mongolia, Xinjiang, and Qinghai. An estimated 317 million hectares of grassland, or about 80 percent of the total, is considered usable for livestock grazing (Li 1998).

In general, China's grasslands are not highly productive. About two thirds of the total have an annual dry matter production potential of less than 1,000 kilograms per hectare, placing them in the low-yield class.

China has 260 pastoral counties accommodating about 39 million people (Zhou 1990), including some of the poorest people in China. Many are nomads who obtain their livelihoods from grasslands and are very susceptible to changes in the health and productivity of grasslands.⁶

In much of China's pastoral region, traditional livestock production and grazing management strategies have been greatly altered in the past several decades, as the nomadic/pastoral way of life has been transformed to one more oriented toward a market economy. In recent decades, the government's goal for livestock production in most pastoral areas has been to increase livestock off-take, which has been promoted through privatization of herds and grazing land, sedentarization, intensive grazing management strategies, and introduction of rain-fed farming techniques for grow-

ing forage and fodder. Many of these developments were responses to economic objectives. In many cases, they have conflicted with the goal of maintaining grassland ecosystem stability. In addition, they may not always have been consistent with the herders' own goals.

Trends. As shown in Table 2.4, the Ministry of Agriculture (MOA) estimates that about 34 percent of all grasslands in China are moderately to severely degraded and about 90 percent are degraded to some degree. Inner Mongolia, Xinjiang, and Gansu are experiencing degradation levels well above the national average.

Grassland degradation not only results in loss of productive capacity, but also reduces other grassland benefits, including (a) biodiversity values, which have declined in terms of the number, variety, and range of wild

Table 2.4 Extent of Grassland Degradation in China, 1998

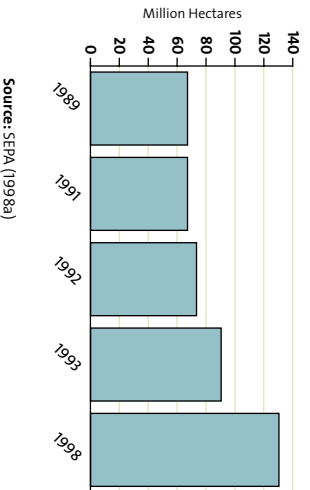
Province	Grassland Area (MILLION HA)	Grassland Area Moderately to Severely Degraded (MILLION HA)	(PERCENT)
Tibet	82.4	21.4	26
Inner Mongolia	79.1	45.9	58
Xinjiang	56.4	26.0	46
Qinghai	36.0	10.8	30
Sichuan	21.1	6.1	29
Gansu	17.6	8.4	48
Yunnan	15.2	0.5	3
Other Provinces	117.8	17.7	15
Total	393.6	136.7	34

Source: Ministry of Agriculture (1999)

animals on the grasslands of China: (b) watershed protection,⁷ and (c) air quality in eastern China.⁸

Data published by the State Environmental Protection Administration (SEPA 1998a), which are illustrated in Figure 2.4, suggest that the total area of degraded grassland increased by about 95 percent between 1989 and 1998, with a notable acceleration in the middle-to-late 1990s.

Figure 2.4 Trends in Grassland Degradation, 1989-98



Causes of degradation. Grassland degradation is caused by many complex factors, but it is hard to avoid the conclusion that the most fundamental underlying cause has been poor government development policies relating to grassland areas. Fortunately, these policies have been progressively improving.

From the 1950s to the 1970s, grasslands were primarily viewed as wastelands. Large areas, particularly those with better soils and access to water for irrigation, were converted to crop production as part of the national food

self-sufficiency policy. There are various estimates of the amount of land converted during this period.

The most commonly cited figure is about 6.7 million hectares (Li 1998 and Yu and Li 2000). Much of this conversion occurred on state farms, which were established in the boundary provinces/autonomous regions of Inner Mongolia, Xinjiang, and Heilongjiang. Much of the investment provided only short-term benefits, and many of the converted areas subsequently became salinized or otherwise degraded.

By the early 1980s, the central government reconsidered its approach and substantially withdrew its support for grassland conversion, redirecting policy toward promotion of livestock and animal husbandry in grassland areas. As with many other aspects of agricultural policy, the emphasis was on maximizing production, with much less concern for the sustainability of the production system. Even though central government policy changed, there was a lot of “inertia” at lower levels, and many provincial and local governments failed to respond to the policy changes made in Beijing. During the remainder of the 1980s and into the 1990s, there are numerous accounts of continued and even accelerated grassland conversion projects that were either approved or tacitly approved by governments below the state level.⁹

As grassland degradation problems worsened during the late 1980s, government policymakers were paying increased attention to the ecological functions of grasslands. Restoration of degraded grasslands became an important factor in national “ecological construction” programs, which were intended to establish artificial grasslands, improve degraded grasslands, increase fencing, and establish grassland reserves. Like many such “ecological construction” programs in China, the focus was almost entirely on investment, with less attention being paid to the underlying social and administrative issues, which are often at the heart of natural resource management problems.

Since 1985, a major innovation has been the move toward establishment of clearly defined individual private property rights to land in the pastoral areas through the allocation of grassland to individual herders on long-term contracts. A premise of the grassland contract system is that herders were deterred from investment in land improvements because of uncertainty as to whether they could appropriate the benefits. The grassland contract system provides a better definition of property rights and security of land tenure, which gives herders the incentive to manage their lands sustainably and invest in grassland improvements (Banks 1997). The approach was informed by much of the emerging literature on the “Tragedy of the Commons” (Hardin 1968), but there are serious questions whether (a) the analysis

actually applies in many pastoral areas, which developed their own community-based institutional arrangements for regulating grassland use; (b) one of the underlying concepts (“carrying capacity”) is actually relevant to “non-equilibrium” ecological systems such as some grasslands in China (see Box 2.1); or (c) the government actually has the staff and financial resources to enforce the policy.

The government is facing a dilemma regarding the effective privatization of land tenure in the context of its extensive pastoral areas. There are high transaction costs associated with the policy, including high private costs of monitoring and enforcing boundaries relative to the benefits (given the low productivity of the grasslands), and high public costs associated with the delineation of boundaries, the adjudication of disputes, and the monitoring and enforcement of contractual provisions relating to grassland management.

Other problems include a general lack of applied, cross-disciplinary, and ecosystem-level research, which would provide a better basis for developing more integrated and sustainable grassland management systems. A disproportionate amount of grassland research is oriented to livestock and ways to maximize productivity from intensive livestock production, rather than understanding how livestock fit into the wider ecological system and how to optimize production in an environmentally and socially sustainable way.

Box 2.1 Non-equilibrium Models and their Relevance to Chinese Pastoral Systems

In regions where climatic variability is high and ecosystem functions are dynamic, recent ecological research suggests that many arid grassland ecosystems function as “non-equilibrium” systems. In such areas, plant growth and grassland productivity are functions of climate more than livestock stocking rates, and the effects of livestock on the grasslands are more sporadic than continuous. Periodic but sharp reduction of forage supplies due to drought increases animal mortality, so that livestock numbers rarely reach a point where they would consume more forage than can be produced. Thus, livestock in non-equilibrium systems do not threaten their overall forage supplies, since ecological carrying capacity is never reached. Grassland dynamics are largely controlled by droughts, the balance between livestock and forage resources is never stable, and the pastoral system operates far from equilibrium most of the time.

This situation prevails across much of the pastoral area of northern China, which is characterized by both variable precipitation and cold winters. Even in the more humid areas of eastern Inner Mongolia, the mountainous areas of northern Xinjiang, and the eastern part of the Tibetan Plateau, periodic heavy snowfalls can decimate livestock herds

and add to the complexity and non-equilibrium nature of the pastoral system. Snowstorms, like droughts, function to regulate livestock numbers and prevent a buildup of livestock numbers to levels where overgrazing takes place. It appears that livestock population growth in much of Inner Asia has been continually checked by climatic factors, rather than by increasing pressure of livestock numbers on the grasslands.

Spatial variability of forage production and nutritive values is also typical of many of the grasslands in northern and western China, which underlies the livestock movement patterns used by nomads. In such a situation, there is an advantage in having flexible access to land, so that herds could be moved to areas with the best vegetation.

These findings change not only how we understand grassland ecosystem dynamics, but human management of livestock in pastoral systems as well. Policies that rest on assumptions of climate stability, and therefore ignore key management requirements of non-equilibrium systems, may be misconceived. The government needs to diversify its policies and approaches to achieve a better alignment with the ecological characteristics of different grassland systems.

FORESTS

Prior to the logging ban applied by the government in 1998 (see below), China's forests provided about 40 percent of the country's rural energy, almost all the panels and lumber for the construction sector, and raw material for the pulp and paper industry. China was the third largest consumer of timber in the

In any event, agricultural research in general suffers from fiscal constraints, and public allocations are inadequate. Real expenditures for research declined at an annual rate of 4 percent during the 1990s, and real research funds per scientist declined by 25-30 percent¹⁰ (Nyberg and Rozelle 1999).

world, and was already facing a widening imbalance between supply and demand for wood products.

Government officials, though aware of the problems in the sector, were hesitant to make fundamental changes, largely because of the potential social consequences. This situation changed following the devastating floods in the middle reaches of the Yangtze River and in northeast China during the summer of 1998, which many local environmental experts said were caused at least in part by deforestation in the catchments of the rivers in these areas. The government took a number of decisive actions. The State Council imposed a ban on logging in natural forests; prohibited the opening of new lands at the expense of forests; froze all construction projects on forestland for one year; and introduced a new requirement for direct cabinet approval for any occupation of forest

land. In addition, it launched a major new investment program (Natural Forest Protection Program—NFPP) to improve natural forest management, covering approximately 95 million hectares of state-owned forests in 17 provinces, and enacted a new land-use law to promote more efficient use of land and increased afforestation.

Notwithstanding the problems in the industry that led to the government's radical action, the state of China's forests has been improving, at least since the mid-1980s. In other respects, however, particularly in terms of the state of natural forests and all the non-wood services they provide such as biodiversity and non-timber forest products, the situation has been in a more or less continuous state of decline for decades.

Current status of forest resources. About 27 percent (257 million hectares) of China's land area is designated as "forestland,"

Table 2.5 Trends in Forest Resources, 1934-93

Year ^a	Forested Area M Ha	Forest Cover ^b (percent)	Timber Area (M Ha)	Forest Volume (B m ³)	Non-timber Area (M Ha)	Bamboo Area (M Ha)
1934	86.3	9.0	—	—	—	—
1962	85.5	8.9	77.7	6.5	5.8	2.0
1976	121.9	12.7	98.0	7.7	8.5	3.1
1981	115.3	12.0	80.6	6.9	11.3	3.3
1988	124.6	13.0	80.1	6.2	17.3	3.7
1993	133.7	13.9	84.9	6.7	16.1	3.9

Notes:

^a Other than for 1934 and 1962, the years represent the end of three-year forest census periods.

^b Forested area as a percent of national land area.

M Ha = million hectares; B m³ = billion cubic meters

Source: Pei and Xu (2000)

although only about 50 percent of that land is actually forested (133.7 million ha.—see Table 2.5).¹¹ The forested part of forestland is referred to as Forested Timber Land; about 80 percent of it is classified as “timber forest.”¹² An additional 15 percent is protection forest, including primarily shelterbelts to reduce wind erosion and for watershed protection; 4 percent is for fuelwood; and the remaining 3 percent is for special uses, including national parks and nature reserves.

The age structure of the timber forest is unbalanced in terms of both area and volume. In terms of forest area, there is a preponderance of young and middle-aged trees, which is substantially a reflection of the major reforestation efforts of the 1980s and 1990s, and a significant deficiency in near-mature and mature forests, which are predominantly natural forests. This is a result of extensive clearing of natural forests, which continued until the 1998 logging ban.

The total volume of timber contained within the nation’s timber forests is estimated to be about 6.7 Billion cubic meters (m³), which accounts for about 68 percent of total standing volume. Of this, about 3.7 Billion m³ is of mature age and potentially suitable for harvesting, but approximately 1.5 Billion m³ is either inaccessible, over-mature, or of insufficient quality to justify harvesting, or is located in catchment areas where it would be no longer environmentally acceptable to harvest. This reduces the potential harvestable resource to about 2.2 Billion m³. At the rate

of extraction that applied until the logging ban of 1998 (around 300 million m³/year), the resource had less than 10 years of remaining life.

Trends in Forest Area and Structure. Forest cover and volume in China have progressively increased over the last 70 years although, as shown in Table 2.5, there were reversals in the late 1970s in terms of both volume and area. As of the last published national forest census conducted during the 1988-93 period, the total forested area was nearly double the estimated level of 1934. Between the censuses of 1977-81 and 1988-93, total forested area increased by about 16 percent. Most of this (13 million hectares) was in timber forest, while the residual (4.8 million hectares) was in non-timber forest, such as nature reserves and shelterbelts.

China’s achievement in terms of forest cover has been quite remarkable, and possibly even unprecedented in a country that is still at a relatively early and rapidly growing stage of economic development and also has to deal with very heavy population pressure.

As shown in Table 2.6, significant reductions in the area of forested land occurred between 1973-76 and 1977-81, with the northeast region being particularly notable. The declines during this period were due to a combination of over-logging, predominantly by state-owned forest enterprises; forest conversion for agricultural development; and illegal logging. Between the 2nd and

Table 2.6 Change in Forest Area by Forestry Region, 1976-93

Forest Region	1 st Census (1973-76) (M Ha)	2 nd Census (1977-81) (M Ha)	3 rd Census (1984-88) (M Ha)	4 th Census (1988-93) (M Ha)
North ^a	3.7	16.4	17.1	18.2
Northeast	36.9	25.0	25.8	26.4
East	19.4	16.4	19.3	21.6
South Central	25.7	23.2	23.1	26.3
Southwest	25.9	24.6	25.5	30.7
Northwest	8.2	7.6	8.6	8.6
Total	121.9	115.3	124.7	133.7

Notes:

^a Forest regions are different than regions defined for other statistical purposes and used elsewhere in this report.

North China includes Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia.

Northeast China includes Liaoning, Jilin and Heilongjiang.

East China includes Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi and Shandong.

South Central China includes Henan, Hubei, Hunan, Guangdong, Hainan, and Guangxi.

Southwest China includes Sichuan, Guizhou, Yunnan and Tibet.

Northwest China includes Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

Source: Pei and Xu (2000)

4th censuses, there were increases in the area of forested land in all regions, notably in the East (31 percent) and Southwest (25 percent).

There was a different trend in the area of timber forest over the four census periods. The aggregate area actually declined by 13 percent between the 1st and 4th Censuses (Table 2.7), and possibly by as much as 23 percent, depending on the anomalous data for the northern region between the 1st and 2nd Censuses.¹³ Thereafter, and with the exception of the timber forests in the Northwest region, the area of timber forest in all other regions consistently increased between the 2nd and 4th census periods.

A substantial part of the increase in timber forests was due to the government's major investments in plantation establishment through both "afforestation" and "reforestation." As of the last forest census, plantations accounted for an area of about 42 million hectares, or 37 percent of the timber forest area. Data cited in Rozelle et al. (1999) suggest that between 1986 and 1993 the total area of land reforested after logging or other activities was nearly 4 million hectares, while the total area of land reforested since records were kept is about 7 million hectares. The authors speculate that much—perhaps all—of this reforestation replaced logged natural forest, and significantly diminished the biodiversity value of the national forest estate.

Table 2.7 Change in Timber Forest Area by Forestry Region, 1976-93

Forest Region	1 st Census (1973-76) (M Ha)	2 nd Census (1977-81) (M Ha)	3 rd Census (1984-88) (M Ha)	4 th Census (1988-93) (M Ha)
North ^a	2.7	13.6	13.4	13.6
Northeast	32.7	21.1	21.6	22.1
East	13.8	10.9	11.4	12.8
South Central	20.5	15.1	14.0	16.0
Southwest	20.7	15.8	15.8	16.7
Northwest	5.7	4.2	3.9	3.7
Total	98.0	80.6	80.1	84.9

Source: Pei and Xu (2000)

There is little doubt that the quality of timber forests in terms of both stocking rates and age class structure, both of which can be used as proxies of biodiversity value, has been progressively declining. The volumetric stock of young trees increased relative to the total stock over the four census periods, while the stock of mature and over-mature trees declined in both volume, by about 40 percent, and relative importance, from about 80 percent of standing stock in 1973-76 to 55 percent in 1998-93.

Of more importance from a biodiversity point of view, the overall area of mature forest declined by more than 7 million hectares, or 35 percent during the period between the 2nd and 3rd censuses.

In summary, the last 30 years saw an initial decline during the 1970s in all measures of the forest resource: area, volume, stocking rates, and age structure. Subsequently, some

of these trends were reversed due, in large part if not totally, to major programs of reforestation, afforestation, and shelterbelt establishment underwritten by the government. As a result, the area of forested land started to increase, as did the volume of wood on forested land. However, the state of natural forests in terms of volume, stocking rate, and age structure continued to decline right through to the mid-1990s, and these trends were particularly noticeable in mature and over-mature natural forests, which are of most value from a biodiversity point of view.

Management problems have been worst in the state-managed sector of the industry (see Box 2.2). Collectively managed forests, on the whole, have been managed much better.¹⁴

BIODIVERSITY PROTECTION

China has one of the greatest ranges of ecological diversity of any country in the world, and probably contains around 10 percent of all species living on earth. It has an especially high number of plant species (about 30,000), including 3,116 genera, of which 243 are endemic. Vertebrate diversity is also high with 2,340 species, including 499 species of mammals, 1,244 species of birds, 387 species of reptiles, and 274 species of amphibians.

China is also 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. It contains nearly 600 varieties of domesticated animals and poultry.

A wide variety of domestic plant and animal species are harvested and used for economic purposes. The MOA estimates there are more than 3,000 species of wild "economic" plants, including 1,000 species of medicinal

Box 2.2 Management Regimes in China's Forests

The state-managed part of the forest sector only covers about 20 percent of the forest resource area, but this area contains most of the highest quality timber forest resources. The sector comprises about 4,000 forest farms, which undertake virtually all forest production activities in their geographical region. They report to the local Forestry Bureau, which is the lowest level of the State Forestry Administration's hierarchy. The center of state forest management is in the northeast region, where the state-owned sector controls about 90 percent of the forest area in the Provinces of Heilongjiang, Jilin, and Inner Mongolia, and produces about half of total timber production from China's state-owned sector.

The factors contributing to poor management of forests controlled by the state-owned sector are similar to those that have characterized many other sectors of the centrally planned economy: (a) a focus on "production" at the expense of sustainability; (b) prices are controlled at levels that bear little or no relation to the scarcity value or opportunity cost of the resource, or of the costs of sustainably managing it; (c) the financial burden required to

meet the social needs of both existing and retired employees, including housing, education, health and other forms of welfare; (d) lack of incentives, and sometimes perverse incentives, for forest managers and staff; and (e) an absence of, or only limited separation between, the regulatory functions of the State Forestry Bureaus and operational functions of the forest enterprises.

In *collectively managed* forests, the forest resource is owned by local communities and managed by village leaders, although they are accountable to officials in local Forestry Bureaus in certain ways. In the mid-1980s, collectives managed nearly 90 percent of the forestry area in the southern provinces of China and produced nearly 75 percent of the value of forestry output in these areas (Rezelle et al. 1999). Although there has been considerable speculation that, in the early stages of the development of the collectively managed system, there was a lot of indiscriminate harvesting of trees, the data show that over the longer term, the collectives have managed their resources much better than the state-owned sector.

plants, 300 species of timber trees, and 500 plants with insecticidal properties. There are also 330 species of “economic” birds, 190 economic mammals, and 60 species of economic fish.

Notwithstanding the richness of these resources, almost all of China’s biodiversity is under stress, and many species are seriously threatened. It is estimated that 15-20 percent of the species in China are now endangered. This significantly exceeds the global average, in which 10-15 percent of species are considered threatened. Of the 640 species listed in CITES,¹⁵ 156—nearly 25 percent—are found in China.

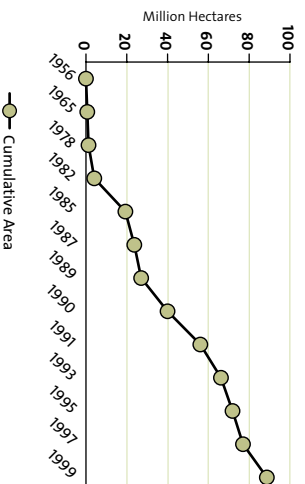
Biodiversity conservation problems in China arise from a combination of historic and modern factors. There has been a long and gradual historical progress of conversion of natural ecosystems for agricultural and other purposes. In the post-revolutionary period, and particularly since the 1970s, the process accelerated and was augmented by other major developments that have been deleterious to biodiversity conservation, including creation of a large-scale forestry industry; implementation of a vast program of water resources development, which has severely impacted aquatic habitat values; and development of a massive and heavily polluting industrial sector.

Changing national development policy from a “rush for growth” to sustainable development will no doubt help the cause of biodi-

versity conservation. More fundamentally, there is a need to establish a strong, comprehensive, well-funded, competently managed network of nature reserves and other designated conservation areas across the country. There are other strategies that can be adopted to assist the cause of biodiversity protection, but without the solid foundation provided by a comprehensive network of reserves, they are unlikely to have any lasting effect.

China’s first national nature reserve (Dinghushan in Guangdong Province) was created in 1956. Since that time, and particularly during the 1980s and 1990s, the number and area of nature reserves have increased rapidly (see Figure 2.5). Institutions such as the State Forestry Administration and SEPA viewed this effort as a race against time. As of 1999, the total area of nature reserves accounted for nearly 9 percent of China’s territory.

Figure 2.5 Area of Nature Reserves, 1989-99



Notwithstanding the rapid growth in reserves, the representation of key ecosystems is quite variable, with some important ecosystems—including grasslands, inland wetlands, and marine and coastal areas—underrepresented.

Responsibility for nature reserve management in China is disbursed. Prior to 1993, there were only four institutions engaged in the management of nature reserves: the Ministry of Forestry (now the State Forestry Administration), National Environmental Protection Agency (now SEPA), State Oceanographic Administration (now the State Marine Administration), and the Chinese Academy of Sciences. By 1997, this number had expanded to more than seven, although the dominant agencies continue to be the State Forestry Administration and SEPA.¹⁶

Although the rate of creation of new reserves has been impressive, particularly over the last 20 years, the provision of staff and financing

to manage and protect them has not kept pace. By 1997, the last year for which data are available, only 67 percent of all nature reserves actually had staff and budgets for their management and protection (see Table 2.8). The remaining third are, in essence, “paper parks.” These parks often do not even have boundary markers to indicate their limits, let alone staff to manage and protect them (Harkness 1999).

Part of the problem is due to the fact that only a minority—13 percent in 1997—of all nature reserves are financed by national-level institutions, which have better and more reliable access to financial resources.¹⁷ The rest are the responsibility of provinces, municipalities, and counties.¹⁸ As shown in Table 2.8, almost all measures of management effectiveness decline progressively through these levels of the government structure.

The crisis in government financing is also having its adverse effects on nature reserve management. Budgetary problems are forcing

Table 2.8 Nature Reserve Staffing Levels, 1997

Management Level	Status of Reserves		All Staff		Professional staff	
	No.	Percent With Staff	No.	Average/ Reserve ^a	No.	Average/ Reserve ^a
State	124	93	6,889	60	1,713	15
Province	392	73	7,718	27	1,196	4
Municipality	84	63	690	13	186	3
County	326	50	1,718	10	451	3
Total	926	67	17,015	27	3,536	6

Note: ^a Average number per reserve that actually has staff.

Source: SEPA (1998a)

provincial and lower levels of government to seek supplementary sources of funds wherever they can. One way this is being done is through promotion of resource development within nature reserves to make them financially self-sufficient. The State Forestry Administration actually provides concessionary loans for certain types of development projects inside nature reserves (Harkness 1999), and even SEPA identifies “protection and development” as one of four different types or stages of nature reserve development in its development plans. Although these policies include caveats stipulating that commercial activities should be subordinate to protection activities, there are no clear guidelines as to what is and is not permissible. Little assistance is provided to local reserve managers as to what resources can be developed, and to what degree without compromising the purposes for which the reserve was established in the first place (Harkness 1999).

There are numerous other serious problems. There is a significant mismatch between the funds reliably available for reserve management and the number of reserves that government agencies are trying to manage. Although it is obvious that more staff and financial resources are needed to adequately manage the country’s reserves, there also may be significant opportunities to rationalize the whole reserve system. Many reserves are either too small to serve the functions for which they were intended, too damaged to

serve any practical purpose, or not located in biologically significant areas. Obviously, there would also be a benefit in revising the system for providing central government financial support to lower levels, so as to remove the incentive to frivolously create nature reserves.

Conclusions and Recommendations

POLICY FRAMEWORK AND CONTROL STRATEGIES

For more than a decade, the government has known that China’s natural resources are deteriorating, and has devoted considerable financial and other resources to reverse the trends. In general, and with a few exceptions, these efforts have not been successful. There are certain consistent features of the policy framework that suggest why this has happened. The government’s overriding development strategy has emphasized growth at almost any cost, with insufficient attention to promoting efficiency and environmental sustainability. If the country wishes to protect its basic natural resources, it needs to increase the priority given to environmental protection and management.

There are major contradictions between different sectoral development policies, which adversely affect sustainable natural resources management.

The major natural resource management agencies—particularly the Ministry of Agriculture, State Forestry Administration, and Ministry of Water Resources—have not had sustainable development at the core of their development objectives. They need to reorient their “mission statements” to emphasize sustainable management and development of natural resources, with due consideration to all beneficial uses provided by those resources.

The major agencies of government concerned with natural resources management need to improve cooperation and data sharing and harmonize their policies as they relate to sustainable natural resources management.

Changing the national policy framework and the broad development mandates of the main natural resources management ministries is not something that can be done or even orchestrated by SEPA. It needs to be done by the State Council, which should convene a leading group or panel of eminent experts to (a) review the laws and regulations of each of the major resource management institutions, one by one, to assess the degree to which their contents conflict with the sustainable development objective; and (b) specify the amendments, modifications, and/or additional laws/regulations that should be developed to better align the mandate of each agency with the sustainable development objective. Mechanisms for promoting cooperation between relevant ministries on environmentally sustainable development also need to be strengthened.

EROSION/SALINIZATION CONTROL

In the area of erosion and salinization control, only efforts to control salinization have succeeded on a large scale. With both water and wind erosion control, there have been localized successes, including the Loess Plateau with water erosion control and parts of Inner Mongolia with wind erosion control, but there is no clear evidence that the problem is being reversed across the board. Given this experience, there are certain policies that seem essential if these successes are to be replicated in other areas and on other land degradation problems.

It is already clear that investment is necessary, but not sufficient, to solve the problem. In most cases, a much broader and more integrated approach will be required that, in consultation with the affected communities themselves, begins with developing a clear understanding of the underlying causes of land degradation in particular areas. This will lead to the development of an integrated package of interventions directed at the cause of the problem rather than its effects. In many cases, investments may not be primarily focused on traditional technical solutions, but on other dimensions of the problem, such as improved roads to improve access to markets; improved education; improved access to production credits; applied research to adapt successful techniques from other areas to local conditions; improved extension services; or improved access to birth control.

There is a strong connection in China between the incidence of land degradation and the incidence of rural poverty.¹⁹ It is likely that intervention on behalf of the rural poor will have a more profound impact on both poverty reduction and land degradation than interventions focused on land degradation alone.

In this context, it is interesting to note that the government, through the Leading Group on Poverty Reduction (LGPR) under the State Council, is already implementing an integrated poverty reduction program with many of the essential ingredients for a concerted and simultaneous attack on both poverty and land degradation. With more active participation by the leading resource management agencies, its land degradation benefits could be enhanced considerably. Key components could be strengthened to enhance environmental/sustainable land management objectives. For example:

- Targeting needs to be improved to ensure that investments are benefiting the poor and not just the people who happen to live in poor counties. The basis for targeting should be an administrative level lower than the county, such as the township, since under current arrangements 20 percent of the poorest counties are not included in the program.

- Investments in education and health offer the most direct means to enhance labor productivity, as well as increase the potential for successful migration of younger members of poor communities.

- Investments in roads, telecommunications, and other infrastructure can increase access to and integration with outside markets, reduce the cost of inputs, and permit greater capitalization of local comparative advantages such as labor.

- Investments in relevant applied research can produce high returns, but research funding has been declining for many years. In any event, research into the problems being faced by poor farmers is not popular, with the result that very few new technologies have been developed for resource-poor areas.

- Improvements in land quality can provide measurable benefits to production and income, provided they improve returns to labor. World Bank experience suggests that, where such improvements are technically and financially sound, adequately financed and supervised, and relevant to the needs of affected farmers, there can be major benefits. On the other hand, poorly financed and implemented projects imposed on farmers by well-meaning officials without adequate consideration of local conditions generally fail.

With the exception of land improvement, none of the above directly address land degradation. However, these priority investments will address the underlying factors that tend to constrain the ability of poor farmers to improve their circumstances and, in the end, the removal of these constraints will progressively reduce their tendency to degrade the natural resources on which they depend.

PROTECTION OF CULTIVATED LAND

A rough balance is being maintained between the loss of cultivated land due to conversion for infrastructure and urban development, and the creation of replacement land through reclamation and drainage. This balance will be increasingly difficult to sustain in the future. A number of actions should be taken to both reduce losses of high quality land and reduce the adverse impacts of land reclamation and drainage. Strategies include:

- Improve land development practices in urban areas. Municipal governments should be encouraged to (a) place more emphasis on protection of high quality agricultural land in development of urban plans; (b) apply time limits to approvals for commercial and industrial developments (approvals to be revoked if construction is not commenced and completed within specified time periods); and (c) review (reduce) open-space provisions for industrial and commercial developments in municipalities or areas where soils are particularly productive.

- Improve planning and design of infrastructure development. Linear developments like highways and railways have particular potential to both directly and indirectly affect agriculture. Planners appear to pay insufficient regard to minimizing adverse effects by selecting routes that, to the extent possible, minimize intrusion onto the highest quality agricultural land, thus minimizing potential adverse effects. These issues should be addressed in environmental assessments (EAs), but are frequently overlooked. EAs need to pay more attention to alternative development options, particularly alternative routes, and strategies to minimize indirect impacts on cultivated land.

The absolute losses of cultivated land area are being offset to a substantial degree by increases in land reclamation and drainage. Much reclamation has come at considerable environmental cost, which will become increasingly unacceptable in the future and make the cultivated land balance more difficult to maintain. Reclaimed land is inherently less productive than the land it is replacing; is mainly created in areas subject to greater water shortages and water use conflicts; is located much further from the main markets than the land it replaces; and, as the best sites are reclaimed, unit costs will probably rise in real terms. The environmental and economic costs of maintaining the cultivated land balance will increase in the future. Steps need to

be taken to rationalize the reclamation side of the balance. The following safeguards should be adopted:

- Land reclamation and drainage above a prescribed size or in particular geographical areas should be made subject to the environmental impact assessment law presently in preparation.

- The government should commission a major national survey with a view to defining land systems that should be excluded from land reclamation/drainage activities.

- The government (particularly SEPA in collaboration with MOA) should develop guidelines and procedures for selection of land for reclamation and/or drainage with a view to minimizing reclamation of environmentally sensitive land or land not otherwise well-suited for reclamation/drainage.

GRASSLANDS MANAGEMENT

The government is facing major difficulties dealing with the simultaneous problems of improving the welfare of people living in pastoral areas and protecting and maintaining the numerous economic and environmental benefits provided by grassland ecosystems. The quantitative data on grassland degradation suggest that current strategies for dealing with these contradictions are not working.

The government has attempted to deal with the common property dimensions of the problem through the Grassland Law and

adaptation of the Household Responsibility System (HRS). Sedentarization and promotion of fodder crop production have been promoted as ways to simultaneously increase production, reduce the adverse effects of natural disasters, and improve access of herder households to education, health, and other social services.

This mix of strategies may not be best suited to all grassland ecosystems, or even represent the optimum method for achieving desired objectives in all cases.¹⁹ A recurring concern expressed by local experts is that Animal Husbandry Bureaus and Grassland Management Units lack the staff and resources to effectively carry out their responsibilities under these policies. This suggests that there is a “misfit” between the management strategy and the resources available to implement it. If the resources cannot be made available, alternative, lower-cost approaches should be considered.

There are also policy contradictions that need to be eliminated. While the government was applying grassland management and protection strategies in an attempt to reverse degradation, it was also implementing policies that promoted grassland reclamation for crop production. The problem of contradictory policies may worsen in the future if the government attempts to overdevelop its livestock industries without adequately considering the environmental and social consequences.

Basic research needs to be strengthened. Researchers should be more interdisciplinary in their approach, increase attention paid to ecosystem-level analysis, and take better account of the social and cultural dimensions of grasslands management, especially in nomadic pastoral areas. Emerging range ecology research findings on the dynamics of arid land grazing systems indicate that “non-equilibrium” models for describing rangeland system dynamics and “state-and-transition” models for explaining vegetation succession are valuable concepts that may provide a basis for the development of new paradigms for pastoral management in grassland areas.

In summary, there needs to be a serious re-evaluation of the approach being taken to grasslands management. While there is no doubt that the government’s diverse efforts on the prevention of particular types of degradation are having beneficial effects in some locations, and there are some promising new production technologies for some locations, there has been insufficient adaptation of strategies and policies to suit local environmental or social conditions. The tendency has been to apply a “one-size-fits-all” approach, which is clearly untenable given the diversity of grassland systems and the cultural diversity of the people who rely on them.

The MOA, as the agency primarily responsible for grassland management and development, needs to re-orient its policy objectives, not only in terms of grasslands management, but in management of rural development in

general. Its traditional mission of maximizing agricultural output is not relevant to current circumstances in China. The need for the 21st Century is for ecologically and economically sustainable development of agriculture and livestock, neither of which is consistent with output maximization. In the particular case of grassland development and development of the livestock production systems dependent on those grasslands, the government and the ministry have to resist the temptation to promote high-input/high-output pastoral production systems as a universal concept. The knowledge base is not there, and the potential feasibility is questionable. The majority of grasslands in China are not highly productive, and are unlikely ever to be highly productive on a long-term, ecologically and economically sustainable basis, although there undoubtedly are areas where there is potential to increase productivity. In short, the ministry needs to be far more discriminating in the development and application of policy. Its strategies should be based on much better consideration of ecological constraints, the interests and aspirations of the pastoralists themselves, and alternative methods of meeting social objectives.

SEPA does not have the staff, the network of local offices, or the expertise to directly influence the problems that are being experienced with grasslands management. These are matters that are ultimately the responsibility of MOA. However, there are several important actions that SEPA can take to raise awareness of the seriousness of the problems being faced,

to tangibly contribute to protection of ecologically important grassland areas, and to promote the search for improved, environmentally and socially sustainable solutions to grasslands management problems. In particular it should:

- In collaboration with relevant institutes of the Chinese Academy of Sciences, develop a satellite-based grasslands ecological monitoring system to provide a basis for preparing authoritative, independent, and accurate annual reports to the National Peoples Congress and senior leaders on the state of the grasslands resource. This would provide an unbiased source of information for national leadership on MOAs progress.

- Widen the scope of the Environmental Assessment regulations to cover land reclamation in general and reclamation of grassland areas in particular. If possible, and given the seriousness of the problem, a regulation should be prepared requiring that all land reclamation activities beyond a certain size (such as 1,000 hectares) will require approval of at least a provincial-level environmental protection bureau. Guidelines should also be prepared to indicate the circumstances under which reclamation should not be approved, and to define recommended procedures and practices for carrying out environmentally acceptable reclamation.

- Work collaboratively with relevant units of MOA, particularly the Grasslands Management Division of the Livestock and Husbandry Division, and other rele-

vant institutions such as the Academy of Social Sciences, to mobilize local and/or foreign funds for pilot-scale development and application of alternative grassland management strategies. The work should focus on developing strategies that are matched to particular agro-ecological zones and cultural situations. It should be based on the new concepts of grassland ecology discussed earlier; beneficiary participation; alternative methods for providing pastoralists with access to modern social services; and other benefits of national development, without undermining the cultural systems they have developed for sustainably managing their environments.

- Commission environmental economic analyses of existing and proposed grassland management strategies and range-based livestock production systems to provide a comprehensive assessment of the real economic implications of these strategies and systems, including environmental and social externalities. This would provide a better basis for decisionmaking.

FOREST MANAGEMENT AND PROTECTION

A process of forest sector reform has commenced and needs to be continued and broadened to cover the entire sector. In the state-managed sector, the government needs to:

- Impose a “pause” on logging operations in all areas to prevent the situation from deteriorating further (the current ban is only partial).
 - Provide interim funding in the form of a “social safety net” to permit workers and enterprises in the industry to sustain themselves while reform decisions are being considered.
 - Decide on a course of comprehensive reform.
 - Implement the reform gradually, at a pace that provides adequate time for the sector to adjust, accepting that transitional costs will continue to be incurred while reform is taking place. A phased approach is particularly important from an environmental point of view, as rapid reform and inadequate social safety nets could spark a round of environmental degradation far worse than has been experienced to date.²¹
- Other essential reform elements include:
- The State Forestry Administration needs to formulate a series of explicit management objectives for the national forest estate that emphasize the long-term sustainable utilization of domestic forest resources and integrated management of all beneficial aspects of the forest resource, including not only long-term sustainable production of timber and non-timber forest products, but also protection and maintenance of biodiversity and other ecosystem services. These multisector objectives should be applied in all forests of the national forest estate, not only in protection forests and other specially designated non-timber forests.
 - A clear and explicit distinction between the functions of “stewardship” of the national forest estate and exploitation and use of the national forest estate needs to be established. The State Forest Administration should concern itself solely with the stewardship function; that is, ensuring that the forest estate is managed in ways that will achieve the government’s overall objectives for the resource and the sector. To the extent that government decides that the forest estate contains resources that can be exploited in an environmentally and socially acceptable way, it should issue exploitation rights to accountable “third parties”; that is, entities separate from but accountable to the State Forestry Administration. These rights should be exercised in accordance with rules, regulations, and standards prescribed by the Forestry Administration. At the same time, the government ought not concern itself with regulating matters that have no bearing on the achievement of its overall objectives.²²
 - In return for providing access to resources within the forest estate, the government should efficiently extract resource rents from users of the forest estate at levels consistent with its overall short- and long-term

management objectives and in ways consistent with the needs of forest resource users, given their financial circumstances, access to credit, etc.

Other reforms specific to the collectively managed sector include:

- The majority of collective forest areas are being “de-collectivized” following the model of the rural HRS. This creates an element of tenure uncertainty, as village leaders are entitled to re-allocate household responsibility land for various reasons. Some leaders exercise this authority judiciously and infrequently, but others do not (Li 1999). This may create uncertainty and act as a disincentive for farmers to make long-term forest investments in, for example, replanting and maintenance. On the question of participation, there are numerous accounts of farmers’ opinions on forest types and species selection being ignored in the design of large-scale, government-sponsored afforestation programs. In areas where there was adequate participation of farmers in planning, less deforestation has occurred (Shi and Xu 2000). A major challenge for the future will be in providing the security of tenure for “household responsibility” forests, to ensure that their custodians will make the long-term investments necessary to sustain the forest resource. Another important objective should be to maintain policy consistency and to develop confi-

dence among farmers that, when policies affecting forest management do change, they will change gradually and predictably.²³

- Harvesting operations in collectively managed forests are controlled by quotas administered by the State Forestry Administration. Logging and transport are also regulated, and timber procurement is restricted to designated firms. Substantial and perhaps excessive rents are extracted throughout the process, which according to some commentators is limiting the ability of farmers to profit from regular forest operations. As a result, a substantial black market has developed in some areas. It has been said that the black market is accounting for as much as 20 percent of total forest transactions in collectively managed areas. The government should extract resource rents from forest users, but it needs to simplify the way in which it is done and set the rental value at a level that does not stifle development of the sector or promote the development of black markets.

BIODIVERSITY PROTECTION

Biodiversity protection has to be addressed on many levels, but all efforts will be wasted if there is inadequate in situ protection, especially in reserves created and managed specifically for that purpose. Key deficiencies in the current approach on nature reserves are (a) too much emphasis has been placed on the number of nature reserves created, rather than their quality and utility; (b) the system is

seriously underfinanced and understaffed at all levels; (c) there are too many institutions engaged in nature reserve management, which is dissipating the limited funds actually available; (d) state-level institutions are insufficiently engaged in the direct, day-to-day management and operation of nature reserves, to the detriment of the system as a whole; and (e) there is no system of classifying nature reserves in accordance with their different characteristics and management objectives so as to provide a basis for rational allocation of budgetary resources.

The system needs to be reformed. Key elements of the reform process include:

- Establish and adequately finance a state-level, state-funded, and state-staffed Nature Reserves Service, which will be responsible for management, operation, and protection of nature reserves in China that are of international and/or national significance. It would generally be expected that these would fall within IUCN's nature reserve categories I–III.²⁴ Because of the vested interests inherent in the current system and the difficulty of reaching agreement as to which institution should house the new Nature Reserves Service, it may be necessary to establish it as a completely new institution with no allegiances to any existing state-level institution. Among other things, this institution would function as a “center of excellence” for developing strategies to deal with the innumerable practical problems facing

nature reserve managers in China; provide on-the-job training for managers and technicians from lower level reserves; and raise management standards for significant nature reserves up to international levels.

- Develop a nature reserve classification system, modeled on IUCN's nature reserve/protected area categories but adapted to Chinese circumstances, to provide a basis for classifying all existing nature reserves in the country. This would provide a starting point for development of a rational, needs-based system of financing nature reserves at all levels and also assist in rationalization of the network of reserves throughout the country.

- Develop improved funding mechanisms for nature reserve management. The most secure and effective method would be (in addition to establishment and underwriting a state-level Nature Reserves Service) to develop a system of tied central-government financial transfers to underwrite establishment and management of nature reserves at provincial and lower levels of government. A counterpart funding arrangement also needs to be developed to ensure that any state transfers are matched by a counterpart contribution.

- Based on the preceding two activities, the number of institutions actively engaged in nature reserves management should be reduced.

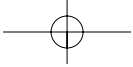
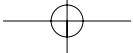
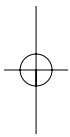
Notes

1. National land area is 960 million hectares, of which cultivated land accounts for about 132 million hectares, land designated as forest land accounts for 263 million hectares, and grasslands account for 392 million hectares.
2. An international study undertaken during the mid-1990s (Lynden and Oldeman 1997) concluded that the total area of moderate to serious erosion due to all causes was about 160 million hectares (17 percent), although it also concluded that the total area affected by any soil erosion at all (including "negligible" and "light") was about 466 million hectares (48 percent).
3. The data on which the discussion is based are derived from a now-discontinued database maintained by the Ministry of Water Resources, based on annual ground survey assessments undertaken by provincial and county-level Water Resources Bureaus.
4. Desertification has been defined by the UN Convention to Combat Desertification as "...land degradation in arid, semi-arid and dry sub-humid areas, resulting from various factors, including climatic variations and human activities."
5. It is now widely acknowledged that data on cultivated land published by the State Statistical Bureau (SSB) in the Government's Statistical Yearbook, at least up until 1996, were inaccurate. A better and improving database is being developed by the State Land Administration (SLA), using analysis of remote sensing data and other direct sources of information. The analysis in the text is based on an analysis of the SLA database undertaken by the International Institute for Applied Systems Analysis (Helmig 1999) as part of its project entitled "Modeling Land Use and Land Cover Changes in Europe and Northern Asia." SSB did not publish cultivated land data between 1997 and 1999, but it recommenced publishing data in 2000. These data were based on the 1996 agricultural census and developed using the SLA approach.
6. The proportion of rural populations living below the government's poverty line (1996) in the major grassland provinces is as follows: Xinjiang-27.4 percent; Yunnan-22.9 percent; Gansu-22.7 percent; Qinghai-17.7 percent; Tibet-10 percent; Inner Mongolia-9.3 percent; and Sichuan-7 percent. All are all well above the national

average of 6.3 percent. Xinjiang is notable for being the only province in the country where poverty increased over the 1988-1996 period: the percentage of poor rural households in Xinjiang increased from 8.8 percent to 27.4 percent. (World Bank at al 2000).

7. The grasslands of the Qinghai-Tibetan Plateau are the headwaters for many of Asia's major rivers, so the condition of these grasslands has potentially important implications for millions of people downstream. There is also a widespread view among Chinese environmentalists that degradation of high-elevation grasslands in the Qinghai-Tibetan Plateau region is adversely affecting flows and the incidence and severity of floods in the Yangtze and Yellow Rivers.
8. The state of the grassland areas has implications for suspended particulate levels in eastern China, particularly in Beijing, where the incidence of dust storms increased notably in the late 1980s and early 1990s.
9. For example, surveys by the Ministry of Agriculture in 34 counties in East Inner Mongolia (Wu and Li 2000) indicated that between 1986 and 1996 a total of 970,000 hectares of grassland (about 1 percent of the grasslands in that region) were converted to irrigated crop production, with most of the work done by state-owned farms, state-owned forestry enterprises, other state-owned enterprises, or foreign joint ventures.
10. According to the CAS, research expenditures have recently increased, but the problem of limited research findings has still not been resolved.
11. The rest supports shrub, scattered trees, seedlings, and newly planted trees, or is classified as "barren land."
12. Timber forest (which in other countries would be more commonly referred to as Production Forest) is intended to provide raw materials for papermaking, construction, and other manufacturing processes.
13. The data for the northern region in the first census are not credible: it was probably not surveyed. If it is assumed that the actual area of timber forest in the northern region at the time of the first census was on the order of 13 million hectares rather than the 2.7 million hectares recorded, the decline in total timber forest area over the four census periods would have been about 23 percent.

- 14.** Statistical analysis in Rozelle et al. (1999) showed that there is a statistically significant relationship between trends in forest cover during the 1980s and the management regime. In areas where the collective sector was stronger, forest cover rose. In areas where the state-owned sector was stronger, forest cover fell. A similar relationship was found in respect to forest area. An important factor influencing this outcome, of course, is that forestry enterprises were established as logging units, not forest management units. Interestingly, the same analysis showed that government forest policies also had a small but negative effect on forest cover; in other words, during the period analyzed, forest policy that was intended to control forest degradation actually may have had the opposite effect.
- 15.** Convention on International Trade in Endangered Species.
- 16.** Nature reserves are supposed to be managed through an interdepartmental structure at each administrative level, which would make the diverse ownership of reserves less of a problem. But, in reality, this does not always appear to be the case.
- 17.** Only three of the state-level reserves are actually staffed by personnel of the state-level institutions, even though they may be funded by those institutions. The remainder are staffed by lower levels of government, under what is essentially a subcontracting arrangement. In short, China has no functioning "national" Nature Reserves Service, which is an extraordinary deficiency given the size and international significance of both China and its biodiversity resources.
- 18.** Even though a reserve may be the responsibility of a lower level of government such as a province or municipality, it will be the responsibility of the counterpart of a state ministry at that level. For example, a provincial-level reserve that falls within the responsibility of SEPA will be managed by the provincial Environmental Protection Bureau, which has a technical line of responsibility to SEPA but gets most of its funding from the provincial government.
- 19.** For example, a land classification system devised by the Chinese Academy of Social Sciences to reflect the "ecological sensitivity" of land in the central and eastern regions showed that there is a very high degree of overlap between ecologically sensitive land and poverty counties located in the same regions (Zhou et al. 1997). There is a similar relationship in the provinces suffering from significant desertification and grassland management problems.
- 20.** Research from Africa suggests that more intensive pastoral production (as advocated by the Ministry of Agriculture) does not always maximize output per unit of land or labor when all outputs of pastoral production (such as erosion control) are taken into account.
- 21.** The need for this type of approach will be accentuated by WTO accession.
- 22.** As a particular case in point, there seems to be no real benefit from a forest management perspective in maintaining the state's marketing monopoly in the collectively managed forest areas. In fact, it is even arguable that this arrangement is detrimental to sustainable forest management.
- 23.** There were a series of rapid policy changes affecting farmer-foresters during the 1980s. Many of these were well-intentioned, but the overall effect was to create widespread uncertainty, and there are anecdotal reports suggesting this may have led to excessive clearing of forest.
- 24.** Category Ia is Strict Nature Reserve; Category Ib is Wilderness Area; Category II is National Park; and Category III is Natural Monument.



3 Water Resources Management and Water Pollution Trends



Rapid economic growth in China has been accompanied by a substantial increase in demand for water and significant changes in the relative importance of different sources of water pollution. Between 1980 and 1993, urban water consumption increased by 350 percent and industrial water consumption doubled. Irrigation use declined by about 4 percent, even though irrigated area increased by about 10 percent.

As demand has increased, so too have problems with water shortages, pollution, falling groundwater tables, and flood/drought damages. These problems are rapidly approaching crisis proportions, at least in some parts of the country, and they are likely to get worse before they get better. The problems are particularly acute in northern China—that is, north of the Yangtze River—and even more so in the catchments of the Huai, Hai, and Huang (Yellow) Rivers, which are often referred to as the “3-H” catchments. The 3-H catchments account for about 35 percent of total GDP and include the economically and politically important Beijing-Tianjin region.

Water Quality Trends

The chemical and biological quality of China's water resources—rivers, lakes, groundwater, and coastal waters—is generally poor. Over the last 10 years, there has been improvement in some of the larger rivers, but the remainder deteriorated. There are no signs of improvement in China's most threatened freshwater lakes; the quality of coastal waters has continued to deteriorate, and there are signs that groundwater pollution may be increasing. The most ubiquitous pollutant is readily degradable organic material from domestic and industrial sources. Other important pollutants include industrial hydrocarbons and plant nutrients. In addition, light lubricating oil and heavy metals are important in some limited parts of water bodies. Bacteriological pollution is not regularly monitored, but is probably widespread and substantial.

TRENDS IN RIVER WATER QUALITY IN THE MAIN DRAINAGE BASINS

Table 3.1 shows water quality on the seven main rivers¹ during the 1991-98 period, measured in terms of the percentage of water quality monitoring sections in water quality classes I/II (good), II/IV (moderate) and V/V⁺ (poor). The data illustrate the significantly lower quality of rivers in northern China. In general, the incidence of Class V/V⁺ river sections tends to be about three times higher in the north. This can be attributed to several factors:

■ The southern rivers have far greater flows (assimilative capacity) than their northern counterparts, and the level of exploitation of their water resources tends to be lower.

■ Population pressures in some provinces in south China are lower than in north China.

■ Most industrialization in the southern river basins is concentrated in their lower reaches, hence avoiding or reducing contamination of their middle and upper reaches. In the north, industrialization encompasses both the lower, middle, and in some cases upper reaches.

Nationally, the incidence of both good quality and poor quality river sections increased over the 1991-98 period, while the incidence of moderate quality sections declined. In the southern rivers, the reduction in moderate quality monitoring sections was associated with an increase in the number of good quality sections, suggesting that there was an improving trend. In the northern rivers, the reduction in moderate quality sections was accompanied by increases in the incidence of both good and poor quality sections. The detailed data on the northern rivers (not presented) highlight the following trends:

Table 3.1 Water Quality Trends in the Seven River Basins, 1991-98

Water Quality Classes	1991	1992	Percent of Samples in Each Water Quality Class					
			1993	1994	1995	1996	1997	1998
A. All China								
Class I and II	3	5	9	11	10	16	16	18
Class III and IV	64	57	64	62	51	44	53	42
Class V and V+	33	38	26	27	39	40	30	40
B. North China^a								
Class I and II	4	0	6	7	6	3	7	12
Class III and IV	56	49	61	57	41	44	53	38
Class V and V+	40	51	32	35	53	51	40	50
C. South China^b								
Class I and II	2	17	17	20	21	43	39	31
Class III and IV	82	76	72	74	75	43	53	54
Class V and V+	16	7	11	6	4	14	7	15

Notes:

^a The 3-H Rivers plus Songhua and Liao.

^b Yangtze and Pearl Rivers.

Source: PRCEE, CNEMC, and CRAES (2001b)

■ In the Songhua, the incidence of poor quality sections increased significantly, while the incidence of moderate quality sections declined accordingly, suggesting that overall quality declined.²

■ Conditions in the Liao appear to have improved steadily, with a steady decline in the incidence of poor sections and increases in moderate and good sections. This may primarily be a reflection of major pollution control investments in Shenyang City, the major industrial and domestic pollution source in the catchment.

■ Conditions in the Hai and Yellow Rivers deteriorated. The incidence of good sections stayed more or less constant, while poor sections increased.

■ The Huai River showed signs of improvement, particularly after 1996. The incidence of poor sections stayed about the same, while the incidence of moderate sections decreased and the incidence of good sections increased. The Huai River Action Plan commenced around the middle of the decade. SEPA's monitoring data suggest that positive results may have been achieved, although other analyses (World Bank 2001 and MWR 2001) do not necessarily support that conclusion.³

WATER QUALITY TRENDS IN THE THREE LAKES

It is estimated that about 25 percent of all lakes in China are adversely affected by eutrophication. Three of the most critically

Table 3.2 Annual Average Water Quality Trends in the Three Lakes, 1992-98

	1992 (mg/l)	1994 (mg/l)	1996 (mg/l)	1998 (mg/l)
Tai Lake				
Total Phosphorous ^a	0.08	0.13	0.11	0.07
Total Nitrogen ^a	2.98	1.73	2.62	1.84
Chao Lake				
Total Phosphorous	0.25	0.34	0.25	0.36
Total Nitrogen	3.83	4.19	3.46	2.88
Dianchi Lake				
Total Phosphate	0.23	0.30	0.23	0.41
Total Nitrogen	2.14	3.00	2.53	4.76

Note:

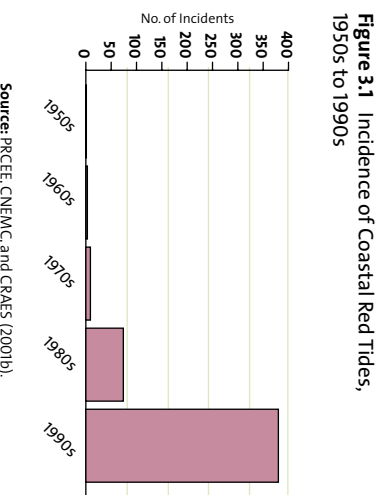
^a As a guide, total N>0.5 mg/l and total P>0.05 mg/l are generally the thresholds beyond which eutrophication becomes a visible problem. By OECD criteria, a water body is considered to be eutrophic when total P falls in the range 0.035–0.1 mg/l and hyper-eutrophic when it exceeds 0.1 mg/l.

Source: Adapted from PRCEE, CENEMC, and CRAES (2001b).

polluted are Tai Lake (Jiangsu-Zhejiang Provinces), Chao Lake (Anhui Province), and Dianchi Lake (Yunnan Province). These have been the main focus of pollution control work during the 1990s. As shown in Table 3.2, there are few signs of substantive improvements. Conditions in Chao and Dianchi Lakes, both of which were hypertrophic throughout the 1990s, appear to have deteriorated.

WATER QUALITY IN THE COASTAL SEAS

Virtually all of the coastal seas are moderately to highly polluted, with about 70 percent of sampling points being classified as Class III or worse. The most serious pollutant is inorganic nitrogen, followed by phosphate and oil. Over the period when data were available, there were no obvious signs of improvement in the quality of seawater. An indirect indicator of eutrophication in China's coastal areas is the incidence of red tides, which increased significantly during the 1990s (see Figure 3.1). The Bo Sea (in north China) is particularly vulnerable to red tides due to its shallow depth and low tidal exchange; the trend in red tide incidents there paralleled the national trend. No doubt some of the extraordinary increase in incidents recorded during the 1990s is due to increased monitoring and surveillance, but there is clearly a significant underlying upward trend.



GROUNDWATER QUALITY

There are no comprehensive time-series groundwater quality data available, so information on groundwater quality trends is anecdotal. Nevertheless, there seems little doubt that quality is deteriorating, particularly in near-surface aquifers and in the vicinity of major cities. For example, a 1994 groundwater assessment of 69 cities in five northern provinces and autonomous regions⁴ plus the Hai River Basin indicated poor groundwater quality in the majority of areas.

The most common groundwater pollutants are nitrate, nitrite, and ammonia. The main sources are leaking sewers and overflowing septic tanks. There are no systematic data on contaminants such as pesticides, herbicides, heavy metals, or other potentially toxic compounds. Anecdotal information suggests that problems could be occurring in some areas. For example, an investigation in the early 1990s (Li 1991) detected organo-chlorine

residues in groundwater in three provinces of southeastern China. In one case, levels were about 50 percent higher than the European Community standard.

Finally, some aquifers, particularly in near-coastal areas, are being contaminated by salinity intrusion due to over-exploitation of the resource and drawdown of the groundwater table.

Groundwater usage in China, as in most other countries of the world, is poorly controlled and overextraction is becoming a serious problem, particularly in the North China Plain. Any strategy for protecting groundwater quality has to be based on a comprehensive assessment of the chemical state of the groundwater environment and of

trends over time. The data on which to base such an assessment do not exist. Rectifying that data deficiency is a first priority.

Water Resources Availability, Consumption, and Demand

WATER RESOURCES AVAILABILITY

China has substantial water resources, but they are unevenly distributed. Per capita water resources availability is high in southern China and low in northern China, and rainfall is highly seasonal. Table 3.3 shows the

Table 3.3 Average Renewable Water Resources; Average 1956-79

	Renewable Water Resources (Billion m ³ /Year)		Total	Water Availability (m ³ /person/year)
	Surface water	Groundwater		
Northern Rivers				
Song-Liao	165	62	193	1,704
Hai-Luan	29	26	42	358
Huai	74	39	96	505
Huang	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
China	2,711	828	2,812	2,343

Sources: World Bank (2001)

net renewable water resources available in each of the nine major externally draining river basins and the internally draining rivers.⁵

As shown, surface runoff is the main supply source in all basins. Groundwater resources are significant only in the northern river systems, particularly in the lower catchments of the 3-H rivers.

Per capita water availability in the “southern rivers”—south of and including the Yangtze—is almost four times that of the northern rivers. Water availability in the Hai-Luan basin is particularly low (355 m³/head/year). Availability in the Hwai and Huang basins is higher, but still below the internationally accepted definition of water scarcity (1,000 m³/head/year).

The northern rivers have far less assimilative capacity than their southern counterparts due to their generally lower flows. This factor is exacerbated by the greater variability of flow of these rivers and the greater water demand. The net effect in these catchments is that frequently the bulk of their flow comprises wastewater. These problems are compounded by the fact that the northern rivers tend to be highly regulated. Average storage capacity in the 3-H basins is equivalent to about 90 percent of average annual runoff, whereas the average for China as a whole is only 17 percent.⁶

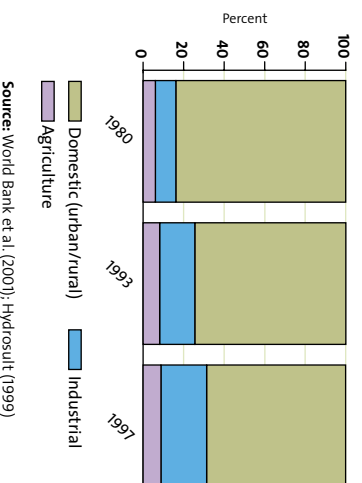
It is probable that the total assimilative capacity of some, if not all, of the northern river basins is already being exceeded. It is

arguable that even if all point sources in the catchment were treated to comply with national discharge standards, the river systems would still be environmentally overloaded.

RECENT WATER CONSUMPTION TRENDS

Figure 3.2 illustrates the changing balance of water consumption over the 1980-97 period. While agricultural use is still the dominant use by far, its share has decreased, while domestic and industrial water uses have been increasing rapidly. Domestic water consumption in urban areas has been rising in both absolute and relative terms due to a combination of (a) increased urbanization; (b) increased per capita consumption of urban residents (from around 113 L/c/d in 1980 to about 230 L/c/d in 1997); and (c) increased water use efficiency within the industrial sector.

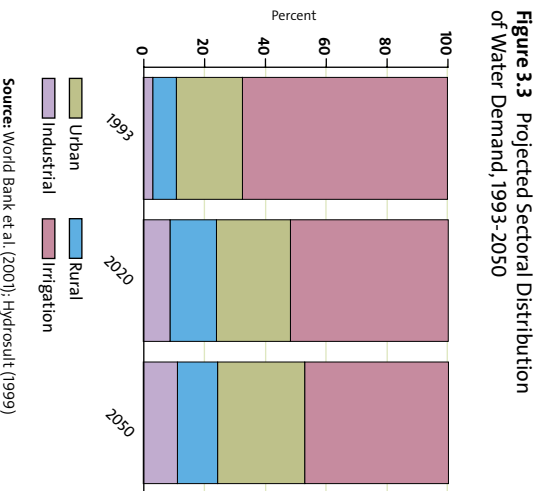
Figure 3.2 Trends in Water Consumption, 1980-97



Use as a proportion of the water available is well above average in the 3-H Basins. Use in the Hai-Luan basin exceeds sustainable yield due to overexploitation of the groundwater resource, which supplies about 60 percent of total consumption. Water resource usage in the southern rivers is quite low—typically on the order of 20 percent.

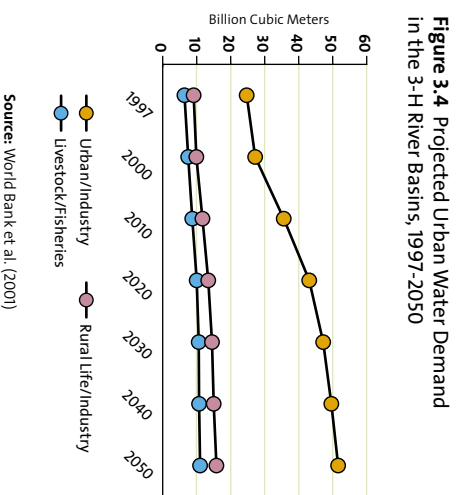
WATER DEMAND PROJECTIONS

The latest national demand projections, prepared in 1999 by the Institute of Water Resources and Hydropower of the Ministry of Water Resources, indicate that the balance between irrigation and other consumptive uses will continue to change in the future (see Figure 3.3).



Irrigation use is projected to decline from around 73 percent of total consumption (1993) to 50 percent in 2050. Consumption for urban and industrial purposes will increase significantly. Both of these forms of consumption lead to emissions of polluted water, so it is likely that water pollution pressures also will increase substantially in the foreseeable future.

Increased water consumption and wastewater generation will be of particular importance in the 3-H basins, which are already the most degraded. The most recent projections covering the period 2000-2050 highlight the significant increases in demand that can be expected from both the urban and industrial sectors (see Figure 3.4). Urban and industrial wastewater production in the 3-H basins will increase in parallel. If these projections materialize, water quality prospects in these catchments are poor.



Trends in Pollutant Emissions

The 1990s saw a progressive change in the nature and relative scale of water pollution sources in China. This process of change is likely to continue. The number of environmentally significant sources will increase, as will the complexity of managing and controlling these sources.

INDUSTRIAL WASTEWATER DISCHARGES

As shown in Table 3.4 and Figure 3.5, the total volume of industrial wastewater discharges declined significantly during the 1990s, particularly after 1995, when action was taken to deal with the relatively unregulated growth of TVIEs.⁸ TVIE-generated COD increased by nearly 250 percent between 1989 and 1995, followed by a reduction of about 50 percent from 1995 to 1998. There were similar trends in

TVIE-generated wastewater flows, which increased by about 120 percent from 1989-95, and then decreased by about 50 percent through 1998. Increases in discharges from CAOEs were generally much lower in both absolute terms and in comparison to the increases in their Gross Industrial Output Value (GIOV).

Figure 3.5 Wastewater Discharges by Source, 1989-98

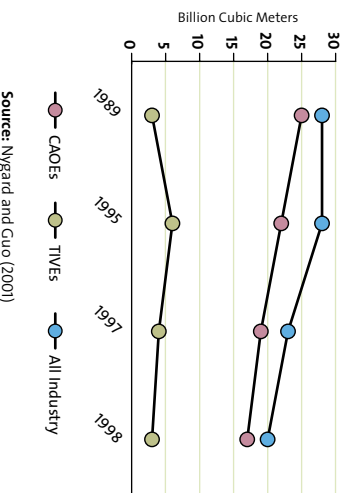


Table 3.4 Trends in Industrial Waste Discharges, 1989-98

	1989	1995	1997	1998
Wastewater Flows (Bcm)				
CAOEs	25	22	19	17
TVIE	3	6	4	3
All Industry	28	28	23	20
COD (Million tons)				
CAOEs	8	8	7	5
TVIEs	2	6	4	3
All Industry	10	14	11	8

Sources: ZTN (1990, 1996); HTN (1999); ZHN (1996, 1998, 1999); PRCCE and CRAES (2001b).

These trends were partly due to economic factors, including the economic slowdown and industrial restructuring, but also due to increasing regulatory effectiveness and the application of emergency measures in response to a major pollution incident in the Huai River in 1994.

The government enacted a series of emergency measures,⁹ including one that facilitated banning, closing, or stopping production of 15 types of small-scale TVIEs that were known to be major sources of pollution. This occurred not only within the catchment of the Huai River, but throughout the entire country.

There can be little doubt that the emergency shutdown program had a measurable impact on industrial wastewater emissions, but there is equally little doubt that this approach had potentially serious adverse social impacts and also generated an element of uncertainty that, if it were to become a routine regulatory tool, could be detrimental to industrial investment and development.

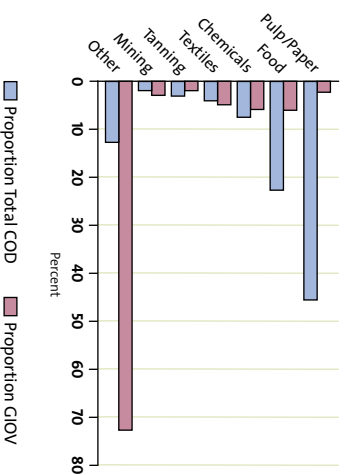
There appears to have been less progress on more conventional approaches to industrial water pollution control during the 1990s. In fact, the data suggest that certain endemic industrial water pollution problems continued more or less unabated during the decade. A disproportionate quantity of industrial pollution load continued to be emitted by a small sector of the industrial economy. Quantities of treated industrial wastewater increased, but the proportion of treated

wastes complying with relevant discharge standards declined, indicating that the regulatory system was not working as intended.

SECTORAL POLLUTION IMPACTS

As in earlier periods, a disproportionate share of total industrial pollution load was generated by a comparatively narrow section of the industrial economy (see Figure 3.6). The pulp and paper sub-sector was most notable, accounting for nearly half of total industrial COD load, while contributing only 2 percent of GIOV. By 1998, six industrial sub-sectors¹⁰ accounted for 87 percent of total industrial COD load but only 27 percent of GIOV.

Figure 3.6 Pollution Loads and GIOV Shares in Main Industries, 1998



Source: ZTN (1999); ZHN (1999)

Many of the enterprises in the pulp and paper and food processing sectors are small-scale and usually locally owned. They are

frequently owned by county and township governments, and are perceived as being important generators of local employment, even though they may be technically bankrupt. It is difficult for local environmental protection bureaus to shut these enterprises down, or to force them to comply with relevant discharge standards.

WASTEWATER TREATMENT RATES

Among CAOEs, industrial wastewater treatment ratios—that is, the proportion of total wastewater generated that passes through a treatment plant—progressively increased through the 1990s. At the same time, wastewater treatment effectiveness—the proportion of treated wastewater meeting relevant national standards—declined. This observation supports the view that, while the regulatory system provides good incentives for installing waste treatment facilities, it provides far less incentive to operate them or to operate them effectively, since pollution levies are set too low.

There are also considerable differences between industrial sub-sectors in terms of wastewater treatment rates and treatment effectiveness. Treatment rates in the four sub-sectors, which are the major sources of water pollution,¹¹ were all significantly lower than the all-industry averages for 1997 and 1998. Treatment effectiveness was significantly higher than average in the food processing

and textile industries, and close to or less than average in the pulp and paper and chemical industries.

MUNICIPAL WASTEWATER DISCHARGES

In absolute terms, China has the largest urban population of any country in the world, and urbanization has been increasing. The official annual growth rate of the urban population through the 1990s was about 3.1 percent, while the actual rate was probably considerably higher. Urbanization is expected to accelerate even further over the next 10 to 20 years.

Table 3.5 summarizes some key indicators of urban development between 1991 and 1998. As shown, the number of officially designated cities increased by about 40 percent to 668. Total water consumption in designated cities increased at a rate of about 8 percent per year, but installed wastewater treatment capacity increased at an even greater rate—about 19 percent per year. The length of sewers increased at only about half that rate. This highlights an issue facing some municipal wastewater utilities—sewage reticulation systems are not keeping up with treatment capacity, resulting in underutilized wastewater treatment capacity.

The combination of a rapidly increasing urban population, increasing urban water supply service levels, and increasing per capita urban consumption are producing

Table 3.5 Selected Urban Statistics, 1991 and 1998

Statistic	1991	1999	Annual Growth (percent)
Official urban population (million)	305	389	3.1
City-based non-agricultural population (million)	148	202	4.0
Number of designated cities	479	667	—
Built-up city areas (km ²)	13,791	21,525	5.7
City-based domestic water use (million m ³ /year) ^a	10,626	18,969	7.5
City-based per capita domestic water use (m ³ /year)	71.8	94.1	—
Municipal wastewater treatment capacity (million m ³ /year)	1,703	5,779	19.1
Treatment capacity/domestic water consumption (%)	11	21	N.A.
City-based sewer length (km)	61,601	134,486	10.3

Note:

^a This figure includes all non-industrial municipal water supply, including institutional demands, urban irrigation, etc. It equates to per capita consumption of about 250 liters per person per day, which is disproportionately high. A good part of the high consumption level is believed to be due to high rates of leakage from old and poorly maintained municipal water supply systems.

Source: ZTN (1992 and 2000).

compounded increases in municipal wastewater flows and pollutant loads. This has significantly changed the water pollution balance over the last 10 years. The sum of municipal and industrial wastewater flows and COD loads remained substantially unchanged over the 1991-99 period, but the significance of municipal flows and loads as a proportion of the total nearly doubled. According to SEPA's data, total wastewater flows and loads from municipal sources now exceed those from industrial sources.¹²

Despite double-digit growth of municipal wastewater treatment capacity over the last decade, Chinese cities continue to be underserved by sewers and wastewater treatment plants. It is estimated that only about 2 billion m³ of non-industrial municipal

wastewater received secondary treatment in 1998, representing only about 10 percent of the total discharge. This is a significant improvement on the 4 percent rate achieved in 1991, but clearly there is still an enormous backlog. Only about 70 percent of installed municipal wastewater treatment capacity is being utilized, so there are opportunities to make immediate short-term improvements by (a) increasing investments in sewage collection systems and rehabilitation; and (b) improving operation and maintenance of existing treatment plants.

Nevertheless, given municipal water demand projections, current municipal wastewater treatment capacity will have to be nearly quadrupled over the next 20 years just to maintain the current level of municipal

treatment service. If the level of service were to be doubled over the same period, and making no allowance for increased acceptance of industrial flows, installed capacity would have to increase by six- or seven-fold, which will require massive investments.

NONPOINT WATER POLLUTION

Nonpoint water pollution due to fertilizer runoff, pesticide runoff, and discharges from intensive animal production enterprises is an issue that is producing visible effects in certain areas and can be expected to increase even further in the immediate future.

Nutrient runoff. Increasing fertilizer use has been a major factor in the remarkable increase in grain and food consumption in China over the last 50 years. Total fertilizer consumption increased by more than 500 percent between 1980 and 1998, by which time it amounted to about 41 million metric tons a year. Consumption in 1999 was equivalent to about 317 kilograms per hectare (kg/ha) of cultivated land, or about 264 kg/ha of sown area. Application rates in some central and southeastern coastal provinces can be 400 to 500 percent higher than the national averages.¹³

While there is some debate whether current application rates in China are excessive, there is almost universal agreement that fertilizer applications are unbalanced. Potassium and, to a lesser extent, phosphorous are underapplied. Deficiencies in potassium reduce the

efficiency of nitrogen and phosphorous applications, requiring larger applications than necessary to achieve a given yield response and also increasing losses from the field into rivers and lakes. Other factors contributing to nutrient runoff include the poor quality of fertilizers, inefficient application methods, and excessive soil erosion.

Nonpoint sources of nutrients are significant sources of eutrophication, which is occurring in many lakes throughout China and also in near-shore marine areas that are shallow and/or experience limited tidal flushing. For example, it has been estimated by researchers at Tsinghua University that nearly 70 percent of the total nutrient load flowing into Dianchi Lake in Yunnan Province is derived from agricultural runoff.¹⁴ Studies on Chao Lake in Anhui Province indicate that about 75 percent of total P and 60 percent of total N is derived from agricultural nonpoint sources (Ecology and Environment 1999).

There are no quick and simple solutions to the control of nutrient runoff from agricultural land. In fact, as the economy opens up and the government's role in directing the agricultural economy continues to decline, the problem will get more difficult to control. The government's capacity to direct farmers to grow particular crops and adopt particular practices is declining almost to the point of disappearance. In the future, it will have to rely much more heavily on education and awareness to encourage farmers to change

Box 3.1 The Case of Dianchi Lake in Yunnan Province

INTRODUCTION

Lake Dianchi is located in southwest China, near the Yunnan Provincial capital of Kunming. The lake suffers from serious eutrophication, in part (a) because it is inherently susceptible due to its shallowness, the warm temperatures, the seasonal rainfall pattern, and its low hydrological exchange; and (b) because of the extensive agricultural, industrial, mining (including phosphate mines), and urban development in the catchment.

Control Strategies: Sporadic attempts to control water pollution began in the 1980s, but an integrated approach only started in the 1990s. There were five main components to the strategy: (1) legislative and regulatory; (2) increased treatment of urban and industrial wastewater; (3) selective removal of nutrient-rich water; (4) sediment dredging in a subsection of the lake (Chao-Hai); and (5) control of algae and macrophytes.

The strategy included legislative/regulatory actions to provide a legal basis for attempts to control important nutrient sources (including cage-fish farming and mining operations) and tightening approval of new projects; increased treatment of urban industrial wastewater; construction of four centralized wastewater treatment plants; an industrial pollution control plan, which bought the majority of sources in the catchment into compliance with relevant standards; selective removal of nutrient-rich water, which involved construction of a channel to withdraw nutrient-rich waters from part of the lake during the wet season; and mechanical harvesting and chemical control.

RESULTS

Notwithstanding the large investment (about 2.5 Billion RMB), the only noticeable improvement has been in Chao-Hai, a small sub-section of the lake. Water quality in Wai-Hai—the larger sub-section of the lake—has continued to deteriorate. Even in Chao-Hai, the main improvement has been aesthetic and in phosphate concentrations, which were reduced up to 41 percent. $\text{NH}_4\text{-N}$ and total N have increased, and Chao-Hai technically remains hypereutrophicated. In Wai-Hai, BOD_5 , $\text{NH}_4\text{-N}$, total N, and total P are steadily increasing, and it is at or close to hyper-eutrophic.

COMMENTS AND CONCLUSIONS

In summary, the strategy has had limited success. The main complicating factors include (a) accelerated economic development in the catchment, which caused pollutant discharges to consistently outpace the control effort; (b) delays in getting the integrated control effort started (the problem was identified in the early 1980s, but serious control efforts only began in the 1990s); (c) too much emphasis on short-term control of “symptoms,” such as sediment dredging, and too little effort on the control of underlying sources of the problems; (d) virtually no attention given to control of agricultural point source emissions (the major source of nutrients); and (e) insufficient attention given to developing an integrated, cost-effective approach.

Source: J. Chen (2000)

In addition, it could affect access to international markets for fruit and vegetables, many of which are very sensitive to food purity issues.

■ Biodiversity impacts. Pesticides influence biodiversity by (a) applying selection pressure to the pests being controlled, which tends to increase their resistance over time, thus reducing the effectiveness of the pesticides; (b) killing non-target insect species, many of which may be pest predators that would otherwise benefit crop plants; and (c) killing or adversely affecting the health and/or reproductive success of non-insect species, particularly (in China) fish and frogs. There is at least indirect evidence to suggest that some of these effects are already occurring.¹⁹

There is no convincing evidence that general contamination of soil and/or water is a major or widespread environmental problem at this stage, although the database on which to make an assessment of this issue is almost completely lacking.

Emissions from Intensive Livestock Production. A notable change in the structure of the rural economy over the last 30 years has been the increased contribution made to the gross value of agricultural output (GVAO) by livestock production, which doubled its contribution from 14 percent in 1970 to 31 percent in 1998. This reflects changing domestic dietary habits. Per capita grain consumption has been progressively declining,

particularly in urban areas, while the consumption of animal products has increased significantly. These trends are expected to continue in the foreseeable future as urbanization increases, disposable incomes increase, and food distribution systems in rural areas improve. Domestic livestock production will also increase, as will the proportion of livestock raised in intensive production units, which can be significant sources of both solid and liquid wastes, as well as odors.

The livestock sector in China is already large. Within the livestock sector, pork production is of major importance. The pork production sector produces 70 percent of all meat produced in China, and 50 percent of the pork produced in the world (Agriteam 1998).

Medium-scale producers, or Specialized Production Households (SPH), maintain as many as 10 sows and account for about 5 percent of total production. Commercial farms typically maintain between 100 and 1,000 sows, although some have as many as 5,000 sows, and account for about 15 percent of total production.²⁰ Both are expected to increase in importance over the next 10 years. It is predicted that SPH and commercial producers could account for as much as 40 percent (20 percent each) of total pig production by the year 2010 (Agriteam 1998).

The calculations in Table 3.6 are intended to provide some perspective on the current and potential significance of the wastes that might be discharged from an intensive pig

production sector of the size implied by the above growth projections. The numbers are obviously speculative, but they support the view that the environmental dimensions of this sector could be potentially substantial.

It is assumed that 80 percent of piggeries are located in the three statistical regions (Central South, Southwest, and East) that presently contain 80 percent of all pigs. In these three regions, the Bank estimates that the COD load in untreated piggery wastes was about 2.6 million tons in 1996 and will be about 8.2 million tons in 2010, representing 28 percent and 90 percent respectively of current urban plus industrial COD loads. One recent study estimated that, in certain study areas within the Huai and Hai River basins, current COD loads from all livestock already amount to between 30 percent (in Zhangjiakou) and 80 percent (in Chengde) of industrial COD loads (World Bank et al. 2001).

There are insufficient data upon which to base similar estimates regarding the intensive cattle and chicken production sub-sectors, although it can reasonably be assumed that they too are significant and will become even more significant over time.

Conclusions and Recommendations

INTRODUCTION

At the beginning of the 1990s, the dominant water pollution issue in China was industrial point source pollution and, more particularly, pollution from industrial point sources located within the state-owned sector. These sources became the focus of the pollution control effort. SEPA and the lower level EPBs used a variety of instruments to address the problem, including command-and-control measures, “administrative” measures, economic instruments, and public awareness. The available data suggest that these measures contributed to the reversal of industrial water pollution emissions observed around the middle of the decade.

While environmental administrators were focusing on CAQEs, the TVIE sector erupted as a new and even more significant source of industrial pollution. When corrective action was eventually taken, commencing in late 1996, the control strategy—shutting down 15 types of small enterprises—also appears to have been effective. Water pollution emissions from TVIEs declined significantly during the second half of the decade.

These improvements were probably enhanced by the general slowdown in economic activity following the regional financial crisis in 1997, combined with industrial restructuring,

Table 3.6 COD Discharges from SPH and Commercial Pig Production Enterprises, 1996 and estimated 2010

	1996	2010
Assumed national pig population (million head) ^a	335	525
Proportion of population in medium and commercial production units (percent)	20	40
Pig population in medium and commercial production units (million head)	67	210
Annual COD production/pig (tons) ^b	0.123	0.123
Average proportion of wastes discharged untreated per production unit ^c (percent)	40	40
Resultant <i>untreated</i> COD discharge (million t/y)	3.3	10.3
Intensive piggerY COD discharge (proportion of 1998 national industrial + municipal COD loads) (percent)	22	69

Notes:

^a Assumes the pig population increases at about 3 percent per annum, which compares with the rate of 2 percent per annum achieved over the period 1981-95. The base (1996) figure is derived from the 1996 agricultural census.

^b Based on 282 g/d volatile solids/pig/day and 1.2 mg COD/mg volatile solids (Gloyna 1971).

^c Assumed treatment rates based on survey data in Zhang et al. (1999) covering 66 large-scale pig, chicken, and cattle production enterprises in four provinces.

Source: World Bank Staff

which favored growth in industrial sub-sectors that tend to use less process water and/or produce less water pollution per unit of output.

This conjunction of events is unlikely to continue. Water pollution management and control will become much more complex over the next 10 years, and it is likely that water quality in rivers, lakes, and groundwater will continue to deteriorate in many areas. The major factors influencing this outlook are:

- Recovery of the industrial economy, which could reverse some of the gains made on control of industrial point-source pollution over the last few years.

- Most of the growth in industrial output in the future is likely to be within the non-SOE sector, which SEPA and the EPBs have the least capacity to regulate due to deficiencies in the current command-and-control system. Recent positive trends in the control of industrial point source emissions may not be sustained, and may even be reversed over the next five years.

- Increasing urbanization, increasing per capita urban water consumption, and possible continuing difficulties in adjusting water and sewage tariffs to financially sustainable levels, could lead to a further widening of the gap between the need for and supply of sewage collection and

treatment capacity in urban areas. If this occurs, there will be a significant increase of pollutant loads from this source.

■ Nonpoint water pollution, and particularly wastewater emissions from intensively produced livestock, is already significant and is likely to become more significant in the foreseeable future.

The combination of these factors will be felt most acutely in the rivers north of the Yangtze, including the 3-H rivers and the Songliao River, where water quality is already severely degraded. From a water quality point of view, these parts of the country have reached the stage where deterioration of the water resource base is threatening the foundations of growth. The immediate need in the northern river catchments is for development and application of an integrated water resources management strategy applied at the river-basin level that addresses all aspects of growth and development impinging on the water cycle. The ensuing discussion outlines some key issues that need to be addressed in applying an integrated water management strategy at the river-basin level. This is followed by suggestions on how particular aspects of the total water pollution problem ought to be addressed, either as part of an integrated river basin management strategy, or as disaggregated strategies in parts of the country where water management issues are not quite so pressing.

INTEGRATED RIVER BASIN MANAGEMENT STRATEGIES

Integrated river basin management (IRBM) is not a new idea. Numerous reports have advocated adoption of a comprehensive river basin planning and management approach as a means for rationalizing water resource management. It also has the potential to provide a better fit between water management strategy and local climatic and geographic conditions, which are extremely variable in China. The State Council, as well as operational agencies such as the Ministry of Water Resources and SEPA, support the concept. The problem is how to move the idea toward implementation.

This topic has been addressed in considerable detail in a number of recent reports (Hydrosult et al. 1999, World Bank et al. 2001). However, in terms of general principles, the most pressing need is to develop new institutional arrangements for integrated river basin management, with particular emphasis on increasing the effective participation of stakeholders other than the national government.²¹

Three basic “design options” for a river basin agency have been tried around the world (Stapleton et al. 1999). The weakest intervention is a committee, which coordinates high-level policy and strategy but has no role in daily operation. The strongest intervention is an authority, which absorbs all or most water and related functions in the basin regardless of which level of government they belonged to in

the first instance. A third option is a commission, which deals mostly with policy, strategy, planning, data collection and management, monitoring, specification of standards, and related matters. It may also have some operating functions for very large works, such as major dams, or for inter-provincial issues. In terms of influence, this option is somewhere between the first and second options.

The commission model is becoming more frequently used internationally—examples include the Murray-Darling Commission in Australia and the Delaware River Basin Authority in the US—and may be adaptable to the Chinese situation.

WATER PRICING

In general, water is used wastefully by virtually all consumers in China. Overconsumption is partly due to the fact that water is generally underpriced or, in some cases such as groundwater, not priced at all. This situation is progressively changing, particularly with regard to municipal and industrial supplies, but progress is slow. Appropriate charging for both surface and groundwater, in all its uses, may be the most effective single method to overcome many water shortage and water pollution problems in China. Almost all other regulatory tools—water use permits, water pollution permits, or levies—and water savings activities will be more effective when supported by appropriate water charges and prices.

China already applies charges to cover the cost of supplying a service such as water supply, and applies water resource charges for the scarcity or opportunity cost of supplying a natural resource.²² For various reasons, these charges are not as effective as they could be.

Water resources administration would be greatly improved if (a) water rights and allocations were made transferable and enforceable; (b) appropriate pricing policies were applied for water services, including bulk water supply and flood control; and (c) resource management fees were applied, or included as a line item in relevant government budgets, to cover the costs of system management.

In many cases, a relatively steep increase in current water charges may be required to have a real impact. This is socially difficult, but in the severely conflicted catchments such as 3-H it may be far more palatable than the alternatives, including large-scale failure of urban and industrial water supplies. Some of these problems are already occurring in the current very dry year in northern China.

WATER QUALITY MONITORING AND WATER QUALITY STANDARDS

China has substantial financial resources, but many developmental problems to solve. It cannot afford to waste scarce financial resources. Yet, at great expense, it maintains two national water quality monitoring systems that substantially overlap and duplicate each other. In addition, it has not recently reviewed its water

quality standards to ensure they are relevant to current economic and technical conditions. Both issues need to be addressed.

Water quality monitoring. SEPA and the Ministry of Water Resources maintain parallel, and in many respects overlapping, national water quality monitoring systems. Fifteen out of 37 surface water quality indicators monitored by MWR are also monitored by SEPA; in the case of groundwater, the figure is 17 out of 27. River flow, which is essential for calculating pollutant loads, is not monitored by SEPA, but is monitored by MWR. SEPA is authorized by law to publish water quality data, while MWR data is mainly for internal use. There is little coordination or cooperation between SEPA and MWR, and the parameters monitored do not necessarily reflect the particular needs in individual river sections. Data is not available in a common database, and there appears to be little if any sharing of data or collaborative analysis of data. In fact, the relationship between MWR and SEPA appears to be more competitive than cooperative. This situation is not tenable and, furthermore, is compromising the analytical value of the national water quality database.²³

As a matter of priority, SEPA and MWR should establish a joint, high-level committee to rationalize their monitoring systems, including station locations; frequency of sampling/ observations; selection of monitoring parameters; and sharing of responsibilities for

sample collection and analysis. In addition to further defining the division of labor between quantitative (MWR) and qualitative monitoring (SEPA), they should agree on data-sharing standards and procedures and identify opportunities for joint research and analysis. Cost savings from adoption of a more collaborative effort could help resolve some of the most fundamental problems with the existing monitoring system, notably inadequate sampling frequency.

Water quality standards. To achieve cost effectiveness in managing pollution, the design of pollution control facilities needs to be based on ambient and emission/discharge standards that are economically rational as well as environmentally acceptable. In many of the severely stressed river basins in China, particularly the northern catchments, there is a huge gap between ambient standards for the main designated water uses and the actual standards that are likely to be achievable within any reasonable planning time-frame. These ought to be reviewed, particularly the minimum quality standards for river water suitable for raw water supply for municipal systems (Class II/III). Not only do these represent an unachievable goal in many catchments, but they may not take adequate account of recent developments in drinking water treatment technology.²⁴ These standards need to be reviewed, with a view to assessing the utility of using the existing standards as “goals” and setting “working

level standards” (WILSS) applicable to the existing status of economic development, for a period of perhaps 10 years. The standards could be revised every new decade, setting the WILSS at levels representing the maximum standards that can reasonably be met at the time, which could be accepted by industry in a constructive manner that would prompt compliance rather than evasion.

INDUSTRIAL WATER POLLUTION CONTROL

Most of the initiatives needed to strengthen industrial water pollution control are of a cross-cutting nature and are covered in Chapter 5. But there are a number of things that are of particular relevance to industrial water pollution. For example:

- Pollution levies have to be increased sufficiently to provide a true disincentive, so that it is cheaper for enterprises to install and operate wastewater treatment plants than to remain in noncompliance and pay the levy.²⁵
- EPPBs need to strengthen the general application of existing regulatory instruments, particularly the “three simultaneous” policy.
- EPPBs need to be far more strategic in the focus of their industrial regulation work. From a national perspective, SEPA needs to continue its focus on priority catchments by providing technical assistance

and administrative support to concerned provincial and lower level EPPBs. More generally, EPPBs at all levels should focus their greatest efforts on monitoring and regulation of the industrial enterprises that produce the bulk of total pollution loads in their jurisdictions, including industrial enterprises below the county level.

- SEPA should assist lower-level EPPBs to make better use of the environmental impact assessment system as a tool in total water pollution load control. Environmental assessments for industrial enterprises need to assess incremental water pollution loads attributable to proposed developments. These should be used to determine how developments can proceed without increasing total loads.

■ SEPA and lower-level EPPBs need to cooperate with finance bureaus and planning departments to promote the concept of industrial estate development for rural industrial enterprises, combined with centralized wastewater collection and treatment, as a contribution to resolving pollution problems with small-scale rural enterprises.

- In urban areas, municipal governments and EPPBs need to encourage discharge of pre-treated industrial wastewater into municipal sewers.
- The national Cleaner Production (CP) program should continue to be supported and strengthened (see Chapter 5).

MANAGEMENT AND CONTROL OF URBAN WATER POLLUTION

The cornerstone of any strategy for dealing with the growing problem of municipal water pollution has to be the creation of a firm and sustainable financial basis for the operation of municipal water and wastewater utilities. Key elements include (a) adequate pricing of municipal water and wastewater services; (b) extending service charges to cover all service beneficiaries, including institutional consumers; and (c) increasing fee collection efficiency.

The capital investment requirements to meet foreseeable urban water and wastewater services will be enormous, and it is likely that private sector participation will be necessary to help bridge the financing gap. However, private sector participation does not eliminate the need to address the fundamental problem of raising service charges. In fact, private sector participation will not be feasible unless service charges are raised to financially viable levels.

From a purely "pollution control" point of view, there are several actions that SEPA and the Ministry of Construction should consider to increase the pressure for improvement in the collection and treatment of municipal wastewater, and to help improve the finances of municipal wastewater management utilities:

- The performance of municipal wastewater treatment plants is generally poor; capacity is frequently underutilized, and treatment efficiency is often low. SEPA needs to extend the scope of its pollution control regulations to cover primary and secondary treated emissions from municipal wastewater treatment plants (MWW/TTPs). This is not a simple matter from a technical, administrative, or practical point of view. Nevertheless, given the growing importance of such emissions, a control strategy needs to be developed and agreed upon as soon as possible. In developing a strategy, SEPA will need to (a) assess the geographical and size distribution of MWW/TTPs; (b) assess the current performance of a stratified random sample of such plants; (c) assess experience and procedures for regulating discharges from MWW/TTPs in other comparable countries; (d) identify a range of regulatory approaches tailored to the urban structure within China; and (e) evaluate the staffing and cost implications of its implementation to form a basis for discussion with other relevant agencies of government, particularly the Ministry of Construction, and for consideration by higher levels of government.

■ Develop a model “trade waste acceptance policy” (TWAP) and related regulations and procedures with a view to encouraging water polluting industries to discharge pre-treated wastes into municipal sewers rather than directly into the environment. The benefits include (a) improved operational economies of scale for the water and sewerage utility; which would charge an acceptance fee for receiving the pre-treated wastewaters; and (b) reduction in the number of industrial point sources, which have to be monitored and regulated by the environmental protection bureau. If implemented, EPBs would only have to monitor and regulate the discharge from the MWWWTP, rather than all the individual discharges from the contributing enterprises. This approach is not new in China—about one third of installed municipal wastewater treatment capacity is already handling industrial wastes—but the suggested actions would help encourage this trend, and also assist in minimizing adverse effects on collection and treatment systems.

■ Promote adoption of “appropriate” municipal wastewater treatment technologies to reduce costs and provide a better fit between the financial and technical capacity of different city administrations and realistic environmental goals. For example, in regions where land is not a constraint and climatic conditions are suitable, oxidation ponds could replace activated sludge systems.

MANAGING NONPOINT POLLUTION

Nonpoint pollution is the most difficult of all water pollution management and control challenges. There are few if any countries in the world that can claim to have all dimensions of the problem under control. The problem will be particularly difficult to address in China because of its geographical scale, the lack of effective land use management controls, and all the problems that bedevil other dimensions of pollution management and control. The government, and SEPA in particular, need to be discriminating in the problems they choose to attack, giving preference to (a) those elements where there is at least some hope of making progress both technically and administratively; and (b) interventions with a substantial “win-win” element, where benefits additional to pollution control can reasonably be expected.

The discussion below focuses on nutrient runoff, pesticides, and discharges from intensive livestock production. The issue of soil erosion control is treated as a land management problem and is discussed in Chapter 2.

Nutrient runoff. As described earlier, eutrophication of the coastal lakes and seas in China is a serious problem. It has been recognized for at least 10 years. The government's strategy has focused on cleanup of the three priority lakes. There is little evidence that the control strategies adopted to date have had any measurable effect.

For the future, the control strategy should continue to be focused on the three priority lakes,²⁶ but more emphasis has to be placed on:

- Improving environmental monitoring, including monitoring of nonpoint sources to improve understanding of underlying causes.
- Improving coordination of the efforts of different government agencies and, more particularly, on the timely and coordinated flow of funds to permit each agency to carry out its assigned tasks at the right time. Formation of ad hoc management structures—a leading group or a specialized project management group with the authority to co-opt the participation of relevant line agencies—may be required to achieve this objective.
- Incorporating “non-engineering” control activities—increased agricultural extension and other forms of farmer education,

increasing availability of compound fertilizers, improved soil erosion control, and increased afforestation—into the overall control plan.

- Strengthening the application of existing laws and regulations, including pollution control and land use planning/zoning regulations, before developing new ones.

- Restricting certain types of development and activities that are known to exacerbate the problems.²⁷

Pesticides. Improving the ways in which pesticides are produced, stored, transported, and used requires strengthening the regulatory system, which seems to be characterized by complexity, overlapping responsibilities, conflicts of interest, and under-resourcing of the institutions responsible for maintaining minimum standards of quality, toxicity, and safety. Notwithstanding some regulatory reforms introduced in 1997,²⁸ further work is required to strengthen pesticide regulations and farmer education. For example:

- The government has already promulgated new regulations to rationalize pesticide management, but they did not go far enough in defining the roles of the various actors or separating regulatory and other functions. In any event, the new regulations have not been applied nationwide. Clearly, there is a need to further strengthen the regulatory function. The best way to do this would be to centralize regulatory

responsibilities within an institution such as the MOA (such as the Institute for Control of Agrochemicals—ICAMA), provided that the Ministry also withdraws completely from the pesticide retailing business at all levels, including particularly the county level.

- There is a need to improve the awareness of farmers on all aspects of pesticide use and management, and the quality and effectiveness of advice being provided by Plant Protection Stations (PPS) on minimization of the use of pesticides. There are many simple things that could be done in this regard. For example, while most if not all pesticides sold in China must include hazard and safety information on their labels, these are only provided in Chinese, making the messages meaningless to the minority farmers who do not read Chinese.
- There are many good things about the ecological aspects of the information and training provided by the PPS in China,²⁹ but it is also clear that it needs to adapt to new circumstances. Integrated Pest Management (IPM) has been successfully tried in parts of China on crops such as rice and cotton, but it is not clear that the plant protection community as a whole has fully accepted it as an approach that is feasible in the Chinese situation. There is little doubt that the IPM approach results in significant reductions in the use of pesticides and improvements in the health of

farmers. Thus far, there is no substantive evidence that it significantly increases the risks of catastrophic pest attacks. The MOA needs to give more support to IPM, particularly in sub-sectors—rice, cotton, and certain types of horticulture—that appear to be suffering from excessive pesticide application.

- The MOA has the primary responsibility for implementing most actions needed to improve the management and use of pesticides in China. However, SEPA also has a role in developing a better understanding of the environmental effects of pesticide contamination through a targeted program of both ambient environmental monitoring (including groundwater and surface waters with limited mixing and/or assimilative capacity, where residue problems are most likely to occur); testing for residues in food products; and monitoring of application levels associated with the observed ambient levels and residue levels.

Wastes from intensive animal production. Given the existing and future significance of emissions from intensive animal production units, there is little doubt that it will be necessary to include at least the larger production units within the point-source-pollution regulatory system. Some provinces appear already to be taking regulatory action on their own account.³⁰

Given the actual and potential future scale of this issue, it is recommended that SEPA and MOA actively develop a national policy on regulation of this sector. Some key elements should include:

- The strategy should involve elements of both prevention, such as prohibiting development of certain types of intensive livestock production units in certain areas, and regulation, such as applying emission controls to operating enterprises.

- For practical reasons, the initial regulatory approach should be restricted in scope. It should focus probably on either geographical areas having particular concentrations of intensive animal production units, and/or areas that are particularly sensitive to high levels of animal waste discharge, including densely populated urban areas or catchments with limited assimilative capacity. As mentioned, some jurisdictions are already taking action in this regard, and this may continue to be a matter to be addressed by local (provincial) EPBs, depending on their own circumstances and provided that the implications of inaction do not affect other provinces. In such circumstances, SEPA's role would be to provide guidance on regulatory options and dissemination of best practices.

- For the great majority of the sector—the 70-80 percent who are backyard producers or Specialized Production Households—the focus of effort should be on education

and dissemination of best practices through animal husbandry bureaus of the Ministry of Agriculture, which already promulgates standard designs of household-level production units. Environmental specialists should review these designs to see if there are opportunities for improvements. It should be noted that the government has already developed small-scale livestock production systems, which not only provide ways of recycling animal wastes, but also incorporate straw ammoniation technologies that avoid the need to burn off crop residues, thus reducing TSP emissions. This is a classic win-win technology that produces direct economic benefits to farmers and reduces both air and water pollution.

Notes

1. The seven main "out-flowing" river systems are the Songhua, Liao, Hai, Hui, Huang (Yellow), Chang (Yangtze) and Zhu (Pearl). These rivers drain about 45 percent of China's land area and account for about 54 percent of its freshwater resources.
2. The data need to be treated with some skepticism. They also show, for example, that there were no class I/II monitoring sections within the Songhua throughout the 1990s, which is not credible. The monitoring sections may be focused around the main development centers, and hence may not be representative of the river system as a whole.
3. MWR water quality data for the Hui River Basin show that in 2000, 85 percent of monitoring stations were classified as V/V+ while the remainder were Class III/IV, indicating considerable deterioration in 1998 and 1999.
4. Xinjiang, Gansu, Qinghai, Ningxia, and Inner Mongolia.
5. About 35 percent of China's land area and 27 percent of its runoff is contained within four large, internally draining (closed) basins, all of which are located in the western part of China: Xinjiang, Gansu-Inner Mongolia, the Qaidam Basin (in Qinghai Province), and northern Tibet. Surplus runoff in these basins is either lost as evaporation or soaks into the desert, where it recharges groundwater.
6. In heavily polluted environments, reservoirs accumulate pollutants, which may then be released in large "slugs" when the reservoir contents are discharged under either normal operating procedures (such as for irrigation or power generation) or under emergency conditions (such as during flood events). The greater the degree of regulation, the greater the potential for adverse impacts due to the release of pollutant slugs.
7. The 1997 per capita consumption level is about twice as high as rates in cities in other countries of similar income (World Bank et al. 2001). Part of the apparent high consumption level may be a consequence of underestimation of the populations served by municipal water companies, and part may be attributable to leakage, which is often high in China (as much as 30-40 percent in some older urban systems).
8. Box 1.1 provides further information on industrial groupings and terminology in China.
9. These included "Temporary Regulation for Water Pollution Prevention in Hui River Basin" (1995), the "Hui River Basin Water Pollution Control Plan" (1996), and general State Council-issued "Decision on the Issues of Environmental Protection" (1996).
10. Pulp and paper, food processing, chemical production, textiles, leather tanneries, and mining.
11. Pulp and paper, food processing, chemical industry, and textiles.
12. SEPA's national data are not necessarily supported by more detailed surveys in river basins such as the Hui and Hai, which suggest that the industrial COD contribution is still outweighing the municipal contribution. "Back of the envelope" estimations tend to support SEPA's view.
13. For example, detailed assessments in the catchment of Chao Lake in Anhui Province indicate that farmers in some areas are applying chemical fertilizers at rates as high as 2,000 kg/ha./year. (Ecology and Environment Inc., 1999).
14. Yunnan EPP's estimates are lower but still significant; 33 percent for N and 41 percent for P.
15. Dianchi Lake in Yunnan province, Chao Lake in Anhui province, and Tai Lake in Jiangsu province.

16. Primarily organophosphates (OPs) and organochlorines (OCs) such as benzene hexachloride (BHC), dieldrin, dithionos, dimethoate, and DDT.

17. Highly to extremely hazardous.

18. Morton (1999) reports cases of cotton farmers (in Shandong) spraying 14 to 20 times per season for control of cotton bollworm in 1995 (up from 3 to 4 sprayings in the late 1980s). Huang et al (2000) undertook detailed surveys in Zhejiang Province, which indicated that farmers were applying pesticides two to three times more frequently than their counterparts elsewhere in either east or south Asia, and were applying between 40 percent and 70 percent more pesticide than could be justified in purely economic terms. Other work, among rice farmers in Sichuan Province (Mangan and Mangan, 1998), showed that farmers could reduce spraying frequency by about 40 percent without having any impact on yields, reinforcing the view that many farmers have an exaggerated view of the risks posed by pests and, as a result, over-apply pesticides.

19. For example, the number of pesticide-resistant insect species in China is reported to have increased significantly over the last 60 years, as follows: 1938–7, 1948–14; 1963–157; 1971–225; 1980–432.

20. The remainder of production comes from small-scale household units, typically with less than two sows, who generally recycle their production wastes through the household farming system, presenting no major threat to the environment.

21. China already has seven River Basin Commissions (RBCs), which in theory should provide the means for ensuring integrated management of multi-provincial river basins, but which in fact do not. One of the key failings of the RBCs is that they are administrative departments of the

Ministry of Water Resources and are not generally perceived as adequately representing the interests of all parties to water resources management within their areas of operation.

22. The Water Law and its regulations make provision for application of a water resources charge, making China one of only a few countries in the world with such provisions.

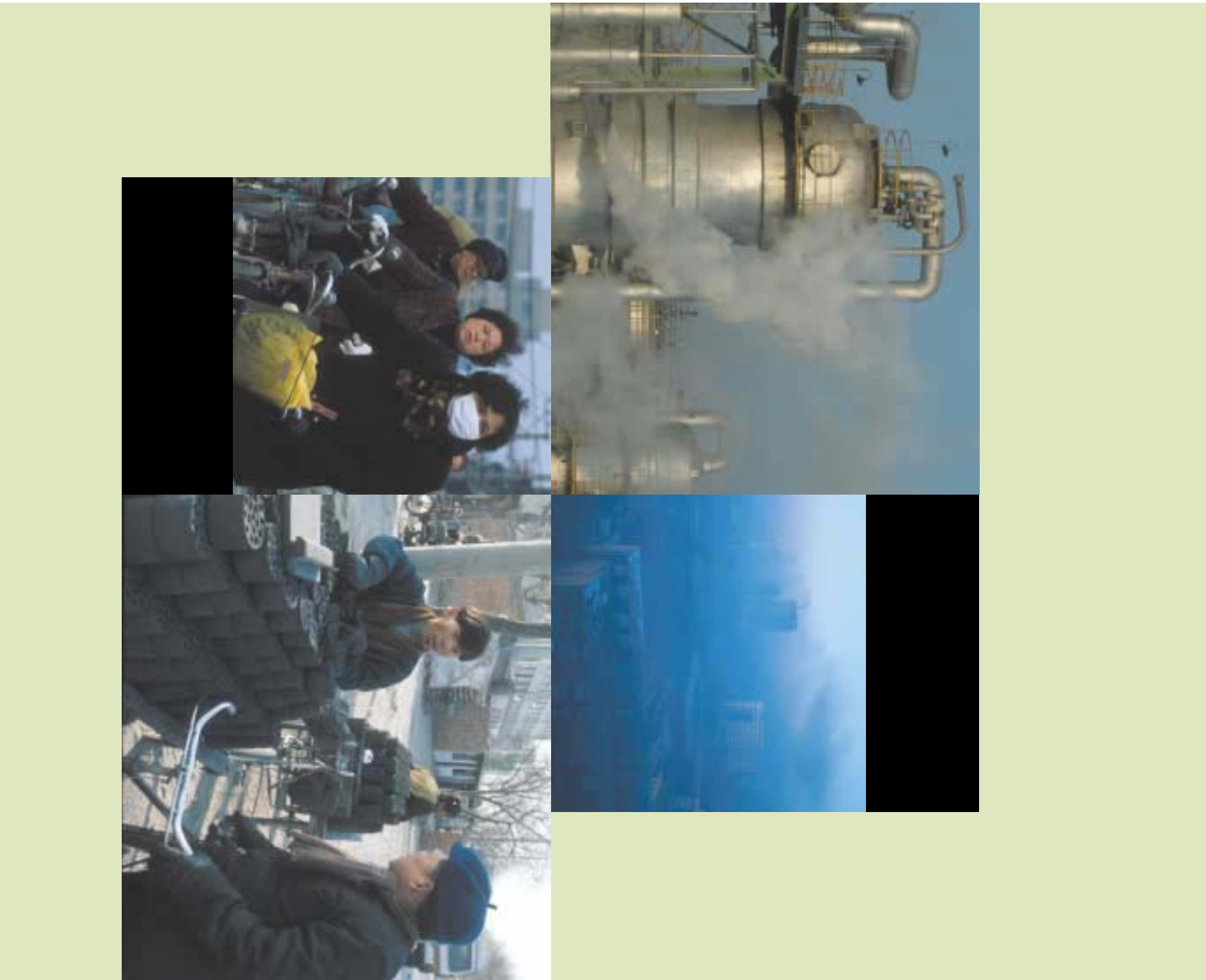
23. It is virtually impossible to establish any relationship between changes in pollution discharges and trends in ambient water quality in any of the river basins in China. This is indicative of deficiencies in the monitoring systems. Main contributing factors include insufficient monitoring frequency, lack of flow monitoring, and inadequate QA/QC procedures.

24. A great deal of research has been carried out in the industrialized countries over the past 50 years on how to improve performance of the rapid sand filtration systems, which are commonly used for treating raw waters to produce an effluent of drinking water quality. Research has focused on the use of new flocculation agents. As a result, it is now feasible to produce quality drinking water using raw water of considerably lower quality than, say, in 1950. Ambient standards in China have not been adjusted to reflect this reality.

25. The levy currently amounts to about 20 percent to 50 percent of the treatment cost, and can be as low as 10 percent for some industries (World Bank et al 2001).

26. As for the question of eutrophication of the coastal seas, the strategy has basically been to improve monitoring. There is little if anything that can be done to directly control the problem. The coastal seas are shallow, the majority are quite warm, and tidal exchange in many is low, so they are predisposed to eutrophication. They receive about 45 percent of the total runoff of China, which contains not only the nutrient emissions from the overwhelming majority of the national agricultural production, but also those contained in the combined human wastes of perhaps 400 to 500 million urban and semi-urban residents. It is difficult to imagine what strategy could be devised to have a measurable impact on this problem. Improvement is likely to be very slow and incremental.

- 27.** As one example, consideration should be given to developing a policy to restrict the phosphate content of household detergents manufactured and/or sold in China. The issue is not sufficiently clear-cut to justify an outright ban, but there would certainly be value in considering applying wholesale restrictions, with perhaps outright prohibitions in high-priority regions such as the catchments of the three lakes.
- 28.** Through a new set of "Regulations on Pesticide Control" (1997), which established new guidelines on pesticide manufacture, transportation, sale, and use with the aim of "protecting agricultural and forestry production and ecological environment and safeguarding human and animal health" (Article 1).
- 29.** The Ministry of Agriculture discourages calendar spraying through its comprehensive pest monitoring system, promotes safe application approaches (such as painting certain pesticides onto the stems of plants rather than spraying), and encourages ecological approaches to pest control (such as planting "guard crops," use of sex pheromones to attract and trap females insects, and promotion of eco-agriculture to increase soil biodiversity and plant health).
- 30.** For example, a survey of 94 large to very large intensive animal production enterprises in four provinces (Zhang et al. 1999) showed that, on average, about 10 percent of the surveyed enterprises were being levied charges for discharge of pollutants and about 13 percent had been required to prepare plans and propose deadlines for bringing their pollutant discharges into line with relevant standards. The survey also showed that quite a large proportion of solid wastes generated by these enterprises, typically in the order of 55–65 percent, was being treated or re-used in some way, either being sold as fertilizer or used for biogas production.



4 Air Pollution Control



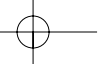
Air pollution is a major health issue in China. Studies have linked the high incidence of premature deaths in China to serious ambient and indoor air pollution (World Bank 1997). In 1999, only one third of China's 338 monitored cities were in compliance with the nation's residential ambient air quality criteria.¹ Indoor air pollution is also a serious problem: about 80 percent of China's people still use solid fuels such as coal, firewood, and crop stalks for cooking and space heating, which can lead to serious indoor air pollution in inadequately ventilated buildings.

Air pollution is a major ecological issue in China. About one third of China's territory is affected by acid rain, which can retard forest and crop growth and endanger aquatic life. China's growing energy demand and its reliance on coal pose difficult challenges to improving air quality and reducing acid deposition, as well as its efforts to reduce carbon dioxide emissions, the main contributing factor to global warming.

Main Pollutants, Emission Sources, and Emission Trends

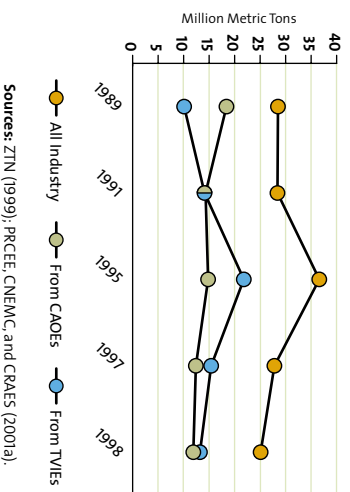
Measured by the frequency and degree of non-compliance with standards, total suspended particulates (TSP) are China's most significant air pollutant, followed by sulfur dioxide (SO₂). A more accurate measure of particulate pollution is fine particulate matter—that is, particulate matter with a diameter of less than 10 microns², or PM₁₀. PM₁₀ monitoring data are scarce in China, so it is difficult to definitively assess the problem. Based on correlations between PM₁₀ and TSP in other data sets, PM₁₀ is the most important air pollutant in China, both in terms of frequency and range of violations of National Ambient Air Quality Standards (NAAQS). It is also the most damaging air pollutant in terms of health costs. More recently, rapid expansion of motor vehicle fleets in large cities has heightened ambient pollution by carbon monoxide, nitrogen oxides, and related pollutants.

Energy consumption, especially coal consumption, is the main source of anthropogenic air pollution emissions in China. Most sulfur dioxide emissions come from this source, as do all soot emissions, which account for more than half of particulate emissions. National survey data show that throughout the 1990s there were continuous improvements in emission control among



medium and large industrial enterprises (essentially CAOEs). Small industrial enterprises (essentially TVIEs) also made improvements during the decade, although not to the same degree as the larger enterprises. As shown in Figure 4.1, they are now the main source of particulate emissions (soot plus industrial fugitive dust). Medium and large industrial enterprises dominate SO_2 emissions, primarily because of the inclusion of power plants within this category. Residential and commercial emissions, while relatively small compared to industrial emissions, usually cause much more significant pollution effects because of their low emission height and proximity to residential areas.

Overall, national pollution survey data also show that total emissions of major air pollutants such as sulfur dioxide, soot,³ and industrial fugitive dust peaked in the mid 1990s and have been falling ever since (see Figure 4.1 Trends in Industrial Particulate Emissions, 1989-98



Sources: ZTN (1999), PRCEE, CNEMC, and CRAES (2001a).

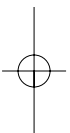
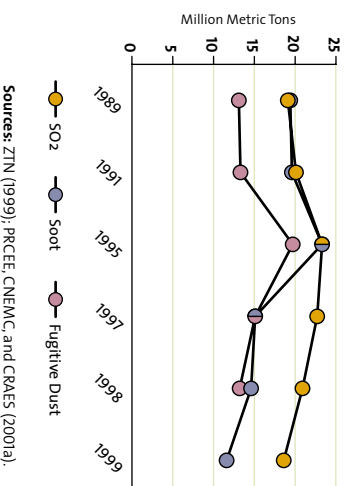


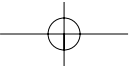
Figure 4.2 Trends in Annual Emissions of Major Air Pollutants, 1989-99



Sources: ZTN (1999), PRCEE, CNEMC, and CRAES (2001a).

4.2). Part of this was due to declining coal consumption, but improved pollution control was also an important factor. The two factors can be differentiated by comparing reductions in SO_2 emissions prior to 1998, when they were not regulated, with reductions in soot and fugitive dust, which were regulated. The 10 percent reduction in total SO_2 emissions between 1995 and 1999 (see Figure 4.2) can thus be attributed to reduced coal consumption and other non-regulatory factors. The greater reductions in soot (38 percent) and fugitive dust (33 percent) can be attributed to the incremental effects of regulatory pressure.

Coal-burning still is the chief contributor to air pollution in China. But air pollution from motor vehicle emissions, mainly a problem in very large cities at the present time, is growing fast and is likely to become a major and much more widespread urban pollution problem in the next 10 years. Despite rapid gasification in many urban



areas, indoor air pollution due to domestic use of coal or solid biomass still affects hundreds of millions of people, most of them among the urban poor and the rural population. Notwithstanding the importance of pollution regulation and control, substantial improvements in ambient and indoor air quality will also depend on improvements being made in energy mix, energy consumption patterns, and energy efficiency.

Ambient Air Quality Trends

Ambient air quality in many urban areas showed signs of improvement between 1991 and 1998. Reported monitoring data for 60 medium and large cities show that 40 cities experienced reductions in concentrations of TSP, and 50 saw lowered SO_2 . The number of cities meeting Class 2 NAAQS for TSP and SO_2 also increased.⁴

Ambient SO_2 levels declined significantly. The median SO_2 concentration in 32 cities with more than 1 million non-agricultural population (NAP)⁵ dropped from 100 to 62 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) between 1991 and 1998.⁶ For the other 28 medium and large-sized cities, with an NAP between 281,000 and 971,000,⁷ the median concentration dropped from 50 to 32 $\mu\text{g}/\text{m}^3$.⁸ For the population in these 60 cities as a whole, the total human exposure to ambient SO_2 pollution above the Class 2 standard dropped by 45 percent between

1991 and 1998.⁹ An equivalent decline in SO_2 -related health damages is likely, assuming a linear dose-response relationship.

Ambient TSP levels dropped slightly, but remained high in most urban areas. The median concentration level in the 32 largest cities dropped from 334 to 324 $\mu\text{g}/\text{m}^3$ between 1991 and 1998, while the median concentration in the 28 smaller cities declined from 260 to 215 $\mu\text{g}/\text{m}^3$. In a few large cities, there were significant increases in TSP. For example, annual average TSP concentrations in Beijing and Tianjin rose from 307 and 247 $\mu\text{g}/\text{m}^3$ in 1991 to 379 and 339 $\mu\text{g}/\text{m}^3$ in 1998, respectively. For the 60 cities as a whole, the total human exposure to ambient TSP pollution above the Class 2 standard actually increased by about 2 percent between 1991 and 1998. This was due to the fact that the increase in population outweighed the reduction in ambient levels.

Nitrogen oxide (NO_x) levels worsened, reflecting the growing impact of vehicular emissions. Fewer cities were in compliance with the class 2 NAAQS for NO_x in 1998 than in 1991. From 1991 to 1998, the median concentration in the 32 largest cities increased slightly from 55 to 57 $\mu\text{g}/\text{m}^3$. The 28 smaller cities also experienced minor increases, rising from 34 to 37 $\mu\text{g}/\text{m}^3$. In general, NO_x pollution is relatively low, but in a few large metropolises—such as Beijing, Shanghai, and Guangzhou—concentrations of NO_x exceed the Class 2 standard by a factor of 2 or more. Among the 60 cities with

reported monitoring data, total human exposure to ambient NO_x levels above the Class 2 level increased almost 60 percent between 1991 and 1998, with virtually all of the increase occurring in the 32 largest cities.

In general, small cities are no better off in terms of ambient air quality than large and medium cities. This is because small cities are more reliant than large cities on coal in their residential and commercial sectors. The data suggest that air pollution levels in general have risen slightly in small cities (see Table 4.1).

Table 4.1 Trends in Ambient Air Quality in Small Cities, 1990-98

	SO ₂	TSP	NO _x
1990	65	327	26
1998	71	330	33

Note: Data are annual arithmetic means ($\mu\text{g}/\text{m}^3$) of ambient monitoring data for 135 county-level cities

Source: PRCEE, CEMC, and CRAES (2001a)

Ambient levels of other pollutants such as carbon monoxide (CO), ozone (O³) and lead (Pb) are not systematically monitored and the trends are not known. However, gasoline-related lead pollution has been effectively dealt with in the past three years as the ban on sales of leaded gasoline expanded nationwide from major cities. According to the government's schedule, a complete national ban on production and sales of leaded gasoline became effective on July 1, 2000.

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It is important to emphasize the serious TSP levels prevalent in all Chinese cities. The problem is becoming more pronounced as ambient SO₂ levels decline, especially in large cities. The persistence of high-level TSP pollution also suggests that there are important contributing factors other than coal consumption. For example, TSP composition studies have shown that dust from construction sites and wind-blown soil is an important contributing factor in some cities (see Table 4.2).

From a human health perspective, fine particulates are the most damaging airborne pollutant.¹⁰ Limited monitoring data suggest that the level of fine particulate pollution in urban areas is high (see Table 4.3). Unfortunately, the effort to monitor fine particulate pollution has only just begun, and a general profile based on comprehensive monitoring information is not yet available. However, if it is assumed that about 60 percent of TSP comprises PM₁₀, fine particulate pollution levels in Chinese cities are very high in comparison to national Class 2 standards.

Interpreting the ambient data for urban areas is complicated by the fact that the air quality monitoring network has not been adjusted to reflect the changing patterns of urban development. For example, China's built-up area grew by 50 percent between

Table 4.2 Sources of Total Suspended Particulates in Selected Cities

City (season)	Coal-burning	Percent Contribution to TSP			
		Smelting	Construction	Soil	Other
Xian (1997 summer)	20.6	6.0	22.7	42.2	8.5
Xian (1998 winter)	38.3	2.6	18.0	37.2	3.9
Taiyuan (1991 summer)	14.3	6.9	16.4	58.8	3.6
Taiyuan (1991 winter)	40.8	10.2	10.0	35.2	3.8
Changzhou (1992)	24.9	2.5	25.8	29.4	17.4

Source: Xian data from Xian Environmental Protection Research Institute, 1998; Taiyuan data from Journal of Hygiene Research, Vol. 24, No. 4, 1995; Changzhou data from Nanjing University Academic Journal, Vol.32, 1996.

1991 and 1998, but the number and location of ambient urban monitoring stations remained unchanged. The monitoring data thus reflect conditions in the inner cities rather than the cities as a whole. The monitoring data may not adequately account for possible migration of certain sources of pollution to the suburbs as a result of inner-city clean-up campaigns and industrial relocation, or for the development of new, small enterprises in “peri-urban” areas.

Indoor Air Pollution

There is a substantial lack of monitoring data or statistical information about indoor air pollution, but improvements in fuel quality suggest that indoor air pollution caused by fuel combustion may have declined significantly. As of 1998, there were over 156 million urban residents using gaseous fuels for cooking and water heating, up from about 40 million in 1991. The fuel mix used by rural households also improved due to increased use of coal briquettes

Table 4.3 Fine Particulate Concentrations vs. TSP concentrations in Selected Cities, 1998 (annual averages)

City	Ambient concentration ($\mu\text{g}/\text{m}^3$)	PM ₁₀ Class 2 standard ($\mu\text{g}/\text{m}^3$)	Multiple of the standard	Ambient concentration ($\mu\text{g}/\text{m}^3$)	TSP Class 2 standard ($\mu\text{g}/\text{m}^3$)	Multiple of the standard
Shijiazhuang	201	100	2.0	349	200	1.7
Tangshan	228	100	2.3	352	200	1.8
Guangzhou	143	100	1.4	205	200	1.0

Source: PRCEE, CEMC, and CRAES (2001a).

Table 4.4 Levels of Indoor Air Pollutants in Chinese Residences

Parameter	Fuel Type Used	Urban Households	Rural Households	Class 2 NAAQS hourly average
TSP	Coal	210–2,800	10–20,000	Not available
	Gas	150–510	190	
	Biomass	—	170–2,600	
PM ₁₀	Coal	160–2,700	120–26,000	Not available
	Gas	140–450	—	
	Biomass	—	830–22,000	
CO	Coal	580–97,000	700–87,000	10,000
	Gas	220–36,000	2,400	
	Biomass	—	500–16,000	
SO ₂	Coal	10–5,800	10–23,000	500
	Gas	10–1,300	20–70	
	Biomass	—	10–9,100	
NO _x	Coal	10–1,800	10–1,700	150
	Gas	10–880	30–50	
	Biomass	—	10–320	
BAP	Coal	30–19,000	530–1,900,000	Not available
	Gas	470–9,300	—	
	Biomass	—	370–310,000	

Note: Data are arithmetic means (µg/m³) over single monitoring periods for individual households using different cooking and heating fuels as reported in a range of published research articles.

Source: Sinton et al. (1995).

and gaseous fuels (biogas and liquefied petroleum gas) and decreased use of raw coal and solid biomass.

Nevertheless, hundreds of millions of people are still using solid fuels for cooking and/or space heating. The serious health

consequences of indoor air pollution due to combustion of coal and other solid fuels have been documented in major case studies in China (He and Yang 1994), and by studies in other countries (Smith 1993).¹¹ It has been estimated that up to 700,000 premature deaths per year in China could be

attributable to indoor air pollution (World Bank 1997, Murray and Lopez 1996). The lack of a national assessment makes it difficult to truly gauge the severity of indoor air pollution in China, but there are some indicative data (Table 4.4) suggesting that indoor air pollution in households using solid fuels still constitutes a serious health risk.

The level of indoor air pollution attributable to fuel combustion is determined mainly by fuel quality, burner technology, and ventilation. Studies have shown that when burning solid fuels with good flue gas ventilation, indoor air pollution levels can be reduced by over 90 percent (He and Yang 1994). This inference can be drawn from the wide range of measured concentration levels in Table 4.4. Switching to electricity or gaseous fuel may be the best (and most expensive) option, but large, low-cost reductions in indoor air pollution can also be achieved through simple strategies such as improving ventilation.

Acid Deposition

The level of acid deposition¹² peaked in 1996 and fell thereafter, following the trajectory of overall coal consumption. But this short-term trend by no means indicates that China has turned the tide against acid deposition. The “two control regions”¹³ program was launched in 1998, and most work to date has been in planning and preparation for implementation.

The area affected by acid rain increased significantly between the early 1980s and the mid 1990s. In addition, the geographic distribution of acid deposition changed. The southwest hotspots, represented by cities such as Chongqing and Guiyang, experienced some moderation in the acidity of acid rain. The central China region, represented by cities such as Changsha, Zhuzhou, Ganzhou, and Nanchang, surpassed the southwest in acid deposition levels and became the most severely affected region. Because of the decline in overall acid deposition, the overall national situation has stabilized since the mid-1990s.

Human-induced acid deposition in China is mainly associated with SO₂ emissions, which are a function of the predominance of coal in the fuel mix and the prevalence of coal with relatively low-temperature combustion characteristics. The balance between sulfuric acid and nitric acid is about 85:15, which contrasts with the US and Japan, where sulfuric acid accounts for 50 percent or less of total acid.

Two developments will likely shape acid deposition mitigation activities in the future. Large point sources, mainly coal-fired power plants, have become the largest source of emissions, and will probably become the dominant contributors to acid deposition in the next 20 years as the share of end-use coal consumption continues to decline. Because of the long-distance transport potential of power plant emissions, the geographical area

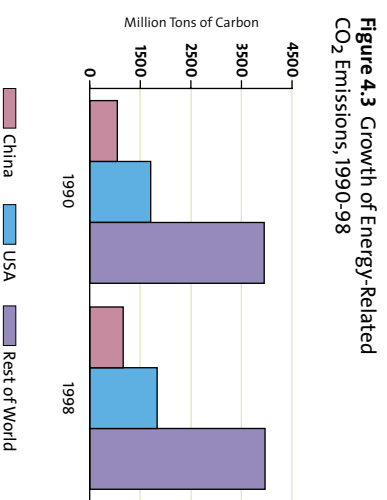
affected may increase. There is also likely to be an increase in the share of nitric acid in total acid loading because of increasing NO_x emissions from high-temperature combustion in newer power plants.

Global Environmental Concerns

In terms of air emissions, China's two most important global environmental concerns are CO₂ from burning fossil fuels and the production and consumption of ozone-depleting substances (ODS). China's long-held policy in energy conservation has made a real and significant contribution to reducing global CO₂ loading relative to growth in either GDP or energy consumption. Fuel diversification has also reduced the carbon intensity of China's energy mix. Through its participation in implementing the provisions of the Montreal Protocol, China also successfully froze ODS production and consumption in 1999 at the average of the levels achieved between 1995 and 1997.

Growth in energy demand, particularly coal demand, increased rapidly during the first half of the 1990s, but turned negative between 1996 and 1999. As a result, growth of energy-related CO₂ emissions was significantly less than had been previously projected,¹⁴ although still significant—a 21 percent increase from 610 to 740 million tons of carbon between 1990 and 1998. China's

global share of CO₂ emissions increased from 10 percent to 12 percent during the 1990s. The USA also increased its global share during the 1990s from 23 percent to 24 percent, while the rest of the world reduced its contribution commensurately (see Figure 4.3).



Almost all recent reductions in coal consumption—as much as 55 million tons of coal equivalent—occurred in end-use sectors (Sinton and Fridley 2000). Structural changes, fuel switching and technical improvements are all working to moderate the momentum of future growth in coal demand, especially for final users. In the next 20 years, the power sector could become the dominant coal user, accounting for 50 percent or more of total coal consumption. Unless there is a major shift in transportation

technology from internal combustion engines to fuel cells or other low-carbon alternatives, China's oil demand could double in the next 20 years. If these developments materialize, most of the future growth in CO₂ emissions will come from these two sectors.

China's consumption of ODS grew by more than 12 percent per annum from 1986 to 1994, peaking in 1995 at 105,070 tons of ozone depleting potential (ODP).¹⁵ After ODS in developed countries were phased out by 1995, China became the world's largest ODS producer and consumer. Production and consumption in 1997 were 95,760 tons of ODS and 87,620 tons of ODP: in 1999, they were supposed to be frozen at about 88,660 tons of ODS and 91,250 tons of ODP. China could still achieve its original commitment to phase out ODS production completely by 2010, but there are still issues that could cause delays. One source of uncertainty is the emergence of ODS in previously unidentified sectors.¹⁶

Key Air Pollution Issues, Policy Implications, and Recommended Actions

China has progressively built its capacity in air pollution management. The first air pollution law went into effect in 1987. It has since been amended twice—1995 and 2000—to add teeth and cover newly emerging issues. The 2000 amendment includes several new

mandates that will enhance future air quality management, including the endorsement of emission fees and emission permits, both of which are potentially important regulatory instruments. China has also made significant gains in adjusting its fuel mix due to large investments in residential fuel switching, and in energy efficiency through technical innovation and structural adjustment. These pro-environment energy policies have provided significant support to the air quality improvement agenda.

Nevertheless, China still faces great challenges. Many of its cities have concentrations of fine particulates and sulfur dioxide that are amongst the world's highest. Hundreds of millions of people are affected by indoor air pollution due to the use of solid fuels for cooking and heating. The impact of acid rain, while tempered a bit in recent years, has the potential to increase again if mitigation efforts fail to protect critically affected areas. Continued reliance on coal and other high-carbon fuels will further increase China's share of global CO₂ emissions. Speeding up the phasing out of ODS will require persistent efforts and additional investments.

In this context, China's air pollution management strategy must achieve multiple objectives, including:

- Reducing ambient air pollution in urban areas

- Lowering indoor air pollution
 - Mitigating the impact of acid deposition
 - Addressing global environmental concerns.
- To achieve these objectives, China must attack its air pollution problems on two fronts: (1) strengthened pollution regulation resulting from improved regulatory effectiveness and efficiency; and (2) continued pursuit of pro-environmental energy policies to promote development and deployment of cleaner and more efficient energy sources and energy technologies.

Energy mix and energy efficiency play key roles in China's ambient and indoor air pollution, acid deposition, and carbon dioxide emissions. Fundamental improvements in those areas will involve, in the short term, substantially reducing coal consumption in small and dispersed end uses, and in the long term significantly reducing the economy's reliance on coal. In the short term, the transition from a coal-based energy system to a low-carbon energy system will require rapid expansion of the use of natural gas. In the longer term, large-scale utilization of renewable energy sources and new energy technologies will have to be incorporated into the strategy.

Building on the momentum of the newly amended Air Pollution Prevention and Control Law, the government should move to implement its total emissions control through a permit system that encourages

emission reduction as well as cost reduction (see also Chapter 5). The government should also build emission reduction incentives into energy prices by levying pollution taxes on highly polluting fuels, such as coal, or fuels in high demand, such as gasoline.

REDUCING AMBIENT AIR POLLUTION IN URBAN AREAS

Fine particulate matter. The predominant ambient air pollutant in Chinese cities is suspended particulate matter, about 60 percent of which is PM_{10} ¹⁷, the main source of associated health problems. Airborne fine particles come from primary emissions, such as soot, fly ash, and fugitive dust, as well as secondary pollutants such as sulfates and nitrates that are products of many atmospheric chemical processes, including gas-to-particle conversion. There is no available analysis of the composition of fine particulates in urban China. Based on emission patterns, the main sources of PM_{10} in Chinese cities are likely to include combustion of coal and other fossil fuels in industrial, commercial, and residential applications; industrial production (fugitive emissions); and internal combustion engines, particularly diesel engines. Contributions from other sources such as construction and natural airborne dust are probably small, although these sources are important contributors to TSP as a whole.¹⁸

Although the median concentration levels of TSP in 60 reported cities decreased modestly in the 1990s, the total human exposure over threshold value has actually increased slightly, suggesting that the health damage due to fine particulates has probably not been reduced.¹⁹ Since health damage caused by fine particulate pollution dominates health costs of all other ambient air pollution forms, reducing ambient fine particulate concentration levels should be the center of attention in China's urban air pollution control agenda.

Past control efforts have focused on TSP emissions from coal combustion and fugitive industrial dust emissions, and are credited for the significant reduction of ambient TSP levels observed in the 1980s. But these efforts have not controlled most fine particulate emissions. Based on analysis of 1998 national industrial emissions survey data, the average industrial soot removal rate, excluding the power sector, is only 70 percent, and the average industrial fugitive dust recovery rate is 74 percent. Both are low and unlikely to have much effect on fine particulate emissions. More than one third of all industrial soot emissions come from industries with less than a 30 percent removal rate. These industries are probably dominated by small firms. The cement industry, which emits 78 percent of all industrial fugitive dust, only recovers 68 percent of its fugitive emissions (ZTN 1999). These numbers indicate that the control of industrial emissions, especially

those from small stationary sources, will have to be tightened significantly in order to substantially reduce fine particulate emissions.

Emissions of SO₂ from combustion, a major source of sulfates, are largely uncontrolled. The utility sector, which accounts for 50 percent of combustion SO₂ emissions from surveyed enterprises, removes only about 8 percent of its emissions. SO₂ emissions from small stationary sources such as industrial boilers, furnaces, and stoves are a particular influence on urban air quality due to their generally low stack heights. Since ambient SO₂ is also an important source of fine particulates, ambient SO₂ pollution control should be an integral part of efforts to control fine particulate pollution.

In order to address fine particulate pollution more effectively, key actions include:

- Rapidly increasing monitoring capacity for ambient fine particulates so that regulatory agencies can improve their knowledge and understanding of the nature and patterns of this pollution problem.
- Clearly identifying reductions in ambient fine particulate pollution as the foremost objective of urban air quality management. A national effort, similar to that of the "two control regions" program for SO₂, should be initiated. Participating cities should be required to submit their compliance plans just as required in the "two control regions" program.

Box 4.1 Some Issues with Air Emission Standards for Stationery Sources

China's air emissions standards are quite comprehensive and cover a wide range of conventional emission sources, such as boilers, furnaces, kilns, as well as industrial fugitive emissions. SEPA recently updated and tightened emission standards for industrial boilers (GWPB 3—1999) to come into effect on March 1, 2000. There are a few issues that may hamper the enforcement of the standards, or may undermine the objective of overall emission reduction goals.

THE COMPLEXITY OF EMISSIONS CALCULATIONS. The emissions calculations prescribed in national standards are unnecessarily complicated, and the accuracy of the calculations is heavily dependent on meteorological data such as average wind speed and air stability, which cause great difficulties for emissions estimation and verification. An alternative would be to specify emissions per day per unit equipment capacity.

POLLUTION LOAD CONTROL VS. CONCENTRATION-BASED EMISSIONS STANDARDS. Most air emission standards are defined in concentration form under standard conditions without specifying excess air coefficients. This allows operators to dilute concentrations by increasing air flow. Using concentration-based emission standards also makes it more difficult to manage local airshed pollution loads, which directly relate to ambient pollution levels. Mass-based emission standards are more appropriate.

RELAXED REQUIREMENTS FOR OLDER EQUIPMENT AND POORER QUALITY FUELS. Different standards are applied to old and new equipment (based on installation date) and to coals of different quality (based on ash and sulfur contents). The relaxed requirements for older equipment and poorer quality fuels do not encourage renovation and use of higher quality fuels and should be phased out as part of the effort to move to a mass-based pollution load control program.

Source: World Bank Staff

■ Focusing control efforts on coal-burning activities. Experience in other countries and China's own experience in the 1990s demonstrates that reducing coal consumption is the most effective way of improving ambient air quality. It is critically important that cities in China make every effort to minimize coal use in urban areas, especially in residential and commercial applications, and to introduce and develop cleaner energy alternatives.²⁰

■ Furthering the effort to curb emissions from industrial coal-combustion. SEPA needs to review existing emission standards for boilers, furnaces, and kilns, with a view to tightening them where technology permits and the economic case is justified (see Box 4.1).

■ Focusing on coal-fired space heating in northern China, which is the most important air pollution source in this region. While Beijing's effort to convert coal-fired heating boilers to natural gas is an excep-

tion for now, northern cities should start planning to follow its lead. In the meantime, they should take immediate steps to curb emissions from coal-fired heating boilers by improving heating-coal quality and improving space-heating energy efficiency (see Box 4.2).

Motor vehicle emissions. Motor vehicle emissions have become a major source of ambient air pollution in a few super large cities, including Beijing, Shanghai, and Guangzhou. On average, mobile sources account for 45 to 60 percent of NO_x emissions and about 85 percent of CO emissions in typical Chinese cities (Walsh 2000). Given current projections of urban transportation growth and analysis of urban air emission sources, motor vehicles, especially passenger cars, will be one of the main sources of urban air pollution in the future. China's fast-growing fleet of diesel-driven trucks and buses in Chinese cities should also be a matter of concern for air pollution regulators. Soot emissions from diesel engines are a serious health concern because they are carcinogens.

The government has already developed a national strategy for reducing motor vehicle emissions based on international experiences and China's situation. Key components include phasing out leaded gasoline; tightening emission standards for all categories of new vehicles; upgrading vehicle inspection and maintenance programs; adoption of cleaner fuels; and implementing traffic

and demand management (Walsh, 2000). The critical issue now is to implement the strategy in a timely and effective manner. Early signs have been encouraging because of the strong push by large municipalities to implement the strategy ahead of the national schedule. Beijing, Shanghai, and Guangzhou, the three cities with the most

Box 4.2 Strategies to Curb Emissions from Small Stationary Sources

CONTROL COAL QUALITY. Pilot programs should be introduced to experiment with a heating coal distribution system in which only licensed fuel companies are allowed to deliver prepared low-ash and low-sulfur coal to heating boilers. The fuel companies then must comply with minimum coal quality standards specified for different size/type of boilers. This also is a defensive measure against the possibility of inferior coals being channeled to small users when tighter TSP and SO_2 controls push up demand for high-quality coal by bulk users such as power plants. Boiler operation efficiency may be improved by introducing energy service companies that seek boiler operation and maintenance outsourcing contracts from boiler owners.

PROMOTE INCREASED ENERGY EFFICIENCY. Major policy reforms will be needed to unleash sustained energy efficiency improvements in space heating. Cities will need to work with the central government to implement policies to reform heat pricing and billing and to promote construction of more energy efficient buildings.

serious motor vehicle pollution in the country, are also moving aggressively to control motor vehicle emissions.

The importance of the leadership role of large cities in controlling motor vehicle emissions cannot be understated. These cities represent the bulk of China's automobile market. Their actions directly affect the whole automobile industry, which indirectly affects the rest of the country. By focusing on major municipalities, the government not only tackles the pollution problem where it is most serious, but also leverages the market influence of those cities for the

Box 4.3 Large Cities Can Set the Pace in Regulating Motor Vehicle Emissions

In early March 1999, the Beijing Environmental Protection Bureau instructed car manufacturers with sales outlets in Beijing that they should be responsible for excessive pollution of their cars. All domestically produced cars sold in Beijing between 1995 and 1998 must be retrofitted with a manufacturer-developed kit designed to meet Euro 1 emission standards. Manufacturers were required to complete the work by December 1999. The program will require retrofitting of approximately 200,000 vehicles. Similar programs are being implemented in some other cities. Beijing has also taken the lead in implementing Euro 1, catalyst-based emission standards for all new cars. The regulation went into effect on January 1, 1999, 15 months ahead of national schedule.

Source: Walsh (2000).

benefit of the national environment. A case in point is Beijing's vehicle retrofit program (see Box 4.3).

China is getting to the stage where a significant number of urban residents are able and willing to purchase cars. International and domestic manufacturers are also jockeying for position to market affordable cars to private citizens. Conceptually, a tightly planned city with highly efficient public transportation systems would serve both people and the environment well. But realizing that would require a convergence of multiple government policies and market forces. As general principles for reducing urban congestion and motor vehicle pollution, large Chinese cities should strive to make mass transit systems the primary urban people movers; should plan and develop in patterns that can most efficiently use mass transit systems; and should implement policies that discourage private car use for commuting to and from work.

The following recommendations are made from the narrow perspective of vehicular emission control. A division of labor and responsibility between national and local agencies concerned with vehicular emissions control is desirable. In broad terms, the national agencies should focus on managing manufacturers of motor vehicles and fuels through:

- Setting emission standards for all categories of motor vehicles and ensuring that manufacturers comply with them.
- Setting quality standards for fuels and ensuring that refineries and importers comply with them.

- Setting vehicle fuel efficiency guidelines and promoting compliance, and encouraging research and development of cleaner and more energy efficient motor vehicle technologies.

- Building institutional capacity for standards enforcement, including clarification of administrative responsibilities of concerned national agencies and local agencies, provision of financial support, and establishment of testing and inspection procedures and facilities.

- Assisting provincial and municipal governments to build capacity for implementing national or local standards.

Local agencies should focus on:

- Enforcing emission standards for operating vehicles through normal vehicle registration procedures that require periodic inspection and maintenance of motor vehicles
- Monitoring local air pollution and using it as guidance for devising measures to control motor vehicle emissions, using options such as traffic management through regulation and/or economic incentives

- Planning for and developing more efficient urban transportation systems, and working with the national government on appropriate financial incentives to support such efforts.

LOWERING INDOOR AIR POLLUTION

Even without an orchestrated national program, the government has managed to reduce indoor air pollution from household fuel consumption on a large scale, largely by expansion of gaseous fuel supply. There are good reasons to believe that serious indoor air pollution will fade in the next 20 years as living conditions continue to improve. That thought, and the fact that most households in large cities are not affected by indoor flue gas, may have given policymakers the illusion that indoor air pollution from fuel combustion is no longer a public health threat.

Such optimism would be premature, since there are still hundreds of millions of people using solid fuels for cooking and/or heating, and the population exposed to serious indoor air pollution may be correspondingly large. The lack of updated research and extensive monitoring data obscures the scale and severity of indoor air pollution in China, preventing the development of an alleviation strategy.

The first order of business for indoor air pollution control is to carry out a national survey of the status and nature of the problem so that a clear policy agenda can be put

together. This could be one of the areas where immediate actions and persistent efforts can have a profound impact on public health, since those who are exposed to high-level indoor air pollution are most likely to be poor urban and rural households. Alleviating indoor air pollution has the double advantage of improving health and bringing environmental equity to the poor and less fortunate.

Indoor air pollution has traditionally been dealt with by government agencies in public health and agriculture, and is not on SEPA's agenda at all. With other public health issues overwhelming the public health agencies, and with the agricultural agencies facing redefined missions, indoor air quality is in danger of being left off the government agenda completely. As China's top environmental agency, SEPA should lead efforts to coordinate activities in addressing indoor air pollution.

MITIGATING THE IMPACT OF ACID DEPOSITION

Recent declines in coal consumption provided a short-term gain for China's SO₂ emissions control program, but coal consumption is expected to grow in the next 20 years, even if at a lower rate than previously projected. Without implementing mitigating policies, SO₂ and NO_x emissions will increase, and the impact of acid deposition will get worse. The next five years represent a critical period for China's acid deposition control effort, as

the government steps up the implementation of the "two control regions" strategy for SO₂ emissions.

China has focused its SO₂ emissions mitigation efforts in areas where environmental and health damages are considered most significant. The current strategy aims to control emissions by regulating both the supply and consumption of coal through a blend of command and control, administrative, and economic measures (see Box 4.4). Implementation of the national strategy has only just begun, and most participating local governments are only at the planning stage.

Based on an initial assessment, China's acid deposition control should:

- Emphasize impact reduction, compared with emissions reduction. This would require improved understanding of source-receptor relationships and impacts themselves. An impact reduction strategy is more likely to lead to national and regional cost savings. Since mitigation activities are implemented locally, it is also important to assist participating governments to identify the most economic options, given their abatement goals.

- Stress cost-effectiveness in selecting abatement measures. SEPA should begin to study and plan for an emissions trading program among coal-fired power plants, and should prepare to implement such a program in the next five years.

Box 4.4 Main Policy Measures Under the "Two Control Regions" Strategy and Potential Problems

There are three main policy measures embodied in the "two control regions" strategy. These measures are a good starting point to avoid drastic ramping up of control costs at the beginning, when experience is lacking. But they are unlikely to ensure a steady reduction of SO₂ emissions as anticipated by the government.

CONTROLLING THE SULFUR CONTENT OF COALS SUPPLIED. Construction of new collieries based on coal with a sulfur content of 3 percent and above is prohibited. Existing collieries mining similar coals will face production restrictions or be gradually phased out. Coal mines producing coals with sulfur content greater than 15 percent should construct washing facilities matched to their mining capacity. Supply-side control is perhaps a necessary and effective measure for emissions control when end user regulation is lagging and relatively difficult to implement, but eventually such regulation will become redundant when consumers begin to put a premium on the quality of coal as a result of pollution regulation.

■ Consider expanding SEPA's acid deposition regulation to cover NO_x emissions from power plants, because of the increasing importance of large point sources and the growing contribution of NO_x emissions in acid deposition.

CONTROLLING EMISSIONS FROM COAL-FIRED POWER PLANTS. Newly constructed or renovated coal-fired power plants using coals with sulfur content greater than 1 percent must install sulfur scrubbing facilities. Existing coal-fired power plants using coals with sulfur content greater than 1 percent must adopt SO₂ emission reduction measures including flue gas desulfurization (FGD). A direct impact of this regulation is that power plants are switching to low-sulfur coal to avoid installing FGD facilities. The average sulfur content of power plant steam coal decreased from 12 percent in 1996 to 1.0 percent in 1998. Since coal-fired power capacity is projected to grow substantially, this regulation will not be able to contain SO₂ emission growth of the power sector.

COLLECTING SO₂ EMISSION FEES. An expanded trial of SO₂ emission fees began in 1998. The current fee level of RMB 200 per metric ton of SO₂ emissions is widely considered to be less than the costs of many available abatement options. Switching to lower sulfur content coals is expected to be an immediate impact of the fees on coal users. There is much uncertainty about which levels of fees can produce the desired amount of emissions reduction.

Source: World Bank Staff

■ Put more emphasis on large point sources. SEPA should consider reconfiguring the "two control regions" program so that acid deposition control is more focused on large point sources, and should consider integrating ambient SO₂ pollution control into the urban air quality management program.

■ Amend some of the loopholes existing in the current “two control regions” program. One apparent problem is the threshold sulfur content value for coal-fired power plants (see Box 4.4). Instead of setting coal sulfur content limits as the trigger for installation of scrubbers, power plants should be licensed and managers given the flexibility to make their own decisions about how best to comply with regulatory requirements. This would also pave the way for introducing an emissions trading program among coal-fired power plants when conditions are right. Emission reduction in the power sector is critical to the success of China’s acid deposition control program because the power sector will be the main source of future growth in SO₂ and NO_x emissions. An emissions permit program should be introduced as soon as possible to ensure the power sector meets its abatement goals.

ADDRESSING GLOBAL ENVIRONMENTAL CONCERNS

The government’s policies in economic reforms, energy efficiency improvements, and alternative energy development have all contributed to its objectives in terms of globally significant air pollutants such as CO₂ and ODS. These policies and efforts need to be continued in light of improved economic efficiency. International assistance should continue to tap into these synergistic areas.

Economic reform. Continued economic reform is critical to China’s long-term contribution to mitigating global environmental damages and to improvements in the overall efficiency of resource allocation. Successful economic reforms accelerate structural changes and foster technology innovations, which are key factors influencing future emissions of greenhouse gases (GHG), the phasing out of ODS, and the control of other global pollutants associated with general economic activities. China’s accession to the World Trade Organization (WTO) will speed up the pace of economic reforms in China, and should be welcomed by the international community.

Energy efficiency improvements. To mitigate GHG emissions, improvement in the technical efficiency of energy use should be among China’s highest priorities. In the short- to medium-term, efforts should focus on the following areas:

- Promoting cost-effective industrial energy conservation, including more efficient utilization of heat, steam and electricity, as well as by-product gas.
- Developing, manufacturing, and effectively marketing more efficient energy consuming equipment, including electric appliances, motors, boilers, and engines.

■ Improving the quality of coal through pricing and regulatory measures. This would encourage the supply and consumption of screened or washed coal graded to meet specific uses.

■ Improving the energy efficiency of residential and commercial buildings, especially in space heating and cooling. Reforming the existing floor-area-based heat tariff and billing system is a prerequisite to sustainable space heating energy efficiency improvement. There is also an urgent need to educate and train practicing and future architects, construction engineers, and building inspectors on how to integrate energy efficiency considerations into their respective professions.

■ Finally, in anticipation of the huge potential for growth in automobile demand, striving to gain access to more advanced and more energy efficient automobile technologies.

Alternative energy development. Greater support for the development and deployment of low- or non-carbon energy technologies is urgently needed now if China is to vastly reduce its reliance on coal in the long term. Given the abundance of low-cost coal resources in China, the government cannot rely solely on market forces as a basis for encouraging adoption of alternative energy technologies. The government needs

to adopt an aggressive program to push alternative energy development, particularly in the areas of renewable energy technologies.

Promoting alternative energy sources that are currently cost-competitive with coal, particularly in the supply of natural gas, also deserves strong support. China's plan to substantially increase natural gas consumption, including coal-bed methane, should be encouraged. International capital, technology know-how, and market development knowledge will help to accelerate the consumption growth of natural gas in China.

Experiences from implementation of Montreal Protocol and Global Environment Facility projects in China have shown there is much to gain for China as well as the international community from active cooperation and well-targeted assistance.²¹ China should be open to innovative ideas in support of international environmental cooperation. It should explore new ways to tap into international capital, knowledge, and technology to enhance its capacity to address global environmental problems.

Notes

1. That is, Class 2 of the National Ambient Air Quality Standard (NAAQS). Details of the NAAQS are provided in the statistical Annexes in the CD-Rom attached to this report. China has a total of 667 classified cities.
2. A micron is one-millionth of a meter. Industrialized countries, such as the US, have moved to regulate $PM_{2.5}$, fine particulates with the most damaging health effects.
3. Called smoke dust in Chinese terminology.
4. The Class 2 NAAQS applies to urban residential and commercial districts, as well as general rural areas (refer to statistical Annex in the CD-Rom). According to the NAAQS, the annual average limit for Class 2 TSP concentration is $200 \mu\text{g}/\text{m}^3$, for SO_2 $60 \mu\text{g}/\text{m}^3$ and for NO_x $50 \mu\text{g}/\text{m}^3$.
5. The definition of the size of cities in China is based on non-agricultural population (NAP). Large cities have NAP above 500,000, medium cities have NAP between 200,000 and 500,000, and small cities have NAP below 200,000.
6. By the end of 1997, there were 34 cities with NAP at or above 1 million. Of these, 32 were listed in the official air quality monitoring report. These 34 cities represent 50 percent of the registered urban population in China's 667 cities (1997).
7. The other 28 cities accounted for 11 percent of the registered urban population in China's 668 cities in 1997. Together with the 32 largest cities, they provide a relatively complete urban air quality profile in China's medium and large cities.
8. In Chongqing and Guiyang, two of the most SO_2 -polluted cities in the country, SO_2 levels declined substantially from 351 and 341 $\mu\text{g}/\text{m}^3$ respectively in 1991 to 183 and 178 $\mu\text{g}/\text{m}^3$ in 1998.
9. Using the class 2 NAAQS as thresholds, total human exposure is defined as the product of the concentration over the threshold and the affected population.
10. China has only just started to monitor PM_{10} , the traditional threshold for fine particles. But a more stringent definition is $PM_{2.5}$. Particles larger than 2.5 microns, if inhaled, are removed in the head or upper respiratory tract. Smaller particles can reach the alveolar region, which has no protective mucus layer and from where the clearance time of deposited particles is much longer, increasing the potential for adverse health effects. Fine particles also are a major contributor to visibility reduction through light scattering.
11. Another study (Hughes and Dunleavy 2000) showed that in India there was a substantial decrease in infant mortality associated with the use of clean cooking fuels, with the effect being greater in rural households (35 percent reduction) than in urban households (20 percent reduction). In China, a similar pattern (42 percent reduction in rural households and 12 percent reduction in urban households) was found in recent studies applying the Indian methodology to data from the 1992 Children Survey of China.
12. Acid deposition—more commonly referred to as acid rain—is caused by emissions of sulfur dioxide and nitrogen oxides, which are converted in the atmosphere into secondary pollutants such as nitric and sulfuric acids, both of which dissolve easily in water. The resulting acidic water droplets can be carried long distances by prevailing winds, returning to earth as acid rain, snow, or fog.
13. China's national SO_2 emission control strategy aims to reduce ambient SO_2 pollution in designated cities (SO_2 control region) and reduce acid rain impact in designated areas (acid rain control region).
14. In all likelihood, China's energy consumption and CO_2 emissions in 2000 will be lower than even the most conservative projections made in the early 1990s. For example, the high-efficiency scenario in a 1994 World Bank study projected a total energy demand of 1,474 million tons of coal equivalent (Mtce) in 2000 (Li et al. 1995). Expected actual energy demand in 2000 will be around 1,350 Mtce.

- 15.** ODP is derived from the physical tonnage of different ODS, adjusted to account for their different effects on ozone.
- 16.** For example, inclusion of CTC applications in chemical feedstocks and additives in 1998 caused a huge jump in ODS production and consumption statistics.
- 17.** In some northern cities, the percentage can go below 50 percent because of high natural-borne dust levels.
- 18.** Levels of natural airborne dust are often high in north and northwest cities, which explains many of the differences in TSP levels between the north (with the exception of the northeast) and the south. Road transportation may be an important but unconfirmed contributing factor to ambient TSP levels, because it re-suspends ground dust.
- 19.** Since monitoring of fine particulate matter (PM_{10}) only started recently and is still sporadic, the assessment made in this report is based on monitoring data for TSP.
- 20.** The latest example is Beijing's effort to convert all small and medium coal-fired heating boilers (1 to 10 ton-stream/hour) within the fourth ring road to natural gas-burning units.
- 21.** The latest such program is the Clean Development Mechanism (CDM) under the Kyoto Protocol, which is intended to provide a mechanism to facilitate international carbon trading.



5 Environmental Management



The economic and social changes that characterized the 1990s in China were also reflected in the environmental agenda. The structure of industry and industrial pollution changed significantly; urban and rural environmental issues became much more visible and important; and the growing middle class became more aware and concerned about the deteriorating state of the environment. Political awareness also increased. At the Fourth National Environmental Protection Conference in 1996, both the President and Premier stated that protecting the environment was essential for maintaining productivity. The subsequent Ninth Five-Year Plan (1996-2000) was the first to include explicit and monitorable environmental performance objectives and a targeted pollution control investment program. Finally, as part of the 1998 central government reforms, the National Environmental Protection Agency (NEPA) was upgraded to the level of a ministry and re-named the State Environmental Protection Administration (SEPA).

This chapter outlines the main institutional and regulatory developments during the 1990s, identifies continuing problems and issues, and provides suggestions on additional reforms that need to be considered.

Developments in Environmental Administration

The 1990s saw both advances and setbacks in environmental administration. On balance, the advances outweighed the setbacks (see Table 5.1).

Recent notable developments include:

- SEPA's elevation to the status of a ministry, clarifying its position as the agency with overall responsibility for environmental management and protection in China.
- Further efforts were made to address the so-called "horizontal-vertical" issue, in which lower-level EPPBs report to higher-level EPPBs and ultimately SEPA, but receive their budgetary resources from the local government.¹ Appointments to head local EPPBs must now be endorsed by a higher-ranked environmental agency. For example, a municipal government's selection to fill the position of EPP director will have to be endorsed by the relevant provincial EPP. This is the second attempt to address this difficult issue.²

■ Lower-level EPPBs were strengthened, either by lifting their bureaucratic status or by giving them independent bureaucratic status. Both changes are important steps in increasing administrative leverage. As of 2000, all 31 provincial EPPBs were independent agencies and 30 of them were first-tier institutions,³ all city-level EPPBs were independent agencies, and most were first-tier; about 70 percent of county EPPBs were independent; and about 1,422 environmental protection units were established at the township level.

Notwithstanding these developments, there remain a number of outstanding institutional issues that will have to be overcome if the challenges of the 21st Century are to be successfully confronted:

■ The cross-sectoral dimensions of environmental management are becoming increasingly important. The dissolution of the SEPC (see Table 5.1) removed a potentially important forum for encouraging collaborative work on cross-cutting environmental issues and for resolving jurisdictional disputes. The SEPC's coordination role was transferred to SEPA, but experience in other countries suggests that SEPA, as a second rank (non-cabinet) ministry, will not be able to effectively carry out this role.⁴

■ The 1990s saw a significant worsening of the gap between SEPA's declining staff resources and the widening mandate assigned to it. This gap extends to EPPBs at the provincial level; it will probably worsen as provincial reform continues. If the government is not prepared to provide the staff and financial resources to match the current environmental mandate, it will have to narrow the agenda.

■ None of the reforms of the 1990s addressed the critical issue of budgets and financing to underwrite the operations of SEPA and the EPPBs. The funding of supervision and monitoring activities is inadequate, and control of point-source pollution is far less efficient and effective than it needs to be. Many lower-level EPPBs are heavily dependent on retained pollution levies to cover their operating costs,⁵ which creates numerous perverse incentives. For example, it is in the interest of EPPBs for enterprises to keep polluting and pay their pollution levy, rather than to comply with discharge standards and stop paying.

■ The organizational structure of environmental administration is very susceptible to interference by local leaders. As mentioned, various measures have been applied to reduce the sometimes conflicting demands of horizontal and vertical influences, but the problem has not yet been solved.

Table 5.1 Developments in Environmental Administration, 1974 to 1998

Advances	Setbacks
<p>1974 ▶ Environmental Protection Office (EPO) established under State Council. Staff allocation: 20.</p>	
<p>1979 ▶ Promulgation of the first Environmental Protection Law. Several provincial and city governments took the initiative to increase rank of EPOs to that of a bureau (first-tier organizations).</p>	
<p>1982 ▶ Staff allocation of the State EPO increased to 60.</p>	<p>1982 ▶ EPO transferred from State Council to the (newly created) Ministry of Urban and Rural Construction and Environmental Protection (MURCEP).</p>
<p>1984 ▶ State Environmental Protection Commission (SEPC) created under the State Council to aid in cross-sectoral coordination. EPO upgraded to a Bureau (National Environmental Protection Bureau—NEPB). Staff allowance doubled to 120.</p>	
<p>1988 ▶ NEPB separated from MURCEP and reclassified as an Agency (NEPA) with a bureaucratic rank slightly below a ministry. It resumed direct reporting to the State Council. Staff allowance increased from 120 to 321.</p>	
<p>1993/94 ▶ Creation of the Committee for Natural Resources and Environmental Protection of the National People's Congress to take responsibility for revising and drafting new environmental laws and assuring their rapid promulgation.</p>	<p>1993/94 ▶ Widespread downgrading of many county EPBs to second-tier status following a new round of administrative reforms.</p>
<p>1998 ▶ NEPA upgraded to ministerial status and renamed as State Environmental Protection Administration (SEPA). More lower-level EPBs raised to first-tier status, offsetting the setback of 1994.</p>	<p>1998 ▶ SEPA's staff numbers reduced from 321 to 200. SEPC of the State Council was disbanded.</p>

Source: Adapted from Jahnel (1998)

Approaches to Environmental Management

The environmental agenda has three major themes; industrial pollution, urban environmental management, and what SEPA refers to as “ecological environmental protection,” which might alternatively be described as natural resources management.⁶ The existing repertoire of environmental laws and regulations addresses all of these issues to varying degrees. The greatest progress has been made in the field of industrial pollution control, which is most amenable to a regulatory approach. Progress on the second two has been more limited, and these will continue to be the main problem areas over the next 5 to 10 years.

INDUSTRIAL POLLUTION CONTROL

The regulatory and administrative framework for industrial pollution control is quite comprehensive. It has been continuously updated and expanded to improve effectiveness and cover emerging issues. The current framework of command-and-control systems, supplemented by economic, voluntary, and public disclosure instruments (see Table 5.2), provides a good basis for effective pollution control. The system suffers from two major shortcomings: (a) the laws and regulations lack teeth and are inadequately

enforced; and (b) they are concentrated primarily on stationary point-source pollution control.

During the 1990s, regulators attempted to encourage three shifts in industrial pollution control strategy. First, at the enterprise level, pollution control shifted toward whole-process control, rather than just end-of-pipe waste treatment. Second, the regulatory focus shifted away from pollutant concentration toward total load control by enforcing a combination of concentration and mass-based discharge criteria. Third, to improve cost-effectiveness, the focus shifted from dispersed-source control, where each enterprise had to individually resolve its emission problems, to a more integrated approach that considered the possibilities for centralized control, by for example encouraging the discharge of semi-treated liquid wastes to municipal sewers.

The shift to total process control is being encouraged by promotion of the “cleaner production” concept and adoption of ISO 14000 certification procedures.⁷ The Cleaner Production (CP) program, which started in 1993, encourages enterprises to adopt in-plant waste minimization technologies as supplements to traditional “end-of-pipe” pollution-control approaches.⁸ There is considerable potential in the CP program, since many of the older and more polluting enterprises are very inefficient and use outdated production technology, but take-up has mainly been focused in areas

Table 5.2 Current Framework for Industrial Pollution Management and Control

Command-and-Control Instruments	Economic Incentives	Voluntary Instruments	Public Disclosure Instruments
Concentration-based pollution discharge limits Mass-based controls on total provincial discharge (pilot only) Environmental Impact Assessment Three synchronous policy ¹ Limited time treatment ² Centralized pollution control Two compliance policy ³ Environmental compensation fee	Pollution levy fee Non-compliance fines Discharge permit system (experimental) Sulfur emission fee (experimental) Emission trading (experimental) Subsidies for energy-saving products Regulation on refuse credit to high-polluted firms	Environmental labeling system Promotion of ISO 14000 system Cleaner Production program	Cleanup campaigns Environmental awareness campaigns

Notes:

¹ The Three Synchronous Policy is intended to ensure that the planning, design, and construction of pollution control facilities occurs at the time that new enterprises are established and that production does not commence until EPB certification is received.

² Imposition of mandatory time limits for non-compliant enterprises to come into compliance or face shut-down.

³ The "Two Compliance Policy"—compliance with discharge standards and ambient standards; that is, moving from concentration-based to mass-based or total load control.

Source: World Bank Staff

with strong incentives, such as the water-scarce areas of northern China. Nevertheless, the technical capacity to undertake clean production audits and feasibility studies has been established, creating the capacity to respond as the demand for these services develops.

ISO 14000 certification procedures were introduced in 1997. The attraction for government in promotion of ISO 14000 is the

belief that it will increase the compliance rate without increasing regulatory effort. The work was initiated by SEPA's Office of Environmental Management Systems. Subsequently, a Steering Committee for Environmental Management System Certification was established within SEPA to provide accreditation services for certification bodies and auditors. Several environmental management and consulting centers have been established to conduct ISO 14000

certification. The adoption rate, as in other countries, has been slow—27 enterprises received ISO 14001 certification during the first year. The majority of participants are either foreign firms or domestic firms engaged in production of export-oriented products, neither of which are the sort of industries responsible for the nation's main pollution problems.

Both of these programs are worth continuing, although it would be a mistake to mandate them in law, which is under consideration in the case of Cleaner Production.⁹ Enterprises will adopt these strategies when they have good incentives. Resource shortages and increasing prices are effective incentives; so too is increased regulatory pressure.

The CP and ISO 14000 programs can make a contribution to solving China's industrial pollution control problems. But they are not a substitute for the budgets and manpower needed to effectively enforce pollution laws and regulations.

The shift from concentration-based control to mass-based control recognized that the key to improvement in ambient environmental conditions was to restrict the total load of pollutants emitted, not just their concentration.¹⁰ In 1987, SEPA (then NEPA) began to experiment with mass-based control to cap or reduce the total level of pollutants released to the environment in certain areas. Seventeen cities and one river basin were selected to participate in trial

implementation of a discharge permit system (DPS) based on the total-load-control concept. The program expanded to over 200 cities and 12,000 enterprises by 1994. However, studies of the pilot program showed only modest gains in environmental quality in participating cities (World Bank 2000), mainly because the program did not address the underlying problem of lax regulatory enforcement. Mass-based control is a necessity if real progress is to be made in improving ambient environmental quality, but it will probably be too complex and expensive to apply on a nationwide basis. The approach should be adopted in pollution hotspots, and has to be accompanied by increased regulatory effectiveness and the increased manpower and operational budgets needed to achieve it.

The third shift, from dispersed-source control to the combination of centralized control and source control,¹¹ was primarily an acknowledgment of practical reality. The previous emphasis on controlling wastes from individual sources was not achieving the desired effects. It placed too many demands on EPB staff for supervision, and in the less-developed areas there was insufficient technical expertise to actually implement the policy. Encouraging discharge of pre-treated wastes to municipal sewers does not eliminate the need for supervision of enterprises. But it reduces the monitoring workload and will improve the economics of the centralized sewerage system, so long as

discharge fees are set at levels that cover the costs of receiving and treating the wastes and the fees are collected.

In summary, the shifts made in industrial pollution control during the 1990s went in the right direction. The level of success varied, but the combined effect was beneficial. The gross value of industrial output more than doubled between 1991 and 1998, while the total discharge of major pollutants barely increased.¹² Waste treatment rates also increased (see Figure 5.1). Due to the inadequate deterrent effect of the levies, the same cannot be said of treatment efficiencies. More progress needs to be made. Table 5.3 highlights areas where improvement is needed, using as models current conditions in the U.S., Japan, and representative European countries such as Denmark and Germany.

Key issues to be dealt with include:

- Strengthening the rule of law and the involvement of courts. The environmental legal system is at an early stage of development, and its effectiveness is hampered by a wide variety of factors.¹³ There is also a deeply ingrained problem-solving culture on the part of all parties—EPBs, other government agencies, and industrial enterprises themselves—that is based on negotiation and bargaining outside of the court system. This militates against recourse to the courts and will have to be overcome.¹⁴ These factors are compounded

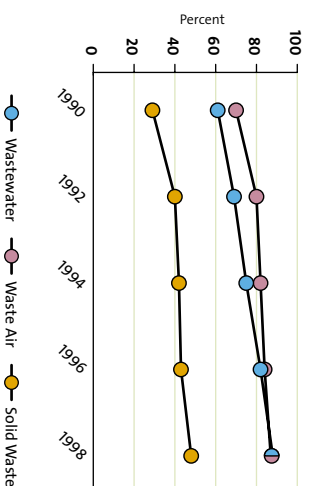


Figure 5.1 Industrial Waste Treatment Rates, 1990-98

Note: Data for CAQES only; TWES have substantially lower treatment rates although they too have been improving.

Source: Guo (1999).

by the lack of a tradition of drafting laws so as to limit ambiguity and provide clear guidance about the rights and responsibilities of different parties. In total, there are major challenges to be overcome. As regulatory effectiveness increases, the demands for legal recourse and an effective legal system will rise accordingly. Due to the complexity of the problem, action on this matter has to be expedited.

- The discharge permit system (DPS) needs to move beyond the demonstration phase and be progressively extended to make it mandatory for all large point sources of pollution, including municipal wastewater treatment plants.

- An effective strategy has to be developed for dealing with small stationary pollution sources.¹⁵ These sources will always be a

Table 5.3 Elements of Regulatory Development Required in China

Key Features in the US, Japan, and Germany	Current Situation in China
<p>Legal and Administrative Framework</p> <p>Strong legal foundations with independent judiciary and/or administrative appeals system</p> <p>Strong command-and-control system, usually incorporating a permitting system.</p> <p>Financial incentives (levies, fines) are very effectively applied</p>	<p>There is a legal foundation, but it is not strong in a legal sense. The courts are not yet playing an active role in adjudicating environmental disputes.</p> <p>The basic command-and-control framework exists but enforcement is uneven and generally weak. Will have to move to a permit system in the short-to-medium term.</p> <p>The pollution levy fee is an incentive mechanism, but it is not set high enough to be effective. It also provides perverse incentives. Fees need to be increased and perverse incentives need to be removed.</p>
<p>Incentives</p> <p>Market instruments (offsets, tradable permits) effectively applied</p> <p>Strong public demand for cleaner environment provides positive reinforcement for environmental agencies</p> <p>Public participation in legislative and administrative processes</p> <p>Voluntary programs only introduced at late stage</p>	<p>Market instruments only applied at limited pilot scale and effectiveness is not very high.</p> <p>Moderate public demand, mainly confined to wealthier urban areas. Continuing public education is needed.</p> <p>Minimal public participation (but slowly increasing).</p> <p>Early introduction of voluntary programs but without strong incentives; participation is limited.</p>
<p>Results</p> <p>Continuous real growth in GDP and environmental protection budgets</p> <p>Massive cleanup over 25-year period, including rapid reduction in short periods; for example, a 50 percent reduction in toxic discharge from 1987-90 in the U.S.</p> <p>New techniques introduced to continue improvements in environmental quality; for example, a recent Japanese law promotes 100 percent recycling and reuse of municipal solid waste.</p>	<p>Environmental protection budgets are not keeping up with GDP growth or the rate of growth of the environmental management and protection challenge.</p> <p>EPBs are holding the ground against industrial pollution (maintaining emission constant while industrial GDP is increasing) but they are not getting ahead of it.</p>

Source: Adapted from Ecology and Environment, Inc (1999)

regulatory headache, since both regulatory and abatement costs tend to be higher than average. There are numerous models from other countries that could be adapted to the Chinese situation.

URBAN ENVIRONMENTAL MANAGEMENT

China's urban environment is under tremendous stress, with high levels of ambient particulate pollution, rising automobile emissions, large amounts of untreated municipal wastewater, and increasing solid waste management problems. The challenge is difficult because of the complexity of the issues, the large number of institutions influencing the pace and nature of development, and the rapid rate of urban growth. The problems are not going unnoticed, however. The government has been assigning increasingly large amounts of development spending to manage some of these problems.¹⁶

The government's approach to urban environmental issues has been based on five integrated principles, which are described as "unified planning, optimum structure, rational distribution, appropriate construction, and comprehensive renovation" (SEPA 2000). Key operational policies during the 9th FYP including the following: (a) all Chinese cities should draft and implement urban environmental protection plans; (b) the responsibility system should be extended to cover municipal governments based upon

specific urban environmental protection objectives; (c) a comprehensive approach should be taken to control urban wastewater, air pollution, solid waste, and noise pollution; and (d) classified guidance should be provided in demonstration cities.

A number of instruments were developed to deal with the adverse environmental effects of urban growth and development (see Table 5.4). However, in comparison to the instruments developed for industrial pollution control, they are fewer in number, less sophisticated, and more weakly applied. As a result, they have been less successful.¹⁷

The main constraints to more effective urban pollution control include:

- Urban environmental pollution is dealt with as problems emerge and along sector lines or media divisions. Most cities do not have environmental master plans and are not taking an integrated approach to the problem, although there are some notable exceptions such as Beijing and Shanghai. Cities that do not enjoy the financial and technical advantages of Beijing and Shanghai need assistance in urban environmental planning through training, handbooks and procedures, and technical cooperation arrangements.

- Urban environmental services—water supply, wastewater collection and treatment, solid waste management—are generally underpriced. They do not provide a basis

for sustainable continuation of the services, nor do they provide sufficient basis for a price response in demand.

- Inadequate attention is given to the environmental consequences of spatial planning. Transport planning, maintenance of ambient water quality, and provision of public open space are particularly notable deficiencies.

- Environmental control of urban construction sites is generally very poor; again, Shanghai and Beijing are notable exceptions. There is an urgent need for development and promulgation of national standards for environmental management of urban construction, with particular emphasis on dust and noise control, runoff management, management of construction traffic, storage of construction materials, and site clean-up.

- The growing environmental problems of small cities and administrative towns are not adequately being addressed. Environmental master planning for these areas is being postponed until their basic infrastructure has been improved.

RURAL ENVIRONMENTAL PROTECTION

Unlike the efforts to control industrial pollution and manage urban environment, rural environmental protection wasn't a major government priority until the late 1990s. At

that time, SEPA was assigned direct responsibility for several dimensions of the problem, including nonpoint pollution control and control of animal wastes. Nevertheless, as a pollution control organization, there are limits to the impact SEPA can have in this field. Progress is likely to depend mainly on the on-going work of the Ministry of Agriculture and other ministries whose work impinges directly on the state of the rural environment, structural reform of the rural economy, and further progress in rural poverty alleviation. Beyond that, priority issues that need to be addressed include:

- Most natural resources management problems in China can be traced back to poorly conceived and/or implemented rural and natural resources development policies (see Chapters 2 and 3). The best hope for the future lies in a significant correction of the current imbalance between development and environmental protection. Without such a correction, almost all other strategies will be undermined.

- Further reform of pesticide management and control procedures is required to clarify regulatory and monitoring responsibilities. Enforcement of existing laws and regulations has to be strengthened considerably.

- The approach to control of fertilizer runoff has been based on a command-and-control philosophy that is unrealistic and inappropriate. The solution lies in reform of the domestic fertilizer market,

continued structural reform in the agriculture production sector, farmer education, and more effective soil conservation work. It is notable that China has no soil conservation service, even though it has some of the worst erosion problems in the world.

National Priority Programs

A final arm of the environment strategy during the 1990s comprised a program of investments to address priority environmental issues. The program was devised in 1996 and incorporated into the 9th Five-Year Plan for Environmental Protection as the “33211” program.¹⁸ The overall concept of the priority program is basically sound; given the scale of environmental problems in China, a mechanism is needed to focus expenditures on priority issues. The effects of various components of the program are discussed in earlier chapters; overall, the results have been mixed.¹⁹ The current scorecard in terms of improvements in ambient environmental quality is:

- Three lakes program. This program has had limited if any effect (see Chapter 3 and Box 3.1).
- Three rivers program. This program may have had some beneficial effect in the Huai River,²⁰ but less so in the Liang and Hai. Conditions remain serious in all three rivers, and could well deteriorate further.

- Two control zones. There has been good progress on planning—175 cities in 27 provinces have formulated pollution control plans—but less progress on implementation; by the end of 1998, only 65 plans had been approved by the relevant local governments. There are some fundamental issues with the program that need to be addressed (see Chapter 4).

- One sea. There has been no detectable impact.
- One city. There have been significant improvements.

Notwithstanding the mixed success, the program has to continue because the objectives have not yet been achieved, but there are a number of problems that need to be addressed:

- Certain elements were far too ambitious,²¹ and in hindsight should not have been included. It might be better to narrow the program in the future.
- Some programs, such as Three Lakes, were inadequately researched, and investments did not necessarily address all relevant factors.
- There were coordination problems, which were exacerbated by the haste to implement the programs. A leading group mechanism for particular sub-programs might provide a means for overcoming this problem.

Table 5.4 Urban Environmental Management Initiatives

Instrument	Content	Results/Issues
<p>Goal-responsibility system of environmental protection (1994)</p>	<p>Compels provincial governors, city mayors, and county magistrates to sign contracts that specify environmental goals to be attained within their jurisdictions during the contract period. They are designed to ensure that political leaders weigh environmental concerns equally with economic development plans.</p>	<p>Contract terms are not published, so their value depends on the weight higher-level political leaders give them. The State Council goal of holding provincial-level pollutant totals to 1995 levels by the year 2000 will be open to independent analysis, and this may improve the incentive to comply.</p>
<p>Air pollution index (1997)</p>	<p>Large cities are obliged to publish regular air quality information. Currently, 46 cities publish a weekly air quality index, of which 7 publish daily data (Beijing provides daily monitoring results from eight sites). Since June 2000, the national television network has been reporting daily air quality indices for 42 cities in its evening news bulletins.</p>	<p>A radical change. Makes data manipulation more difficult and allows independent analysis of air quality trends and, by extension, of the municipal government's effectiveness in pollution control. May have been one of the most effective public education exercises yet undertaken in the environmental field.</p>
<p>Annual urban environmental quality assessments (1989)</p>	<p>SEPA conducts an annual, quantitative assessment of environmental quality in 46 key cities and 524 ordinary cities. Twenty weighted indices covering the areas of air, water, solid waste, noise, and tree coverage are used to assign an overall score for each city. Results of the assessments are released to the media. The policy also requires mayors to incorporate objective environmental quality objectives into their development plans, and serves as a platform for local leaders to assign pollution control responsibilities among concerned sectors, as well as a channel for public participation.</p>	<p>Limited effect.</p>

Table 5.4 Urban Environmental Management Initiatives (Continued)

Instrument	Content	Results/Issues
Environmental model cities program (1997)	Cities can volunteer to have environmental sustainability of their development programs evaluated by panels of experts organized by SEPA. The evaluation criteria include a range of indices of environmental quality, investment, and management as well as other indicators relating to social and economic conditions and public environmental awareness. As of the end of 1998, 11 cities had been nominated as environmental model cities.	Cities participate in the belief that receiving the title of environmental model city will create a favorable investment environment, increase tourism, and otherwise benefit the local economy. Take-up has not been very high. A contributing factor may be that the risks of getting a bad rating outweigh the benefits of getting a good one.
Environmental review of regional plans (1998)	SEPA is required to carry out environmental reviews of regional plans and sectoral economic policies.	SEPA lacks both the staff and expertise to effectively carry out this function.
Urban environmental tariffs (1999)	The "Notice on Increasing Wastewater Treatment Fees and Establishment of Centralized Urban Wastewater Treatment Systems" (SDPC, MOC, SEPA) requires that centralized civil wastewater treatment fees be collected nation-wide. Wastewater treatment plants are required to be run as enterprises, to keep separate accounts, take full responsibility for profits and losses, and to pay taxes. Municipal water companies will incorporate wastewater-treatment fees into the water tariffs and remit these to wastewater-treatment companies monthly.	An essential policy. It has been implemented in a wide range of leading cities, including most notably, Beijing, which now charges households RMB 3 (US \$0.36) per month as a waste disposal fee. This is probably not covering O&M costs, but it is a step in the right direction.
	In cities without centralized wastewater treatment plants, the wastewater-treatment fee may be used, subject to local government approval, to accumulate investment funds for new treatment plant construction, although they must be completed and operational within three years from the date the local government starts fee collection.	

Note: ¹ If it is assumed that an average family of three generates 120 l/c/d of wastewater, the fee works at about RMB 0.3/m³, which would be considerably less than the nominal 0-and-4M cost (RMB 0.5–1.5/ m³, depending on the circumstances).

Source: World Bank Staff

■ The focus was almost entirely on capital investment, which was not always the sole source of the problem. Other factors generally not covered included lack of operational funds, lack of technical capacity, and lack of public awareness. These issues need to be addressed in the future.

To increase political attention and investments, a similar approach is being developed to address “ecological conservation” issues. During the 10th Five-Year Plan, SEPA intends to implement a “three areas strategy” with the following components:

■ The Special Eco-functional Protection Area is a program of investments focused on the headwaters of the Yangtze and Yellow Rivers that is intended to address the underlying causes of recurrent flooding, water shortages, waterlogging in the lower reaches, and sandstorms.

■ The Key Resources Exploitation Area is intended to rationalize natural resources management in the Tarim River Basin (Xinjiang Province) and the catchment of the Three Gorges Dam.

■ The Rich Biodiversity Area and Ecological Sound Area would establish 20 nature reserves of national significance in Hainan, Jilin, and Jiangsu provinces.

This program needs to be approached cautiously. Superficially, it may develop problems similar to the 33211 program. Great care is needed to ensure that (a) expectations of

political leaders are not raised too high; (b) a step-by-step approach is followed, starting with small-scale pilots and gradually building up; (c) resources are directed at manageable problems; (d) the programs should not only support capital investments, but also provide support for institutional development, capacity building, and other “soft” problem areas; and (e) the new three-areas program should not divert resources and attention from the ongoing 33211 program.

New Challenges

Two new challenges are of particular concern to SEPA and were reviewed as part of the background research underlying this report: (1) China’s accession to the World Trade Organization (WTO); and (2) the government’s proposed “Great Western Development Plan.” These issues, which are briefly summarized here, are reviewed in detail in a chapter in the statistical annex (see attached CD-ROM).

ACCESSION TO THE WORLD TRADE ORGANIZATION

The main effect of WTO accession will be to reinforce and probably accelerate many changes in the patterns and forms of production that are already taking place.

In agriculture and forestry, WTO accession will probably speed existing production shifts toward China’s areas of comparative

advantage, including labor-intensive activities such as livestock, fruit and vegetables, aquaculture, non-timber forest products, and highly transformed timber products such as furniture. It will tend to shift production away from areas of comparative disadvantage, including water-intensive agricultural sectors such as grain production, and land-intensive forms of forestry production such as woodchips and low-grade pulp. On balance, the direct environmental effects are expected to be beneficial, although the incremental impact may be little different from effects already being experienced due to domestic structural reform.

The indirect effects arise primarily as a result of the social implications of change. From a macroeconomic perspective, it is likely that the aggregate effect of the changes in agricultural and forestry production attributable to WTO entry will be economically and socially beneficial. However, it is equally likely that these benefits will not be spread evenly across the rural community. There will be winners and losers; on balance, some of the most significant adverse indirect environmental effects could be associated with the losers. Communities most likely to be losers are inland rural communities, particularly those located in the poorer counties where susceptibility to land degradation is highest, and who have the least physical, intellectual, and/or financial capacity to diversify production in the face of changed market conditions. If these communities

cannot successfully adapt to change, they may increase their usage of the only factors of production readily available to them—their own labor and surrounding unutilized land. This could increase land degradation and exacerbate associated environmental impacts such as erosion, sedimentation, and loss of biodiversity.

The degree to which such risks actually materialize will depend on the level and effectiveness of support provided by the government to help these communities adapt to changing circumstances. The types of support most likely to be of assistance include increased (a) labor-intensive public works programs to help maintain income levels during transition periods; (b) access to new production technologies through support for applied research, enhanced agricultural extension services, and production and/or development credit; (c) vocational training, particularly for younger farmers; and (d) access to childhood education and improved health services to improve the capacity of the next generation to transcend local constraints to development.

A similar story holds for industrial pollution. The main effect of WTO accession will be to increase competition for local industries, which will require them to strengthen their technology, knowledge base, and quality of management (CASS 2000). The most adversely affected industries will be the “smokestack” industries, which are signifi-

cant pollution sources and are frequently characterized by their low state of technological development, low product quality, and high consumption of raw materials, particularly energy and/or water.²² These industries are already disadvantaged by the new industrial development environment in China, so it is difficult to see that WTO accession will add anything new to existing trends.

The winners are likely to include the apparel, electronics, textile, leather, food processing, and other light manufacturing sectors. Some of these—particularly textiles, leather, and food processing—can be significant pollution sources, and it will be important to bring them into the regulatory net from the outset. In general, it is far easier to apply pollution control systems to new enterprises than retrofit them to old enterprises, so the environmental risk associated with this new industrial development will be somewhat less than with the old industries.

A potentially beneficial indirect effect of WTO accession could arise in terms of the variety and quality of environmental protection technology that becomes available on the local market. Increased foreign competition could prompt consolidation of local firms and increase investments in new technology, which could reduce pollution control costs.

Overall, the experience to date suggests that international trade has not adversely affected China's environment, and the prospects are that this experience will continue following

WTO accession (Wheeler et al. 1999). The main need is to remain vigilant against potential migration of polluting activities or import of hazardous materials in response to weak domestic enforcement of relevant laws and regulations. The challenge to environmental management is not a flood of dirty industries, but about how to help raise the environmental performance of domestic industries and other trading sectors so they can face increased international environmental scrutiny.

ENVIRONMENTAL IMPLICATIONS OF THE GREAT WESTERN DEVELOPMENT PLAN

The "Great Western Development Plan" (more literally, "Great Opening of the West"; *xibu dakaiifa*) is intended to re-direct state-sponsored development expenditures away from the wealthier coastal provinces toward inland provinces and autonomous regions, which have been relatively less favored by such expenditures over the last 20 years. The details of the plans are still being worked out, but the main focus is expected to be on (a) infrastructure development; (b) ecological construction; (c) industrial restructuring; (d) strengthening science, technology, and education; (e) strengthening local administrative capacity; and (f) promoting foreign direct investment.

China has a history of ambitious government-sponsored development initiatives. These initiatives have generally been well-

intentioned, but have had limited development impact and adverse environmental consequences. This experience is not unique to China: the track record of large-scale regional development programs in many other countries has also been mixed, with development impacts frequently not meeting expectations, while adverse environmental consequences were worse than originally expected. There is a risk that the Great Western Development Plan could result in a repetition of these mistakes, particularly if it is carried out hastily and with inadequate planning and evaluation. This risk has been widely recognized among environmental experts in China.²³

The key to minimizing the adverse environmental consequences of the plan will be to “make haste slowly,” particularly with regard to investments that have uncertain environmental impact potentials, including large-scale infrastructure developments, agricultural production initiatives, and other investments with the potential to register direct and/or indirect environmental impacts at scales larger than the project itself. In the Bank’s analysis, Great Western Development projects have been placed in one of three priority categories: (a) “Go,” which includes developments that have little or no adverse environmental impact potential and/or are precursors necessary to reduce the adverse environmental impact potential of later investments; (b) “Go Slowly,” which includes developments with only localized

impacts that can be effectively evaluated through conventional environmental impact assessment procedures; and (c) “Wait,” which includes developments that could have adverse impacts at a regional scale and need to be carefully studied and evaluated before proceeding.

Future Management Needs and Priorities

China has reason to be pleased with its progress in developing the laws, regulations, and institutions necessary to underwrite environmentally sustainable development. It is amongst the leaders in the developing world. But given the scale of problems confronting it, best in class is not good enough. China has to match the environmental management performance of the leading OECD countries; by that measure, it has a long way to go. The long list of priority actions on environmental institutions and legal/regulatory instruments is as follows:

INSTITUTIONS

- Cross-sectoral coordination on environmental issues needs to be strengthened. The best option is to reconstitute an “SEPC-like” institution under the State Council to provide a venue for negotiating and agreeing on collaborative approaches to cross-cutting environmental issues, particularly development policies.²⁴ It would ensure that environmental effects

are taken into account in setting sectoral development policies; reduce overlaps and contradictions; maximize synergies between the work of different agencies; and adjudicate disputes. For this institution to be effective, it needs a pro-active secretariat and the financial resources necessary to commission studies and spin off technical groups to address particular issues. An alternative would be to raise SEPA's status to the level of a front-rank cabinet ministry, but this would be less effective.

- Tighten the connection between resources and responsibilities in environmental protection agencies. As a matter of priority, the government should carry out a major management and staffing review of environmental institutions at all levels to assess the significance of the gap and develop strategies to deal with it.²⁵ Even without the benefit of such a study, it is already obvious that environmental protection agencies need to (a) narrow their focus; (b) concentrate the bulk of their efforts on that small number of issues where they have comparative advantages, both technically and administratively; and (c) give priority to technical problems that are potentially solvable.

- Move toward full financing of environmental institutions through the government's regular budget. The ultimate objective should be to fully finance the operations of EPBs through normal budg-

etary channels, but this will require reform of the entire fiscal system. An interim solution would be to continue with the current system, but to modify it to remove the perverse incentives. An example would be moving away from levies, which are applied only when concentration standards are exceeded, to pollution taxes, which apply to all discharged pollutant loads, whether or not they exceed prescribed standards. This is technically feasible, although not simple (World Bank 2000), since it will require major improvements in the environmental monitoring system. In the long term, all such taxes—and, for that matter, all other administrative fees—should be passed on to the relevant taxation agencies. In the short-to-medium term, however, there seems no realistic alternative to their partial retention by the concerned EPB.

- Resolve horizontal/vertical contradictions. Options for proceeding further on this matter include (a) increasing the direct regulatory function of SEPA itself, perhaps through adoption of a regional structure along the lines of the US EPA and the People's Bank of China; and/or (b) delegating regulatory power over all but the smallest industrial enterprises to municipalities and provinces and away from the county level; and/or (c) increasing supervision and audits of the performance of

lower-level EPPBs by higher levels to expose instances of continued failure to enforce relevant laws and regulations.

REGULATIONS AND INSTRUMENTS

- Improve the rule of law and increase the role of courts. The agenda is huge. Key steps include (a) increasing public awareness of the possibility that the courts could be an ally in pursuing pollution complaints; (b) developing more transparent legislative and rule-making processes to build consensus between the regulating agencies, the regulated parties, and the public on the value of a stronger legal base; (c) allowing more active public participation in the regulatory process at all stages, from drafting of environmental legislation to enforcement activities; (d) further modifying existing environmental laws to include provisions for common-law presumptive judgments that make a violation of a standard by itself a crime; (e) involving the court system in reviewing the constitutionality of legislation, interpreting its ambiguities, and reviewing the clarity and propriety of the delegation of administrative authority; and (f) increasing the role of the court system in trying and punishing violators.

- Introduce a permit system for large point sources of pollution. A permit is essentially a contract between the pollution control agency and an industrial enterprise that

contains a variety of standard terms and conditions (that is, they do not have to be developed for each new enterprise) and other undertakings relating to the

Box 5.1 Environmental Permits in OECD Countries

Permitting schemes are established by general environmental protection laws, but most of the details are contained in regulations (which are easier to change). The regulations specify the industries, processes, installations, and chemical substances or types of nuisances to which permitting applies. They also define the criteria for industrial facilities subject to permitting and further break down the target industries according to size, type of activities, and toxicity of releases. Usually, thresholds are set below which enterprises are exempted from the permitting process. Depending on the country's environmental framework, the type of facilities concerned, and the environmental circumstances under consideration, permit administration may be delegated to regional and local authorities. In many, if not all countries, permit requirement conditions can be appealed.

Almost always, there are provisions for non-compliant enterprises to come into compliance over a defined period of time.

In summary, the permitting system is a procedure by which an authorization is granted to a facility or individual to perform an activity under specific legal conditions deemed necessary to ensure the protection of environmental quality and public health.

Source: OECD (1999)

legal and regulatory obligations of the enterprise (see Box 5.1). The permit can include an acknowledgement that a breach of the permit conditions constitutes a violation of the law. An essential adjunct to the permit system would be elimination of the concept of a pollution levy and its replacement by a schedule of administrative fees to issue permits and punitive fines for any breach of conditions.

- Develop flexible and mixed instruments for small stationary sources. Different countries have developed different approaches, but the method used in the Netherlands would be worthy of close study. To reduce the need for discharge monitoring, small and intermediate firms are assigned a number of pollution units based on the general pollution characteristics of their sub-sector, and their pollution charges/permit fees are based on those general criteria. If a firm feels that it can better the general sector performance, it retains the option of direct measurement to establish that fact.

- Increase training and human resource development at the lower levels, particularly in the western region. SEPA should assist lower-level EPPs to make better use of the environmental impact assessment system as a tool in mass-based pollution

control; that is, environmental assessments for industrial enterprises need to assess incremental pollution loads attributable to proposed developments, and these should be used to determine how developments can proceed without increasing total loads. In addition, partnerships between EPPs in eastern and western areas should be encouraged as a basic part of the current western development strategy.

- Review and update discharge and emission standards. The existing industrial emissions standards need to be reassessed according to mass-loading control objectives as well as ambient quality goals. Meanwhile, requirements for flow metering and alternative methods for calculating total load should be added to the discharge standard. Fine particulate control emissions standards for industrial boilers will need to be tightened.

- Promote urban environmental master planning. The effectiveness of SEPA's mandate to review urban master plans is limited due to staff shortages and the technical difficulties of actually doing the work. Most cities do not have environmental master plans, and their planners have limited knowledge of the environmental consequences of different planning strategies. SEPA, in collaboration with the Ministry of Construction and State

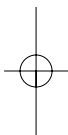
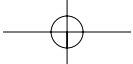
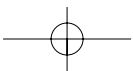
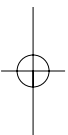
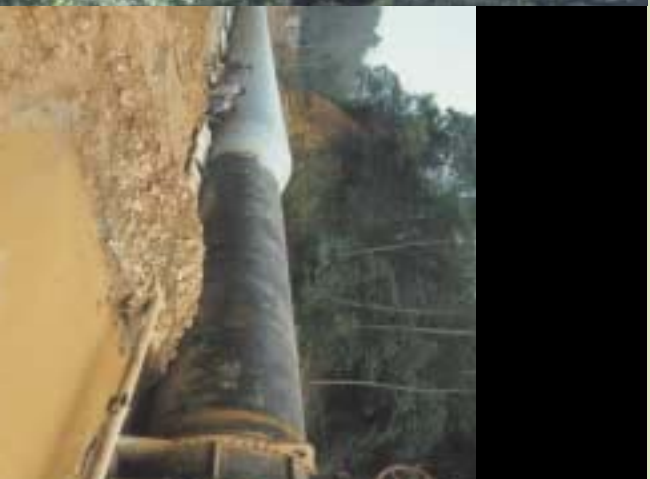
Development Planning Commission, needs to develop and disseminate some basic urban environmental planning guidelines and manuals, including a comprehensive checklist for environmental considerations in urban development. SEPA also should advocate increased public participation in urban planning and collaborate with MOC on piloting public participation procedures in selected cities.

- The sequenced policy for dealing with urban environmental issues should be reconsidered. The current plan is for urban environmental protection plans to be developed progressively for large cities (9th FYP), medium and small cities (10th FYP), and small towns (11th FYP). It would be better to prioritize according to the seriousness of environmental problems rather than the size of the urban area.

Notes

1. This refers to the conflict between an EPB's vertical responsibility to higher-level EPBs and SEPA, and its horizontal allegiances to its own level of government, which provides its budget. Local governments often have a different view from SEPA on the balance between the environment and development, particularly in cases where the local government may be the whole- or part-owner of a polluting enterprise. This represents one of the most serious constraints on the effectiveness of pollution management in China.
2. The first was the environmental responsibility system of 1989 (still in force), under which local government leaders sign annual contracts with higher-level EPBs agreeing to help EPBs reach certain environmental targets and specifying specific investment projects to meet these goals. According to environmental administrators, this system has improved environmental management in the jurisdictions concerned.
3. In this capacity, they can report directly to the provincial governments rather than through an intermediary.
4. For example, the US Environmental Protection Agency is an independent agency reporting directly to the president, giving it many of the characteristics of a cabinet-level ministry. In Germany and France, the environmental agencies are cabinet ministries. In the UK and Netherlands, the environmental agencies are part of much larger and powerful cabinet-level line ministries working in related fields such as housing and physical planning. (Lovei and Weiss 1997)
5. Some city EPBs are reported (World Bank 2000) to rely on pollution levies for as much as 90 percent of their funding.
6. These terms are not entirely synonymous. SEPA's term did not originally encompass every dimension of what western environmentalists would know as sustainable natural resources management. It started out focusing on nature conservation (in its own nature reserves) and issues such as nonpoint pollution (particularly due to runoff of fertilizers and pesticides), promotion of ecological agriculture, management of livestock wastes, and control of "white pollution" (litter due to discarded plastic film). More recently, it has expanded to encompass concepts such as regional land use management—the "Three Areas Strategy" is an example. In making such distinctions, SEPA is attempting to avoid overlap with the on-going work of other agencies such as the Ministry of Water Resources, Ministry of Agriculture, and State Forestry Administration.
7. The ISO 14000 series is a collection of voluntary consensus standards intended to assist organizations to achieve environmental and economic gains through the implementation of effective environmental management systems. The series includes a wide variety of subsidiary standards covering matters such as formulating an environmental policy, developing and implementing environmental management systems, and environmental auditing.
8. The program was developed with the assistance of UNEP and UNIDO. The World Bank provided material support through the Environmental Technical Assistance Project, which established a US\$6 million line of credit to underwrite installation of demonstration cleaner production systems in five representative industrial enterprises, plus technical assistance funds to underwrite various technical studies, training, and preparation of basic procedures manuals.
9. A Cleaner Production Act was drafted by the State Economic and Trade Commission and submitted for review to the National People's Congress in February 2001.
10. The national pollution control objective for the year 2000 was to maintain emissions of 14 major water, air, and solid waste pollutants at their 1995 levels. By the end of 1999, average emissions of five major pollutants (COD, SO₂, soot, fugitive dust, and industrial solid waste) were about 30 percent lower than the targets, significantly exceeding expected performance.
11. Principally, this is achieved by promoting discharge of semi-treated wastes to municipal sewers or, in areas without sewerage systems, development of centralized wastewater treatment systems in industrial estates.
12. As discussed in Chapter 1, there were other contributing factors, including the industrial slowdown during the second half of the decade which played a minor role, and industrial restructuring, which has favored development of industries producing less pollution per unit of output. The rest of the observed result can be attributed to the effects of increased administrative and regulatory pressure through the three shifts plus the application of short-term and ad hoc interventions such as the program to shut down 15 kinds of small enterprises.
13. Most forms of non-compliance with pollution control laws are not actionable offenses. EPBs have limited access to legal expertise; there is no tradition of settling regulatory

- issues through the courts, and most industrial firms do not acknowledge that violating environmental laws and standards is a legal offense.
- 14.** Negotiation and arbitration are useful methods of resolving disputes, but they will not be sufficient to deal with serious and economically significant disputes that will inevitably arise when EPBs start rigorously enforcing the laws.
- 15.** Two key issues are air emissions from small industrial boilers and furnaces in urban areas, and water emissions from small-scale industrial enterprises.
- 16.** For example, the majority of the USS19.3 billion in national infrastructure bonds floated in 1998 and 1999 was used to underwrite municipal water-supply and wastewater treatment systems. The funds were partly used to finance 253 municipal wastewater treatment plants with a total treatment capacity of 23 million m³/day.
- 17.** Compliance with urban pollution targets during the 9th FYP was much less than compliance with industrial pollution targets. Some urban pollution targets were not met (for example, SO₂ emissions were more than 50 percent above target) and others were met less convincingly than in the industrial sector (for example, urban COD loads were only 13 percent better than target, whereas industrial COD discharges were 57 percent better than target).
- 18.** Three Rivers (Huai, Hai and Liang), three lakes (Chao, Dianchi and Tai), two control regions (SO₂ and acid rain), one sea (Bohai), and one city (Beijing).
- 19.** Some of these programs have long-term time horizons and are meant to be approached in step-by-step fashion. The fact that improvements have not been registered in the initial stage of a program does not necessarily mean it is failing.
- 20.** The conclusion depends on which environmental database is consulted. SEPA has concluded, based on analysis of its own data, that conditions in the Huai River improved. However, analysis of multiple databases (World Bank et al. 2001) suggests that water quality, as reflected by COD, continued to deteriorate. The fact that it is so difficult to determine what actually happened illustrates the need to significantly improve environmental monitoring and data management systems.
- 21.** A good example is the "one sea" component. The sources of pollution of Bohai are so diverse that it is difficult to imagine any program of remediation that could have any impact in less than a decade, even if then.
- 22.** The most significant of these from an environmental point of view are non-metal mineral production; chemical production; pulp and paper production; textiles; ferrous smelting and processing; and mining and electricity production (World Bank 2000).
- 23.** The chairman of the environment and natural resources committee of the National People's Congress, Professor Qu Geping, has warned that without proper controls the new program could lead to severe environmental degradation (China Youth Daily, March 4, 2000). He noted that historically in China, severe pollution and environmental degradation accompanied rapid development. An editorial in the China Environment News (March 7, 2000) also advocated that readers should take a more sober view toward what it called the "Western development craze." It pointed out that the West suffers from widespread soil erosion, low agricultural productivity, water shortages, and water quality problems. Irrational development could cause significant ecological damage. The top priority for Western development should be environmental sustainability.
- 24.** An option suggested by some Chinese commentators is to use the existing coordination arrangements (between SDPC, SETC, and SEPA) that were used for review of the 9th and 10th Five-Year Environmental Plans and for setting the national environmental targets for 2010. This mechanism has worked reasonably well for industrial pollution issues, but may be less effective when it comes to "green" environmental issues.
- 25.** The issues to be addressed in such a study, perhaps through a series of case studies of EPBs from different levels in the hierarchy, would include: (a) current budgets and resources, and recent trends; (b) the scope of work of EPBs, as defined by relevant laws and regulations, what they are actually doing, and the extent (and reasons) to which they are not carrying out all assigned responsibilities; (c) how the current skills mix of the EPBs fits with the range of activities they are trying to carry out; (d) how effectively and efficiently they are using current budgets, and what opportunities are available to extract more value from their current budgets; and (e) the degree to which the duties of EPBs are likely to change in the near future due to changes in economic structure and/or the roles and duties assigned to them, and the budgetary and manpower implications of these changes. The findings would provide a basis for SEPA and the lower-level EPBs to develop strategic plans, staff development plans, training plans, and so on.



6 The World Bank's Environmental Portfolio in China



This environmental sector update started with a review of the World Bank's 1990-2000 environmental portfolio in China. The review was intended to assess the relationship between the Bank's assistance program and priority environmental issues in China identified in relevant Five-Year-Plans and the Bank's own 1992 environmental sector study (World Bank 1992). The results provide a basis for identifying ways to strengthen environmental support during the 10th FYP.

Overall, the review showed that the Bank's environmental investment program was quite strong. There was a good geographical fit with priority environmental issues. In terms of sectoral distribution, the rural development and urban/environmental sectors dominated the portfolio in terms of both number of projects and lending volume, substantially reflecting the priorities identified in the 1992 environmental sector strategy. There was a less complete fit between the portfolio and the environmental priorities in the 9th FYP.

The review revealed opportunities to strengthen environmental support, even though China is no longer eligible for concessional International Development Association (IDA) assistance. To realize this potential, action will be required both by the Bank and the Government of China.

The Portfolio

There were 140 completed and active projects in the 1990-2000 portfolio, representing cumulative lending of about US \$23.5 billion. Of this total, 82 percent was provided by IBRD and 18 percent by IDA.¹

The dominant sectors in the portfolio in terms of the number of investment projects were rural development (29 percent of the total number of projects); transportation (17 percent); urban development and urban environmental improvement (17 percent); and the energy sector (16 percent).² Geographically, the eastern region accounted for the greatest proportion of lending volume (44 percent), followed by the central (29 percent) and western (27 percent) regions. As would be expected given the poverty distribution in China, IDA commitments were highest in the central region, followed by the western and the eastern regions.

Environmental Dimensions of the Portfolio

INVESTMENT PROJECTS

Forty-one investment projects (30 percent of the portfolio) are defined as environmental projects. These fall into two categories: (1) 15 investments that were primarily focused on environmental issues (referred to below as Category A projects); and (2) 26 investments that were not primarily environmental, but included one or more components intended to deal with environmental issues (referred to below as Category B projects).

As shown in Table 6.1, the Category A projects accounted for about 40 percent of environmental lending volume. The overwhelming majority of these—13 projects—addressed the “brown” environmental agenda,³ while only two addressed the “green agenda.”⁴ On the other hand, a significantly larger number of rural development projects—14 in all—included components that were intended to address some element of the environmental agenda.

These patterns largely reflect the realities of project lending in China. In the urban sector, it is relatively easy to identify investments that provide environmental benefits plus the short-term economic returns necessary to repay the loan.⁵ It is much more difficult to do this in the rural development

sector. The two Category A rural development projects (Loess Plateau I and Red Soils II) provided a rare combination of investments that were both profitable and environmentally beneficial as a whole. In other rural development projects, it has been much more difficult to identify such “win-win” investments. The only alternative has been to address environmental issues as sidelines to other investments intended to produce short-term financial benefits.⁶

Among the principal environmental themes in the Category A portfolio, water pollution control was undoubtedly the strongest at \$1.2 billion. Lending for air pollution control and solid waste management was much lower, totaling about \$130 million, primarily due to the greater complexity of design issues, cost recovery problems, and the lower priority of these issues in the government’s urban development agenda.

There was a good fit between the regional distribution of investments and the pattern of environmental issues on the ground. There were more brown projects in the eastern region, where problems of industrialization and urbanization are the most acute. The bulk of lending for the green agenda was focused in the central and western regions, which have more fragile ecological conditions.

Concessionary financing through IDA was most important in the rural development sector, water supply and sanitation, and

Table 6.1 The 1990-2000 Environmental Portfolio by Sector

Investment Sectors	Category A Projects ^a No. (US\$ million)	Category B ^a Amount (US\$ Million)	No. (US\$ Million)	Total No.
"Brown" Agenda				
Urban	12	\$ 1,944	5	17
Energy	Nil	Nil	3	3
Health	Nil	Nil	1	1
Water Supply & Sanitation	1	\$ 250	1	2
Total Brown Agenda	13	\$ 2,194	10	23
"Green" Agenda				
Rural Development	2	\$ 446	14	16
Water Supply & Sanitation	Nil	Nil	2	2
Total Green Agenda	2	\$ 446	16	18
Total	15	\$2,640	26	41

Note: ^a See text.

Source: World Bank staff

urban. IDA was particularly important in supporting the environmental dimensions of rural sector lending. Projects involving water and soil conservation had the highest IDA share, followed by "eco-agriculture," rural water supply, desertification, afforestation, and agricultural nonpoint pollution. The loss of IDA will further complicate the provision of assistance in these areas in the future.⁷

TECHNICAL ASSISTANCE AND GLOBAL ENVIRONMENTAL PROJECTS

The only environmental technical assistance project was the IDA-financed Environmental Technical Assistance Project (US\$50 mil-

lion), which supported improvements in environmental monitoring and data management, promotion of cleaner production, strengthening of environmental assessment procedures, improvements to ecological research, and basic environmental research. The project was successful. In the absence of IDA, there is virtually no opportunity for a Bank-financed follow-on, unless the government changes repayment arrangements.

The Multilateral Fund for the Montreal Protocol (MFMP) and, to a somewhat lesser extent, the Global Environment Facility (GEF) have made significant contributions to addressing global environmental issues in

Table 6.2 Portfolio Linkages to the 1992 Environmental Strategy Paper

Priority Sectors and Themes Identified in the 1992 Strategy Report	Patterns of Support in the 1990-2000 Environmental Portfolio	
	Strengths	Weaknesses
Priority Sectors		
Energy, Industry, Urban, Rural	Urban Environment Rural Development Energy	Industry
Water Resources	Urban wastewater Urban/rural water supply	Integrated river basin management
Air Quality	District heating	Mobile sources
Solid and liquid wastes	Solid waste management	Hazardous/toxic waste management
Energy conservation, industrial efficiency and pollution control	Energy conservation (GEF)	Industrial pollution control
Natural resource management and conservation	Reforestation Water conservation Soil conservation	Biodiversity conservation
Sustainable agricultural practices on marginal lands	Pest Management	Integrated agriculture/ natural resources management
Environmental institutions	Institutional strengthening Policy and regulatory development	Capacity building for natural resource management
Co-financing from GEF on energy conservation	Co-financing from GEF on biodiversity conservation	Aid coordination
Strategic Themes		

Source: World Bank staff

China. The MFMP program (\$323 million) is the biggest in the world. About 67,000 tons of ozone-depleting substances (ODS) have been phased out under the

program, which far exceeds the combined performance of all other signatories to the Montreal Protocol.

Most investment—\$128 million—under the GEF has been for greenhouse gas (GHG) reduction projects. There has been much less

GEF assistance for biodiversity conservation (\$13.7 million, only 3 percent of total global portfolio volume), although the number of projects in the pipeline has recently started to increase.

Clearly, there are major opportunities to increase access to global programs, particularly biodiversity protection programs through the GEF, and also through possible new initiatives such as a convention to support the phaseout of certain persistent organic pollutants (POPs).⁸

Strategic Directions in the Assistance Program

CONSISTENCY WITH THE 1992 ENVIRONMENTAL STRATEGY

The 1992 Environmental Strategy Paper was the first of its kind for China,⁹ and appears to have had significant influence on the government's thinking about environmental issues. It also influenced the pattern of World Bank lending although, as shown in Table 6.2, there were a number of gaps between priorities identified in the strategy paper and the contents of the assistance program. Removal of these will require action by both the Bank and the government (see Table 6.3). On the Bank's side, better use can be made of the GEF biodiversity window. On the government side, action is required to remove institutional constraints

to integrated river basin management and to modify rigid loan repayment conditions, which limit the Bank's ability to provide support for investments with substantial externalities.

CONSISTENCY WITH THE 9TH FIVE-YEAR-PLAN

The 9th Five-Year-Plan (FYP) included for the first time quantitative targets and indicators for industrial pollution, urban environmental improvement, ecological environmental protection, and agricultural and rural environmental protection. A key element of the investment plan was the "33211" program, a series of priority pollution control projects in five geographical areas.¹⁰

The major gaps were similar to those summarized in Table 6.2, and the underlying causes were also similar.

Opportunities for the Bank Under the 10th FYP

There have been clear strengths and weaknesses in the Bank's portfolio as it relates to both its own environmental sector strategy and the environmental planning priorities set out by the government in the 9th Five-Year-Plan.

Table 6.3 Factors Preventing Action on Certain Dimensions of the Bank's Environmental Strategy for China

Main Factors Preventing Action	
SECTOR	
Industrial	Pre-condition for Bank participation would be reform of SOEs plus adjustment of pollution levies to provide proper incentives for improvement of industrial sector pollution control performance.
Integrated river basin management	Government has not succeeded in getting all relevant ministries and interests thinking in the same way on this subject. Bank has been attempting to participate through Huai He Pollution Control Projects, but the integrated approach has not yet been fully accepted. If progress is to be made, there needs to be a major breakthrough on the government side.
Non-point pollution	Government needs to develop a technical approach that is likely to be effective. Unfortunately, most of the solutions are non-structural, and hence not amenable to an investment solution.
Hazardous and toxic waste management	Some technical assistance provided through Southern Jiangsu Environmental Protection Project, but this is not presently a priority issue for municipal governments, the Bank's main counterparts. Payback mechanism could be a problem.
Industrial pollution control	The same problem restricting overall Bank participation in the industrial sector. Unlikely to be any avenue for increased involvement in this field.
Biodiversity conservation	Insufficient use made of GEF. Partly historical due to Bank agreement that UNDP should cover this field in China. That situation has now changed and a much improved GEF biodiversity pipeline is being built up.
Integrated agriculture/ Natural resources management	Research has just been commissioned to assist the government to identify proposals for assistance. New Operational Program 12 under GEF might provide an opportunity.
Capacity building on natural resources management	Main assistance has been through IDA-funded Environmental TA Project and GEF-funded Nature Reserves Management Project. Future support will only be possible through GEF projects or collaboration with donors providing grant assistance.
Aid coordination	Has not been a strength in the past. Recent collaboration with ADB on GEF may provide a way forward.

Source: World Bank staff

The gaps between the strategies and the portfolio are largely explained by a variety of practical considerations. Three general conditions are evident: (1) areas where there is potential for further engagement, provided there is action by the Bank; (2) areas where there is potential, provided there is action by the government; and (3) areas where there is limited potential for the Bank to contribute. These are summarized in Table 6.4.

Looking at the fit between the Bank's portfolio and the government's environmental strategy under the 9th FYP, the main weaknesses were in the fields of ecological environmental protection, rural environmental protection, biodiversity conservation, and marine environmental protection—

items 2, 3, 7, 8, 9, and 10 in Table 6.4. Of these, items 7 and 8 require action by the Bank to facilitate greater engagement, and the remaining four items (2,3,9, and 10) require action by the government.

The government has been preparing the 10th FYP for environmental protection, which is regarded as a key driver of state spending on environmental technologies and services, and also indicates how foreign finance will be allocated. The current draft of this plan highlights the following principals and priorities:

- The main principal is to attach equal importance to both pollution control and ecological conservation.

Table 6.4 Preconditions for Wider Bank Participation in the Environmental Agenda

Theme	Precondition for Increased Bank Participation Action by the Bank	Action by Government	Limited Potential
1 Industrial pollution			●
2 Integrated River Basin Management		●	
3 Nonpoint pollution		●	
4 Mobile source pollution	●		
5 Hazardous/toxic waste		●	
6 Industrial efficiency			●
7 Biodiversity	●		
8 Wetlands/grasslands	●	●	
9 Eco-agriculture		●	
10 Capacity building on NRM			●
11 Aid coordination	●	●	

Source: World Bank staff

Table 6.5 Actions Required to Strengthen the World Bank's Environmental Program

Priority Sector/Area	Action Required by Bank and/or Government
Industrial pollution	Will probably remain a continuing weakness in the program, although the potential for participation would be improved if pollution levies were increased to provide the necessary impetus to operate clean production/pollution control facilities once installed.
Urban environmental management	The program is already strong, although mechanisms need to be found to broaden the range of issues addressed, particularly solid waste management and mobile source controls.
Ecological conservation	More work required by both the government and the Bank to devise more integrated rural development projects, which provide an improved balance between increased production and improved natural resources management. There are certain models (Loess Plateau I and II and Red Soils I and II) that provide a guide. There are opportunities to improve collaboration with other donors, particularly those who have grant-based resources.
Rural environmental protection	There has already been some contribution to management of livestock wastes (Smallholder Cattle Project), which might provide a model for promoting "clean production" technologies for smallholder livestock producers. This could be extended to SPH production units, perhaps in combination with a program of increased enforcement.
	Bank participation on improvement of pesticide management would need to be based on a comprehensive review of pesticide management and regulatory issues to provide an agreed position on problems and issues in the sector on which investment programs could be based. There is probably good potential for some kind of investment program based on promotion of Integrated Pest Management, although repayment arrangements would continue to be a constraint.
	There could be opportunities in development of pilot-scale rural industrial estates for TVIEs and centralized wastewater treatment, although finding the right funding mechanism will be difficult.
Priority Areas	The Bank and government need to work together to identify rural development options in the priority areas that provide an adequate balance between production increases and natural resources management, and which also solve the funding/repayment problem.

Source: World Bank staff

■ Priority sectors include (a) industrial pollution prevention, focusing on industrial structural adjustment and promotion of cleaner production; (b) urban environmental management, emphasizing centralized treatment of wastewater and solid wastes and control of TSP and SO₂ emissions; (c) ecological conservation, focusing on the “three areas strategy”¹¹ and ecological surveys and monitoring of the Great Western Development plan; and (d) rural environmental protection, promoting development of rural industrial development zones as a way of handling pollution from small-scale rural enterprises and addressing nonpoint pollution sources, including livestock, fertilizers, and pesticides.

■ Priority areas include continuation of the “33211 program,” while expanding it to cover the “two resource areas” (see Chapter 5).

Some of these areas are in sectors that have traditionally been a strong point in the Bank’s program, such as urban environmental management, while others are in areas that have been weaknesses, such as rural environmental protection. Actions required to improve the Bank’s contribution to the environmental strategy are summarized in Table 6.5.

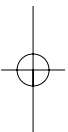
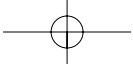
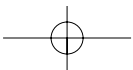
An essential part of the assistance strategy will be improved coordination between donors to maximize the differing advantages inherent in their programs (interest rates, repayment conditions, procurement constraints, political risks, etc.). This is particularly important in view of the restrictions arising from China’s graduation from IDA eligibility.

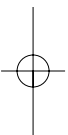
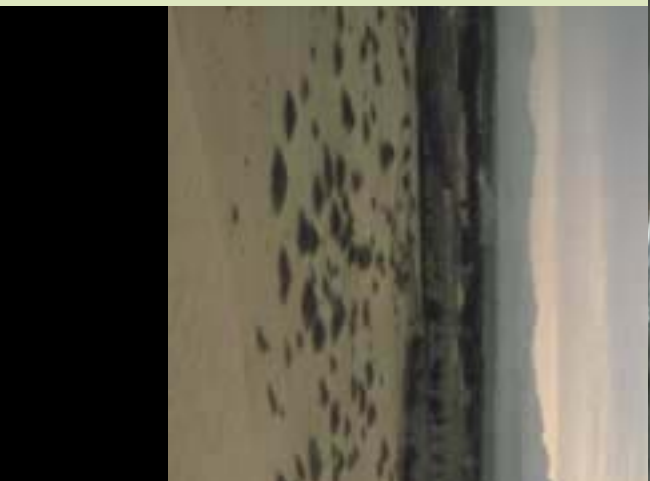
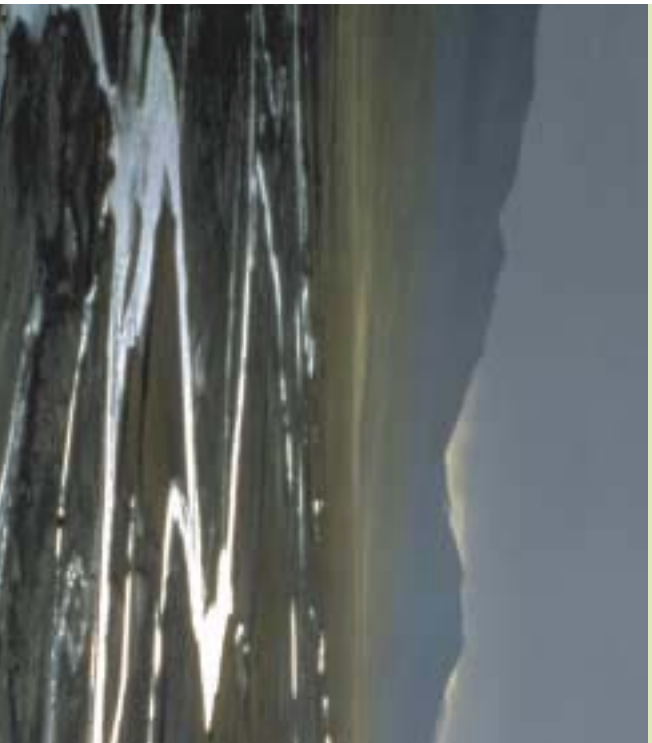
Co-financing accounted for only about 9 percent of total project costs in the 1990s, so there is clearly a lot of room for development. Most co-financing was for commercially oriented projects. No attempts were made to use concessionary co-financing to dilute the terms of Bank funds for purposes such as pure environmental projects. This is an area that could be developed over the next few years. It would meet the Bank’s objective of maintaining its engagement in the environmental area, and also meet the needs of many bilateral financial sources with strong social and/or environmental objectives.

Partnerships like this were difficult in the past, since each donor dealt with a different government ministry. This situation was partly remedied as a result of the government reorganization of 1998,¹² and the feasibility of a more integrated and cooperative approach by foreign donors has been improved to some degree. Nevertheless, some work will still be required to promote cooperation between MOF and MOFTEC.

Notes

1. The IBRD provides long-term loans to middle-income countries at semi-commercial interest rates—current terms are about 5 percent repayable over about 20 years with a grace period of 5 years. IDA provides credits to very poor countries on concessionary terms—zero interest, a low annual administrative charge (0.75 percent), and a repayment period of 35 or 40 years with a 10-year grace period. Countries with per capita incomes of less than \$925 (in 1996 dollars) are eligible for IDA credits.
2. The order was only slightly different in terms of lending volume: rural sector (32 percent); transportation (21 percent); energy (21 percent), and urban development and urban environmental improvement (15 percent).
3. Urban and industrial environmental management.
4. Natural resources management, biodiversity conservation, etc.
5. Water supply, sewage collection and treatment, and urban road improvements/traffic management are the main forms of investment.
6. This is a situation unique to China due to the government's policy of delegating loan repayment responsibility to all project beneficiaries. The policy is considered to be largely responsible for the high rate of project success experienced in China, but there is equally little doubt that it makes it much more difficult to make a real contribution to environmental issues, particularly those in the green agenda.
7. China "graduated" from IDA in 1998.
8. POPs are organic chemicals that persist in the environment and can adversely affect human health and the environment through bioaccumulation. Due to their persistence and transportability, they pose risks beyond the immediate time and place of their production and use. The United Nations Environment Program is coordinating efforts to agree on an international treaty to phase out production and use of certain specified POPs. China and other countries are already taking steps to develop capacity to carry out baseline surveys to underwrite development of national POPs implementation programs in anticipation of an international treaty being developed and agreed to in the near future.
9. In addition to the strategy paper of 1992, there were three other sector studies produced during the decade that had a bearing on environmental strategy: (1) National Environmental Action Plan; (2) Urban Environmental Services; and, (3) China 2020: Clear Water, Blue Skies.
10. The "33211" program is described in Chapter 5.
11. The "three areas strategy" is described in Chapter 5.
12. Responsibility for major lenders (World Bank, Asian Development Bank, Japanese Bank for International Cooperation) was consolidated in the Ministry of Finance (MOF). The Ministry of Foreign Trade and Economic Cooperation (MOFTEC) is responsible for bilateral grant cooperation.





7 An Environmental Strategy for the New Millennium



The Challenge

During the 1990s, the government devoted substantial financial resources to environmental improvements and made major efforts to strengthen the regulatory environment. The tide of industrial air and water pollution was stemmed, due substantially to the government's efforts. To a large extent, however, these efforts were overwhelmed by the government's strikingly successful growth and development program. The environmental agenda increased both in scope and complexity. There were growing problems with other sources of pollution, such as municipal wastewater, fugitive dust, and emissions from mobile sources of air pollution. And the state of the natural environment continued to deteriorate.

The environmental challenge will become even more complex in the foreseeable future, particularly during the period covered by the 10th Five-Year-Plan (FYP). The government is projecting:

- A continuation of strong economic growth, with average annual increases in GDP projected in the 6-7 percent range
- Higher growth—about 8-10 percent annually—in industrial output
- A resumption of strong growth in energy consumption, on the order of 3-4 percent annually
- Continued growth in urban population, projected to increase at about 3.4 percent annually
- Increased agricultural intensification.

In this context, the government's environmental objectives for the 10th FYP are ambitious.¹

A Strategy for the New Millennium

The central lessons to be learned from China's environmental experience over the last 10 years are that (a) environmental institutions cannot possibly manage everything by themselves in an economy as large and diverse as China's; and (b) to make real progress on environmental quality, the whole mode of development in China has to be changed. To meet future challenges, the government needs to re-order its priorities and revise its overall development policy, so as to significantly improve the fit between development and environmental sustainability.

It made several moves in this direction during the 1990s, but they were not sufficient. The current track is not environmentally sustainable, particularly in the context of what SEPA refers to as “ecological environmental protection.”²

To implement an environmentally sustainable development strategy, the government has to take concrete actions in three main areas:

- The institutional arrangements for dealing with environmental issues
- The instruments applied to achieve environmental objectives
- The investments made to achieve environmental objectives.

INSTITUTIONS

The new and developing environmental challenge, as already recognized by both the government at large and SEPA in particular, is to promote environmentally sustainable development of China’s natural resources. Making progress will require the full attention of government and coordinated efforts by all relevant agencies, which in turn will require changes in the way that all relevant government institutions approach their work. Priority tasks include:

- Mainstreaming. Government agencies, particularly those concerned with economic and/or spatial planning and natural resources management, need to adjust

their policies and objectives to (a) fully incorporate the concept of environmentally sustainable development into their development objectives; (b) emphasize their primary roles as “stewards” of the national estate; (c) divest themselves, to the extent possible, of resource exploitation responsibilities; (d) review their policies and operational programs to remove development/environment contradictions; and (e) increase the support they provide for research, design, and implementation of environmentally sustainable development strategies. This work will take time, but needs to start immediately.

- Cross-sectoral coordination. Most sustainable natural resources management issues cut across normal lines of administrative responsibility. A means has to be established to coordinate the work of different agencies, reduce overlaps and contradictions, maximize synergies, and adjudicate disputes. A coordinating body is needed to replace and improve on the State Environmental Protection Commission (SEPC), which was dissolved during the 1998 reorganization. This coordinating function could be established by re-constituting the SEPC, establishing an alternative “SEPC-like” institution under the State Council, or creating an alternative venue outside the State Council, such as a ministerial committee. What matters is that (a) a coordinating function should be

established at a sufficiently high level to ensure effectiveness; (b) it should be given the necessary secretarial support to permit it to pursue an active agenda; and (c) a means should be provided to resolve inter-ministerial deadlocks.

■ Reform the approach to biodiversity conservation. Given the importance of China's biodiversity resources and the level of threat they are facing, priority has to be given to significantly strengthening the approach to biodiversity protection and management. A central element should be establishment of an independent, state-level "Nature Reserves Service" to

- (a) manage nature reserves of national and global significance; (b) develop into a center of excellence for nature reserve management; (c) represent the country in international conservation forums; and (d) provide the lead and set standards for counterpart institutions at provincial and lower levels. There are many other things that need to be done on biodiversity conservation, but this is the key.

■ Push forward with integrated river basin management in water-scarce regions. There is wide agreement among technical experts that a more integrated, river-basin approach is required to sustainably manage water resources in the most heavily conflicted catchments, which are mostly in north China. But no significant progress is being made toward achieving that objective. This situation needs to

be corrected. The major barriers are essentially administrative and political. The government should create new and separate river basin management institutions whose governance structure makes adequate provision for effective participation of key stakeholders—principally provincial governments—in their decisionmaking processes.

In contrast to the situation with natural resources management, institutional arrangements for carrying out the basic tasks of pollution management and control are essentially in place in China. Several things need to be done to strengthen the effectiveness of these institutions, including:

■ Increasing EPB capacities and effectiveness, with particular emphasis at the local level. Technical capacity and resources made available to EPBs, particularly at the lower county and township level, need to be increased through training, partnership programs, increased budgetary allocations, and the provision of assistance from higher levels in setting strategies and priorities.³ At the same time, oversight by higher levels has to be increased to counteract the strong and growing localism in economic development, and to ensure that enterprise inspections are carried out more comprehensively and rigorously; regulations are objectively enforced, and the quality of environmental monitoring is improved. An essential element of this work will be to resolve contradictions between

horizontal and vertical responsibilities at all levels. Options available include (a) delegating more regulatory authority to provinces and municipalities and away from counties; and/or (b) increasing supervision of lower levels by higher levels through performance audits and public reporting; and/or (c) developing a regional structure for SEPA, along the lines of the People's Bank of China, to strengthen supervision by the state. This work needs to be resolutely attacked at the earliest possible time.

- Strengthening the legal system. An essential pillar of the approach should be development of a strong body of environmental law backed by an impartial judiciary to interpret the laws and adjudicate legal and regulatory disputes. This will be long-term work, and cannot proceed in isolation from general strengthening of the legal system as a whole. Nevertheless, it needs to be initiated as soon as possible. Given the numerous conceptual, social, and technical dimensions, the task will not be simple, but it should be a priority.

- Continuing to promote public participation in environmental decisionmaking. One of the strongest elements of SEPA's environmental strategy has been its work on public participation, public dissemination of environmental information, and environmental education at all levels. This work has to continue, with an emphasis on extending the environmental constituency

beyond wealthier urban areas in the east. Environmental messages and modes of delivery need to be varied to take account of local conditions, particularly in the central and western parts of the country, which are less urbanized and where education levels tend to be lower.

INSTRUMENTS

China already has many of the basic policies and instruments necessary to achieve a high level of effectiveness in the management and control of point-source pollution. Main priorities for the future should be:

- A new approach for point-source pollution control. The effectiveness of current regulatory procedures for industrial pollution control can be significantly increased without making any conceptual changes to the system. A first priority is to make the existing system work to its maximum advantage by pursuing the institutional strengthening measures outlined previously. Nevertheless, new approaches have to be developed to deal with the growing number and diversity of point sources and to eliminate some contradictions in the existing system, particularly in relation to the pollution levy fee system. This report advocates adoption of a permitting system, under which all significant point sources of pollution (industrial, municipal, even large intensive animal production units), regardless of ownership, must

secure a permit or license to operate and must pay an administrative fee to cover the costs of issuing the permit. A schedule of graduated and increasingly punitive fines for breach-of-permit conditions would also be required. The permitting system could be incorporated into or completely separated from the environmental assessment (EA) system,⁴ and it works equally well with concentration-based or total load-based regulatory approaches.⁵

■ Keep working on supplementary control strategies. Command-and-control instruments played a key role in determining industrial pollution trends during the 1990s. On their own, they may not be sufficient to meet future challenges, particularly those arising from changing industrial ownership patterns, the declining role of the state, and the increasing role of the private sector. Work has to continue on development of the three other pillars of the control strategy: economic, voluntary, and public disclosure instruments. New and much more comprehensive approaches need to be developed to deal with problems associated with agricultural nonpoint pollution. These may include a combination of economic measures, education, and selected administrative measures.

Command-and-control strategies will not provide an answer to natural resources management problems; a much more comprehensive approach will be required. It needs to be based on a clear understanding of the

underlying causes of problems, and the creation of incentive frameworks to encourage sustainable development of natural resources. Priorities include:

■ Continued price reform for environmental improvement. Reform of resource pricing, particularly energy and water, has to be continued, broadened to include resources such as groundwater, and accelerated so as to allow prices to reflect scarcity and environmental externalities and to increase the price-responsiveness of demand. This is particularly important in areas already suffering from major resource conflicts.⁶ Continued reform of prices for basic raw materials can also have beneficial effects in terms of industrial pollution control, insofar as it will increase incentives for development and adoption of cleaner production technologies and utilization of alternative energy sources.

■ Strengthen focus on the poverty/land degradation connection. Chinese researchers have established a clear geographical link between rural poverty and rural land degradation, and it is also likely that there are causal links. China has an extremely effective poverty alleviation program implemented through the Leading Group on Poverty Reduction (LGPR), and many of the program components target underlying causes of rural land degradation. Institutions concerned with “ecological environmental protection” issues need to get more engaged in

the LGPR program and identify ways of working collaboratively to increase the environmental benefits of the program.

- Re-orient natural resources development policies. The degraded state of natural resources in China is a result of development policies that focused on maximizing output at the least cost to the rest of the economy. Policy needs to focus on promoting production levels consistent with the long-term maintenance of the resources in question. Policy needs to be based on relevant research, which needs to be increased and made more cross-disciplinary to ensure that adequate account is taken of both the social and ecological dimensions of natural resources management.

INVESTMENTS

The work on institutional and policy development provides the framework for environmental improvement, but investment is the driving force needed to achieve results on the ground. Certain steps are needed to increase the impact of environmental investments, including:

- Keep focused on priority issues. The range of environmental responsibilities assigned to SEPA and the EPBs is expanding at a far greater rate than their staff and financial resources, running the risk of dissipating their energies over too broad a range of issues and reducing their effectiveness. EPBs need to maintain, and be permitted

to maintain, their focus on pollution management and control, which is their area of strong comparative advantage and greatest effectiveness. They have to be careful and selective in identifying their role when expanding into the “green” or eco-environmental agenda. Priority should be given to monitoring and reporting to government on the state of the natural environment, and assessing and reporting on the implications of proposed government policies on the state of the environment through instruments such as Strategic Environmental Impact Assessments (SEIA). SEPA and the EPBs could also play a useful subsidiary role in promoting and facilitating implementation of new development ideas (as is already being done in collaboration with the Ministry of Agriculture and others in certain priority agro-ecological areas); helping the government define environmental investment priorities through programs such as 33211 (see Chapter 5); and related strategic activities.

- Increase environmental expenditures in real terms. Total environmental investment for the 9th FYP was less than 1 percent of GDP, while the projected figure for the 10th FYP is about 1.3 percent. The actual amount will increase by about 55 percent in nominal terms, from about RMB 450 billion during the 9th FYP to RMB 700 billion during the 10th FYP. Judging by the magnitude of environ-

mental problems facing China and its growing wealth, spending as a proportion of GDP needs to increase,⁷ and much greater allocations need to be made for basic capacity building.⁸ To put these expenditures into perspective, the most conservative estimates for China are that environmental costs are equivalent to 3.5 percent of GDP per annum.

■ Improve the effectiveness of investments into ecological construction and conservation. The government is allocating substantial resources to “ecological construction” work, but the effectiveness of these investments could be substantially improved by placing more emphasis on addressing the underlying social and economic causes of land degradation and less on treating the symptoms. Investments in ecological conservation are only expected to account for about 7 percent (RMB 50 billion) of environmental protection investments during the 10th FYP period, which is low compared to overall investments in traditional “brown” areas of water and air pollution control, as well as solid waste protection.

■ Invest more and “more smartly” in urban environmental infrastructure. Financial commitments for construction of basic sewerage and solid waste management infrastructure have to be significantly increased to meet the challenge of increased urbanization. Consideration should be given to tapping new sources of public capital, such as floating municipal

bonds, or increasing private sector participation.⁹ But investment also has to get “smarter.” For example, municipal sewage treatment standards need to be adapted to local circumstances.¹⁰ There also may be opportunities to develop industrial estates with centralized wastewater collection and treatment, which could provide cost-efficient solutions to the growing problem of small- and medium-sized enterprises with high water pollution emissions.

■ Less haste and more thought on environmental improvement programs. Some targeted environmental improvement programs have been less successful than intended. Effectiveness will be improved by: (a) spending more time and resources on feasibility studies; (b) paying more attention to the cost-effectiveness of investments; (c) reducing emphasis on investments in physical capital, and increasing investments in human capital development; and (d) avoiding the temptation to broaden the agenda before priority problems are solved.

The Role of Donors

The environmental challenge under the 10th FYP will be substantial, as will the government’s need for technical and financial assistance. The World Bank and other foreign donors could significantly enhance their environmental contribution by

focusing assistance on the three strategic priorities discussed above within the following framework:

- Enhancement of donor contributions. The government and donors need to increase work to eliminate redundancies, reduce overlaps, and better match donor participation to their respective strengths in terms of factors such as available instruments (loans, grants, technical partnerships, and collaborative arrangements), technical strengths and experience, program size, and administrative procedures. The government needs to take the lead on this and to maintain the critical mass of staff within key agencies, such as the Ministry of Finance, necessary to lead the coordination role. In particular, it should (a) develop a communications strategy to facilitate information flows between relevant arms of government and donors; (b) compile a roster of potential donor partners to include their areas of expertise, strengths and weaknesses, and individual program priorities; and (c) establish an informal mechanism for periodic exchanges of views and information between the government and donors on environmental issues and programs, with a view to tackling this vast and complex agenda as efficiently and effectively as possible.
- Donors should take more account of the government's five-year environmental planning priorities. The government's five-year plans provide very clear guidance on

domestic priorities over the planning period. All donors need to take much more explicit account of these plans in setting their priorities and identifying assistance opportunities.

- Increased use of collaborative approaches. An integrated approach to environmental problems often requires a variety of assistance needs that extend beyond the vehicles available to any particular donor. In such circumstances, collaborative approaches between different donors may provide a way forward, provided that the potentially formidable administrative difficulties can be overcome.
- Increased role and use of technical partnerships. SEPA has already signed cooperative agreements with Ministries of Environment in 26 countries, which have led to substantial developments in terms of research on environmental instruments and technology transfer. Other relevant ministries have made similar arrangements. Nevertheless, the possibilities remain substantial, and this could be an area in which bilateral donors would have a distinct comparative advantage. Areas for beneficial partnerships include (a) further development of environmental instruments such as EIA and Strategic EIA; (b) integrated river basin management; (c) nature reserve management and protection; (d) sustainable agricultural land management; and (e) general technical training.

■ Private sector participation. Private sector participation in environmental management and control, which is a new and developing area in China, may be of particular interest to bilateral agencies. In addition to development of environmental infrastructure, the private sector could make a contribution in education and training, technology transfer, policy formulation, and public awareness.

■ Role of NGOs. Environmental NGOs are just starting to develop in China. As public interest in environmental issues grows, their role should increase substantially in the future. This is another area in which foreign donors could play a role through training and technical assistance, brokering partnerships with external NGOs, and provision of material support.

It goes without saying that all foreign institutions interested in the environment and development agenda in China have a role to play in helping to underwrite the huge investments that will be necessary to meet the environmental challenge in China. In reality, their aggregate contribution will always be small in relation to the need. The best use of foreign investment support will be in leveraging benefits beyond the boundaries of particular projects by supporting innovative ideas and new development concepts. Based on the review underlying this report, and taking account of the government's environmental strategy for the 10th FY¹¹, investments likely to be of particular

environmental value include (a) rural development projects that combine poverty alleviation with environmental protection and/or sustainable natural resources management, with particular emphasis on grassland areas, hilly and mountainous areas, and priority areas under the "Three Regions" policy; (b) urban pollution control and environmental management, including support for sustainable development of urban environmental infrastructure as well as increased private investments in specific investment projects; (c) biodiversity conservation and development of new approaches that integrate rural development with biodiversity conservation; and (d) development of new approaches to management of wastes from small-scale rural enterprises by, for example, establishment of industrial development zones with centralized waste collection and treatment.

Notes

1. It intends to "... (achieve) improved environmental performance in pollution control while the deteriorating trend in the ecological environment will be halted."
2. The concept of sustainable development was mentioned in the 9th FYP and is elaborated upon further in the 10th FYP, which refers to the need to achieve more harmonious development of population, natural resources, and the environment, although the details of how such an objective will be achieved are unclear.
3. For example, by encouraging them to focus their regulatory efforts on priority geographical areas and/or industrial sub-sectors, which contribute disproportionately to local pollution problems.
4. The EA system already covers developments that do not fall within the ambit of point-source pollution control (such as dams and other large scale construction projects), and it will probably extend to cover an even wider range of developments in the future, including land use change, significant building developments, and certain types of large scale rural development. There is no necessary reason why EA and pollution permitting have to be tied together. In some jurisdictions, the two processes are administered by completely different agencies—a planning agency and a pollution control agency. For example—often at completely different stages in the development approval process. In others, they are handled together.
5. The regulatory approach—concentration-based or mass-based—is only one small part of the permitting process.
6. World Bank et al. (2001) provides a comprehensive discussion of the effects of water pricing in the Hwai, Hai, and Huang River Basins of Northern China, and illustrates the significant dampening effects that increased water prices can have on effective demand.
7. The World Bank estimated (World Bank 1997) that investments of around 2 percent of GDP on air and water pollution control through the year 2020 would produce an environmental standard of living (in terms of air and water quality) comparable to that in the United States today. Additional expenditures would be required to address other elements of the environmental agenda.
8. Only about 1.5 percent of projected environmental expenditures will be for capacity building, which is far too low given the major training and technical assistance needs, particularly among the lower-level EPPBs.
9. It should be noted, however, that neither option eliminates the difficult task of increasing service cost recoveries to sustainable levels. There are additional risk premiums associated with both options, which may outweigh the efficiency gains that could theoretically be achieved.
10. For example, in the short term, and given financial constraints, secondary treatment may be appropriate in water-shortage areas, but it may not be the optimum solution in some water-rich areas (such as along the Yangtze River and along the coast) that have the capacity to assimilate screened or only primary treated waste.
11. The four main environmental priorities under the 10th FYP are (1) improving water pollution control in large river basins through the promotion of integrated river basin management; (2) urban air quality management; (3) combating land degradation; and (4) increasing the effectiveness of rural environmental protection, with particular emphasis on the management and control of nonpoint pollution sources.

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