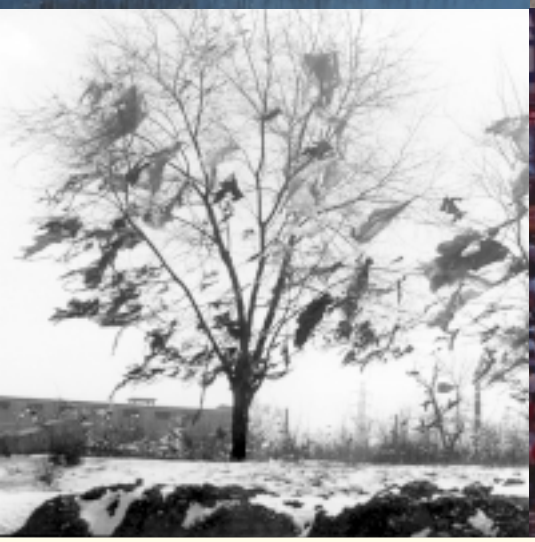
China Human Development Report 2002

Making Green Development A Choice





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China Human Development Report 2002

Making Green Development a Choice

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Foreword

This third China Human Development Report (CHDR) deals with China's challenge at the crossroads towards sustainable development. China's development is central to global stability. Annual growth rates have been averaging nearly 10% the last 20 years. Also government reforms over the last 20 years have reduced poverty for a quarter of the population. China's rapid transition towards a market-based economy and entry into the WTO are changing the global scene. And the world has never witnessed such a fast pace of urban modernization that we see today in China. The challenges of fulfilling a vision of green development in China are monumental, requiring a complex orchestration of policies and activities at a scale of operation the world has never seen. There is commitment, and there is awareness but still the right choices have to be made to achieve green development.

The UNDP commissioned Stockholm Environment Institute to produce this CHDR in order to ensure that the report would raise the central questions surrounding sustainable development and the critical options at hand. The report is also well timed since it arrives while the world is preparing for the World Summit on Sustainable Development 2002 in Johannesburg.

It is thus timely that the CHDR examines the general system of societal, environmental and economic factors that together make what China is today and what it can become in the future. The report is an assessment of modern China and some of the bottlenecks requiring attention in the manifestation of a greener agenda. This is not a state of the environment report but a critical assessment of progress made and challenges and choices remaining. The report presents options and attempts to ask the "right" questions. In this way it tries to stimulate a healthy debate on identifying suitable solutions. It also takes a candid look at the past to draw upon the most useful lessons for determining what could be done now for the future.

The report describes the physical and geographical challenges that this country presents to its populace. These are obviously central factors in determining the limits of human development. It also examines China's people and their history and culture as the resource and foundation to build and modernise this vast land. It describes the perils of the current state of the environment including status of land, water, air and biological resources. It examines the associated impacts of development on human health and welfare. It provides an assessment of the drivers and linkages between society and environment, and two scenarios – one based on current trends and one based on a greener future. The main message of the report is that there is a real opportunity at hand to green China's development agenda but that critical choices must be made by China's leaders, policy makers and interested stakeholders for this to happen.

Kerstin Leitner
Resident Representative
United Nations Development Programme in China

Roger Kasperson
Executive Director
Stockholm Environment Institute

Preface and Acknowledgements

This report has been developed over the past two years (2000-2002); a period during which China has undergone many significant changes. We have been trying to capture the main changes with regard to the environment and sustainable development, while at the same time providing the reader with an overall impression of where China is today, how it evolved to the present situation, and what options there are for the future. This is not a state of the environment report but a more pointed analysis of the interaction between environment, society and government and the policy challenges therein.

Chapter 1 provides an overall introduction to the report including the overall contents of each chapter and the final chapter 5 summarizes the main issues. The reader is also encouraged to examine the Scenario Boxes that run through the report as a background element in revealing the two alternative paths of development, the *perilous path* and the *green reform path*. The Scenarios have been adapted for China on the basis of the East Asia Scenarios from the GEO-3 (Global Environmental Outlook) process, for the use of which we owe gratitude to the UNEP.

A few words on how we have worked with various data sources are also in order. Availability and reliability of data is a key challenge for anyone who has been assigned the task of describing China. Being more of a continent than a country, and with various conditions changing dramatically across the country, any attempt to try describing China in terms of average, aggregate numbers runs the risk of missing some of the crucial information. As an example, China has on the average a little bit more than 2,200 cubic metres of freshwater available per capita per year, putting China on par with countries like Germany, the UK, Nigeria or Sri Lanka, where water is indeed a limited resource, but not scarce. What the average of 2,200 cubic metres fails to recognise is that almost 600 million people in China's north are living in areas that belong to the most water scarce locations on earth, and that many places may suffer from both flooding and drought within the same year. The same can be said for resources such as arable land, grasslands, forests and erosion areas. Countrywide average per capita data do not reveal the hot spots nor the critical issues. We have therefore taken a critical look at the various regions within China and examined the highly skewed distribution of human settlements and natural resources.

Another problem is the lack of comprehensive and reliable datasets covering the whole country. Crucial data that have been collected through Chinese government statistical systems through decades, sometimes centuries, are characterised by serious quality and systematic errors. One illustrative example is the acreage of arable land, which used to be estimated at roughly 90 million hectares, or less than 10 percent of the Chinese landmass, but which due to new and better methods, using remote sensing and geographical information systems, is now estimated at more than 130 million hectares. These types of broad-based errors in the range of 50 percent that relate to key resources may of course have considerable implications on the entire policy situation and development strategy.

So, in outlining the course of China's environmental and societal development and the prospects for future sustainability we have had to rely on both the available routine data, but also on "common sense", based on reasoning supported by anecdotal evidence, media reports, monitoring campaigns with limited geographic or thematic coverage, and by sound professional judgement. Our attempt has been to provide the story about the environmental situation and opportunities in China where the context is more important than just the individual data. This largely qualitative approach has been supported by a broad reviewing process including Chinese officials and experts, as well as international experts.

This report is aimed at a wide audience, and in doing so there will always be some readers who find certain parts superfluous, too detailed or plain incomprehensible. Spanning as wide academic fields as environmental sciences, sinology, and social sciences, as well as methodologies for envisioning different future options, there is also a risk that some readers will be challenged by some of the particular topics. In order to help, we have ensured that all technical aspects of the report are written as simply as possible. When it comes to the world of acronyms and terminology, we have provided a list of abbreviations with explanations for those that have been used in the report.

For those with more specific interests relating to the Human Development Index, the Annex chapter contains relevant datasets. A new item is the Health Risk Index, which has never been attempted before in a UNDP Human Development Report.

A note regarding Chinese various transcriptions of names is worth raising here in order to facilitate cross referencing with other literature. We have tried to be consistent in using standard *pinyin* transcriptions only, so China's Capital is spelled *Beijing* and not *Peking*, which is straight forward for most readers today. But there are other names that are more ambiguous, in particular geographical names such as rivers. China's greatest river, the *Changjiang*, is referred to in the report by its older international name the *Yangtze River*. The famous *Huanghe* we have referred to as such, in addition to using the English translation, the *Yellow River*. Furthermore there is an issue of whether or not to combine the names of the rivers. The northern river that empties near Tianjin is referred to in the literature as *Haihe* or *Hai He*, but since the word *he* means *river* it is also sometimes referred to as *Hai River*. This ambiguity applies to most names of rivers. Similar problems arise with the word *shan* meaning mountain, *hu* meaning lake, and *hai* meaning sea.

Chinese history, not least the modern period, is full of important milestones, which we have referred to in different contexts throughout the report, the most important one being the period from when Deng Xiaoping seized the control of China's development following after Mao Zedong's death and the downfall of the Gang of Four in 1976. This is commonly referred to as the *reform period*, which stretches from late 1978 until today. Other periods worth explanation are *"Post liberation"* or *"Communist" China*, which is the period after 1949 when the People's Republic of China was established. The *Maoist period* usually refers to the years up till Mao's death 1976.

The process of developing this report involved two groups of writers over the two-year period. The first group consisted of some of China's best specialists in geography, biological diversity, energy resources, water and air pollution, solid waste, health, related policy reforms and HDI statistics. They were assigned the task of writing summaries of the present data and knowledge in their respective fields. Plus a large database of human development and environmental statistics was assembled. Following this, a team of generalists was assembled to write the final report, providing the critical balance between descriptive detail and pointed analysis.

Team leader for the project was **Arno Rosemarin** at SEI. **Zhu Hua** at UNDP, Beijing, provided managerial assistance and co-ordination in China throughout the whole process. **Karl Hallding** at SEI has been the lead author of the report, but the entire and invaluable core team of writers have been deeply involved in the process of drafting, commenting and revising the whole report. The core team included:

- Dennis Fenton, formerly UNDP China
- Changhua Wu, former Director for China Studies, World Resources Institute
- Jintao Xu, Professor, Center for Chinese Agricultural Policy, Chinese Academy of Sciences
- Guoyi Han, SEI
- Annette Huber-Lee, SEI (mainly responsible for Scenarios)
- Arno Rosemarin, SEI

The group of excellent experts that provided written input include:

- Li Shi (Professor) Institute of Economics, Chinese Academy of Social Sciences (Annex)
- Liu Pei Zhe (Director) and Esther Deng, Waste Management Asia (China) (air and water pollution)
- Niu Wenyuan (Professor) Chinese Academy of Sciences (geography)
- Shi Han (Director) Center for Environmentally Sound Technology Transfer, ACCA 21 (policy aspects)
- Wang Sung (Professor) and Dr. Xie Yan, Institute of Zoology, Chinese Academy of Sciences (biodiversity)

- Zhou Dadi (Director-General) and Senior Staff Dai Yande, Jiang Kejin, Gao Shixian, Yu Cong and Dai Lin, Energy Research Institute of the State Development Planning Commission (energy)
- Zhou Qiulin (Professor) State Oceanic Administration (water resources)
- Jonathan Sinton, University of Berkeley (energy)
- Michael Lazarus, Stockholm Environment Institute (SEI) (energy)
- Eric Kemp-Benedict, SEI (scenarios)
- Input from the UNDP-WHO study *Environment and People's Health in China* carried out by Institute of Environmental Health & Engineering (Chinese Academy of Preventive Medicine), Institute of Quantitative & Technical Economics (Chinese Academy of Social Science), Ministry of Health and State Environmental Protection Administration (health aspects)

Valuable comments were provided by**:**

- Roger K. Raufer, University of Pennsylvania
- Peter J. Schei, Directorate for Nature Management, Norway
- Martin Linde-Rahr, University of Gothenburg
- Thomas B. Johansson, UNDP and University of Lund
- Yannick Glemarec, formerly UNDP China (now UNDP Bangladesh)
- Christine Loh, Civic Exchange, Hong Kong
- Monica Gullberg, SEI
- Aaron Maltais, SEI
- Kerstin Leitner, UNDP China
- Macleod Nyirongo, UNDP China
- Anita Nirody, SURF, UNDP Bangkok
- Environment and Energy staff, UNDP China
- Shuqin Liu, Beijing

The maps used were provided by IIASA. Source: Heilig, G.K. (1999): Can China Feed Itself? A System for Evaluation of Policy Options. CD-ROM, Laxenburg, Austria, International Institute for Applied Systems Analysis.

Photos were taken by Lynn Yen of Beijing.

Layout was carried out by Lisetta Tripodi of SEI.

The translation into Mandarin was performed by Changhua Wu (also core group author).

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The project was managed independently by SEI in collaboration with UNDP China.

This report is based on an objective analysis of facts and figures readily available from databases, libraries and knowledge institutions in China and around the world. The opinions or interpretations given in this report are those primarily of the authors and not official policy of the UNDP or Sida. The data accessed in this report do not include Taiwan, Hong Kong Special Administrative Region or Macao Special Administrative Region.

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Contents

Tables, Figures and Boxes

Tables

Figures

Boxes

Annex Contents List

Abbreviations

ABC	ammonium bicarbonate (fertilisers)
ACCA21	Administrative Centre of China's Agenda 21
ADB	Asian Development Bank
AEZ	Agro Ecological Zones (IIASA)
API	Air Pollution Index
bcm	Billion cubic metres
BEDI	Beijing Environment and Development Institute
BP	British Petroleum
BWG	Biodiversity Working Group (CCICED)
CAS	Chinese Academy of Science
CCICED	China Council for International Co-operation on Environment and Development
CDIAC	Carbon Dioxide Information Analysis Centre
CEN	China Environmental News
CGT	China Green Times
CHDR	China Human Development Report
CO_2	Carbon dioxide
COD	chemical oxidation demand (water pollution load indicator)
COPD	chronic obstructive pulmonary disease
CRED	Centre for Renewable Energy Development
EIA	Environmental Impact Assessment
EPB	Environmental Protection Bureau (local level environmental administrative units)
ERI	Energy Research Institute
ERM	Environmental Resources Management
ERPC	Environmental and Resources Protection Committee under the NPC
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FON	Friends of Nature
G77	Group of 77 Developing Countries
GDP	Gross Domestic Product
GEO	Global Environmental Outlook (UNEP)
GMO	Genetically Modified Organism
GNP	Gross National Product
GONGO	government non-governmental organisation
HC	hydrocarbon
HDI	Human Development Index

HRI	Health Risk Index
IED	Institute of Environment and Development (China)
IIASA	International Institute for Applied Systems Analysis
ISO	International Organization for Standardization
kWh	kilowatt-hours
LEAD	Leadership for Environment and Development
LNG	liquid natural gas
MBI	Market based instruments
MOST	Ministry of Science and Technology
NBS	National Bureau of Statistics
NEPA	National Environmental Protection Agency, predecessor of SEPA
NGO	non-government organisation
NOx	Nitrous oxides, includes nitrogen dioxide (NO_2), nitrogen monoxide (NO), and dinitrogen oxide (N_2O)
NPC	National People's Congress
ODS	ozone-depleting substance
OECD	Organization for Economic Co-operation and Development
PAH	polyaromatic hydrocarbons
PRC	People's Republic of China
R&D	research and development
RMB	Renminbi Chinese currency (yuan)
RTCCCCS	Research Team of China Climate Change Country Study
SDPC	State Development Planning Commission
SEI	Stockholm Environment Institute
SEPA	State Environmental Protection Administration
SETC	State Economic and Trade Commission
Sida	Swedish International Development Cooperation Agency
SO_2	Sulphur dioxide
SSB	State Statistical Bureau
SSTC	State Science and Technology Commission
TCM	Traditional Chinese Medicine
TFR	total fertility rates
TSP	total suspended particulate
TVE	township and village enterprises
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United Sates dollars (currency)
USEPA	United States Environmental Protection Agency
VOC	volatile organic carbon
WCED	World Commission on Environmentat and Development
WHO	World Health Organization
WRI	World Resources Institute
WWF	World Wildlife Fund

Chapter 1

Setting the Scene: Grounds for Green Reform

China enters the new millennium with "favourable timing, terrain, and unity of people", as the old Chinese saying goes. After two decades of double-digit growth, China's economy continues to be one of the most dynamic in the world. Hosting the 2008 Olympics in Beijing will grant China extraordinary opportunity for international attention and scrutiny. Accession to the World Trade Organisation (WTO) is certain to provide the world's most populous country with unprecedented access to world markets.

The promises for growth and development, however, rest against a backdrop of persistent environmental degradation. Population pressure continues to trap the country in vicious cycles, challenging the world with its most daunting environmental and social problems. Ever-worsening industrial pollution is affecting human health. Income disparities, particularly between the fast-developing areas along the eastern coast and the underdeveloped western inland regions, are widening. The combination of poverty and unemployment poses a potential threat to social stability.

"History has left little manoeuvring room to us and to our posterity; the time we have to make change is short; and the conditions we will have to accept are arduous" (National Conditions Analysis Group, 1988). Nearly fifteen years after the Chinese Academy of Sciences, in its report on national conditions, cautioned that "China is now faced with multiple simultaneous crises", the situation has not improved substantially. Population, land, environment, and food supply, as identified in the 1988 report, persist as the four major impediments restraining China's long-term economic and social development.

Recent actions across China show that its government and people are trying hard to grapple with the environmental challenges, realising more and more that environmental constraints on economic growth and social development matter crucially to the nation and its people. For better or worse, changes in China's ecological environment and the living standards of its 1.3 billion citizens will have significant repercussions on the country and the rest of the world.

The opportunities for greening development in China are significant and so are the attendant challenges. A closer look at the complexities of the country, its diverse environment, and its people will help readers understand the potentials and constraints. With this in mind, we have given the *China Human Development Report*: **Making Green Development a Choice** an underlying theme linking people to the environment.

1.1 People and the Environment in China

Previous editions of the *China Human Development Report* (UNDP, 1998a and 2000) examined the great transitions that Chinese society has undergone and the major forces shaping China's path of development. These forces include the transition from a planned to a market economy, pursuit of economic growth, rapid integration with the world economy, and institutional and governance reforms.

The present report examines environmental trends and degradation, which at first blush, can be rationalised as *results* of past and ongoing development, although the report goes on to demonstrate that the environment is not simply a passive recipient of impacts. On the contrary, environmental degradation has now become so acute that it is one of the main factors forcing future multi-faceted change. Indeed, environmental factors are likely to constrain, or even reverse, social and economic progress.

The main objectives of the current report are to review the environmental challenges in today's China, to examine the people-environment nexus on how environmental changes affect people's health and livelihoods, to see how people's choices can change the environment, and to explore possible options for a sustainable future. Underpinning the report is a fundamental belief that although real opportunities exist for stopping and even reversing environmental degradation in China, unleashing those opportunities requires firm choices to be made now. Notably, the dynamism in the economy and society, the advances in economic, technical and governance spheres, and the increasingly international na-

ture of China, all contribute to the solid foundation on which China can build a sustainable future.

This introductory chapter discusses the themes running through the report. These include the interactions between China's people and its environment, the vast diversity and variations across the country, the philosophical and cultural foundation and the changing perspectives on environment and development, and the necessity to shift the development paradigm in order to find the path towards a sustainable future. China can decline towards environmental catastrophe, or it can become a leading environmental model. Throughout the report, the case is made that good governance, combined with a committed populace, can set China firmly on a sustainable path. If this can be done, protecting the natural resource base will contribute to economic growth and social stability.

Chapter 2 provides a snapshot of the status of China's environment, illustrating how the activities of people have affected the environment and how environmental decline is affecting people and the economy. It also notes that problems attributable to limited and unevenly distributed land, water, and forest resources, already a bottleneck to development, are compounded by severely polluted air and water, further damaging health, agriculture and other sectors of the economy.

Whereas chapter 2 looks at indicators and the impact of environmental decline, chapter 3 examines the forces and trends that determine environmental change, discussing the major future uncertainties surrounding China's development path over the next half century. These drivers include population growth and changing population patterns, economic growth, changing civil society, and technological advances. Other drivers, such as international co-operation or global environmental change, may originate outside China.

The shift to a sustainable future requires strategic and immediate choices and actions. In recent years Chinese leaders and people have stepped up their responses to environmental challenges. Chapter 4 critically investigates those responses and discusses their merits and inadequacies. Even as we witness an increase in commitment and awareness among leaders and the public, it is important to confront two overall weaknesses in the responses. First, there is too much reliance on the state to address problems. Second, the responses in some cases have been too reactive, with a focus on costly cleanup rather than effective prevention. In general, the responses have mainly focused on environmental impacts (reviewed in chapter 2) rather than underlying environmental drivers (reviewed in chapter 3).

Chapter 5 concludes that for China's leadership—and, to an increasingly important extent, Chinese people—the time to make the right choices is *now*. Today's decisions—or absence of decisions—will have significant influence on the degree of sustainability in China's future development for many years to come.

1.2 Chinese Landscapes—the Diversity of A Continent

China, a land of diversity, stereotypes, and extremes, is in many aspects more like a continent than an individual country. Hemmed in by major mountain ranges in the southwest and west, with deserts and steppes to the north and the Pacific Ocean to the east, China's heartland is very much an enclosed geographical entity. Nevertheless, the ecological stress created by a population that is approaching 1.3 billion, in combination with the pressures generated by the country's rapid economic development, make China's environment a global concern.

China covers almost 10 million square kilometres—the same size as the United States, or Europe to the Urals—and its physical conditions, climate, preconditions for human settlements, and culture vary tremendously across the vast territory. In order to understand China's environmental situation, one must explore the whole spectrum of environmental problems—from glo-

SCENARIO BOX 1 DEVELOPMENT SCENARIOS FOR CHINA

The report provides alternative scenarios to help illustrate two possible development paths—both outcomes of development policy choices. The *Perilous Path* sketches development based on reactive policies, where downright bad decisions are not so much a problem as the absence of more proactive, reform-oriented policies. Although absence of public participation or policies that put the market to work for the environment might not affect short-term economic growth, it would lead to serious, continued degradation of the environment and depletion of natural resources, leaving large parts of the Chinese population behind in the development process. This path is perilous in that it reduces the Chinese society's resilience to withstand uncertain future developments, undermines China's mid- and long-term growth potential, and increases the risk for social unrest and political instability. In short, it points to increased vulnerability. The *Green Reform Path* builds on proactive environmental policies and the development of social partnerships, as well as policies to share more equitably the benefits of the changing economy. Although some of the damages to ecosystems from previous decades, in particular biodiversity losses, are irreversible, some restoration has occurred, and the human impact on the environment has decreased as a result of the integrated economic and environmental policies.

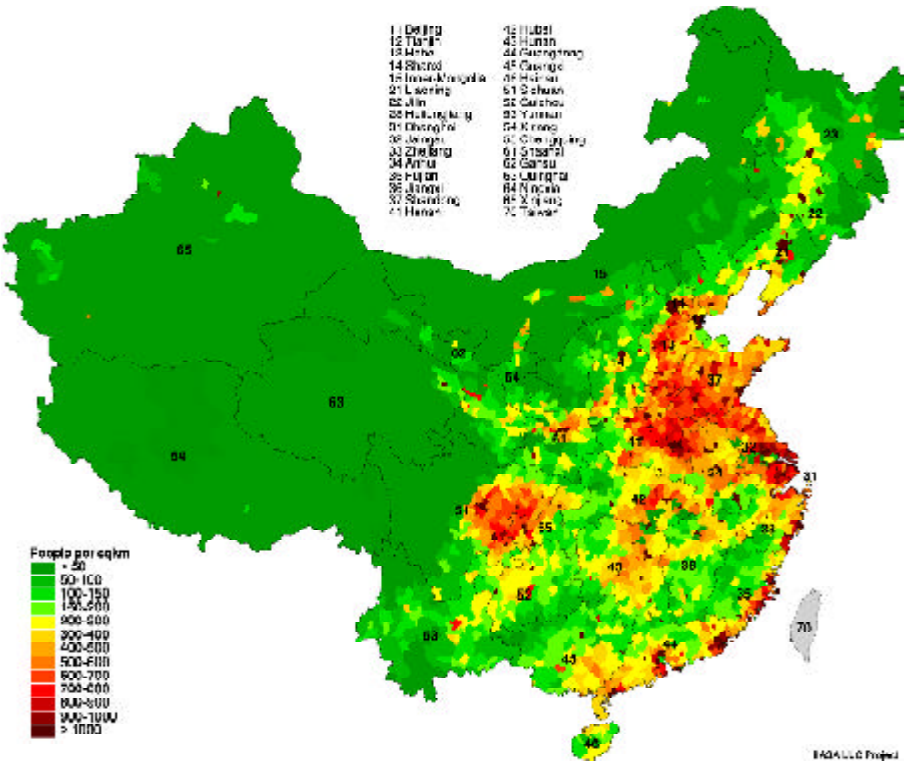


Figure 1.1 Population Density Map of China (Heilig, 1999)

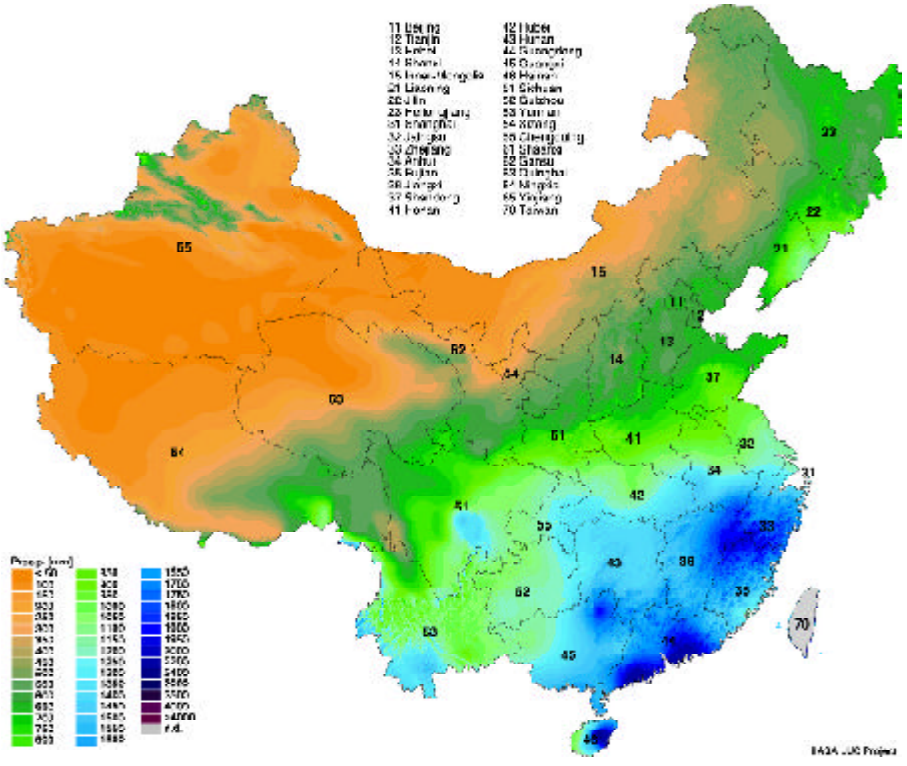


Figure 1.2 Precipitation Map of China (Heilig, 1999)

bal issues to local problems—while taking into account the preconditions and the limitations set by its natural endowments in interplay with human development.

China's environmental situation is closely connected to a high population pressure on scarce resources. Population density averages 120 people per square kilometre. Although this figure is slightly higher than Europe's 96, it does not, in itself, reveal the full severity of the situation.

Being mountainous and with a harsh and very dry climate, the major part of China's western half—the Tibet-Qinghai plateau, and the Gobi and Taklamakan deserts—can support only limited populations. Instead, it is the river valleys and fertile river plains in the eastern parts of China that have offered favourable climatic and physical conditions for human settlements, and they are where the first Chinese civilisations developed. Today, some of the world's most densely populated and intensively utilised resource bases are situated here. Cumulative calculations of the distribution of China's land area and population density show that:

- nearly 115 million people—10% of the population—live on a total area of just 50,000 square kilometres, merely 0.5% of China's total landmass, an area that accounts for the most densely populated counties and cities with an average of ca. 2,500 people per square kilometre;
- half of China's population occupies less than one-tenth of the country's total land area with an average population density of 740 people per square kilometre;
- more than 90% of China's population is concentrated in less than one-third of the country, where the average density of 350 people per square kilometre equals that of the most densely populated countries in Europe (Heilig, 1999).

Given this diversity, and given the size of China, any attempt to describe and analyse its environmental situation begins by reducing the country into a manageable set of homogeneous zones and regions. This is no easy task. This section focuses on the prevailing physical (topographic, climatic, and geological) influences across China.

Topographical Features

In many respects, China's physical relief and basic geographical conditions dictate the scope and limitations for its development.

The relief of China may be divided into three levels, moving from west to east. The first level includes the Tian Shan Mountains, the Pamir and the Qinghai-Tibet Plateau, the latter of which is located in both the Tibet Autonomous Region and the province of Qinghai and with an average elevation of well over 4,000 metres above sea level, is the highest upland area in the world. The mountains descend sharply to heights of between 2,000 and 1,000 meters, after which basins intermingle with plateaus. This second level includes the Mongolian Plateau, the Tarim Basin, the Loess Plateau, the Sichuan Basin, and Yunnan-Guizhou highland region. The third level—the eastern China lowlands—extends to the China Sea, almost the whole area made up of hills and plains lying less than 500 meters above sea level. The general decrease in altitude from west to east means that most rivers flow eastward, connecting China's interior with its coastal areas.

The rolling and rugged land surface makes ecosystems and human settlements increasingly vulnerable to changing conditions in, for example, land-use patterns, or climate. In addition, the jagged relief—emphasised by a mean elevation of no less than 1,500 meters, or twice the world average—puts extra strain on development efforts, particularly infrastructure development, and increases the energy intensity of transportation considerably. Energy-efficient railway systems are particularly difficult to develop.

A particular effect of China's geomorphology is the locking of its northwestern half into an interior drainage basin that has no connection to the sea and corresponding roughly to the area that receives less than 400 mm precipitation per year, i.e. the yellow/orange part in Figure 1.2. The combination of lack of sea drainage and very low precipitation adds to the fragility of ecosystems and societies in China's western areas.

Climatic Influence

Three climatic zones can also be identified that correspond to a limited extent with the topographical zones. Using climatic features, China can be divided into three major areas: the East Monsoon Region, the Northwest Interior Region, and the Qinghai-Tibet Plateau.

The East Monsoon Region

The East Monsoon Region, the Chinese heartland and home for 95% of the population, has two main characteristics. First, the climate is dominated by the East Asian monsoon, which governs both the spatial and seasonal precipitation patterns. In general, rainfall decreases from the southeast towards the northwest, concentrated during the warm half of the year. The high variability of the monsoon frequently leads to floods and droughts in the area. Second, the Region contains all major low-lying alluvial plains in China – the Northeast Plain, North China Plain, Middle and Lower Yangtze Plains, Pearl River Delta, and Sichuan Red Soil Basin, all belonging to the most intensively cultivated and densely populated areas in the world. With few exceptions, the landscape of the

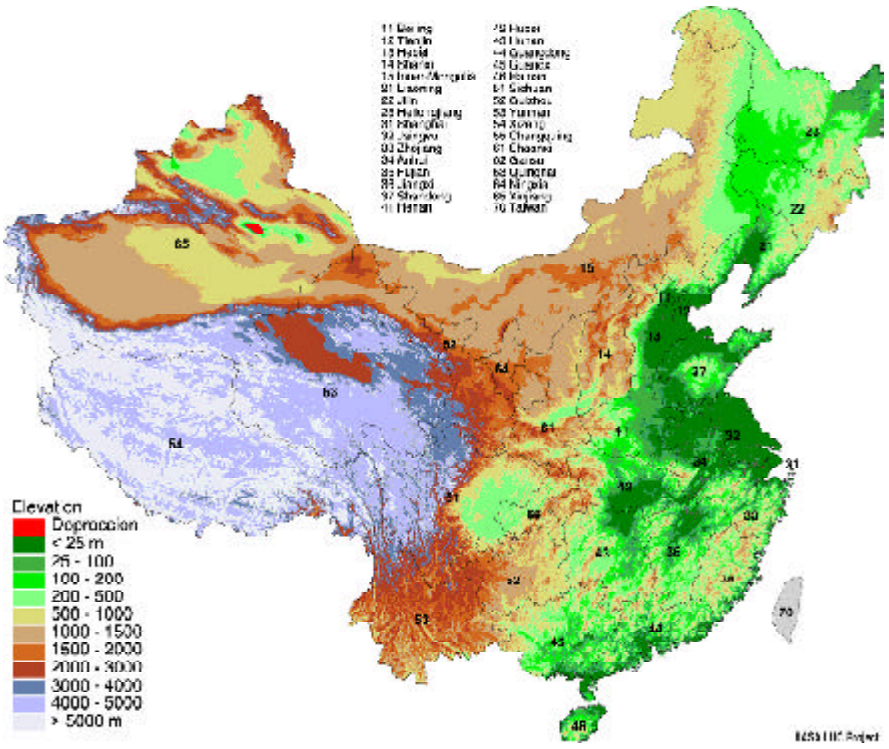


Figure 1.3 Relief Map of China (Heilig, 1999)

East Monsoon Region has been altered by millennia of agricultural activities. As a result very little natural vegetation is left, and the extreme population density produces enormous human pressure on most resources.

The climate ranges from subtropical and tropical in the far south, to temperate and cold-temperate in the northernmost parts. Summers are warm and humid all along the eastern lowlands with July mean temperatures generally above 25ºC, and the temperature range between North and South China is quite small with the July isotherms roughly running parallel to the coastline. The northeast is cooler with mean July temperatures 15–25ºC. The Siberian air mass, which dominates the climate during the winter half of the year is quite stable, extremely cold and dry, and often has temperature inversions. Winters in China are therefore cold for its latitudes and very dry. Mean temperatures in the far south still do not fall below 15ºC in January, while the northeast has –10ºC and below. The cold winter climate, in combination with the common temperature inversions that hinder air circulation, make the air masses in North China's cities particularly vulnerable to air pollution.

A north-south divide within the eastern monsoon region corresponds roughly to a line along the Qinling Mountains and the Huai River. The northern half, with its flat relief and long history of agriculture, contains almost two-thirds of China's cultivated land. However, the northern half receives only about one-sixth as much rain as the national average. This imbalance between north and south in allotment of water resources and farmland has led to a situation where the northern half of the East Monsoon Region is one of the most water-scarce areas in the world, a situation which is even more critical since more than half a billion people live in the area. The lack of water makes societies and ecosystems exceedingly fragile and vulnerable to new and increasing environmental pressures.

The Northwest Interior Region

The Northwest Interior Region comprises an unbroken rampart of territory that has served through history to separate and protect the Chinese heartland from its northern and western neighbours. Covering about one-third of the country, the Region is sparsely populated and contains only a small percentage of the total population.

Located deep in the Eurasian Continent, the Northwest Interior Region is a vast, semiarid or arid territory characterised by mountain ranges, desert plateaus and basins. Summers are hot with July mean temperatures reaching above 25ºC, particularly in the deserts. Winters are very cold with January averages below –12ºC for most of the territory and large areas reaching below –20ºC. Water is scarce, with limited rainfall. Most rivers are not perennial, and with almost the whole area belonging to

the interior drainage basin, rivers disappear into the sand or discharge into salt marshes or saline lakes, the main exception being the areas watered by the Yellow River's northernmost bend.

Apart from the massive mountain ranges and vast deserts, the rest of the Northwest Interior Region consists of more or less fertile plateaus with grasslands and steppes. The traditional livelihood, particularly among the indigenous populations such as Mongolians and Uygurs, has been herding—cattle, sheep, horses, goats, donkeys, and camels—rather than agriculture. Agriculture has been limited to areas with somewhat secure water supply, wheat and corn being the most important staple crops, but with substantial orchard production, especially along the middle and lower reaches of the perennial rivers where snow-melt water from the mountains supports oasis farming.

Northwest arid China is an area with harsh living conditions and the human impact has been limited, mainly due to the low population pressure. Up to now, the region has had limited economic importance, but recent evidence of a wealth of natural resources, has sparked bold development plans. There are many problems associated with developing a vast, desolate, and jagged region, where the sheer geographical conditions make any infrastructure development effort both cumbersome and delicate. In addition, most of the ecosystems are fragile and natural limitations, such as chronic lack of water, reduce the capacity to support larger populations.

The Qinghai-Tibet Plateau

Known as "the roof of the world", the Qinghai-Tibet Plateau is a mountain wilderness that occupies one-quarter of China, but is the home of less than one per cent of the population. With an average elevation of more than 4,000 metres, the plateau itself is the highest in the world. Most of the area belongs to the interior drainage basin, but the Qinghai-Tibet Plateau is nevertheless the source of six of the world's longest and most legendary rivers: Indus, Brahmaputra, Ganges, Mekong, Yangtze, and Yellow.

Extreme altitude gives the Qinghai-Tibet Plateau an array of very special characteristics, including a thin atmosphere, extreme difference between day and night temperatures, large areas of permafrost, strong solar radiation, and strong winds. Due to the special conditions that prevail in different altitude zones, the Qinghai-Tibet Plateau has rich fauna and flora, with many rare species that are peculiar to the very special ecological conditions. Still, natural conditions are unfavourable to human activities, not only because the harsh climate is inconducive to supporting larger societies but even more because the Tibetan Plateau is so rugged that simply getting there and back again sets its own limits.

Key Zones

Many, perhaps an infinite number, of unique areas are identifiable within China. Taking into account the above-described climatic and topographic factors, and imposing on them the development and political factors, a series of zones can be identified and analysed from an environmental point of view. Most of China falls into at least one of five such zones, proposed below. It is important to note that each zone includes industrial and agricultural areas; modern cities and remote, "backward" communities; and developed and undeveloped areas. There is, also, an inevitable overlap among these zones.

The "West"

The "west" covers more than half of China—including the provinces of Gansu, Guizhou, Ningxia, Qinghai, Sichuan, Shaanxi, Tibet, Yunnan, and Xinjiang. Many of these provinces and autonomous regions are the same size (in terms of population and area) as many Asian countries. And as can be seen from the Annex, in terms of Human Development, some would belong to the category of least-developed nations. These areas generally also have low population density, high populations of minority groups, large mineral deposits, and fragile environments. The development of this area is currently one of the most fundamental development objectives of the Chinese government for the next decades—the so-called Western Development Strategy. Much of this area suffers from severe land degradation, in part due to the arid conditions, although the southernmost extremity—Yunnan and Guizhou—is naturally lush and green.

The "Northeast"

The "northeast" consists of Heilongjiang, Jilin, and Liaoning provinces. This area was the industrial heartland of China for the first decades after 1949, and is hence the home of the heavy, old, high-polluting, low-efficiency industries. As industry restructures and many state-owned enterprises lose competitive advantage, unemployment has become a problem. This same area also includes China's largest grain-producing region and large floodplains.

The Central and Southern Coastal Provinces

Over the past two decades, the central and southern coastal provinces that stretch from Shandong to Guangdong, including Jiangsu, Shanghai, Zhejiang, Fujian, and Hong Kong, have experienced the most rapid economic growth. New industrial sectors, often high-tech, have been spurred on by economic reform, foreign investment, and export-oriented strategies. Rapid economic growth has made this area a magnet for investment and migrant workers. In these densely populated eastern areas, some of the regions of interwoven urban, suburban, industrial, and agricultural areas are as large

as some European countries. Population pressure has grown to a level where per capita availability of most resources—including basic necessities such as water—are among the lowest in the world. Unchecked pollution from industry and agriculture is mirrored in mortality statistics of pollution-related diseases. This area covers the Yangtze and Pearl River estuaries, and two of the main rice-growing regions of the country. Economic growth has focussed on cities and towns, and many people living in rural and mountainous areas have not benefited from these developments.

Southern Central China

Southern central China includes Anhui, Chongqing, Hubei, Hunan, Jiangxi, and Sichuan provinces, stretching along the Yangtze River valley from glistening, modern Shanghai to the Tibetan Plateau. The region is home to a large population and extensive rice-growing areas. Mountainous and hilly regions contain ecosystems with high biodiversity, whereas low-lying lands are subject to regular inundation by the Yangtze. Hence there are great, low-lying lakes.

The Dry, Densely Populated "North"

This area covers primarily Beijing, Hebei, Henan, Shanxi, and Tianjin provinces and municipalities, with small parts of adjacent provinces. Lying close to the bed of the Yellow River, this area is often considered the cradle of Chinese civilisation. The region has fared reasonably well in economic terms since 1949, both before and after the reforms. However, land degradation and water shortages threaten to undo most of the social and economic advances made in the region.

1.3 Tracing A Historic and Cultural Foundation

Human attitudes towards nature and the way human societies have affected natural systems in the past are crucial elements for our understanding of what is going on in with the environment and which options are available (Ludwig, 2001). Five millennia of unique cultural, economic, social, and political development have shaped the Chinese society as it enters the new millennium. The last two centuries involved dramatic changes, originating in the decline and final breakdown of Imperial China in 1911 and leading up to the establishment of the People's Republic of China in 1949. This legacy influences the way individuals think and act, it affects priorities and the way groups form, and it affects how government operates. In short, it affects the environment.

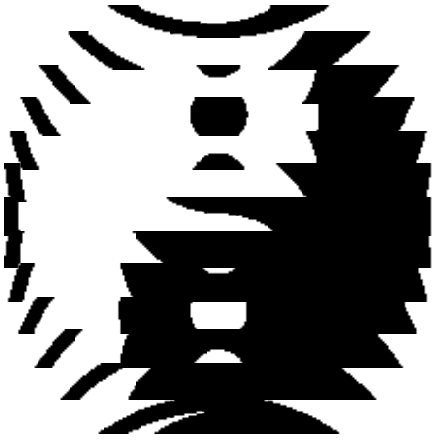
As far back as the 2nd century BC, the Qin Dynasty in China had a Farmland Law that actually prohibited against felling trees, filling up of dams, burning grass, or catching fish before and during the reproductive period in the spring and early summer (Zhang, 1999). This and similar examples show how traditional Chinese philosophies were built on a reverence for nature. More interestingly, it reflects a deeper understanding of the value of protecting natural resources against overexploitation. But despite this strong foundation in Chinese philosophy of nature as something to be treasured and cared for, China has failed to escape environmental problems throughout ancient and modern history.

This section traces the relationship between the human society and the natural environment through Chinese history. After reviewing how the understanding of nature has been reflected in human behaviour, and in social and political structures, the section examines how the traditional human – nature relationship played out in modern Chinese history, and how it could play a role in the pursuit of sustainable development.

Traditional Ideas of Nature

Two concepts are essential for our understanding of the traditional Chinese view of the universe: *yin-yang*, the two complementary forces known through the *yin-yang* symbol in figure 1.4; and *wu xing*, the five elements, metal, wood, water, fire, and earth. *Yin* and *yang*—first described in the ancient classic *Yi-Ching* (the Book of Changes)—are seen as two cosmic forces that shape and balance all cosmic matter, including human existence. As opposites—*yin* literally meaning "the moon" and *yang* "the sun"—the y*in* and *yang* forces are in continuous, dynamic interaction. The resulting flux and tension produces the five elements, which in turn make up the basic components out of which all things in the universe are composed. In the traditional Chinese understanding, the cosmic order—and thereby also the social order—is secured by maintaining the balance between *yin* and *yang* and the proper mix and relations among the five elements. Central concepts of this ancient view include strong notions of coexistence and

Figure 1.4 The yin-yang symbol



coevolution in the relationships of humans with nature (Cortner and Moote, 1999).

The human relationship with nature in traditional Chinese philosophy was defined and interpreted with the *yin-yang* principle as a basic concept. *Yin* and *yang* forces are present everywhere in nature, such as water being *yin* and fire *yang*, and through human interaction with nature these natural forces had to be managed in order to preserve the delicate balance. The art of acting in harmony with the *yin* and *yang* forces was laid down through the practice of *Feng-shui*, or geomancy, which prescribes how to act not to disturb the natural flow of *yin* and *yang* in the landscape.

In the human–nature relationship, nature is understood as *yin* and therefore the receptive part, while human is *yang* and the active part. Accordingly, any aggressive human action upon nature would violate the principle of balance, and excessive behaviour would be considered unnecessary and potentially damaging. *Feng-shui*—which is still actively practiced in China, for example, during the construction of skyscrapers in the larger cities—thus describes a way of living harmoniously with, rather than conquering, the natural world. The idea of *yin-yang* balance, therefore, provides a basic principle for treading more gently on the earth.

Three broad philosophical traditions—Taoism, Confucianism, and Buddhism—prevail in China. Confucianism and Taoism share the same fundamental ideas, based on *yin-yang* and *wu xing*, of a cosmic harmony that evolved from the ancient Chinese view of the universe. Buddhism, however, entered China from India at a later stage, and although it enjoyed an interregnum as a dominant philosophy in the middle of the first millennium, lost its influence during the later Tang dynasty, in the mid-eighth century, while Confucianism grew to a status of "imperial philosophy". Yet, Buddhism is still practiced in China, particularly as a folk religion with many similarities to, and often mixed, with Taoism. Although Confucianism became the guiding principle of Chinese civilisation in the course of the last millennium, Chinese understanding of nature still reflects a mix of Confucian and Taoist ideas. An old Chinese saying portrays the typical imperial official as abiding by strict Confucian rules during professional service, while devoting private life to Taoist virtues of seeking the heart of natural mysticism through poetry and arts. Similarly, Chinese society's relation to nature has been dominated by values rooted in Confucianism, whereas Taoist beliefs have been nurtured in the private sphere.

Taoism—nature as a sacred pattern for society

Although the pursuit of harmony, balance, and order are central to both Confucianism and Taoism, the two philosophies differ when it comes to "how" and "why". "Tao" means "the way" and in relation to travel, Taoism teaches that the journey is more important than the destination—that "the way" people act is as important or even more important than the reason for acting. "The way" people are to live their lives is in coexistence and balance with each other and with nature, following the example that, according to Taoists, is set by nature itself. Taoism thus seeks accommodation with nature and believes and advocates harmony between "heaven and humankind" (Tickell, 2001).

For a Taoist, nature is sacred and animated, and by living simply and within the scope of blessings offered by nature, with a maximum of well-being but a minimum of consumption, humans may liberate their souls. Taoism preaches that material wealth in itself is no hindrance to liberation of the soul, rather, it is human attachment to wealth and the craving for pleasurable things, rather than their enjoyment, that are problematic.

Given its minimalist principles of a simple life in harmony with nature, coupled with a sober, slightly anarchic distrust of society, Taoism was not the spiritual raw material on which to build a state philosophy. It is scarcely surprising, then, that Confucianism, with its well-developed social structures, roles, and moral codes became the guiding principle of the Chinese state.

Confucianism—nature as a reflection of the social order

For Confucians the social order is embedded in a larger cosmic order that builds on a number of hierarchical social relations, the top one being the "mandate of heaven" according to which the emperor was granted the right to rule "under heaven". In the Confucian understanding of the world, nature is not a sacred model for human behaviour; instead the natural environment and the society are viewed as each other's reflections. Any human action on nature is thus understood and evaluated in relation to its social implications, and activities with the purpose to improve nature are seen as beneficial also to society. It is on the basis of this pragmatic and human centred view that the Chinese civilisation has grown and the Chinese landscape has been altered for thousands of years, and extension of agriculture, felling of forests for building material and for improving the defence against hostile northern tribes, dredging of channels for transport, are only a few of the processes that have entirely changed the landscape of eastern China.

At the same time the environmental consequences have been far-reaching. First, the Confucian principles proved so efficient in utilising nature for improving social conditions that mounting population pressures started threatening both the natural basis for society, as well as the social order itself. After having been the arguably most advanced and prosperous country in the world by the late 18th century, China entered a century of

turmoil that ended only with the Communist takeover in 1949—a turmoil that except for blatant political mismanagement was caused by natural catastrophes in combination with sharpening competition for scarce resources. Second, once the basic principles for the social order changed from the traditional Chinese view of harmony and balance to the set of values that were to govern the social order after 1949, the pragmatic view of utilising nature to serve the social order became a foundation for massive environmental destruction.

The War Against Nature

After a century of devastating turmoil China had reverted from a position among the most prosperous countries in the world by year 1800 to one of the worst mismanaged and poorest countries by mid 20th century. One of the bloodiest civil wars yet seen in the world may have killed as many as 80 million people in China throughout the 19th century, at the same time as the coastal area of the crumbling empire was exploited by western powers. Political mismanagement and ruthless exploitation of people and resources had impoverished the country and made wide areas of eastern China increasingly vulnerable to the natural pattern of repeated flooding and drought, which has been a basic condition for the development of the Chinese civilisation during thousands of years. In 1911, imperial China collapsed, and with it the concept of the emperor's "heavenly mandate" to rule. Chinese intellectuals argued that there must be something inherently wrong with the basic concepts on which the Chinese civilisation had been built, and when the Communists came to power in 1949 they did so with a mandate to build a new China—a China that was to challenge and break with most central aspects of the Chinese cultural tradition.

The break with the "old cultural evils" was inspired by ideas rooted in Marxism-Leninism, where conflict, contradiction, and struggle were held not only as a natural feature of society, but also as important means of radical progress. The combination of Marxist-Leninist political ideology and the traditional Confucian concept

Box 1.1 Many Cultures, Many Legacies

China is the home to many ethnic groups, often living in biodiversity rich areas. Their cultures often reflect the natural environment, worshipping nature and attending to biodiversity. For example, most Chinese minorities have the concept of so-called "fengshuilin" (geomantic omen forest). The Dai, Miao, Buyi nationalities and some other nationalities esteem some mountain forests as "shenshan" (divine hill), longshan (dragon hill) and shengshan (sacred hill) where gods reside. Wildlife in these forests is regarded as the companions of gods and felling, hunting, browsing and reclamation is prohibited except for the rearing of medicinal plants and other minor products. Some "fengshuilin" traditions date back more than a 1000 years.

The Dong nationality, living in the remote mountainous areas of the Hunan, Guangxi, and Guizhou provinces, is also accustomed to planting "fengshuilin". These "fengshuilin" vary in size up to 8 hectares. They reflect local peoples' worship of nature, but also provide many ecological functions such as water conservation, soil conservation, climatic adjustment and improvement, protection of rare and endemic species, and countryside beautification.

To protect the indispensable vine resource, Hali villages have vine forest reserves. Often over 100 years old, these forests contain a diversity of biological species and compare favourably with local virgin forests. In addition, the Yao nationality and other minorities in the Dayaoshan Mountain also have the tradition of making agreements by engraving stones. This is called the "stele law" and includes regulations on protecting forests.

Many minorities' religions are influenced by animalism - worshipping mountains, rivers, forests, animals or totems. For example, the Tibetans deem that trees hanging religious flags and the surrounding forests can not be destroyed; the Khalkhas worship Snow Leopards and cattle; totem worship prevails among the Gaoshan people and they highly praise trees, bamboo, calabash, stone, soil, snakes, dogs, birds, insects, eggs and the Sun. Many plants are related with Buddhist doctrines, and among them the most important is the "bodhi tree". Due to the varying natural conditions and religious succession, "bodhi trees" are different in different nationalities and regions, but they mostly are local rare species such as gingko, bass (including "Nanjing Bass" and "Manchurian Linden"), jasmine, honeysuckle, megranate, clove, soapberry, palm, peony, and chrysanthemum (Jiao Yali and Zhang Yijun, 2000).

The Mongolia and Kazakstan nationalities living in the northern drought and semiarid regions and the nomadic Tibetan tribes all have the custom of "Daochang" browsing (browsing in shifts), which helps to lighten the grazing pressure resulting in the sustainable use of pastures. In recent years pointing grazing has often been carried out, and a new method of protecting "glass Kulun" (meadow) has been developed by the pastoral people. This means meadows can renew more quickly, and the carrying capacity is increased.

Not all minority practices have positive impacts on biodiversity. For example, hunting is popular among minorities living in mountains. The Green Peacock, a first grade nationally protected animal, was once widely distributed in the Zixishan Mountains of Yunnan province but hunting by the Yi peoples contributed to its dramatic reduction (Long Chunlin *et al*., 1999).

of man as the active part in the man – nature relationship resulted in a confrontation between society and nature, where a nature portrayed as vicious and deceitful was deliberately set against the prospect of prosperous progress of the human society. Nature had to be "conquered" and "defied"—words reappearing in propaganda at the time, showing the aspiration to manipulate nature in order to boost agricultural production. News headings from the early 1960s speak for themselves: "Chairman Mao's Thoughts are Our Guide to Scoring Victories in the Struggle Against Nature", "The Long Battle to Control the Huai River", and "The United Will of the People can Transform Nature" (Hallding, 1991).

Although the fateful path that environmental development came to take after 1949 was largely influenced by communist ideology, the Chinese cultural tradition, particularly Confucianism, provided a deep-rooted foundation for the idea of human control over nature.

Environment? Not Our Problem

The conviction that Chinese civilisation could and should master nature became a cornerstone in the socialist development project, paving the way for several decades of polices that were either detached from any notion of natural limits, or ignorant about the risks associated with development efforts outside the scope offered by nature.

After a century of ruinous chaos with corruptive misgovernment, civil and international wars, and endless natural catastrophes, economic reconstruction became the overriding goal when Mao Zedong's communist government took office in 1949. But already the first five-year plan, which envisioned China catching up with the United States in terms of total industrial production within ten years, revealed a blatant lack of reality in the Chinese future planning. "The Mass Movement for Economic Development" and "the Great Leap Forward" were mass campaign policies of the 1950s, which were so detached from the realities of the war-ridden country that—quite on the contrary to their fanciful goals—they resulted in large-scale capital destruction, economic decline, serious overexploitation of people and resources.

But the mad, zealous ambitions for catch-up-development did not stop even with the failure and human tragedy of millions dead that resulted from famine and the Great Leap Forward at the dawn of the 1960s (Becker, 1998). Although the worst insanities were halted, the 1960s and 70s saw new development policies with little or no foundation on basic natural conditions, such as extension of wet rice in water scarce areas, felling of forests far beyond regrowth, integration of severely polluting industries in residential and agricultural areas, and irrigation with polluted, often toxic industrial wastewater leading to severe pollution of water sources and soils.

Among Mao's headstrong policies, the idea that a China with more people would provide defence against a world of enemies is the one that left the most far-reaching consequences in terms of sustainable development. Mao paid little attention to the call from academic circles that limiting the growth of China's population and implementing family planning should be part of the overall economic development strategy (Duan, 2000). From the 1950s till the late 1970s, married couples were encouraged by the government to have more children, and population jumped from 500 million in 1949 to one billion in 1978, generating exacerbated pressure on farmland, forests, grassland and freshwater systems. When these policies were finally reversed a quarter of century ago, a population momentum had already been created which will continue driving the population growth for several generations to come (see further in section 3.1).

During the Cultural Revolution, industrial pollution became rampant; in most cities, groundwater was severely polluted, and the ambient air concentration of particulates was exceedingly high. Ecological destruction was beyond any parallel. Soil and water erosion caused tremendous loss of nutrient and land productivity. As an example the Dongting Lake, one of the largest freshwater lakes in China, shrank nearly a third in size.

At the same time, environmental pollution was described by the government as "the vicious consequences" of capitalist societies in their drive to achieve wealth—growth for the rich at the expense of the poor. Socialist countries like China, according to the rhetoric at the time, should not need to worry about the environment because as propaganda bluntly put it "it is not our problem". Along that line, the call to preserve environmental qualities and natural resources—even if it were for strictly internal reasons—was muted (Duan, 2000).

The legacy of central planning, as illustrated in chapter 2, includes a staggering cleanup bill for the advanced state of environmental deterioration. The pollution daunts efforts to achieve true development for years to come.

Stockholm and Afterwards

China's environmental awakening came around 1972. When the Chinese government sent its first delegation to the United Nations Conference on the Human Environment in Stockholm, Sweden, that year, China was still a very much self-enclosed society in the middle of the Cultural Revolution turmoil.

Thirty years later, the Chinese government sees the value of employing the market to make environmental protection profitable and motivate a knowledgeable population to control compliance and environmental qualities. The Chinese people, especially the younger generation, have become more conscious than ever of the importance of having a clean environment and a decent

quality of life. Over three decades, substantial changes have taken place in both the system and public mentality.

The 1972 Stockholm Conference served to make the Chinese delegation realise that China shared the problems of environmental degradation with the rest of the world. It was followed up, a year later, by the convening of the first National Conference on Environmental Protection in Beijing, and in 1974, the establishment by the State Council of the Group on Environmental Protection. These events, followed by a series of legislative efforts in the late 1970s, marked the beginning of the government's efforts to place environment protection on the national agenda.

Deng Xiaoping launched the economic reform in late 1978, and the revised Constitution from the same year declares, for the first time, "the State shall protect the environment and natural resources". The 1979 promulgation of China's Law on Environmental Protection represented the beginning of environmental legislative efforts that are still ongoing today.

Since 1983, environmental protection, along with population control, has been described as a "fundamental national policy" in official documents. In the past few years, the government has issued new guidelines stating that "pollution prevention should be primary focus" for all industries; and "combining prevention and environmental remedy should be the basic policy". Most recently, the term "sustainable development" has been used as part of the national strategy. The government has been experimenting with market-oriented tools in environmental protection management. The regulators have learned how to price drinking water and utilities, based on market values, how to trade sulphur dioxide pollution rights, and how to use taxation to regulate pollution-heavy industries. The concept of environmental governance has become part of national discourse to encourage information disclosure and public participation.

Notwithstanding these promising developments, there is a long way to go before China could be said to be on a sustainable path. China is certainly not alone in facing pressing environmental problems, nor the only country that must deal with it from relative poverty and limited capacity. But the combination of a high and increasing population pressure on already scarce resources, an already critical environmental situation, and a bold push for economic growth—all these aspects add up to an uniquely incompatible situation. Therefore the environmental awakening since 1972, and the featuring of environmentally prudent development concepts in recent national policies and strategies, must now be followed by a choice to implement sustainable development; a choice that would increase the chances that China achieves its future goals without sacrificing already constrained natural resources and a deteriorating environment, and without threatening the survival and development of future generations.

Listen to the Past; Learn from Others

As the twentieth century drew to a close, it became increasingly clear that growth has its ecological limits. Developed countries learned the lesson through a couple of centuries' industrialisation, urbanisation, and blind belief in the efficacy of exponential growth of both the human population and human economy. China, as the world's largest developing country, has learned its lesson dearly by following the footsteps of many developed countries.

With increasing awareness worldwide, governments and peoples are moving towards sustainable development—the art of satisfying "the needs of the present without compromising the ability of future generations to meet their own needs", to quote the 1987 Brundtland Report (WCED, 1987). China is no exception.

At the dawn of the 21st century, China is wrapped up in the midst of rapid and fundamental societal, economic, and even political transition. At the same time China is searching its soul. The visions of bright and prosperous futures are there, but the path that should lead the Chinese civilisation there is not clear.

In order to find the right track China needs to listen to its own past, while at the same time learning from the experiences and findings of others.

1.4 Seeking A Sustainable Future?

China's future will be shaped by the choices made by its leaders and the Chinese people. Although there is an infinite number of possible futures for China, two optional pathways stand out on the basis of the previously described historical and cultural foundations. Scenario Box 2 describes how a scenario-based approach has been used in this report to assess China's long-range future options—involving such unpredictable aspects as ignorance, surprise and volition—with the goal to sketch pictures about alternative futures for China to the mid 21st century.

One possibility is a "growth-first future" called the *perilous path*. Based on trends in the last decades of the 20th century the *perilous path* sketches a future China shaped by the ongoing process of globalisation, and a continued, gradual spread of the dominant economic values and consumption patterns of industrial societies.

The other possibility is a "balanced-growth future" called the *green reform path*. Based on a firm choice to continue and deepen reforms, the *green reform path* paints a future China where traditional Chinese values

for nature and the environment become a foundation for sustainable development, and where China continues to integrate with the international community, learning from best practices and gradually developing its own sustainable models.

The Perilous Path

Under the *perilous path*, China in the first decades of the 21st century faces two serious perils: continued social instability and environmental degradation. These two trends interact and reinforce as the poor suffer most from the degraded environment, and at the same time contribute to further environmental stress in their desperation to eke out livelihoods. Human well-being and standards of living improve slowly, but the degree of inequity continues to increase. The economic growth continues, but the pace is much slower than the last decades of the 20th century—and, more importantly, the risks increase of ending up with considerably lower growth.

At the same time, the environmental impact per unit of activity decreases as technology becomes more efficient and pollution control improves. But the exponential growth in the scale of activity overwhelms these improvements and the overall demand for resources and level of environmental pressure continues to rise. The emphasis on economic growth allows vested interests of Chinese society, which benefit from market-driven growth, to maintain a strong influence along with the central government. Concerned with the threat to their incomes, these interests successfully thwart major efforts to reduce environmental degradation. The public continues to perceive environmental protection as a role of the state, not individual responsibility. All these translate into very significant, negative impacts on the environment.

The Green Reform Path

The *green reform path* charts a different future. The gradual deepening of environmental and social stresses prompt a popular outcry for a new development strategy. The engagement of civil society is reflected in a mushrooming of NGOs seeking to promote transparency and participatory processes in the governing of the nation. Citizens start taking own initiatives to improve environmental qualities, empowered by a greater recognition from the government, and feeling they have a greater stake in the well-being of their environment because of the return to traditional Chinese values for nature and environment. The aspiration for Western lifestyle is tempered by these new values and a respect for non-material values—the beauty of the environment, personal fulfilment and the importance of community.

The government responds by looking for mechanisms to increase the degree of partnership with citizens, corporations, and NGOs. The partnership emerges into policies that are pro-active on environmental issues, and stress increasing equity in sharing the benefits of a changing economy. Although some of the ecosystem and biodiversity losses from the previous decades are irreversible, development and implementation of integrated economic and environmental policies will help reduce the human impact on the environment. As a result, natural ecosystems start recovering, and biodiversity losses are halted or even reversed. The impact of industrialisation and urbanisation on the environment is tackled by a series of forceful policy reform packages. These alternative futures are illustrated in figure 1.5 below.

The Choice for a Green Future

The choice is clear. Chinese people desire a sustainable future. Sustainable development is now adopted as the guiding strategy for national development. Environmental protection, family planning, and education have become fundamental national policies. The government is beginning to encourage public participation. The central authorities have begun to appreciate an articulate, knowledgeable population to help strengthen the enforcement of regulations and policies.

Chinese people start taking actions for positive changes. With more and more people awakening to the fact of reduced numbers of urban blue-sky days, waterways turning into stinking puddles, suburban garbage dumps, and the environment-related health problems, they demand changes. Student groups have begun emerging on campuses to organise activities, such as getting styrofoam containers banned on campus, and publishing newsletters to raise public consciousness of the value of saving on water. When Beijing and a couple other large cities started phasing out leaded gasoline, people in Dalian and Xiamen dialled their mayors' hotlines to request the same measures be adopted in their own cities, because they want their children to grow up healthy.

But uncertainties do abound—worries about the way events might unfold and the way people might respond to these events. The uncertainties have cultural, economic and environmental dimensions. For example, the rise of inequality is beginning to surface in various forms of social unrest. What if conflict reaches a critical level and social stability is threatened? Consumption patterns are undergoing a shift in Chinese society. What if consumption patterns gradually replicate those in the United States? From a cultural standpoint, responsibility for environmental protection is currently perceived to lie largely in the hands of the government. What if environmental awareness increases among the general public, and personal responsibility for the environment becomes pervasive in Chinese society?

SCENARIO BOX 2 THE USE OF SCENARIOS TO ANALYSE CHINA'S FUTURE OPTIONS

This report uses scenarios to examine alternative development paths open to China. Scenarios offer a means for examining the forces shaping our world, the uncertainties that lie before us, and the implications for tomorrow of our actions and our choices today. A scenario is a story, told in words and numbers, concerning the manner in which future events could unfold, offering lessons on how to direct the flow of events towards sustainable pathways and away from unsustainable ones. While we cannot know what will be, we can tell plausible and interesting stories about what could be.

In the theatre, a scenario is a summary of a play. Analogously, development scenarios are alternative stories about the future with a logical plot and narrative. Scenarios usually include images of the future — snapshots of the major features of interest at various points in time — and an account of the flow of events leading to such future conditions. Compelling scenarios need to be constructed with rigor, detail and creativity, and evaluated against the criteria of plausibility, self-consistency and sustainability, a process that requires thorough and intensive analysis.

Scenarios draw on both science—our understanding of historical patterns, current conditions, and physical and social processes—and the imagination to conceive, articulate and evaluate alternative pathways of development and the environment. In so doing, scenarios can illuminate the links between issues, the relationship between global and regional development, and the role of human actions in shaping the future. It is this added insight, leading to more informed and rational action that is the foremost goal of scenarios, rather than prediction of the future.

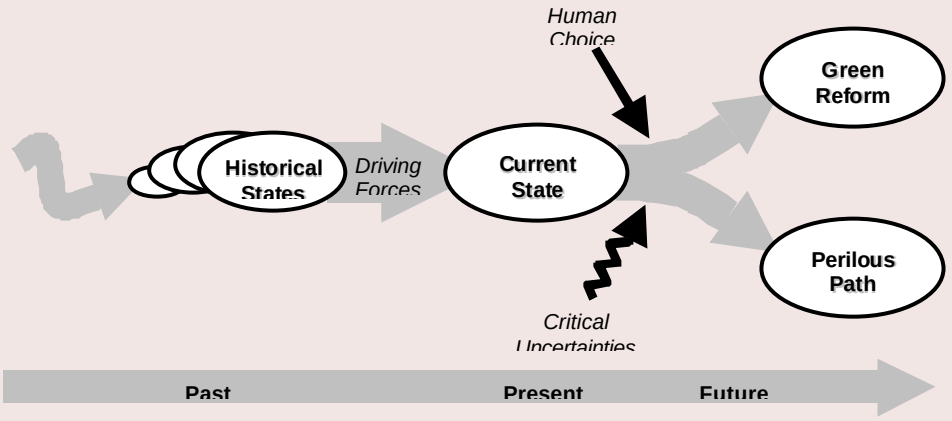


Figure 1.5 The Scenario Approach

Figure 1.5 sketches major features governing the dynamics of change of combined human and environmental systems. The *current state* of the system (chapter 2) is the outcome of an historical process that is driven forward by a set of *driving forces* (chapter 3). These forces condition, but do not determine, the future trajectory of the system. Moreover, the capacity of human beings to imagine alternative futures and act intentionally (chapter 4) means that images of the future can act as attractive and repulsive forces in shaping a scenario. Attracting attributes of future states might include their consistency with sustainability principles. Negative images can play an important role, as well, in raising awareness and guiding efforts to redirect the evolution of the system away from perilous conditions. In addition, there is the possibility that surprising and extreme occurrences — called *critical uncertainties* in the figure — could effect development. Many unexpected events could matter (e.g. a breakdown of the climate system, a world war, cheap fusion power, a major natural disaster, a rampant global epidemic), but probabilities cannot be assigned, nor can all the possibilities be imagined. From a sustainable development perspective, scenarios would be encouraged that minimize vulnerability of societal and environmental systems to unfavourable events and enhance their resilience.

Scenario formulation generally involves the following steps:

- the *boundary* of the analysis is specified in several senses — spatially (global, regional, sub-regional), thematically (coverage of sectors, issues), and temporally (the time horizon of the analysis)
- *current state* is described across a range of dimensions — economic, demographic, environmental, institutional and so on
- the important *driving forces and trends* that are currently conditioning and changing the system are introduced
- a *narrative* or story line provides the plot by which the scenario stories unfold (often quantitative indicators are used to illuminate aspects of the scenarios)
- an *image of the future* paints a picture of conditions at one or more points in time

Some scenarios are "forecasts" that describe how alternative futures might develop from current conditions and driving forces. Others are "backcasts" that begin with an image of the future and seek to identify plausible development pathways for getting there.

The GEO Process

The United Nations Environment Programme was mandated to assess long-range environmental issues through its Global Environment Outlook (GEO) Project launched in 1995. UNEP's GEO project has used a **scenarios-based approach** in order to assess long-range future options that involve such unpredictable aspects as ignorance, surprise and volition. The GEO process has been cross-sectoral and participatory with the aim to develop scenarios that incorporate regional views and perceptions, and build consensus on priority issues and actions through dialogue among policy-makers and scientists at regional and global levels. Through this process, four scenarios have emerged:

- *Market Forces*: market-driven global development leads to convergence toward dominant values and development patterns
- *Policy Reform*: incremental policy adjustments steer conventional development toward environmental and poverty-reduction goals
- *Fortress World*: as socio-economic and environmental stresses mount, the world descends toward fragmentation, extreme inequality and widespread conflict
- *Great Transitions:* a new development paradigm emerges in response to the challenge of sustainability, distinguished by pluralism, planetary solidarity, and new values and institutions

These scenarios are depicted graphically in Figure 1.6.

Figure 1.6 Global Scenarios Structure with Illustrative Patterns of Change

China's future will be shaped by the choices made by the Chinese both now and in the future in response to changing social, ecological and economic circumstances. Alternative development paths are open to China and can be effectively examined through an exploration of plausible scenarios. Two of the GEO scenarios that had been developed for China and East Asia are further explored in this report, Market Forces, renamed the ***Perilous Path***, and Policy Reform, renamed the ***Green Reform Path*****,** and described in more detail in the red-shaded Scenario Boxes that follow in the report. These two scenarios, adapted to represent China alone, do not represent large deviations from the current trends in development, and are in that sense conservative images of the future.

Also environmental change in itself imposes a large degree of uncertainty on China's future. As chapter 2 illustrates, many of China's environmental changes are close to critical thresholds, where natural resources, as well as land and water ecosystems begin to deteriorate rapidly. This perilous trend constitutes threats to China's future development. The positive signal is that the government and Chinese people are responding to these threats. But are the responses adequate, and are they sufficient to halt and reverse the negative trend? A closer examination of the current state of the environment, the driving forces behind those changes, and the on-going responses, will help the world's most populous country meet these challenges and uncertainties and embark on a sustainable path.

Chapter 2

State of the Environment

It takes little insight to recognise that the large and still increasing population, the unevenly distributed and rapidly depleting resource stocks, and the widespread deterioration of environmental conditions are inextricably related in China.

This chapter outlines the current state of the environment in China by looking at how the natural environment is affected by and is affecting various human processes, human health included. The chapter starts with a general account of the land resources, followed by a broad description of the current status in terms of biodiversity, water, air quality, solid waste, and their impacts on human health. The chapter rounds up with a brief summary of the socio-economic costs, and the regional variations of the environmental impacts.

2.1 Land Resources

Throughout history, the relationship between land resources and human development in China has been multifaceted.

On the one hand, history shows an element of resilience. For longer than any other agrarian civilization, farmers have tilled and tamed China's soil, tapped its water resources and used its forest and pastures, creating a legacy of abundance and sustainable land use. Despite a population of nearly 1.3 billion, China has harnessed its resource base to fuel the drive toward modernization, providing most of its citizens with sufficient food, clothing and housing, as well as a wealth of reasonably priced products for its rapidly growing urban and industrial economy.

But on the other hand, this development has concurred with a disquieting widespread degradation of land resources. With one-fifth of the world population and over two-thirds of the country's land area as mountains and deserts, China has always been stressed by scarcity of land suitable for human settlement and development. In recent decades—largely as a result of rapid economic growth, and despite numerous remedial government programmes—this already strained people–land relationship has been further intensified and alarmingly worsened with widespread grassland destruction and desertification, deforestation, soil erosion, salinisation, land pollution and biodiversity loss.

Grasslands

"Lambs and cows are spotted everywhere when the wind lowers the grass".

This childhood pastoral poem evokes the image of China's northwestern grasslands for many middle-aged Chinese. But the image no longer holds in reality. The grasslands of the northwest have been receding at a rate of about one million hectares every year. China still has 40 percent of its territory classified as natural grasslands. But 90 percent of this has been degraded to varying degrees (SEPA, 2001).

China has a total of close to 400 million hectares of natural grasslands, distributed mainly in the arid and semi-arid north, northeast and northwest where annual precipitation is less than 400 mm (see precipitation map in figure 1.2). Constrained by the limited and highly variable rainfall, high slopes and elevation, most of the grasslands in China are either of low productivity or difficult to access.

About 100 million people live in grassland regions, of which 11 million are herders, whose livelihoods depend on grassland. Nearly three-quarters of the grassland is used for livestock grazing, and roughly one-fifth for harvesting of hay. Because of low productivity—merely one-third of the world average—and the Chinese preference for pork and poultry above beef, grassland contributes less than 10 percent to the meat production in China, compared with 70 percent in the US which has a comparable size of pastureland (Liu Jiang and Zou Lianwen, 2000).

Widespread degradation has reduced the grassland biomass by 30-50 percent since 1950. It also has decreased biodiversity, and the grassland capacity for watershed protection, contributing to ecological imbalances well beyond the grassland areas themselves. An example is the increasing occurrence of sand storms in the Beijing region during recent years, and the fact that they are so extensive that sand can now be tracked eastwards by weather satellite across the Pacific Ocean.

The situation is critical over large areas, driven by a number of concurrent, destructive processes including conversion of grassland to cropland, overgrazing, transition from nomadic to sedentary pastoralism, changing diet, and unclear property rights.

Conversion of Grassland to Cropland

The rural roots of the Chinese Communist Party and the need to feed a starving and continuously increasing population have made policies to boost agricultural production a centrepiece of the Chinese development strategy since the early 1950s. By single-minded promotion of crops, almost 20 million hectares of grassland—or five percent of the present grasslands—were converted to croplands, by state-owned farms, state-owned forestry operations, and other state-owned enterprises. Labelled "newly claimed virgin croplands" in the 1950s, these are now severely degraded. The trend continued over the last few decades. Recent government surveys by the Ministry of Agriculture in 34 counties in east Inner Mongolia indicate that, between 1986 and 1996, a total of almost one million hectares of grasslands were converted to irrigated crop production. Conversions nationwide have resulted in desertification of a staggering estimate of eight million hectares of grassland (Wu *et al*., 1999).

Overgrazing

Grassland in China, mostly regarded as common property, suffers a schoolbook case of the "tragedy of the commons": overgrazing is widely held to contribute to destruction of grassland ecosystems, which in turn leads to reduced capacity to raise livestock in the future. Still, there is no incentive for the individual herder to limit grazing to what would be sustainable as long as others benefit from the free pastoral resources. Estimates of the level of overgrazing range from about 30 percent above carrying capacity in northern China as a whole (Zhao Yongxi, 1998), to 15 percent in Qinghai, 60 percent in Inner Mongolia, 130 percent in north Shaanxi, 150 percent in northwest Shanxi, and a staggering 250 percent above carrying capacity in Ningxia. The total sheep population grew from 170 million in 1978 to 256 million in 1997, at the same time as the grasslands were continuously degraded. However, the debate surrounding carrying capacity of grasslands in northern China is not resolved.

From Nomadic to Sedentary Pastoralism

Partly contributing to grassland degradation in China is the shift of pastoralism—from traditionally mobile to a more settled operation. This has been a government policy aimed at improving the living standards of nomadic herders. By settling down, herding families get better access to water, energy supply, and other infrastructure, as well as to markets. Over the short term, stationary herders also tend to have more livestock—a display of affluence. Mobile herding on the other hand, though appearing harsh on herders' lives can give grasslands time to rejuvenate. The damage to the grasslands due to settled herding has been evident in Inner Mongolia and other Central Asia regions.

Transition in Diet Structure

Although international trends are in favour of more vegetarian diets, access to meat in China still means a better life. Chinese people are consuming an increasing amount of meat. It is estimated that from 1980 to 1998, the annual consumption of meat including pork, poultry, beef, and lamb increased 2.5 times. Pork still accounts for more than half of consumption, but shows the lowest growth (Ma Hengyun, 2000). The rising demand has pushed up prices, therefore creating incentives to raise more livestock.

Property Rights Ambiguity

The rural *Household Responsibility System*, established in the early 1980s, was not well adapted for herding. Livestock and other mobile means of production were redistributed from the collective to the household level, while pastoral land remained a freely accessible collective resource. No controls were imposed on how much livestock could be raised on a particular piece of pastureland. With increasing demand for meat and rising prises, there were strong incentives for herders to raise livestock at levels far above the carrying capacity of the pastureland.

Incentives are now in place to help stop grassland conversion, and policies are redirected towards promoting livestock and animal husbandry. In the late 1980s when grassland degradation worsened, the government developed national programmes including promotion of artificial grasslands, setting up of grassland reserves, as well as numerous attempts to restore degraded grasslands, both through active and usually labour-intensive interventions, and by fencing off degraded land to let it recover naturally.

In the 1990s individual property rights have been strengthened through allocation of grassland to individual herders using long-term contracts. Herders can now plan over the longer term with more incentive to invest in the land and manage it in a more sustainable way. By the end of 1995, about half of the country's pastoral areas had been contracted out to pastoral households (SEPA, 2000). The transaction costs, however, turn out to be very high. They include monitoring, enforcing and delineation of boundaries, adjudication of disputes, and monitoring and enforcement of contractual provisions related to grassland management.

Forests

Five millennia of Chinese civilisation have had a profound impact on forests, and there is no clear picture today of the changes of forest coverage that have occurred through history. It is still reasonable to assess that most of the original forests have been lost to agriculture and urban use. Much of this land conversion occurred centuries ago, and in some cases the land has changed further into grasslands or barren areas.

While in the past, major causes of deforestation were extension of agriculture, felling for construction materials, but also campaigns of burning of forests for military defence purposes. Presently, the major cause is the unsustainable exploitation of forest products, mainly wood. Chen (1998) claims that every year, over 1.1 million hectares, or about one percent, of forest disappear due to over-extraction. For example, over-extraction reduced forest coverage on the upper reaches of the Yangtze from 30 to 40 percent in the 1950s to only 10 percent by 1998.

From forest coverage in 1949 as low as 85 million hectares (less than one-tenth of the country), China now has about 160 million hectares covering about 17 percent of its land surface (China Statistical Yearbook, 2001). Even though the overall trend is increasing, the per capita forest coverage in China is still very low, at approximately 0.1 hectares, less than one-fifth of the world average, one-tenth of the US average, and one-twenty-fifth of that of the former USSR (FAO, 1997).

Geographically, more than two-thirds of China's forest resources are located in the northeast and southwest of the country (see figure 1.3) and most of the remaining areas are scattered in the south-central zone. In terms of distribution among provinces, Heilongjiang Province has the largest forested land area, accounting for 12 percent of the national total. In terms of timber stock, Tibet owns more than one-fifth of the national total.

The Continuous Reforestation Struggle

Since 1949, and especially during the past two decades, continuous efforts have been made in China on reforestation. About 50 million hectares were planted between 1980 and 1993 alone. In recent decades, the primary goals have been broadened from solely increasing growth production to maintaining and enhancing various ecological functions such as preventing desertification, coastal erosion, and reducing runoff in river basins. Efforts to increase forest cover received a further boost in 1998 as widespread deforestation in the upper reaches of the Yangtze River was identified as one of the main contributing factors to the devastating floods in the middle and lower reaches.

Official figures state that a total of 250 million hectares are classified as suitable for forest plantation and growth. If all this area were to be forested, which is a long-term goal for ecological reconstruction, a quarter of the Chinese land area would be forested—a change that would have far reaching consequences for China's entire ecological situation. However, even with a total population not exceeding 1.5 billion, per capita forest cover would be a mere 0.17 hectares, still very low compared to the world average. And moreover, China is very far from carrying out such an impressive reforestation effort, even if it would be feasible.

The Declining Quality of Forests

Notwithstanding an increase in forest coverage of eight percent, half a century of backbreaking reforestation efforts has not improved the quality of forests; in fact there is evidence of the contrary. It is common knowledge that the large, ambitious reforestation programmes launched in succession since the 1970s have reaped poor results. This is partly due to lack of management, particularly the need to care for saplings once planted.

A commonly accepted indicator of quality is the age of standing trees. Official figures from four consecutive forest censuses from 1973 to 1993 show that the percentage of mature trees in forest stands declined from over 36 percent to less than 28 percent (*National Forest Resource Statistics*, Forestry Dept of China). Still, many experts believe these figures significantly underestimate the decline in China's forest quality. Smil (1993) concluded that there is probably very little mature forest left in China at all, and that the wood mass volume per square kilometre is only one-third of that of natural forests.

The picture thus evolves that China loses high quality mature forests in the northeast and southwest, while at the same time trees are planted in other parts of the country, but for other purposes. A large part of the reforestation campaigns have been carried out to protect against erosion, and have mainly been directed to marginal, agricultural land in hilly, desiccated areas such as Shaanxi, Inner Mongolia and Yunnan.

Another important issue that has been raised more recently concerns the lack of attention to biodiversity issues when carrying out large-scale reforestation. Much of China's forests are monocultures, a result of large-scale planting of single species. Lacking diversity, such forests do not provide the same range of ecological services as natural forests do and are much more sensitive to fire, climate fluctuations and disease.

From Timber to Biodiversity Services

Forest degradation affects families and rural communities whose livelihoods may be threatened by direct or

indirect consequences of the declining forestry qualities, but also the regulations imposed in order to protect unsustainable use of forestry products. However, in the larger societal picture, forest degradation is intimately linked with land degradation, leading to a vicious downward cycle including lower agricultural productivity, water shortages, soil erosion, and the inability of degraded and denuded forests to hold water and help buffer flooding.

The contributions of forests to the economy are often long-term, intangible and informal, and hence difficult to value in monetary terms. However, some figures can be linked to the contribution of forests to China's economy. With a consumption level of about 300 million cubic metres of standing stock, China is the world's third-largest consumer of timber. FAO estimates that China imports approximately 12 million cubic metres of timber, at a value of over USD 5.5 billion, while exports are estimated at a mere USD 824 million (FAO www.fao.org).

The biggest commercial users are the pulp and paper, and construction industries. Other estimates suggest that two-thirds of the wood harvested in China is burned as non-commercial fuel (FAO, www.fao.org). In 1995, approximately 15 percent of the energy supply for China's 880 million rural people was provided by wood (from Zhou Dadi, SDPC).

Implementation of a nationwide logging ban has reduced timber production dramatically in the last two years. Domestically, this reflects a shift in the function of forests from supplier of timber to supplier of water, biodiversity, and a stable climate. At the same time, however, it shifts the problem of deforestation to countries that do not have effective law enforcement mechanisms. The Russian Far East, Southeast Asia and Brazil, amongst others, have become increasingly important timber and forest products suppliers for China.

Management and Mismanagement

Most forests in China are owned by the state or by collectives. Managers of state-owned forests are charged with the contradictory goals of making profit while at the same time keeping large workforces employed. Forestry management is not well monitored, and there are strong incentives for managers to sell products through the black market. The combination of perverse incentives and poor regulation is part of the explanation for the serious degradation of state-owned forests. Collectively owned forests have fared a little better.

Forestry management is presently going through a major restructuring in line with the basic principles of the rural Household Responsibility System. Research shows that given adequate incentives and basic tenure rights, these measures can increase productivity while at the same time improve protection of forest resources. The institutional forces affecting deforestation and the national response to these forces are discussed in more detail in chapters 3 and 4.

Cultivated Land

Arable land is scarce, with only 13 percent of the total land area—about 135 million hectares—being used for agriculture (Heilig, 1999). With only 0.1 ha of arable land per capita, China's population pressure on agricultural land is among the highest in the world, compared with the world average of 0.24 and the European Union allotment of 0.22 ha per capita (World Bank, 2001).

The overall quality of cultivated land in China is low with almost four-fifths being classified as medium and low productivity. About 30 percent of the cultivated land suffers from various degree of soil erosion, and only 40 percent has access to irrigation (Liu Jiang and Zou Lianwen, 2000).

The trend for cultivated land in China is the shrinking of high yield land and expansion of low yield land. The overall change is still under debate but consensus exists with regard to the structural change. In the northwest and northeast of China, the area of cultivated land is increasing. Cultivating more land is still the means to feed more people there. In the coastal areas of East China, however, cultivated land, especially the fertile land, is being converted to industrial and urban development. The overall land productivity is thus dropping.

Despite the land scarcity and the trend to shrink high quality cultivated land, current land use is far from being economic and careful. The land is often under-valued, and there exist plenty of examples of land misuse. According to a survey in 1997, the land purchased by the government but left unattended, amounted to 116,000 hectares, more that half of which was valuable cultivated land (Liu Jiang and Zou Lianwen, 2000). Another form of land misuse has been the conversion of forests and grassland into cultivated cropland in ecologically fragile areas, which has led to increased soil erosion and desertification. With the further economic growth linked to WTO entry, management of cultivated land in China probably will have an increased focus on enhancing land productivity to reduce the need for more land.

Land Degradation

Accompanying its rapid economic growth, China today suffers from severe land degradation, the extent of which has few parallels in the rest of the world. Erosion, desertification, salinisation, and pollution further reduce the usability of land resources that are already conspicuously scarce in relation to China's large population.

Erosion

With about two-thirds of its territory classified as mountainous, much of China's land is inherently vulnerable to

erosion due to high slopes and sensitive soil. Areas that fit this description cover most of the seriously eroded lands in China, including the Loess Plateau and the red soil area in the southwest. Soil erosion in the Loess Plateau—amounting to more than 2 billion tons of top soil being washed away each year—is mainly due to the soil being inherently low in organic matter and clay content, which makes it easy to cultivate but highly susceptible to water and wind erosion.

Much exacerbated by human activities, the soil of China makes it one of the most seriously eroded countries in the world. Nearly two-fifths of the total land area, suffers from various degrees of soil erosion—an area that includes half of the country's cultivated land (Yan, 1994), and more than two-thirds of its grassland. Even more worrisome is the increasing trend. All existing studies show that, in the last decade, land that suffers erosion has increased significantly, by somewhere between 20 to 30 percent. The most rapid increase has occurred in southwest China and the region along the mid-lower reaches of the Yangtze River.

Erosion has posed enormous threats to the limited land resources and reduced productivity further. Along with the eroded soil, millions of tons of nutrients are lost to the coastal zones each year. As a result, more than half of the cultivated land is potassium-deficient; about half does not contain adequate trace elements; and more than three-quarters is deprived of nutrient renewal (see box 2.1). As much as poverty has driven land erosion, land erosion has forced people into poverty. Official reports point out that more than 85 percent of the poverty-ridden counties are located in serious land erosion regions.

Desertification

More than a quarter of China's land area is desertified. Except for natural deserts such as the Taklamakan where very few people live, roughly 40 percent of China's deserts are located in areas with high population density and intensive human activities. In addition almost 4 million hectares of farmland and 5 million hectares of grassland are threatened by desertification.

Recent decades has witnessed an increased rate of desertification. Between the 1950s and 1970s about 1,500 km^2 of land each year have become desertified. In the 1980s, the rate has increased to more than 2,000 km^2 annually, and now China loses alarmingly 2,500 km^2 of land to desert every year (Liu Yingqiu, 1999).

Desertification often occurs where agriculture and husbandry meet, partly the consequence of policies, which for years favoured agriculture over husbandry.

Salinisation

Farmland salinisation causes significant decline in productivity. Recent estimates put the salinised land area in China somewhere between 80 and 100 million hectares, about ten percent of which is cultivated land. This is mostly concentrated in the flat, water-scarce and groundwater-irrigated areas in the North China Plain, and the northwest dry areas, such as Xinjiang and Inner Mongolia. Salinisation in these regions is usually the result of poorly developed irrigation systems, either inadequate application of water or low-standard drainage. North China Plain—mainly covering Beijing, Tianjin, and the provinces of Hebei, Henan, and Shandong—suffer the most serious salinisation. Though covering only four percent of the country's total land area, the salinised land in this region accounts for 30 percent of the national total. Provinces or autonomous regions with more than one million hectares of salinised land are Xinjiang, Hebei and Shandong.

Pollution

About 10 million hectares of farmland in China are polluted, leading to an annual loss of 20 billion kilograms of staples worth USD 1.5 billion per year (Liang, 1999). Among the major sources of pollution are industrial and municipal solid wastes, acid rain, wastewater used for irrigation, remains of plastic film, and excessive use of chemical fertilizer and pesticides.

Box 2.1 The Black Soil Layer of Northeast China Might Disappear in 50 years

The black soil region in northeast China is one of the three major black soil regions in the world. It is mainly distributed in the provinces of Heilongjiang and Jilin, with a total area of 117,800 km^2. The highly fertile soil contains one of the major grain belts in China, producing about 10 million tonnes of commodity grains per year. Due to water scarcity and destructive human activities, soil erosion in this region has created ecological deterioration.

The Ministry of Water Resources report water-related soil erosion in the region has impacts on 44,700 km^2, or 38% of the total area, with top soil losses averaging 0.3 to 1 centimetre per year. Back in the 1950s the black soil layer had a depth of 60 to 70cm; more than half of which is now gone. In areas where the entire black topsoil layer has been eroded, the land has lost most of its productivity. It is estimated that the existing black soil layer of the farmlands will be completely eroded within half a century should current rates of soil erosion continue.

Annual economic losses due to lower soil fertility are estimated at between USD 50 and 100 million. In addition, the erosion has resulted in ecological deterioration and more frequent floods, drought and sand storms. The serious floods in the Songhuajiang and Nenjiang River basins in the summer of 1998 caused direct economic losses of USD 8 billion. Apart from the enormous rainfall, a major contributing cause was the serious water and soil erosion in the upstream and middle stream areas of the rivers.

Source: Wang Libin, *Daily Tele-Messages*, p. 1, 2000-07-26, Beijing. Xinhua News Agency.

Solid wastes, commonly dumped in suburbs of large cities, have caused pollution in 20,000 hectares of farmland (Wang Junping, 1999). Acid rain now affects about one-quarter of the total land area in the country (SEPA, 2000). Wastewater irrigation, a practice in China for a long time, has caused serious soil contamination. With most of industrial and municipal wastewater still discharged directly into water bodies without prior treatment, nearly a quarter of the rivers in China fail to meet irrigation standards (Liu Jiang and Zou Lianwen, 2000).

Excessive use of chemical fertilisers and pesticides causes serious soil pollution. Pesticides, when applied inappropriately, pollute agricultural products. According to a sample survey conducted by the Ministry of Agriculture, almost 20 percent of inspected livestock products fail to meet state contamination standards. Pesticide residues have been found in more than half of the foods grown and produced in suburbs of large cities (Shao Wenjie and Deng Min, 2000).

Plastic film is now widely used in China to increase plant productivity. However, the remains of film pollute farmland and stunt the growth of crops, reducing crop production up towards 20 percent (Zhang Chengyuan, 2000). As much as 20 percent of the film is left on farmland after use. China has an average amount of 60 kilograms per hectare plastic film residue (SEPA, 2000).

2.2 Biodiversity

China's flora and fauna are among the richest in the world; yet biodiversity is under severe pressure from population growth and economic development.

China accounts for one-tenth of the world's animal and plant species. The richness of biodiversity rests on a wide variety of habitats and ecosystems, largely results of China's vast territory, complex climate, varied geography, large river networks, numerous lakes, and long coastlines. In addition, China holds a number of rare, precious species of animals and plants that are extinct in other parts of the world, including the giant panda, the Yangtze River dolphin, the dawn redwood, and the Cathay silver fir.

China's ecosystem diversity comprises a variety of biotopes including forest, scrubland, meadow, steppe, savannah, desert, tundra, marsh, marine, rivers, and lakes. It is the combination of diversity in species and ecosystems that provides the foundation for rich genetic diversity—between different species and within the same species. And this genetic diversity is vital for the ability of both ecological and social systems to adapt and evolve when faced with environmental changes.

The Value of Biodiversity

The affluence in biodiversity has played a decisive role in shaping China's cultural diversity, providing an outstanding range of products and valuable ecological services.

Estimates of the monetary value of ecological services associated with biodiversity indicate the vital importance of preserving biodiversity. A conservative estimate of the total value of both ecological products and services in China arrives somewhere between USD 257 and 421 billion per year (BWG/CCICED, 1996). Table 2.1 breaks down the various values associated with biodiversity in China.

Table 2.1 Estimated Economic Values of Biodiversity (BWG/CCICED, 1996)

Item	billion USD/yr
Carbon sequestration of forest	140 – 200
Soil and water conservation of forest	20 – 48
Recreation and Tourism	20 – 30
Agriculture production	6 – 8
Direct harvest of foods from nature	5 – 7
Firewood supply	5 – 12
Medicinal plants/animals	5 – 20
Timber and construction wood	8 – 15
Rattan/bamboo	4 – 6
Wildlife heritage and keystone effect	4 – 7
Fisheries	15 – 20
Contribution to animal husbandry	4 – 6
Carbon sequestration by rangelands	7 – 17
Environmental cleaning services	14 – 25
Total products and services	**257 – 421**

Biodiversity Losses

Preservation of biodiversity is indispensable to sustainable development, and the loss of diversity at any level—species, ecosystem, or genetic—reduces the ability of natural and social systems to respond to changes in the environment. Biodiversity in China is seriously threatened by human activities including deforestation, overexploitation of animal and plant resources, pollution, and introduction of invasive species. Estimates from China's Red Data Book of endangered species show that more than one-tenth, or more than 500 vertebrate species and about 15-20 percent, or about 4,000-5,000 species of higher plants are endangered (Biodiversity Committee/ CAS, 1992). The dominating causes of biodiversity losses are biotope destruction, pollution, and wildlife trade.

Destruction of Biotopes

Logging and land reclamation are two of the most serious causes of biotope destruction in China. The sharp reduction in natural forests directly threatens the sur-

Box 2.2 The Value of Biodiversity—Not only a Matter of Caring for Pandas

The value of biodiversity goes far beyond caring for threatened species as such, and includes innumerable examples of products and services that are essential for human society.

Making use of a rich resource of wild crop strains more than 5,000 new varieties of 41 crops were bred in China from 1949 to 1992, and have contributed significantly to improving agricultural yields (Hou Xiangyang and Gao Weidong, 1999). Today, half of the rice-producing areas are planted with hybrid crops developed from wild kindred species. At the same time the elaboration of new species or varieties of species is always associated with the risk of creating invasive species, which proves so strong that they take over and threaten to destroy entire ecosystems.

The WWF estimates that currently, over 40 percent of the drugs prescribed worldwide are based on natural resources. In China the medical benefits from biodiversity are particularly important given the important role of traditional Chinese medicine. A recent large-scale national survey indicates that there are over twelve thousand types of traditional Chinese medicine, most of which come from wild sources that depend on the existence of a natural ecosystems. But the increasing interest in, and demand for Chinese medicine pose a serious threat to biodiversity. In the last five years the sale of Chinese traditional medicine in Britain increased 70 percent, while that in America increased 280 percent in the last ten years, and 28 out of the 426 medicinal plants that appear in the 1995 Chinese Encyclopaedia of Medicine are listed in the Chinese red list of endangered plants (Zhang Endi and Zheng Hanchen, 2000; BWG/CCICED, 1997 and 1999).

Biodiversity also provides the backbone for tourism, and is a prerequisite for eco-tourism. By the end of 1999, China had established more than one thousand nature reserves, covering more than 8 percent of the national territory. In 1994, the total tourism income of all Chinese nature reserves was 30-50 million yuan, while forest parks received revenues of half a billion yuan. Tourism in general is an important source of income for China, and in 1999 the total tourism revenue was 400 billion yuan (Lu Dadao *et al*., 2001). But tourism is also a threat to biodiversity, including penetration of ecologically fragile areas, and the considerable amounts of pollutants generated not least from transportation.

vival of plants from lichen and moss to higher order species (Chen *et al*., 1993; MacKinnon *et al*., 1996). In addition, logging is responsible for creating fire-prone grassland that in turn, produces forest fires. Over the past 25 years, China has lost 8.6 million hectares of forest biotopes to fire.

Reclamation of forest and wetlands for agriculture and construction is another cause of biotope destruction. As much as one-third of China's current farmland may have been developed by reclaiming virgin forests, a problem which is particularly serious in the tropical areas of China.

Wetlands cover 25 million hectares and include some of the most biologically diverse, yet threatened ecosystems in Asia. Through the increasing pressures of human activities, wetlands have been closed off to extend agriculture, filled to accommodate urban development, and polluted by municipal, industrial, and agricultural effluents. Over the past half century, half of the coastal wetlands area has been transformed, and from 1950 to 1980 one-tenth of the total lake area in China disappeared.

Pollution of Biotopes and Poisoning of Organisms

Pollution is a significant cause of biodiversity loss, particularly in freshwater and marine ecosystems. Discharges of nutrients and organic matter from municipal, industrial, and agricultural sources cause eutrophication that leads to overgrowth of shallow water biotopes and wetlands. Chemical fertilisers, pesticides, heavy metals and other dangerous toxins from industrial and agricultural sources poison aquatic life, thwarting reproduction, causing genetic defects and killing aquatic organisms.

The decline of China's marine fishery resources began in the mid-1960s. During the 1970s, along with the large-scale exploitation of petroleum as well as the increase of industry and wastewater discharges, the pollution of coastal fishery waters became increasingly serious. Today, the total marine fishing area has been reduced by one-third. Pollution has also caused marine eutrophication, repeatedly setting off red tides and algal blooms that kill large numbers of fish, shrimp, and shellfish.

Trade in Endangered Species

In recent years wildlife trade has had a significant impact on biodiversity in China. With the increasing demands on wildlife mainly for food, traditional medicine, and fashion, illegal trade has increased dramatically and is now threatening the survival of several endangered species and diminishing populations of non-listed species.

The Consequences of Damaged Ecosystems

Recent as well as long-term changes over different parts of China reflect how loss of biodiversity reduces the ability of ecosystems to support human society. The flooding that hit large parts of eastern China in 1998 is partly explained by the loss of ecological services of forest biotopes to moderate the impact of heavy rainfall. Silting up of reservoirs, carrying enormous costs in terms of lost capacity and reconstruction, is partly the result of successive destruction of a naturally diverse vegeta-

tive cover to protect soils from eroding. Sharply reduced fish catches in coastal areas can be attributed to the impacts of pollution on marine habitats and spawning areas.

2.3 Water Resources

Water is arguably China's most critical resource. Nearly 700 million Chinese lack access to safe water, and consume drinking water contaminated with animal and human waste that exceeds the applicable maximum permissible levels for faecal coliform bacteria. With an average annual availability of just over 2,200 cubic metres of fresh water per capita, China does not qualify on the World Bank's list of water scarce countries. Still, China suffers some of the most extreme water shortages in the world.

Regional Disparities in Water Access

China suffers from substantial regional disparities in water access, a problem exacerbated by an unfortunate allocation of most of the arable land to the water scarce parts. The eastern part and the areas south of the Yangtze River account for 34 percent of the total land area, but have 81 percent of the water resources. Regions north of the Yangtze account for 47 percent of the land area, but only seven percent of the water resources; the semi-arid and semi-humid central and middle regions have 19 percent of the land area and access to 12 percent of the water. The distribution of groundwater resources is similarly skewed with the south having four times more groundwater deposits than the north.

Nearly half of China's population, 550 million people, live in critically water scarce areas in the northern half of the Eastern Monsoon Region—the river basins of Heilongjiang, Songhua Jiang, Liaohe, Haihe, Huaihe, and Huanghe; each basin providing annually less than 750 cubic metres per capita. This is also where most (58 percent) of the arable land is located with a corresponding need for irrigation. Still, a closer look reveals that the 130 million people in the Haihe River basin, where Beijing and Tianjin are located, and the 200 million in the Huai River basin share a mere 355 and 515 cubic metres per capita per year, respectively. The water situation in these areas matches the most water scarce areas in the world, with the alarming difference that in northern China there are several hundreds of millions facing absolute water scarcity (Johnson *et al*. 1997; World Bank, 1999).

The northern water scarcity is the result of monsoon climate that produces most precipitation in the southeast, where 2,000 mm per year is not unusual, with a decreasing gradient towards the northwest, where there are parts that may receive no rain at all over several years (see Precipitation Map, figure 1.2). Another feature of the monsoon is that almost the entire annual rainfall occurs during summer, leading to repeated occurrences of floods, such as the critical situation that developed over large areas of China during summer 1998. Large interannual variations add to the problem such that those areas subjected to flooding one year, may suffer drought the next, and that water shortages may strike areas also in China's less water-scarce southern regions.

A peculiar aspect of China's water resource situation is the fact that the western half of China lacks drainage to the sea. This interior drainage basin coincides roughly with the area with less than 400 mm annual precipitation, where rain fed agriculture is virtually impossible (see figure 1.2). The lack of drainage in combination with low precipitation and high evaporation make water resources in the west even more fragile and susceptible to pollution.

Water Usage

There is a battle going on that no one can win—that between increasing water demands and limited available water resources. Groundwater levels over large parts of the North China Plain have fallen due to over-extraction of water for irrigation and urban supply; water tables in northern towns and cities are falling in the order of one meter per year, and 300 out of 640 major cities face water shortages—in 100 cities the situation is severe (Wu *et al*., 1999; WRI, 1999). Many rivers in the North typically run dry during several months of the year. As a consequence, competition for water is increasing, particularly in the northern river basins, between urban, industrial, and agricultural consumption, and between upstream and downstream users.

The bulk of available water is used in agriculture, which consumes more than three-quarters of total withdrawals, mainly for irrigation. Yet, the increase in agricultural water consumption has been remarkably low, or less than 4 percent between 1980 and 1993. Industry is the second largest water user and accounts for just under one-fifth of total withdrawals. Between 1980 and 1993 water use in industry almost doubled, and in Southern China more than tripled. Municipal supply accounts for no more than 5 percent of the total, but shows the highest increase, 2.5 times, between 1980 and 1993 (Heilig, 1999).

China is wasting large amounts of water. Water-use efficiency is very low in all sectors, but particularly in irrigation, where traditional flood irrigation causes losses through evaporation of well over half of the precious water. There are also significant water losses due to outdated water supply infrastructure, bad maintenance, and poor management practices.

Water Pollution

What goes in must come out. The major part of industrial and municipal withdrawals is discharged back to rivers and lakes, polluted with bacteria, organic matter,

nutrients, and toxic substances. Agricultural withdrawals are consumed largely by biomass production, but the remaining agricultural drainage water contains ever-increasing amounts of pollutants such as fertilisers and pesticides.

The combination of scarce water resources and high pollution pressure is lethal—for ecological systems, for the economy, and for human health. More than 90 percent of urban river sections are polluted to the extent that the water is unsuitable for human contact; more than half of the river sections do not meet the lowest Chinese surface water standards, meaning that the water is not even suitable for irrigation (figure 2.1). Northern rivers show the most degradation.

Industry is the largest source of water pollution in China accounting for more than half of the total wastewater discharge not including unmonitored township and village enterprises (TVEs) and smaller industries. An absolute majority of industrial wastewater is untreated or has passed only a rudimentary pre-treatment process. Facilities for treating industrial wastewater are poorly maintained, often operating with outdated technology, and recycling of process water is minimal. Statistics show a slight decrease in pollution discharges from regulated industry starting from the mid-1980s—a figure, however, that ignores the substantial increase in pollution discharges from TVEs that has accompanied booming rural industry.

Less than one-tenth of municipal wastewater receives some kind of treatment, while three-quarters of all urban areas lack adequate water supply systems (Johnson *et al*., 1997; Heilig, 1999). Municipal discharges tripled from 1981 to 1995—a 7 percent annual increase. China has a total of over 600 cities, but only less than 300 municipal sewage treatment plants, adding up to a capacity of barely 15 percent of the total discharges. Roughly 200 million people live in 20,000 small towns without any sanitation other than maybe pipes that lead wastewater to the nearest ditch.

And on top of this comes agricultural sources, including pollution from crop production and animal husbandry, as well as discharges from numerous countryside point sources such as TVE agro industries. Agricultural pollution varies across the country, but a study of Hangzhou Bay shows that agricultural sources were responsible for an absolute majority of the total organic pollution load to the Bay in 1994 (Johnson *et al*., 1997). The use of fertilisers and pesticides has doubled since reforms started. Fertiliser application now is three times the world average and higher than the European Union's (World Bank, 2001). Yet, the effectiveness of fertilisers is low, mainly because of overuse of low quality, fast ammonia bicarbonate, so called ABC fertilisers that

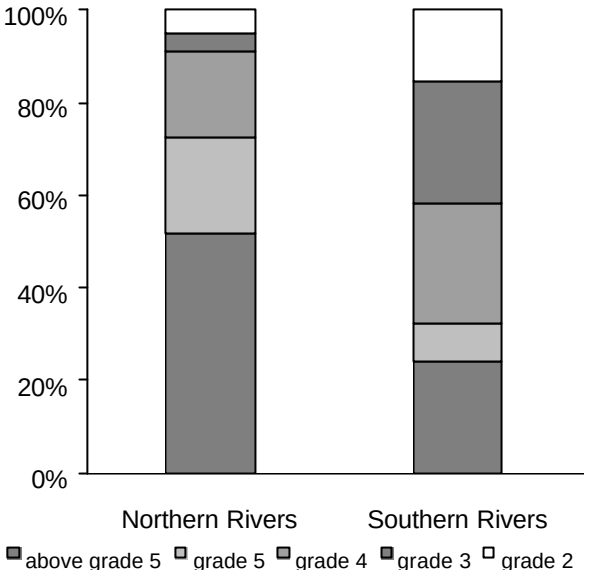


Figure 2.1 Water Quality in Urban River Sections (note grades 4 and 5 are not suitable for human contact) (WRI, 1998).

are cheap and easy to apply, but just as easily washed away.

Livestock production has tripled since reforms started in the beginning of the 1980s—faster than almost any other country—and much of the manure finds its way into streams and waters instead of being utilised as a much needed fertiliser and soil improvement agent.

Sinking Groundwater Tables

Excessive extraction of groundwater in China has brought about a funnelling effect causing sinking ground, fissures, seawater intrusion, and other serious environmental problems (Hongkong Far East Economy Review, 2000). There are over 50 areas in the country where this funnel phenomenon extends over 100 km^2. In Beijing, Shanghai and some other major cities, the funnel effect covers an area of over 1,000 km^2. The worst case is in the region of Wuxi, Changzhou and Suzhou in Jiangsu province, where the funnel effect covers a total area of over 5,000 km^2, which seriously threatens the social and economic growth of this region.

Rapidly sinking ground water tables have also caused subsiding ground level, a serious problem in cities where houses and other construction works are not built on bedrock. This is often the case for cities like Tianjin and Shanghai which are located in estuaries that rest on mighty flood sediments.

All major cities in northern China are critically dependent on groundwater, and the fact that these groundwater sources are sinking shows that the situation is not sustainable. If the trend continues, which it is

likely to do, the groundwater sources will be increasingly expensive to extract, and finally will be exhausted. In conclusion, this means that sooner or later northern China will have to rely on precipitation for water supply, the alternatives being expensive water transfer from the south or similarly expensive and energy consuming desalination of sea water.

Coastal and Marine Situation

All major Chinese rivers drain to the coastal zone and so do the mix of pollutants they contain. China's 20,000 plus kilometre-long coastline has suffered its most severe damage and degradation over the last two decades. Estuaries and coastal areas are threatened by increasingly intensive occurrences of red tides, oil spills and pollution from inland sources. The East China Sea and Bohai Sea have experienced worsening water quality in the last few years. The year 2000 witnessed the worst coastal water quality along the coasts of Shanghai, Zhejiang, Liaoning, Tianjin and Jiangsu with 28 occasions of red tides affecting about 10,000 square kilometres.

Pollution raises concerns over fish kills, seafood safety and public health, when more Chinese people are shifting their diet towards more seafood. One example is the vast wetlands to the east of the Jiaozhou Bay in Shandong Province. Once an important habitat for a number of shellfish species, uncontrolled discharge of industrial and household sewage into the coastal areas has damaged the wetland and almost completely depleted the biodiversity. Another example, from Shanghai and eastern Jiangsu Province, is the 1988 outbreak of Hepatitis A from consumption of contaminated mussels.

Recent reports have also mentioned sharp drops in fish catches from coastal waters (FAO, www.fao.org), most likely a combined result of pollution and over-fishing. The total fishing capacity of Chinese vessels in the East China Sea increased seven-fold between the 1960s and 1990s, at the same time as catch-per-unit declined three-fold. In coastal seas such as the East China and Yellow Seas, there has been a shift in catches from large high-valued fish to lower-valued smaller fishes, from demersal and pelagic predator fishes to pelagic plankton-feeding fishes, and from mature fish to immature fish. Reduction of fishing effort in some areas is considered an urgent priority.

Environmental problems affecting fisheries in the region include land reclamation, impacts of extensive mariculture, heavy metal pollution and oil spills. In the Yellow Sea, virus and bacterial epidemics are causing mortality of cultured shrimp.

2.4 Air Quality

Of all China's environmental challenges, the appalling levels of air pollution are the most obvious to foreign visitors as they step off the plane into almost any Chinese city. This instant recognition contrasts sharply with the standard response of the average resident of Chinese cities who is so used to the situation that it is no longer noticed, except on extreme days—and also when air pollution-related mortality statistics are released.

Air quality in many Chinese cities falls well below international standards. World Development Indicators (World Bank, 2001) shows that 16 of the world's 20 top polluted cities are Chinese. Although such ranking is changing constantly and depends very much on the monitoring system, it can be safely assumed that Chinese citizens are exposed to many of the worst air pollution levels. Figure 2.2 gives the example of how China's urban TSP (Total Suspended Particulate) levels compare to levels in London, Tokyo and Brussels.

A combination of conditions makes the situation the worst of all in the northern parts. Due to the cold climate, heating and energy needs are greater in the north. Winters in northern China are characterised by stable climatic conditions, leading to inversions—an atmospheric

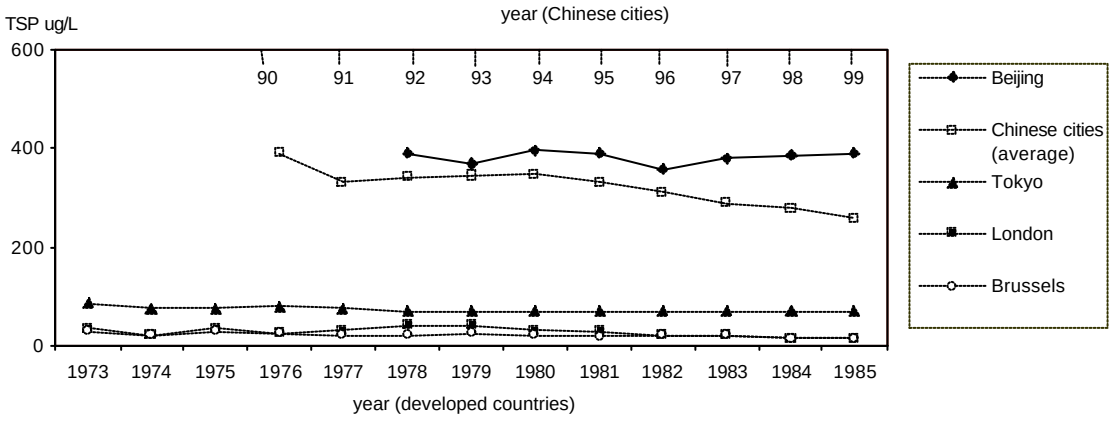


Figure 2.2 TSP Emissions in Chinese and other Cities

lid—that can cover northern cities for weeks leading to air pollution accumulating to extreme concentrations.

Status and Trends in Air Pollution

There is no standard or simple way to measure air quality. The Chinese authorities have developed a composite indicator—the *Air Pollution Index, (API)*—to indicate general air quality as a function of the levels of sulphur dioxide, nitrous oxides and total suspended particulates. The State Standards system is based on the API, with Grades I and II being considered suitable for long-term living conditions, Grade III acceptable for short-term exposures, while Grades IV and V are unsuitable for humans.

The three pollutants in the API have different sources, trends and impacts, and using a composite indicator can mask individual trends and dangers. It is quite possible for a site to have a safe API level, but at the same time dangerously high levels of one of the three pollutants, or indeed other pollutants not considered in the composite. In particular the API fails to capture the single most important factor to measure health impact, which is the amount of very small particles in the air, usually measured as $PM_{2.5}$, PM_5 or PM_{10}, each measuring the amounts of particles smaller than 2.5, 5, and 10 microns, respectively. The smaller the particles, the deeper they can penetrate into the human respiratory system, and monitoring campaigns in Beijing show episodes of very high $PM_{2.5}$ levels, particularly during periods of smog accumulation in the summer.

Of the 335 Chinese cities regularly monitored, only 33 percent met either Grades I or II in 1999, with over 40 percent falling into Grades IV and V (see figure 2.3). Hence almost half of Chinese cities monitored are unsafe by Chinese API standards. This percentage would certainly rise if the figures for each pollutant were known, and most Chinese cities experience unsafe levels of at least one pollutant. For example, using a different measuring system, only Haikou (Hainan), Sanya (Hainan), Xiamen (Fujian) and Beihai (Guangxi) met the WHO air quality directive.

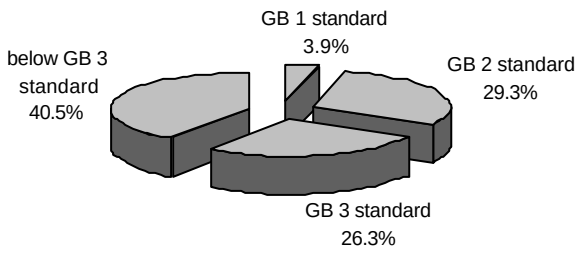


Figure 2.3 Ambient Air Quality in Chinese cities (GB is short for *Guo Biao* or *State Standard).*

The general trend in API levels across China shows a small improvement (figure 2.4) over recent years. Despite general progress, there are still many unacceptable cases of air quality in China, with, for example, Tai Yuan city having TSP levels 8 times higher than WHO standards. Also, there is reason to believe that some pollutants, such as TSP and SO_2 are being brought under control in some areas, whereas levels of others like NO_x are increasing. There is reason to fear that the recent trends are towards lower aggregate levels of pollutants, but that more harmful pollutants may increase, such as toxic and carcinogenic pollutants, or those small enough to penetrate the human respiratory system.

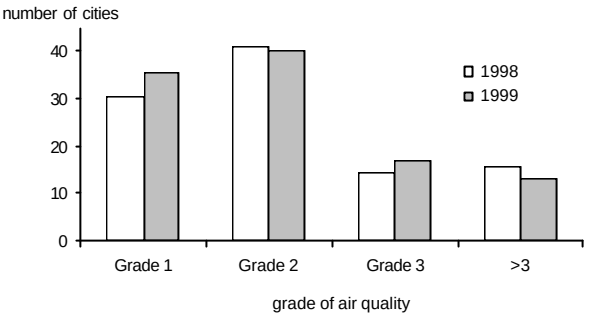


Figure 2.4 Ambient Air Quality in Chinese cities in 1998 & 1999.

Sources of Air Pollution

The principal sources of outdoor air pollution in China are power generation, energy use in industry, small-scale heating and cooking, road transport, construction, and ecological degradation—each having different causes, characteristics, and impacts.

The Traditional Evil—Energy, Heavy Industry, Heating and Cooking

For both industrial energy and power generation it is the large-scale, inefficient utilisation of poor quality and poorly prepared coal that leads to large emissions of pollutants. The main pollutants are sulphur dioxide (SO_2), carbon dioxide (CO_2) and soot. With the gradual implementation of sharper construction and discharge standards, newer facilities do generally show higher energy efficiency and have better pollution control equipment.

At the other end of traditional sources of air pollutants is small-scale heating and cooking, which used to fill Chinese streets with thick, sticky smoke saturated with soot and a mix of other pollutants. With the gradual, ongoing modernisation of Chinese cities, fuels have shifted from coal to coal gas or even natural gas, residential boilers have been upgraded, and street stall cooking on open coal fires is prohibited, while gas-based cooking is encouraged. As a result, the street canyon

levels of pollutants have decreased dramatically, with lower exposures to people as a result.

The New Evil—Increasing Motor Traffic

While urban areas have begun to alleviate air pollution associated with coal burning, they are gradually seeing a shift in air pollution sources. Since 1980, the number of vehicles has been growing annually at a rate of 20 percent in many urban areas. It is estimated that there are currently about 20 million motor vehicles in China, and the figure is expected to reach upwards of 50 million by 2010 (He, 2001; Wu, 2000). With the exception of greenhouse gas emissions, the main pollutants in transport exhausts are nitrogen oxides (NO_x), but given the poor level of maintenance, a wide range of toxic substances including lead, carbon monoxide, and hydrocarbons are very much a concern. As an example by 2010, Shanghai is expected to experience 75 percent of its total nitrogen oxide (NO_x) emissions, 94 percent of total carbon monoxide (CO) emissions, and 98 percent of total hydrocarbons (HC) coming from vehicular emissions.

A recent study in Beijing revealed that at all monitoring points within the Third Ring Road—roughly delineating the downtown area—CO levels exceeded the national standard of 4 micrograms per cubic metre persisting over a day. During the summer, ozone concentrations, which are measured on an hourly basis, repeatedly exceeded the national standard. In addition, concentrations of N_2O have almost doubled over the past decade. Besides forming secondary particles, vehicular exhausts also cause "photochemical smog". First witnessed in Los Angeles, such smog irritates the eyes and respiratory system. Most larger cities in China experience similar episodes.

So far there is only one area where Chinese authorities have really taken action to solve the problem—the phasing-out of leaded gasoline. Started in late 1997 in a few big cities, the programme is now implemented nationwide, and no leaded gasoline is supplied in cities any more. But this does not eliminate the effects of lead exposure from the past. China does not perform routine monitoring of environmental concentration or blood lead levels and only a few studies exist. These data suggest that ambient lead levels in the urban area of major cities such as Beijing are usually 1 to 1.5 micrograms per cubic meter—the national standard is 1 microgram per cubic meter. In some areas, ambient lead levels can reach as high as 14 to 25 micrograms per cubic meter. The health effects are significant, in particular to child development.

Blowing in the Wind—Dust from Construction Sites and Ecological Degradation

Construction is widespread and poorly regulated in China, leading to huge emissions in total suspended particulates (TSP), and in some localised cases more dangerous pollutants—although few figures exist describing this phenomenon. In addition to construction, ecological destruction is another main contributor to high levels of TSP in much of north China, as sand storms have become more frequent as witnessed in northern cities like Beijing.

Acid Rain

Acid rain is the result of SO_2, CO_2 and NO_x emissions dissolving in atmospheric water to form acids, which are deposited in the form of rain, fog or mist. In the 1980s, areas affected by acid rain covered large parts of Guangdong, Guangxi, Sichuan, and Guizhou. By the 1990s, this area had grown considerably, and included large parts of Hunan, Jianxi, Fujain, Shanghai and Shangdong provinces. By 2000, nearly one-third of China was affected.

Box 2.3 Beijing Road Traffic Air Pollution

Beijing is a typical case where traffic causes serious air pollution. The number of vehicles registered in Beijing reached 930,000 in 1995 which was the highest in China (Song Ruijin *et al*., 1998). In 1991, automobile exhaust contributed to 58% of the CO concentration in the atmosphere, 69% of the NO_2 concentration and 87% of the HC concentration. At 8 traffic crossings in Beijing, measurements in 1998 by the China Preventive Medical Science Academy (Song Ruijin *et al*., 1998) showed that CO exposure levels were as high as 41 mg/l or 13 times the ambient CO level (3.1-3.5 mg/l). CO_2 was as high as 0.612 mg/l or 12 times the WHO air quality index. Size of automobile exhaust particles were mainly below 2 microns, small enough to deeply penetrate the respiratory system. Using dose-response relationships, the life expectancy of traffic police in Beijing has been calculated to be roughly 40 years.

The consequences are exceedingly costly, one estimate putting the economic cost of acid rain at 110 billion yuan in 1995, or almost 2 percent of the GNP. Impacts include damage to agricultural crops and forests, reduction in food production, destruction of lake ecosystems, and damage to buildings. Guangxi province is estimated to experience a 5-10 percent general reduction in food crops, and since 1980, 85 percent of pine stands in forest areas have been affected, with the death rate reaching 35 percent. Figures on damage to buildings are less complete, but examples abound, for example the Jialingjiang bridge in Chongqing has been seriously corroded, and must be treated and repainted each year. No comprehensive studies have been undertaken of the impact of acid rain on lakes and human health (Draft United Nations Common Country Assessment on Environment and Energy, Sept.1999).

Indoor Air Pollution

Indoor air pollution is an often-overlooked major health risk problem that includes the effects of fuel burning, passive smoking, cooking-oil emissions, and gases released from home decorations. And the problem is not limited to poor, rural areas. One study of recently decorated buildings showed bacterial levels to be double the allowed standards, and volatile organic compounds reaching 10 times Chinese standards and 30 times the WHO index (Wang *et al*., 2000).

Indoor fuel-burning causes the greatest problems in rural areas. Indoor air pollution is poorly recorded worldwide, but dose-response calculations indicate major contributions to health problems in rural areas. A study from Xuanwei country in Yunnan Province indicates a high correlation between indoor levels of smoke and associated carcinogenic compounds and lung cancer, where the annual age-adjusted lung cancer mortality rate reached over 26 per 100,000, compared to the national average of 3.2 for women and 6.3 for men (He, 1990).

Regional Variations

In general, air pollution in the north is more serious than in the south, especially in winter when coal is burned for heating and when thermal atmospheric inversions are common. Cities along the south-eastern coast are faced with complex air pollution problems caused by increased vehicle use, the ensuing photochemical production of smog and ozone, and increased industry emissions.

Most air pollution problems in China follow industrial and urban development. TSP and SO_2 problems are found in cities where industrial development was promoted, mainly in the northeast and in industrial centres across central and into southern China. NO_x problems are increasingly focused in cities with high car densities. Figure 2.5 shows the distribution in API levels between major cities, indicating that the worst places are Taiyuan, Urumqi, Beijing, and Lanzhou.

Air pollution is also a problem in many rural areas. Township and village enterprises (TVEs) are responsible for a growing part of China's CO_2 and SO_2 emissions with their typical low-tech set-up, usually too small to benefit from economy of scale, typically running exceedingly polluting operations in sectors such as cement, bricks, chemicals and metallurgy. Burning of straw seasonally covers countryside areas in thick smoke, a double loss since this potentially substantial source of energy is transformed to smoke and dust for no purpose at all.

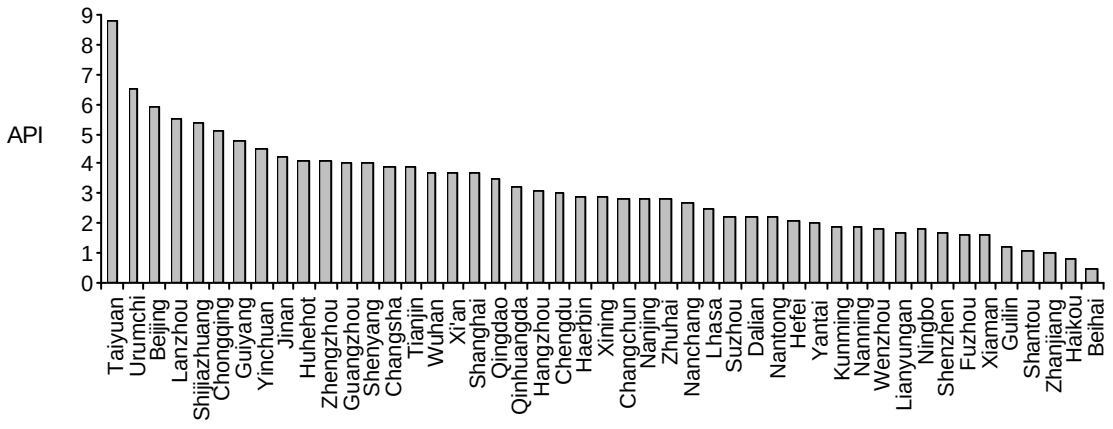


Figure 2.5 API Comparison between Chinese Cities

Box 2.4 Case Study: Tough Life in Xuanhua

Xuanhua County (northwest of Hebei Province) is situated in a harsh zone with stony hills and sandy soils with sand storms. When the Yang River dries out each year, farmers must rely on rainwater. Besides wind and sand, Xuanhua has always had industries. There are the steelworks, chemical factory, paper mill and pesticide plant, fertilizer plant and so on, altogether more than 10 major industries. Most of these were built right after the Liberation in 1949, and are heavy polluters. On entering the County, one can see, almost touch, the smog of all colours in the atmosphere, smell the distinct irritating stench and be amazed by the thousands of pieces of plastic trash brought by the wind and hanging on the trees.

Liu Zhiwei (a lawyer and ex-high school history teacher) and his wife, Yin Shuling (works in the county government office, ex-math teacher) live in the town. “They say that Beijing is thinking of moving its huge Capital Steel Plant to Xuanhua.” Mr. Liu smiles with bitterness. “Air pollution along with the sand storms bring everyday thick layers of dust in the house; it is useless trying to remove it. But what is most worrisome is the bad effect on our health.” Ms. Yin says: “They say that the whole zone has high occurrences of cancer, mostly lung and liver cancer. If you are told by a doctor from Zhangjiakou or Xuanhua: ‘Go consult a doctor in Beijing’, then in 95 percent of the cases, it is cancer.” How do the Xuanhua people feel? The couple says: “The Chinese people are cows, they eat grass and they give milk; their living environment, they accept and feel helpless.”

The pollution in Xuanhua not only affects the local people. Its air pollution spreads with the help of the sand storms to the neighbouring regions; and its industrial wastewater even affects the water supply of Beijing. The recently closed-down paper plant is an example of this.

The couple thinks that Xuanhua alone, being one of the poorer counties in the Province, is not able to change its situation. If one closes down the plants, there will be the problem of laid-off workers. Perhaps with the help of Beijing, the situation can be changed.

2.5 Solid Waste

Well into the beginning of the 1990s the rate of spontaneous reuse of solid waste in China was high and garbage was a minor problem. With the recent rapid economic development, new consumption patterns have followed, and during the latter half of the 1990s piles of garbage began appearing in suburban and countryside locations. Today, when travelling through China, it is not unusual to see cities surrounded by their own garbage; smelly dumps litter riversides, back streets and commons; most suburban areas have been overburdened and worst hit by the flux of wastes from the city centres; and piles of industrial waste leach toxic substances into surface and ground waters.

Municipal Waste

With improving living standards, the traditional thriftiness has been much compromised by increasing consumerism, which has resulted in a rapid increase in municipal waste over the past two decades. Municipal solid waste reached almost 150 million tons in 1998, corresponding to a daily waste generation of about 1 kg per urban citizen—a figure well in level with cities in developed countries, with Stockholm at 1.2 kg, and somewhat higher than Indian cities (SEPA, 1999; World Resources Institute, 1998). Generation of waste in large Chinese cities grows by the order of 10 percent annually (Li Shichao, 2000), far ahead of urban population growth at

just 3 percent (projections for the period 2000-2005 from World Resources Institute, 1998).

Today, less than half the total amount of municipal waste is reported to be treated—a figure that is up from only a few percent during the mid-1980s. About a third of this is labelled as landfill, but given the fact that China has only a handful of decent standard landfills, the conclusion is that garbage is actually dumped at a site that may or may not have been allocated for that purpose, and most likely not designed to be a landfill. Just below 10 percent is composted, but with low quality in the composting process and high risk for toxic pollution, composting proves difficult to sell on the market.

Industrial Waste

Industrial expansion, not least the mushrooming township and village enterprises, in combination with lack of regulation and economic incentives, have led to rapidly increasing amounts of industrial waste products. Moreover, the changing composition of solid wastes has made traditional small-scale "recycling-by-reusing" increasingly difficult and problematic in itself. Chinese industry generates five times as much waste as its municipalities, or about 800 million tons in 1998, of which less than 10 percent was reported as "discharged" (SEPA, 1999). The remaining 90 percent is categorised as "treated", "recycled", or "stored", the area occupied by industrial waste storage alone totalling 557 km^2, including 30 km^2 of arable land in 1994 (Zhang Lijun, 1996). Information on the accuracy of these figures is scarce, but it is reasonable to believe that these categories include a considerable amount of uncontrolled industrial waste dumping, leading to pollution of land as well as adjacent surface and groundwater sources and air.

Hazardous Solid Waste

SEPA (1999) provides a figure of just below 10 million tons of hazardous waste generated in 1998 or roughly 1 percent of the total industrial wastes. Other sources estimate 20–40 million tons. Beijing authorities estimate that less than half of the hazardous waste is treated to a reasonable degree or re-used—the rest joins the uncertain fate of other industrial solid waste streams (Stover, 2000).

2.6 Human Health Impacts

The Chinese population is living much longer and healthier than 50 years ago, when the average life expectancy was only 35 years and when hunger, malnutrition, lack of primary health care, and infectious and parasitic diseases were common ailments. Today, the average life expectancy of nearly 71 years is very close to that in developed countries. Also official statistics indicate that China's infant mortality has dropped dramatically over the last half century, from 200 per 1,000 to 31 per 1,000 (Ministry of Public Health in China, 1996). Infectious diseases, though still a serious problem, particularly in some parts of the country, currently account for a rather small share of total deaths.

The remarkable turnaround is generally credited to the government's efforts in improving the health care system, raising people's living standards, and in particular the Chinese system of rural health care providers, where the "barefoot doctors" have been trained to treat epidemics and common diseases.

However, in the coming decades, China's deteriorating environment threatens to undermine the gains that rising incomes would otherwise bring. The rapid industrialisation, urbanisation, and economic growth are contributing to the increase in incidences of respiratory diseases and chronic illnesses such as cancer. Levels of particulate air pollution from energy and industrial production in several of China's megacities, such as Beijing, Shanghai and Shenyang, are already among the highest in the world, leading to corresponding problems of lung disease. The seriousness of water pollution in some regions, such as in the Huai River Valley, cannot be overemphasized.

Air Pollution Health Effects

Air pollution is having serious and widespread affects on human health, although comprehensive data is not available. Based on the Chinese Air Pollution Index (API) data, there are currently at least 270 million urban residents experiencing air with a quality below what is considered acceptable by the Chinese ambient air quality standard. Epidemiological surveys in China have established a correlation between air pollution and respiratory diseases. These numbers can be extrapolated to show that each year, air pollution causes 1.5 million cases of bronchitis, and 23,000 and 13,000 deaths from respiratory and heart diseases, respectively (Wang Huijiong *et al*., 1999). Wu (2000) also reported that for the year 2000, there were 600,000 premature deaths, 5.5 million cases of chronic bronchitis, and 20 million cases of respiratory illness due to air pollution. Figures from Chongqing and Changsha cities show that deaths from lung cancer are 4.7 and 8.8 times higher in highly polluted areas than in clean areas (Draft United Nations Common Country Assessment on Environment and Energy, Sept. 1999).

Coal burning is a major culprit of air pollution. China relies on coal for roughly two-thirds of its energy supply. Coal burning exposes the population to high levels of benzopyrene, a known human carcinogen, particulates, and sulphur dioxide (SO_2). An investigation of 26 cities between 1976 and 1981 found strong positive correlation between concentrations of particles and benzopyrene, and death from lung cancer. SO_2 is

associated with respiratory disease, irritating the lining of the airways and causing inflammation that could lead to a variety of chronic and acute respiratory conditions. The impact is particularly severe to children's health. A recent investigation in China found that the incidence of asthma among children in Chinese cities has been rising. Henan, for instance, has seen an increase of three-fold compared with ten years ago (China Environment News, 1998).

Air pollution is thought to be one of the leading risk factors for respiratory diseases, such as chronic obstructive pulmonary disease (COPD), lung cancer, pulmonary heart disease and bronchitis, diseases that are the leading causes of death in China. Although only a limited number of epidemiological studies have been conducted, air pollution has clearly contributed to both excess mortality and morbidity in China. Based on dose-response functions from studies conducted within China and in other countries, the World Bank has estimated the number of deaths and diseases associated with air pollution among urban populations. Using the Chinese standards as a benchmark, they estimate the number of deaths that could be prevented if air pollution were reduced to those levels. According to their calculations, approximately 178,000 deaths, or 7 percent of all deaths in urban areas, could be prevented each year. Another measure of the health impact of air pollution is the number of hospital admissions from respiratory diseases. This study found 346,000 hospitalisations associated with the excess levels of air pollution in urban areas (Johnson *et al*., 1979)

Air pollution is also a major aesthetic problem, having negative impacts on morale as many cities including Beijing, experience very few truly sunny days. Yet, no studies have been undertaken into this area.

Indoor Air Pollution

Recent studies tend to identify indoor air pollution as a more important factor in respiratory diseases than outdoor pollutants. Most humans, particularly women, spend most of their time in the home, particularly near cooking stoves. People living in the north spend even more hours exposed to indoor pollution during the winter months.

Well over half of the Chinese population use coal in their homes, and about one-fifth of rural homes rely on coal for domestic fuel (Karasov, 2000). The effects of coal burning are magnified because coal often is not washed before its use, and it is burned in poorly vented stoves. Cooking with tainted coal can expose people to arsenic, fluorine, lead, and mercury. A 1993 study confirms that indoor concentration of SO_2, particulates, and benzopyrene are frequently much higher than outdoor levels of the same pollutants. In winter months, indoor pollutant concentrations can rise up to ten-fold over summer month concentrations (Chen Y. *et al*., 1993). A study by Wang Lihua (1988), a senior professor of environmental health at Beijing University's Medical School, demonstrates that Beijing women in coal-burning families have more respiratory symptoms than those in natural gas-dependent families.

Smoking

Compounding the situation is smoking. China has an estimated 300 million smokers, the largest number of any country, including about 63 percent of adult men and 3.8 percent of women. China consumes 30 percent of the world's cigarettes, and is the largest producer of cigarettes in the world. Smoking not only directly affects smokers' health, but also indirectly threatens women and children's health. Tobacco contains many carcinogens, like polycyclic aromatic hydrocarbons (PAHs). Chinese official statistics over recent years indicate a rising curve of lung disease-related morbidity and mortality, in particular lung cancers. Some Chinese studies have also found correlations between passive smoking and premature births and birth defects. The Journal of American Medical Association reports that at current smoking rates, by 2025, two million smoking-related deaths would occur in China each year (McGregor, 2001).

Water and Human Health

Water pollution and water scarcity affect human health in three primary ways:

- First, access to a minimum per capita amount of water is necessary to ensure physical survival and promote hygiene.
- Second, contaminated water serves as a pathway for exposure to microbial and contagious diseases. Therefore, drinking or bathing in water contaminated by animal or human excreta facilitates transmission and proliferation of disease vectors. China's water pollution exacerbates water-borne infectious and parasitic diseases such as hepatitis A, diarrhoeal diseases, typhoid, roundworm, guinea worm, leptospirosis, and schistosomiasis.
- Third, surface and groundwater can act as sinks or transportation routes for chemicals, heavy metals, algal toxins, and organic substances that produce chronic systemic illnesses, malignancies, and birth defects, and impair immune system function as a result of direct or indirect exposure.

As countries begin to industrialise, they often undergo a health risk transition. Changes in environmental conditions alter the type of environmental health risks to which a population is exposed, and over time, influence the overall pattern of disease in the population. This transition usually encompasses a shift from a predomi-

nance of traditional infectious and parasitic diseases to a predominance of modern diseases, such as cancers, heart disease, and respiratory diseases. However, China's modernisation has been unique in creating a combination of traditional environmental health risks, such as sewage irrigation, and modern environmental health risks, such as increased use of pesticides and fertilizers, creating a double health burden.

Access to Safe Drinking Water

The health of China's people depends, to a great extent, on the quantity and quality of its drinking water supply, the quality of which is largely determined by sources of incoming water, modes of water supply, and the level of water treatment. The majority of Chinese urban and some suburban residents now have access to tap water, while the largest portion of the rural population still relies on hand- or motor-pumped wells, or they fetch water directly from rivers, lakes, ponds, or wells, with little or no treatment at all. Large rivers are the most common source of urban drinking water, as well as the major source for rural residents in many parts of the country.

The Human Development Index (HDI – see the Annex) shows that only 19 percent of the total population have access to tap water in China. And yet in only 6 of China's 27 largest cities does drinking water quality meet state standards. Groundwater does not meet state standards in 23 of these cities.

Waterborne Infectious Diseases

Although the incidence of waterborne diseases is still high compared with many other countries, effective medical care has kept mortality low, averaging less than 0.1 per 100,000. Still, the population still suffers from a number of diseases associated with inadequate drinking water quality and sanitation.

- For the past two decades, diarrhoeal diseases and viral hepatitis—both associated with faecal pollution—have been the two leading infectious diseases in China. Hepatitis, however, was almost reduced by half through the first half of the 1990s, down to 63 cases per 100,000.
- After a sharp drop from 1991 and 1992, the incidence of dysentery has risen since 1994, in part because of the deterioration of water quality.
- A sudden upswing in the incidence of typhoid fever in 1991 and a large outbreak in some provinces in 1992 were also partly attributed to the poor drinking water quality in rural areas. In 1991, typhoid fever incidence reached as high as 10.6 per 100,000.

Industrial and Chemical Water Pollution

It is more difficult to establish the impacts of industrial and chemical water pollution on human health than those caused by sewage and human waste. However, recent epidemiological studies suggest that exposure to organic and inorganic chemicals in drinking water may significantly contribute to chronic disease. In July 2000, a survey in Zhejiang Province published by the Chinese Preventive Medicine Journal found five to eight times more morbidity of intestine cancer caused by microcystin toxins in water than among people who have access to cleaner drinking water (Zhou Lun *et al.*, 2000).

Liver and stomach cancers are the leading causes of cancer mortality in rural China. Since the 1970s, deaths from liver cancer have doubled, and China now has the highest liver cancer death rate in the world. In southern China, where some of the population has long depended on ponds for drinking water, the rates of digestive-system cancers are very high. An investigation of 560,000 people in 23 villages and towns showed that between 1987 and 1989, cancer mortality was 172 per 100,000, which is much higher than the average mortality rates in rural China. Further research is needed to confirm this link and identify the specific pollutants at fault.

Irrigation with Wastewater

To use wastewater for irrigation has been a common practice in many parts of China throughout history. Nowadays this practice is especially common in the northern regions, where water is scarce. Pollutants, including organics, heavy metals and other carcinogens, enter the food chain in the irrigation process affecting human health.

Numerous studies since the 1970s have shown significant increases in cancer rates and deaths, as well as birth defects, in areas that have relied on wastewater for irrigation. For example, the incidence of intestinal infections and enlargement of the liver in Shenyang and Fushun was 49 percent and 36 percent higher, respectively in the irrigated areas than in the control area. There were twice as many cancer patients in the sewage-irrigated area (Wu *et al*., 1999).

Township-and Village Enterprises (TVEs)

A conservative estimate holds that the TVEs discharge more than half of all industrial wastewater in China. Most TVEs have no wastewater or hazardous waste treatment facilities, and since TVEs are widely scattered across vast rural areas, their wastes endanger the health of many people.

A 1989–1991 investigation of the 10 leading TVE industries in seven provinces and municipalities showed that industrial wastes were customarily discharged without any treatment and control. An analysis of the health of 860,000 people in these areas revealed that the incidence rate of chronic diseases was between 12 and 29 percent, much higher than the national average for rural areas, which is approximately 9 percent. Total mortality in polluted areas averaged 4.7 per 1,000, higher than the average 3.6 in the control area. Life expectancy in the

polluted areas was 2 years lower than the control (Wu*et al*., 1999). Although not definitive, evidence suggests that industrial pollution from TVEs could become a major threat to human health in China.

Pesticides and Chemical Fertilizers

Lack of knowledge and information has resulted in overuse and misapplication of chemical fertilizers and pesticides. In addition to affecting water, land, and quality of food products, they also cause public health effects. A 1989 survey in 30 Chinese cities found worrisome levels of both DDT and BHC residues in mother milk. An eight-year continuous monitoring of DDT levels in mother's milk in Beijing concluded that it could take 15 to 20 years for levels to be lowered to the 1980s levels found in most developed countries (Wu *et al*., 1999).

Epidemiological studies in some other countries have demonstrated strong associations between chlordimeform—a popular crop and cattle insecticide—and the incidence of urinary bladder cancer. Surveys in China found up to seven-fold increases in mortality among farmers who used this compound (Xu, 1999). A 1973–1975 survey found a mortality rate in urinary bladder cancer of less than 1 in 100,000—by 1997 it had increased to 1.4. The increase is particularly high in rural China.

With recent increase in public awareness of environmental and health concerns, China banned the production and use of DDT, benzex (hexachlorocyclohexane), chlordimeform, and other highly potent farming chemicals in the early 1990s. Still, some TVEs continue production due to inadequate control and lack of monitoring mechanisms. And the public health nightmares linger on because of their long-lasting effect and bio-accumulation in food chains.

The implications of the combined set of traditional and modern risks to China's environmental health transition are significant. More efforts and resources are required for both the Chinese government and Chinese people to grapple with these daunting problems.

2.7 Impacts on the Economy

Being one of the poorest and most polluted countries in the world, China faces harsh economic allocation decisions between present development goals and long-term sustainability. Where and when shall its population forego present consumption in favour of future welfare increments? China's impressive reconstruction of its economy since 1978 and the convergence towards a market-based economic system is undisputed. The accompanying economic growth has brought a dramatic reduction in poverty and improvements in living standards. However, despite decades of successful economic development, there has been a serious toll of environmental damage, mainly due to under-priced natural resources. Pollution, natural resource depletion, and ecosystem destruction are costly in terms of health problems and reduced productivity of labour and land, which means in the end these environmental side effects have negative repercussions also on people's welfare.

Premature deaths of 178,000 people in major cities each year due to pollution, children's high blood-lead levels—up to 80 percent above critical levels—and the 7.4 million working days that are lost to health problems related to air pollution, are all grave examples of health-related costs of environmental problems that are inflicted on society. Also seriously affected is the agricultural sector where both desertification and polluted water affect grain production negatively. It is estimated that in 1993 approximately 8 percent of the agricultural area used water unfit for agricultural purposes, which resulted in an estimated loss of grain production of 1 million tons. The World Bank (Johnson *et al*., 1997) has estimated that if wastewater treatment were increased from the current 20% to 50% coverage, total grain production could increase by 24 million tons by 2020.

The list of the effects described above is by no means exhaustive and other impacts include irreparable damage to invaluable assets—for which there is no substitution available, or for which alternatives are extraordinarily costly. These include, for example, microclimates that are destroyed by deforestation and subsequent desertification to the point where these areas become uninhabitable, or on a global scale, the hazard to the stratospheric ozone layer.

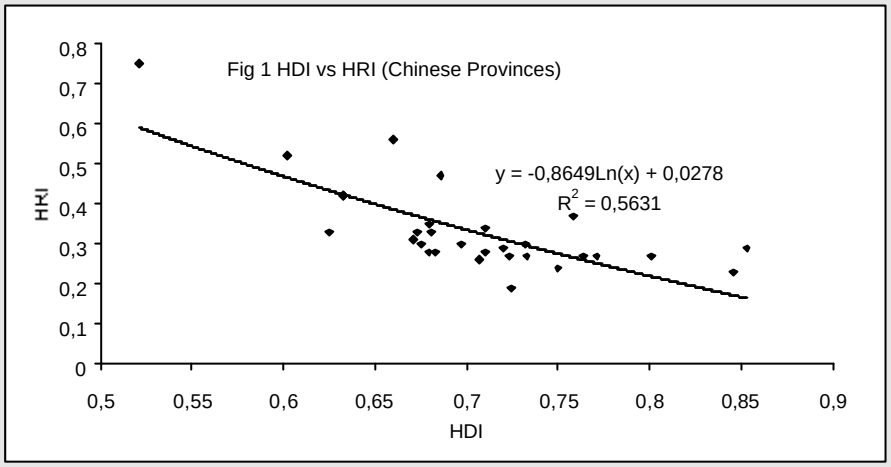
The Cost of Unsustainability

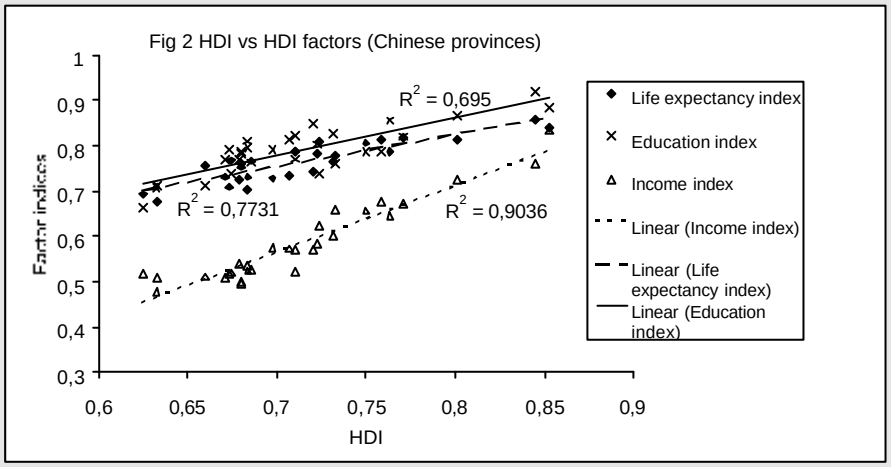
Non-market values are difficult to measure, and careful economic analysis might call for non-market valuation. The World Bank (Johnson *et al*., 1997) estimates that air and water pollution costs between 3.5 to 8 percent of the nation's GDP. The largest impacts are from health losses related to air pollution, indoor air pollution and chronic disease from water pollution. Yet, the estimates lack a number of high cost candidates, such as damage to crops from ground level ozone and loss of agricultural production due to drought, flooding and chronic water shortages. The World Bank underscores that the estimates are conservative.

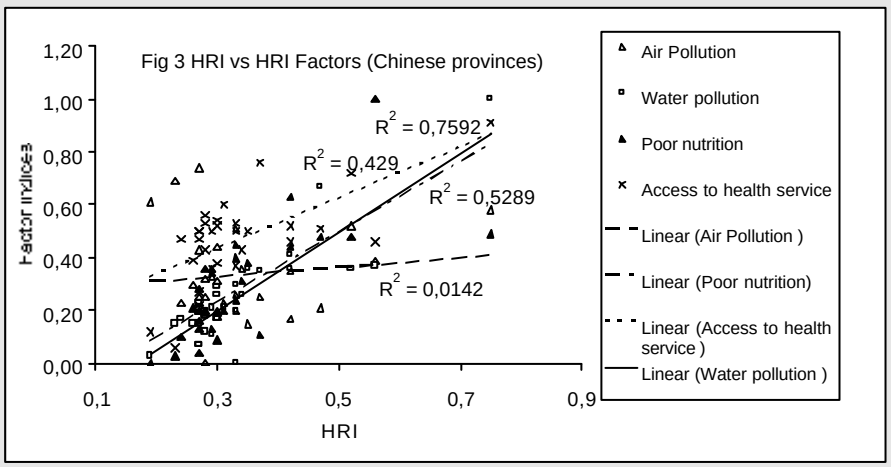
Gross Domestic Product (GDP) is the most common point of reference for measuring economic development. Still, it does not take into account most environmental damages. Several attempts have been made to calculate a corrected value of economic development, for example, UNDP's Human Development Index (HDI), and the World Bank's Genuine Domestic Savings Index. The latter index is based on standard national accounting on net domestic savings that has been adjusted to reflect resource depletion, and damage due to carbon dioxide

Box 2.5 Comparing Human Development Index with the Health Risk Index

Traditionally in the UNDP Human Development Reports, HDI or the Human Development Index has been used to monitor developmental progress around the world. HDI is based on three major indices: life expectancy, education, and income. Since the HDI doesn't directly delve into health and environmental factors, an additional index has been suggested. This China Human Development Report is the first attempt to calculate the so-called HRI or Health Risk Index which is composed of four factors, air pollution, water pollution, nutrition, and access to health services. In order to see how the two indices compare, we took the HDI and HRI for each province of China and performed a series of correlations. Figure 1 shows a negative relationship between the two indices in that HRI drops as HDI increases. The relationship is not 1 to 1, but closer to 1 to 2. It was also of interest to see what contributing factor or factors affect these indices most. In the case of the HDI, the income index has a larger influence than the education or longevity indices (Figure 2). In the case of the HRI, water pollution and poor nutrition are clearly the two factors that influence the HRI most, followed by access to health care (Figure 3). Air pollution had the lowest correlation. A preliminary observation from this analysis is that improvements in environmental quality, nutrition and health should be positively correlated with increases in income. For more details on HDI and HRI see the Annex chapter.







emissions. The index is also adjusted for human capital investments. There are still significant gaps, however, in the composition of the Genuine Domestic Savings Index reflected by the lack of important environmental costs. But also lack of reliable data furthermore aggravates the problem. Thus, a true evaluation of the Genuine Domestic Savings Index is limited to what is possible to measure through standard national accounting systems.

China's Genuine Domestic Savings for 2000 are reduced by some 10 percent as compared to the conventional measure of Gross Domestic Savings (World Bank, 2001). Still on the face of it, with Genuine Domestic Savings at 13.7 percent of GDP, China does not appear at all worrisome. However, the shortcomings of the Index call for caution in using Genuine Domestic Savings as a sustainability measurement for China, in particular since it does not at present reflect central problems, such as over-exploitation of scarce water resources, or extreme levels of air and water pollution.

In general, China seems to undervalue its natural resources, at least from a historical perspective. Presently, there is a growing concern over the negative economic effects from environmental degradation, and attempts are being made to upgrade the pollution levy system even though political resistance is making it difficult.

Despite the grim picture presented here, there are positive trends in terms of decreasing pollutant discharges per produced output. These trends must not be taken as a sign of sustainability, however, since they are not related to carrying capacity.

To calculate the cost of the environmental side effects resulting from Chinese economic development is extremely complex; still to make no attempt would be similar to say that the cost of pollution and environmental degradation is negligible. Therefore, present efforts from international organisations and increasingly also from Chinese environmental economists, to internalise the costs associated with environmental problems are highly valuable.

2.8 Regional Impacts

China's environmental situation varies tremendously across the vast country. From the east coast to the west inland, the geographical condition for permanent human settlements rapidly deteriorates, as climate turns from humid to arid, with narrow low-lying fertile fluvial plains being replaced by the mosaic of plateaus and basins, long mountain ranges and vast deserts. Consequently, the east is densely settled, intensively developed, richer, and more urbanised with aggravating environmental pollution threatening human health and quality of life, while most of the west remains poor, facing severe ecosystem destruction.

While the geographical settings of the land have laid this foundation, the regional differences are further complicated and diversified by various human processes. This includes the rural-urban division, industrialisation and technology development, cultural variety, the contradiction between traditional practices and modern technology, and the unbalanced economic development that has resulted in a wide rich-poor equity gap. For the past two decades, the entire country has been experiencing historical transitions in both economy and society, but the departure points and the rate of change among regions vary considerably across the country. It is at the regional level one can begin to appreciate the complexity of the nexus of development and environment and its interactive impacts on the environment and the people.

The East Monsoon Region

Corresponding to the key zones identified in section 1.3, the East Monsoon Region roughly encompasses the Northeast, the dry, densely populated North, the central and southern Coastal Provinces, and much of Southern Central China.

The Northeast

The forests in the Northeast are one of China's major timber sources while the fertile black soil belt supports a rich grain-producing region called China's "Grain Barn". Both resources are being depleted or destroyed due to excessive extraction and land degradation. During the past half century, at least one-third of the natural mature forest in the area has been cleared out, and the black soil, researchers warn, may vanish within the next half century if the current trend of destructive use continues.

The dream of becoming industrialised has been a ferocious force transforming the Chinese landscape since the 1950s. Its impact probably is more evident in the Northeast than elsewhere in the nation. From the 1950s through the 1960s, with the assistance of the former Soviet Union and blessed by the discovery of the Daqing oil field, the Northeast became a major base for heavy industry, oil extraction and refining. Expeditious development without a clear awareness of environmental impacts created cities with suffocating air, rivers and streams seriously contaminated and sometimes void of life, and agricultural lands irrigated with wastewater dangerously polluted with heavy metals. Today, while environmental pollution continues, deeper social impacts start to emerge as the strategic adjustment of the economic structure unfolds. One of such impacts is the increasing number of urban unemployed, laid off from large and poorly managed state-owned enterprises. According to 1999 data (SSB, 2000), annual urban household income per capita in Heilongjiang, Jilin, and Liaoning averages

4,680 RMB, among the lowest in the country. Increasing urban poor compounded with surplus labourers from rural areas pose a sensitive issue for social stability and a formidable challenge furthering the on-going economic reform.

The Urbanised East Coast

The Beijing–Tianjin–Tangshan, the Nanjing–Shanghai–Hangzhou, and the Guangzhou–Zhuhai–Shenzhen metropolitan areas are China's three major modern urban industrial regions. While air pollution and water contamination are major environmental concerns for all three, the causes and degree of impacts vary. Located on the North China plain with heavy dependence on coal burning for residential heating, Beijing suffers severe air pollution. The situation has worsened in recent years due to vehicular exhaust from the rapidly increasing number of vehicles, and from the recurring sand storms originating in the ecologically degraded areas in the Northwest, the North, and the Northeast. Problems with water in Beijing are mainly a matter of quantity, although maintaining the quality is also troubled by upstream-downstream confrontation with neighbouring province, Hebei, where developmental pressure is tremendous.

The location of the Nanjing–Shanghai–Hangzhou area on the Yangtze River Delta in the middle of east China and the Guangzhou–Zhuhai–Shenzhen area on the Pearl River Delta to the south, exposes both metropolitan areas to other environmental challenges. The proximity to the sea allows both to enjoy fair air quality, and the main concerns are to maintain and improve water quality. Heavy pollution in Shanghai's Huangpu River has already forced the City to spend billions of yuan to relocate its water supply further upstream.

It is noteworthy that these metropolitan areas have attracted most of the limited national budget for environment protection and improvement. It is also in these cities where public environmental awareness has started to awaken.

The Drying-out North China Plain

Highly variable monsoon rains and chronic water shortage in the North China Plain, combined with rapid industrialisation and urbanisation and China's recent accession to the WTO, are creating for agriculture and millions of farmers a precarious future. The temperate climate and mild winter in the region supports triple cropping every two years, though this high yield is sustained by irrigation. Henan and Shandong, for example, are two main agricultural provinces in the North China Plain, and their irrigation systems depend heavily on the Yellow River. Since 1972, due to the increasing demand for urban and industrial water and excessive extraction from the upper and middle reaches, part of the lower reach of the Yellow River dries out completely for part of the year, the so-called "Duanliu" phenomenon. In 1997, the worst year by far, the Yellow River had no flow reaching the sea for 226 consecutive days.

Floods Remain an Enormous Threat

While recurring droughts harm much of northern and western China, floods are the most costly natural hazard. Much of the East Monsoon Region, with its seven major rivers seeking paths to drain excessive runoff to the sea, is threatened by floods. Proportionately, a mere 8 percent of China's total land area is categorised as flood-prone. Yet this 8 percent coincides with the most densely settled and economically developed areas in China, containing over 40 percent of the cropland where the nation's food security rests, half of its 1.3 billion population, most of the major cities, producing 70 percent of the nation's GDP. Through history, floods have been a natural feature of eastern China and a prerequisite to the renewal and development of agricultural practices. On average, each year, over three thousand people have lost their lives to floods, and millions of acres of cropland inundated. In recent decades, flood damages have been escalating. Four of the world's 20 worst flood disasters in the 1990s occurred in China, with an average direct economic loss of 20 billion USD each (Munich Re, 2000). The main causes for the increases in floods are attributed to human activities, such as narrowing river courses, converting lakes to agricultural lands and settlements, and increasing siltation due to deforestation and cultivation on hills in the upper streams. Given the maximum stream flow of the 1998 flood in the middle and lower reaches of Yangtze River, the flood water level could have been 1 meter lower if the natural capacity of the river system for draining floodwater had remained the same as in 1954 when a similar disastrous flood occurred. Still, the casualties in 1954 counted over 50,000 dead, while the victims of 1998 flood was limited to less than 4,000.

The Northwest Interior Region

With the beginning of the new century, China is launching a major development effort in the west, the so-called "Great Western Development Programme". Given the high sensitivity of the ecosystems and the current state of the environment, caution flags have been raised at the heated western development strategy, calling for careful planning with attention to biodiversity protection and the involvement of the people of the region.

The Dryland of Northwest

The arid and semi-arid northwest has experienced another set of regional impacts from change and development. In the Gobi Desert and the oases of Xinjiang and Gansu province, urban and industrial development has

caused pollution and ecological degradation, mainly as a result of over demands on limited surface and ground water resources. For example, petroleum exploration and oil field development along with agricultural water extraction in the upper and middle reaches of the Tarim River have caused rapid disappearance of riparian forest in the river basin. Since water is the main limiting factor for development in most arid areas, competition for water between urban and industrial uses on the one hand, and agriculture and ecological maintenance in the oasis on the other constitutes the overarching problem for economic development and environmental protection of the region. Grassland resources in this region are also under pressure due to economic and demographic change.

The grasslands of Inner Mongolia are being transformed and rapidly degraded by changing forms of pastoralism (described in section 2.1), mainly escalating grazing pressure in combination with decreasing mobility of the herds and herding population as they are confined to private plots. Technology for improving the quality and productivity of pastoral lands focuses on developing irrigated artificial pastures. Yet, decreasing groundwater levels and limited, unreliable surface water flow render such approaches a short-term remedy that hinder the development of a long-term sustainable pastoral development strategy.

Desertification has occurred widely across the region, while success in combating desertification is limited to a few places where large investments in money and labour have been made available. A Ministry of Science and Technology task force estimated that desertification costs China about USD 2 to 3 billion annually. An estimated 110 million people suffer first-hand from the impacts of desertification and, by official reports, another 2,500 square kilometres turn to desert each year. Ultimately, people's livelihoods in pastoral regions are at stake. The capacity of the grasslands to support animal and human population is indisputably decreasing, while demands from the grassland communities are increasing due to increasing populations and improved standard of living.

Dryland farming on the loess plateau is facing difficulties also due to short water supply. As soil erosion prevails, the already unproductive agricultural lands become less fertile, and sediment deposited downstream has caused damage to the east China region. Irrigation districts along major river systems experience declining productivity caused by salinisation and lack of irrigation water. In the impoverished farming areas, farmers, left at the mercy of nature, mine the lands that their entire livelihood depends on to meet subsistence needs. Industrial development, coal-mining in particular, causes air and water pollution, as well as harming the local ecosystems.

The Qinghai-Tibet Plateau

With an average elevation over 4,000 metres above sea level and an extremely rugged terrain, the Qinghai-Tibet Plateau offers harsh physical conditions for human settlement, rendering the region the least developed area in the country. 1999 data show that GDP per capita in Tibet is only 4,262 yuan, roughly one-seventh that in Shanghai. In terms of education, primary school enrolment is the lowest in China, less than 80%, and merely half of the school children enrol in secondary school. As a result, as much as two-thirds of the adult population is illiterate. These statistics are echoed by China's highest birth-rate and a natural population growth rate of about 15 percent. Life expectancy for Tibetans is only just over 60 years; about 10 years lower than the national average. It is no surprise that Tibet has the lowest Human Development Index (0.52) among all provinces, autonomous regions, and provincial-level cities (see Annex).

While enjoying the lowest potential exposure to outdoor air pollution, people in Tibet suffer the highest level of indoor air pollution due to the high coal consumption per household. Although living in a place where four major rivers in Asia originate, more than 80 percent of the population in Tibet is exposed to unsafe drinking water.

Prevailing poverty is the result as well as the driver of increasing ecological destruction in the region. Overgrazing in the highland pasture has forced people to migrate, and the resulting erosion has raised concerns for the millions downstream along the Yellow and Yangtze rivers whose water supply depends on clean, rich sources. In addition, large-scale forestry, not unoften illegal, has been denuding the slopes on the Himalayan foothills for a quarter of a century, however not providing much benefit to the poor populations that live in the harsh conditions on the Qinghai-Tibet Plateau.

Chapter 3

The Society–Environment Nexus

The previous chapter described the perilous state of China's environment. It identified many of the immediate sources of China's environmental problems—such as heavy industry and forestry production. However, the origin of China's environmental challenge is far more complex than these immediate causes. It lies in the broader trends and forces, which shape people and society, such as population growth, economic reform, and globalisation. This chapter looks behind and beyond the visible environmental situation with the aim to assess the critical trends and forces. This is not a one-way process. Environmental constraints, such as air pollution and water shortages, are shaping Chinese society, at the same time as society and its institutions set the preconditions for environmental sustainability.

This chapter addresses six broad development issues —population growth, economic development, poverty, awareness, consumption and technology development before turning to brief sector reviews of water, energy, transportation, and agriculture. The final two sections focus on important roles played by globalisation and governance in understanding China's future options.

Each of the following sections outlines significant sectoral trends, and concludes with a sketch of possible future development paths, as well as the uncertainties that are critical in order to understand the wide span of possible futures that China may develop towards.

3.1 Population Growth and Migration

Population pressure on conspicuously scarce resources is one of the main forces behind China's environmental predicament. This situation is set to become even more challenging, as the population grows, the age structure changes, migration rates increase, and the population competes for increasingly scarce resources.

Population Growth

At the founding of the People's Republic of China (PRC) in 1949, the country had a population of about 540 million. Within three decades, that figure had increased to more than 800 million. This created a strong population momentum that is still driving China's demographic growth. The number of adults of reproductive age (20–49) should peak at some 660 million by around 2010, and the two decades around this peak are critical to future growth patterns. For twenty years, China has implemented successful family-planning campaigns, and it is worth pondering that, without these, the population could have been 200 million more than it is now.

Most projections of China's population estimate an increase to 1.5 billion before levelling out and possibly beginning to decrease. Even in these medium projections, which assume a continuation of historically low Total Fertility Rates (TFR), the first quarter of the 21st Century will witness an increase of 250 million people—equal to the population of United States (Heilig, 1999). Higher projections, based on higher (but still not high) TFR, have China's population topping 1.7 billion by 2050 (see figure 3.1).

Population growth is distributed unevenly between regions, ages and gender. The *natural* growth rate varies from minus 1.1 percent in Shanghai to over 14 percent in Guizhou and Tibet (see Annex). In some cases, this uneven natural growth rate may be balanced by rural-to-urban migration. In other cases, the migration may exacerbate the imbalance—for example, Guangdong's natural growth rate is almost 10 percent, and the province also attracts migrants. The age pyramid illustrates that China's population is set to age dramatically in the coming decades, with the consequence that there are to be proportionally many more old people. The gender ratio is also skewed, with almost 103 males for every 100 females—rising to almost 111 in Hainan province (see Annex). These dynamics mean the make-up of the Chinese population is set to change; different age groups, genders, and regions impose differing demands on the environment, and these complex population dynamics make sustainable management of natural resources even more challenging.

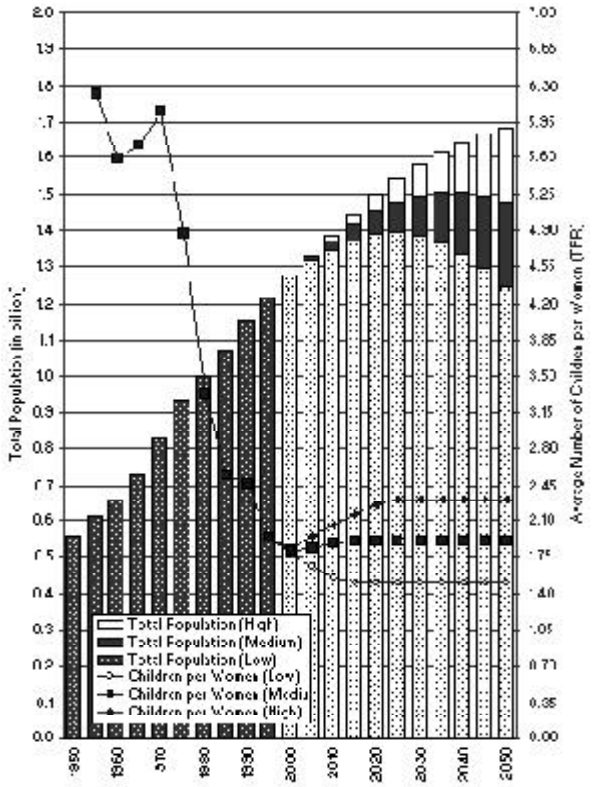


Figure 3.1 UN population growth projections (Heilig, 1999)

Fewer Resources, More Pollution

Despite significant natural resource deposits, the high population results in the fact that the resources per capita are often very low. For freshwater, cropland and forest, the average Chinese citizen has between 15 and 30 percent of the world average.

Regional variations serve to exacerbate this situation. People in the dry northern provinces including Beijing, Tianjin, Ningxia, Hebei, Henan, Shandong and Shanxi have less than one-quarter of the *Chinese average* water availability. Per capita availability in these areas is comparable with North African and Arab states. And even in Heilongjiang province, which overall is relatively well endowed, almost one in five people face water shortages. With regards to arable land, Jiangsu province has more than 70 million people and a population density that exceeds 700 per km^2, which is almost equal to Bangladesh—922 per km^2 in 1996 (WRI, 1998).

The mounting population has also contributed to increased water, air, solid waste and noise pollution. The current population is already overwhelming the capacity of the ecosystems to absorb emissions in vulnerable areas throughout the country and in the densely populated areas in the east. Patterns of consumption and economic development exacerbate the problem (see sections 3.2 and 3.5).

Urbanisation and Migration

Until the beginning of the 1990s, China was successful in applying strict controls to avoid wide-scale internal migration and related problems. Liberalisation and deregulation have brought a relaxation of the controls on travelling and resettlement. Two overall and growing migration trends are evident, superimposed on the population challenge. First, as in most countries, there is the move from rural to urban areas, including both temporary and permanent migrants. Second, there is a general move down the slopes from west China to the generally richer eastern areas. Taken together these trends result in large migrations from rural western areas towards the coastal cities.

Low per capita access to resources and environmental degradation help drive this migration. Shortages of resources in rural areas, including access to good land and clean water, lead to poverty and unemployment. Increased opportunities for travel prompt unemployed and poor people to move to urban areas in search of a better life for their families. This general process is exacerbated by sudden disasters, such as the 1998 floods, which led to "economic displacement" of large numbers of young people from flood-affected areas. Many other forces are contributing to migration, notably of course, the chance to improve one's economic and social status.

Most migration in China is to urban areas. During 1980–1998 urbanisation levels grew from 19 to 30 percent —a net movement of well over 100 million people. The level of urbanisation is forecasted to grow to 45 percent by 2010 (United Nations Team in China, 2000). Thus, within the next 10 years, over 200 million people will move to the already stretched urban areas. There are also inter-rural migrants, but these are less significant in terms of impact on the environment.

Once in cities, migrants add to the growing environmental challenges, partly because the recipient urban areas lack the management capacity requisite to absorb the newcomers. Even without the influx of migrants, most cities in China already face huge challenges in delivering basic services such as clean water and air. If the anticipated additional 200 million people arrive, this may well result in truly atrocious living conditions—in terms of water, air, and noise pollution. Although the migrants will undoubtedly suffer the worst of these conditions, many of the most vulnerable original city dwellers will also suffer. Deteriorating living conditions will in turn have an impact on health and, possibly, social stability. Migration to cities also has an impact on land use. In China's eastern cities escalated demand for housing has

resulted in converting prime agricultural land around the cities to residential areas.

Migration often causes severance from traditional customs and practices. Migrants usually leave behind social, religious, or communal obligations—including those related to the environment. Having arrived in the new urban area they have fewer rights (if any) than local citizens and may therefore also have less respect, understanding, and ownership for the environment than those who have been living there for generations. This could be particularly true for the estimated 100 million "floating population". Why bother keeping the air and streets clean, if you have no local rights and may anyway have to move on?

The search for employment adds to migration within China. For example, the large numbers of construction schemes—dams, roads and airports—displace people by attracting them to new workplaces. These accumulatively lead to significant numbers of people moving across China. Hundreds of millions of people moving large distances to new areas, often shipping their belongings and returning home every year, create a huge demand for transport, which in turn has environmental consequences (see section 3.6).

With almost half of China's population living under conditions of severe water scarcity in the northern river basins, having even less water will affect people's livelihoods, if not survival. Degrading environmental conditions and an emerging awareness are factors that may decrease fertility rates. One only has to go back to the Great Leap Forward of 1958-1960 to see what dramatic consequences an evil combination of ignorant policies, bad governance and water scarcity can have on demography. Figure 3.1 illustrates how TFR was affected by the combination of mismanagement and environmentally related stresses during these years. For a present day example, one only needs to look at Russia, where a complex combination of environmental, economic and political instability has led to a dramatic decline in population growth over a short period.

Box 3.1 When Resources Cease to be Enough

Can China support an additional quarter of a billion people within just a quarter of a century? Food supply is crucial and has been discussed intensively over the last years, notably Lester Brown's Malthusian report of China's food demands draining world food markets (Brown, 1995). A more recent and comprehensive contribution to this ongoing debate is *"Can China Feed Itself?"* (Heilig, 1999) which arrives at the more positive conclusion that China *can* feed itself under certain conditions: family planning has to be effective in keeping population development down; water needs to be utilized more efficiently; and there must be better flood control. Heilig also notes that large-scale water transfers from the south to the north may be inevitable, but points out that in economic, environmental and social terms, a favourable alternative is that water-thirsty economic and urban sectors migrate slowly southwards.

What if we reverse the question and ask: "could environmental problems affect population development?" Due to environmental constraints, Heilig's conditions may not hold. For example, what would happen if water efficiency does not improve, if water demand in the north is not reduced, if supply is not increased or if precipitation decreases, due to natural fluctuations or climate change?

Future Trends and Uncertainties

Because of China's enormous population, even slight variations in fertility and mortality assumptions are bound to yield wide differences in long-term population projections, particularly in absolute numbers. UN's medium variant prediction for 2050 projects an additional 200 million Chinese. But as figure 3.1 shows, the span between the low variant of a *decreasing* population of just 1.25 billion by 2050, and the high variant of a still *increasing* population of almost 1.7 billion, amounts nearly to a staggering half billion people in the balance.

3.2 Economic Growth and Development Strategies

Economic growth, the mainstay of Chinese development policy in the post-reform period beginning in 1979, remains at the top of the priority list. This growth has been a driver of declining environmental conditions in China, but economic growth is not inherently detrimental to the environment. Rather, environmental degradation is a function of the content of the growth and how well environmental considerations are integrated with economic development. Whereas governance aspects of these trends are further discussed in section 3.12 (Governance and Institutions), this section reviews the approaches and perceptions underlying China's growth model, discusses the kinds of environmental consequences this growth model may entail, and looks finally into future trends and uncertainties, and the ways in which development strategies are incorporating environmental concerns.

Economic Growth as a Key Development Strategy

In retrospect, the development strategies that took form in the wake of the Mao era and the subsequent decade of turmoil during the Cultural Revolution, placing economic reform and growth at its heart, have been very successful.

In terms of the global economy, China has grown from an economic dwarf with limited overseas trade in the 1970s, to its present position as an emerging world

economy, with a year 2000 GDP of 1.099 billion USD—twice the Indian, more than half the German, and more than a tenth the US economies (Economist Intelligence Unit, 2001a). Measured in terms of its relative purchasing power instead of the exchange value, China's economy would be ranked the third largest in the world, growing more than twice as fast as the OECD countries. With the recent WTO entry and as host of the 2008 Olympics, China's global role is likely to become even more pronounced.

When the reform-oriented leaders under Deng Xiaoping came to power in the late 1970s, they showed an interest in China's East Asian neighbours as formidable examples of effective development strategies. Japan, South Korea, Taiwan, and to some extent Hong Kong and Singapore, all had followed a similar development path. The cases of Taiwan and South Korea, among the absolutely poorest countries in the world as late as around 1960, are particularly striking (Hallding, 1991).

This miraculous development formula applied by China's neighbours had started with land reforms that created incentives to increase agricultural production and generated surplus among broad groups of farmers. With some spare money in hand, farmers started demanding simple products, first to increase agricultural output and second to improve living standards. In the early stages of this development strategy, import substitution policy protected domestic producers from international competition by means of various kinds of trade barriers, thereby giving domestic industry leeway to develop. Later on, the government switched to a development strategy of export-led growth, through which companies that had grown competitive on the domestic market received government support to boost exports. One example of the latter, copying Taiwan and South Korea, is the establishment of special export zones along the Chinese coastline, to enable foreign companies to set up joint ventures and benefit from low taxes.

The economic records for the last half-decade, with an average GDP growth of 8.3 percent between 1996 and 2000 (Economist Intelligence Unit, 2001b), is evidence of the remarkable strength that China's economy has gained. Seen in an East Asian context, China was the only country in the region that was seemingly unaffected during the 1997-98 Asian Crisis, and now China has developed into a stabiliser and important driver of the overall Asian economy.

The Treacherous "Get-Rich-Fast, Clean-Up-Later" Strategy

From a somewhat broader sustainable development perspective, this miraculous economic growth took place at the cost of severe environmental degradation—consequences that were not unknown to the Chinese decision makers.

"China is a developing country. Its financial resources are limited in the face of the heavy task of full-scale economic reconstruction. Therefore the state cannot afford to make lavish appropriations for environmental protection for some time to come." This 1988 statement from Qu Geping, then head of China's National Environmental Protection Agency speaks tellingly to the level of ambition of Chinese environmental policy-makers—it should be done, somehow, but it must not cost anything, at least not now. Throughout the reform period a tendency has prevailed among Chinese leaders at different levels to see environmental problems as an unpleasant side effect of economic development, a necessary evil that one has to live through as the nation grows rich, and only then can start thinking about cleaning up (Hallding, 1991).

Indeed, the "get-rich-fast – clean-up-later" strategy was precisely the environmental development model that China's East Asian neighbours had followed during much of the latter half of the 1900s. Japan, the ultimate success story, once having reached the height of the mad dash for economic development, became renowned for its notoriously polluted environment, with urban citizens inhaling oxygen from street corner automats, and images of maimed victims of Minamata mercury poisoning filling news media. For more than a decade Japanese environmental controls have been among the strictest in the world—now when they can and must afford them.

Several indications suggest that the "get-rich-fast – clean-up-later" strategy is inappropriate and even dangerous for China. First, it ignores significant technological advances that render environmental investments much cheaper today than previously. Second, the ability of a country to "clean up" depends on its geography. China, with its vast territory and long river systems, will not be easy to restore. Third, the people who favour this strategy are not usually the ones who suffer from the resulting pollution and environmental degradation. Finally, this approach goes against the generally accepted *precautionary principle*—i.e. there is a point of no return, it is not known where this point is, so stay on the side of caution.

In combination, these objections make the "get rich fast – clean up later" strategy particularly treacherous for China. Important parts of the ongoing environmental degradation may be irreversible. Once biodiversity is lost, river ecosystems destroyed, arable land desertified, and groundwater contaminated, there is no going back, at least not at a feasible cost. At best, the "get-rich-fast – clean-up-later" strategy is the least cost-effective ap-

proach. At worst, it becomes a "get-rich-and-dirty—stay-dirty-get-poor" approach.

The Inside View: How Economic Growth has Affected the Environment

During the Maoist period until 1979, China's economy was centrally planned and supply driven. Prices of most basic resources as well as many commodities were set at artificially low levels in relation to the cost of production, and without relevance to the costs of pollution or depletion of natural resources stocks. The result was low efficiency in resource use and an economy characterised by low output and relatively high levels of resource consumption. Add the fact that few effective environmental regulations were in place, and the ground was laid for an economy in which further growth was destined to cause serious, widespread environmental degradation. The fact that the pre-1979 economy operated on a modest level, with negligible competition and little trade, reduced somewhat the scale of the negative environmental consequences at the time.

Since then, China's economic output has quadrupled over a two-decade economic surge, running an outstanding 8 percent annual average growth (Ziegler, 2000). This period of economic growth first resulted in heavy exploitation of natural resources with direct negative environmental impacts. Following on from the legacy of the Mao era, there was little concern for environmental consequences, with exploitation of natural resources far beyond carrying capacities. This has continued largely unabated and unregulated for many years. In the absence of regulatory controls, competition in certain sectors—stock chemicals and cement to mention two—has promoted a "race to the bottom" in terms of who can most quickly exploit human and natural resources in order to make profit and attract investment.

Pervasive economic subsidies have moreover continued to distort the prices of water, energy, and other basic natural resources. Scarcity and environmental externalities have not been reflected in the prices of these essential goods. Water is a good example where prices are artificially low and price increases, in most cases, have not provided enough incentive to enhance water conservation or to finance treatment of dirty water.

Finally, competition, both internally and with foreign producers, has been limited to a few sectors—a situation bound to change with China's WTO membership. Monopolies are common and privatisation has a long way to go still, so many enterprise managers and decision makers are inclined to increase production and employment rather than improve competitiveness. A considerable part of economic development occurred in an economic environment that permitted entrepreneurs to benefit from cheap inputs of material and labour, without having to pay for chemical discharges or workers' health—an unsustainable growth model carrying enormous social costs.

Ameliorating this negative trend, however, have been the market-oriented reforms that instigated economic growth and also set off positive environmental side effects. With prices increasingly reflecting scarcity of resources and true production costs, quality and efficiency in resource utilisation have improved considerably. At the same time, privatisation of state-owned enterprises and the growth of a substantial private sector have created a more profit-oriented, and thus more cost- and resource-efficient industry. In addition, the opening-up of internal and external trade has increased competition, providing further incentives for resource efficiency. Finally, with a shift away from the planned economy, much of the heavy supply-side industries are no longer needed. There has been a corresponding macro-level economic restructuring, as these polluting industries have been to some extent closed and replaced by higher-tech and service industries—albeit situated in other parts of the country. From the late 1970s to 1998, the service sector increased its share of GDP from one-quarter to one-third. These new sectors consume fewer resources and emit fewer pollutants per unit of GDP.

Sustainable Growth in Theory and Practice

The Chinese leadership finds it easy to embrace concepts of sustainable economic development and "economy and environment developing in tandem." The hard part comes in trying to put this into practice. A substantial part of Chinese society, notably leaders at provincial levels and below, and industry managers, still favour the "get-rich-fast – clean-up-later" approach. Also, when tough choices need to be made, it may remain easier to sacrifice the long-term environment in favour of short-term economic or political gains. For example, current preferences for employment over environmental considerations reveal that authorities are concerned about the effects of huge unemployment figures.

So, a crucial gap exists between theory and practice, and herein lies the key uncertainty as to how the economic growth model will affect China's sustainability in the future. China is faced with a sharp trade-off between the requirement for long-term sustainable growth, and demands for short-term economic returns. To a large extent this is an outcome of the different realities between the level of macroeconomic policymaking, and the microeconomic level where day-to-day decisions actually take place.

Seen from the local point of view, one new low-end, polluting factory can boost the local economy by providing labour for an unemployed agricultural workforce, causing only minor environmental problems. The sec-

ond and third factories that follow would make environmental consequences more of a concern but still manageable. By say the "seventh" plant, the environmental stress could well have exceeded tolerable limits putting a stranglehold on further economic development. And *vice versa* if one locality puts the "seventh" plant on line and causes a local environmental catastrophe, it is still only a local problem. But when a larger number of localities build beyond carrying capacity, they can jeopardize the sustainability of an entire region. A disquieting number of Chinese localities are operating dangerously close to the "seventh" plant, where short-term gains imperil all future economic growth.

Yet as the market approach becomes more widespread, and as people, industry and government think increasingly in terms of market forces, many new opportunities for environmental protection will unfold. To set the tone, these opportunities will have to be initiated at the macroeconomic level, for example in terms of fiscal, tax and trade policy, and green accounting. Many other opportunities are to be found at the sectoral level. China is already moving in this direction, with pollution taxes, experiments with emissions trading, and slowly increasing prices with some consideration of environmental externalities. As the market framework becomes more comprehensive, and as market forces truly permeate all corners of the economy, and as more detailed and reliable information becomes available, Chinese authorities can develop a full array of market-based incentives, including fees, fines, permits, emissions trading and green taxes to promote clean behaviour and generate revenue to finance costly clean-up and prevention. Market-based instruments provide incentives to the private sector to finance environmental protection. The way forward in this respect is outlined in chapter 4.

Future Trends and Uncertainties

The major trend so far indicates that growth has been bad for the environment. Although resource use and pollution discharge per unit of output in the Chinese economy have decreased as a result of market-oriented reforms over the past decade (SEPA, 1999, 2000, 2001), economic growth has been so strong that total levels of emissions and resource extraction have increased. The key question, therefore, is to what extent will market economic reform prove powerful enough to internalise environmental costs, so that future economic growth—crucial as it is to improve the living conditions for several hundred millions of poor Chinese—can become truly sustainable. As section 2.7 (Impacts on the Economy) indicates, the costs of environmental degradation discount considerably the value growth that has occurred over the past decades.

The Chinese economy is expected to grow substantially in the future, although how much and how fast, is impossible to predict. It is also safe to assume that inter-

Box 3.2 Sustainable Development in Reality

One interesting way of understanding how future economic development will evolve could be to look at how recent and current development programmes manage to internalise environmental costs without creating environmental deficits.

The *Great Western Development Strategy* is a central development activity that takes a market-oriented approach to developing the poorer western provinces. On paper, it has ecological conservation and sustainable development at its heart. Although translating this into practice is an enormous challenge, the strategy offers obvious opportunities for merging growth and environmental protection. For example, the west is rich in renewable energy resources, and these, rather than fossil fuels, could be put at the centre of development. And cleaner sector activities can be stimulated to provide much of the employment and economic growth. Information and communication technology may also provide opportunities for the west to avoid many of the industrial environmental problems experienced in China's east. But there are far less alternative sustainable development paths for how to utilise the vast west. Improved transport infrastructure—a central aspect of the western development—could be a mechanism for transferring pollution-intensive industries to the west, such as paper, low-tech chemical manufacturing, coke and steel, while at the same time emptying the western provinces of their natural resources. Such a strategy is likely to generate economic growth, and possibly also provide room for environmental improvement in China's coastal provinces. But the result for the west would be long-term, devastating environmental problems.

The *Beijing Green Olympics* strives, as the name indicates, to position itself as the first Olympic Games with a strong environmental focus. And it would be surprising indeed if Beijing itself did not come through as a much more environmental and "green" city in 2008 that it is now. With monumental construction projects, upgrading of transport systems, and other large economic undertakings, the preparations for the Games are bound to generate economic growth. The question is to what extent is it possible to promote this growth in a more sustainable way, and whether Beijing in 2008 will prove to be a more sustainable urban system than Beijing 2002. The Beijing Olympics represent a showcase opportunity to demonstrate how economic development, modernisation, and environmental improvements can all be part of the same sustainable package. But if the greening of the Olympics amounts only to ostentatious construction projects relying on hefty one-time government subsidies and over-utilisation of water resources at the expense of surrounding water-scarce areas, then the Olympics would not only fail to be "green" in the sense of "sustainable" but moreover would cause yet more pressures on the already heavily stressed ecological system in the larger Beijing capital area.

nalisation of environmental costs and efficiency gains from a more market-oriented economy will not suffice to neutralise the environmental toll generated by economic growth yet for many years to come. In the foreseeable future, therefore, economic growth in China will continue to have an overall negative impact on the environment. Furthering governance reform, as outlined in section 3.12 (Governance and Institutions), is crucial for China's ability to generate high economic growth while minimising the environmental impacts.

But there are also risks for environmental backlashes to the economy, particularly if areas in eastern China that stimulate the economy, exceed environmental thresholds, creating, e.g. chronic water shortage, or are struck by natural catastrophes. Such events, depending on their magnitude and context, could trigger a downward spiral with slumping growth and unfortunate social repercussions leading further into economic stagnation.

With China's global and regional economic importance on the rise, the global economy and international trade issues affect China's path into the future more than ever before. Therefore, China's response to the WTO entry is likely to have far-reaching effects on its opportunities to achieve sustainable growth.

3.3 Poverty, Equity, and Environmental Justice

Poverty is often simply considered to be a cause of environmental decline, but the causal relationships are very complex, and poverty is more often a result of environmental degradation. This degradation can reach a point of no return, after which poverty and social instability are inevitable. A large proportion of the Chinese population is likely to remain poor for many decades to come, and ensuring they have adequate access to environmental resources may be essential to maintaining stability and economic growth.

Inequity and Poverty in Modern China

As a result of previous policies to promote rural development, social welfare, basic education and support of women, China used to be a poor but by international standards relatively equitable society. However, many inequities do exist, and these have grown substantially since the reforms took off in the early 1980s. These inequities appear as economic and social disparities among and within provinces and cities, between rural and urban areas, between east and west, between the Han and minorities, and between men and women. Whereas many residents in China's eastern provinces enjoy a high standard of human development, more than 140 million Chinese people live in provinces that, if classed as independent countries, would fall into the low-end category (see Annex).

Some official figures illustrate these discrepancies. GDP per capita in Shanghai in 1999 exceeded 14,000 USD, more than 10 times that of Guizhou at 1185 USD. Rural females in five provinces (Ningxia, Gansu, Qinghai, Guizhou and Tibet) experience adult illiteracy rates over 40 percent, compared to under three percent for males in most cities (see Annex). Even within relatively wealthy Fujian province, adult illiteracy levels vary from under four percent for men in cities to over 30 percent for women in rural areas (UNDP, 2000).

In terms of poverty, the country still has about 50 million people living in absolute poverty in rural areas, with an annual income of less than 635 yuan (about 75 USD), and 12 million urban people with an annual income of 2,000 yuan (240 USD) or less. China accounts for one-quarter of the 900 million poor people in Asia. Although the poor often live in the inland provinces, in rural and remote areas, and in areas with large minority groups, the picture is becoming more complex. There are new types of poor such as the urban poor, laid-off workers, and the environmental poor. Most provinces in China have significant numbers of both rural and urban poor, enough to threaten social stability.

Inequity and Poverty Create Environmental Degradation

Some evidence exists that poverty and inequity are driving factors in creating environmental degradation. Particularly in rural areas, in combination with inappropriate economic and social policies, poverty can force people to exploit land and forest resources in unsustainable ways that may result in land degradation, deforestation, biodiversity loss, and water shortages. From a local perspective, the point of no return is quickly reached, both for the environment and for the people, who are forced to move on. Educational poverty can also contribute. For example, farmers who out of ignorance inappropriately use pesticides and fertilisers can inadvertently harm themselves, their families, and the soils and water on which they depend.

One-sided policies dealing with poverty can also lead to increased environmental stress. In the 1970s, to overcome rural poverty and promote Mao's policy of local self-sufficiency, the government initiated the township and village enterprises (TVEs). Extremely successful in boosting the rural economy, this strategy has proved devastating to the local environment, consuming resources—notably coal and water—very inefficiently, emitting large volumes of air, water, and solid waste pollution, including much toxic waste. By 1999, TVEs employed well over 100 million people (State Statistical Bureau, 2000), but were responsible for 50 percent of industrial water and air pollutant emissions (SEPA, 2000). Up to 20 million hectares of arable land has also been

polluted by TVEs (Research Group of Sustainable Development and Comprehensive Productivity in Chinese Agriculture, 1995). This conflict continues, as the national authorities close down many enterprises on the grounds of pollution, and the local authorities re-open them, partly to avoid fall-out in terms of poverty, inequity, and social unrest.

Environmental Degradation Feeds Poverty and Inequity

Poor people usually have less access to natural resources. As the environment degrades, there are even less resources, and in most cases it is the poor who are the first to suffer. This "environmental poverty" contributes further to economic poverty and increased inequity, and could be a ticking time bomb for China's society.

Environmental Justice for All

Environmental justice, in general terms, implies that no group of people, including all racial, ethnic, and social groups, suffer disproportionately from the negative environmental consequences of industrial, municipal, and commercial operations, or the execution of federal, state, local, and tribal programmes and policies (USEPA, 2001). Injustice occurs in cases where some people benefit significantly from activities that cause ecological damage, at the expense of others who are subjected to the environmental costs of the damage. One obvious example is the large-scale, unchecked, and often illegal felling of

Box 3.3 The School in the Sand Storms

Xuanhua Secondary High School is situated in Xuanhua County in Hebei Province 180 kilometres from Beijing. It is about 10 kilometres from Huangyangtan, one of the sources of the sand found in Tiananmen Square in March 2000, after one of the worst sand storms. Xuanhua people have a rhyme: "Twice a year it blows; six months lasts each blow". Sand and wind are part of everyday life for the students in Xuanhua Secondary High School.

"The wind starts in February each year and it lasts about a week each time. The sand saturates the atmosphere and makes walking to school a hard task", one of the students says. Nonetheless, the schooling and outdoor exercises go on. It seems that the windy conditions have gotten worse the last couple of years. "We plant trees each year around the school, and we are told the importance of environmental protection. But we feel our force and help are very limited to fight against the wind".

The deputy principal, Mr. Xue acknowledges that the tree-planting has little impact against the strong north wind. "Besides, the general environmental consciousness is low and many new trees are destroyed. There used to be more trees in the area; lots of them were cut down by the farmers, after the land reform, for construction and furniture making".

Sand storms cast shadows over the lives of Xuanhua people. At the school gate, candy-stick peddler Guo Runxi recounts that he cannot sell candy sticks when the wind is strong. For about one to two months, between early spring and June, he cannot do business. He attributes the worsening situation to the development of the west. "The hills are flattened and the storms become fiercer without their protection". Walking out from the school, postman Sun Wanping adds that the sand storm last year was so strong that it prevented him from opening his eyes. "To deliver post, I had to push the bicycle. Although there is reforestation in the County, there is not enough follow-up to ensure survival of the trees".

In Xuanhua, people sing: "A tree in the spring, a dry twig in the fall; every year we plant trees, never to become timber". They say that with all the trees planted in China, it should be covered several times with forest.

trees, which destroys old ecosystems that have provided sustainable services including food and housing to people for hundreds of years. Another example is when a factory pollutes air and water leaving local people with health problems, depriving farmers of their land, while the factory owners increase their wealth.

In many cases, however, it is very difficult to correct things through enacting environmental justice. There are often two sides to every story, as the following examples illustrate:

- Emerging middle class Shanghai families live in clean, air-conditioned apartments, enjoy a secure energy supply and sometimes even own a car. Nearby, recently arrived migrant workers sleep outdoors, lack toilet facilities and access to water, breathe dirty air, and cannot sleep for the noise and mosquitoes. All this seems like an injustice, as the migrant workers were probably already the victims of poor policies and resource over-exploitation in their original places of residence. However, Shanghai's residents, who may have invested time, energy and finances over several generations to improve their city and society, may argue that the migrant workers have less right to the city's facilities and cleaner areas. Who then has the rights to local environments?
- When farmers in upstream areas of the Yellow River overdraw the limited water resources for local irrigated farming, downstream farmers and city dwellers suffer, as they no longer have a secure supply. To whom does the water belong?
- The Three Gorges Dam case involves the relocation of several million people, denying them access to ecosystems that have long served as their primary source of livelihood, often for several generations. At the same time, the dam is to generate "clean" energy, not polluting the air, reinforcing millions of other people's right to fresh air. Which is most justifiable, land rights, or clean air?

Each of these cases is a result of a series of linked circumstances that are the subject of this report. Leaving the contextual issues behind for a moment, however, what these examples illustrate is that although questions of environmental justice are clearly involved, these questions are not so clear-cut as either side usually portrays them.

What the conflicts over rights associated with environmental qualities actually reflects is China's weak governance framework, in particular the lack of channels for various groups or individuals to voice their views, the absence of transparency in the decision making process, and the lack of mechanisms to balance interests and offer compensation.

Adding the global perspective, one might argue that all people in developing countries suffer from environmental injustices, as they are the victims of global environmental problems they have not caused themselves—climate change being an obvious and topical example.

Gender

Men and women are exposed to different environmental stresses. Their work environment often differs, a fact that may have considerable health consequences given China's dismal occupational health situation. Also, women are more exposed to high levels of indoor air pollution due to the fact that they spend more time at home, especially in the kitchen. As agriculture is increasingly the work of women, it seems reasonable that they should be more involved than men in questions surrounding the sustainability of agriculture. Yet, strong patriarchal traditions prove counterproductive to this, and Chinese media have recently reported that women farmers have been denied equal rights to contract land (ADB, 2000). Women farmers will be increasingly subject to the ill health effects of pesticides and fertilisers.

Future Trends and Uncertainties

Given increasing pressures on limited resources, environmental inequity in China is a growing concern. The *haves*, those with water, clean air, and access to land are the environmental elite. These *haves* are likely to continue to increase their consumption, displacing their environmental damage to areas where the poor live. The *have-nots*, living in dirty, smelly, conditions, without access to land, have fewer and fewer alternatives other than further damaging the environment, further reducing their access to land and water, increasing their exposure to pollution and worse poverty.

Given China's critical environmental situation, one could easily imagine catastrophes followed by increasing social instability, should nothing be done to break the evil circle. A widening inequity gap would also likely have negative impact on the economic growth potential, since although environmental problems can contribute to the poor getting poorer—they may not necessarily contribute to the rich getting richer. To gradually narrow the gap between the *haves* and *have-nots* will require reforms in Chinese society that go beyond what normally falls under environmental policies. Equity is therefore an important factor associated with high uncertainty for assessing China's future options.

Certain groups of people, depending on natural conditions as well as the social context in which they live, will prove to be more vulnerable to changes in the society–environment nexus. For example, the threshold that determines when people choose to uproot and seek better living conditions elsewhere, may depend on condi-

tions such as availability of water, the local labour market, and education. The magnitude of groups with pronounced vulnerability to the large-scale environmental threats that China faces is an important factor when evaluating its path into the future.

3.4 Environmental Awareness

Public awareness of the condition of the environment, and of the social and economic impacts of environmental degradation, has probably been, worldwide, the most important driving force for environmental improvement. A well-informed and articulate population, and a diversified cadre of well-educated environmental experts, are essential conditions for environmental improvements. It is usually the public, supported by well-informed and articulate experts, not the government and certainly not businesses that have put the environment on the agenda.

Raising Awareness and the Importance of Media

Until as little as five years ago, public awareness of environmental issues was very low in all parts of China. In response to the growing environmental challenge, and to some key events such as the 1998 floodings and the campaign to host the 2008 Olympics, this is changing. This growing public awareness is mostly the result of an increasingly active media, but is also in part due to the proactive measures of the government. Equally important is the establishment of a social climate that not only allows but also encourages public debate.

China has massive media coverage—more than 300 million radios, 250 million television sets, and no less than 5,500 different newspapers. These media are taking an increasing interest in the environmental situation. Until recently the focus was on the action being taken to curb pollution. This seems to be changing, as testified by recent news stories on the health impact of pollution, illegal logging, consumption of wildlife, poaching, and the water crisis.

Realising the watchdog power of the public, the government supports raising awareness, and uses this awareness to implement regulations. For example, in some provinces, an award system has even been set up to encourage the public's reporting of infringements. This and other incentives have mobilised more people to look for and report environmental violations.

Environmental Expertise in Short Supply

Led by the slogan "better red than expert", respect for learning suffered heavily during the Cultural Revolution era. Despite changes since 1979, primary education is just average compared with other populous nations. The shortage of personnel with understanding of anything from environmental engineering to environmental economics—particularly necessary in a market economy—is severe.

At the same time a positive trend towards better education shows that Chinese universities are graduating increasing numbers of young professionals with degrees in a wide array of environmental disciplines. The increasing international exchange, with considerable numbers of Chinese undergraduate students doing their master or doctoral degrees at academic institutions around the world, is also helping to improve the level of Chinese environmental expertise, as do the elevated position of expert institutions.

Still, the future will witness a deficiency of environmental experts in general, and people with a broad understanding for the societal aspects of environmental problems in particular.

Health as a Driver for Change

In western countries, health concerns lie behind many environmental concerns. When the health impacts of environment degradation are understood and become common knowledge, environment moves from being a marginal to a central concern. When a child's health is at stake, parents push for change. In general, this requires specialised knowledge, information systems and strong co-ordination between the health and environment sectors, in governments and in research institutes. In China, knowledge of the impacts on health is limited, and information is difficult to obtain and analyse. For these reasons, health awareness is low, and the potential to use health to push for environmental change remains vastly under-exploited.

Does Increasing Awareness Have an Impact?

Some anecdotal evidence suggests that public awareness has already had impact.

- A popular saying states that local polluters are not afraid of government inspections but of media exposure.
- The daily air-quality reports, covering 47 cities since 1997, have attracted enormous public attention and imposed tremendous pressure on local officials to take measures. As a result, air quality has improved in some locations, and demand for further actions has increased.
- A pilot programme in the cities of Zhenjiang and Hohot used the colours black, red, yellow, and green as simple indicators to communicate to the public the pollution-control efforts taken by enterprises. As well as raising public awareness, this provided a feedback mechanism to government and enterprises, and as a result, some enterprises now go to the media to make public commitments about improving their performance.

One result of increased environmental awareness is that it spurs people on to protect the environment and their own health and welfare. Complaints filed by the public

to local Environmental Protection Bureaus are increasing. People are also better organised as is well illustrated by the emerging and nascent environmental NGO movement in China (see chapter 4).

Future Trends and Uncertainties

Despite recent advances, some forces limit public pressure and its impact on environmental change. First, in general, the public continues to view environmental protection as the government's responsibility. As long as this perception persists, awareness may remain low and ineffective. Second, the public tends to accept the argument that environmental problems are inevitable side effects of economic development and can be cleaned up later. Even when made aware, the public tend not to demand action. Third, although awareness is on the rise, the basic *understanding* of environmental problems remains very low, and so the public may be unable to push for appropriate responses. Finally, government officials in some economic sectors and at local levels, and most enterprise managers, do not consider public awareness a constructive force.

Given the strong impact that public awareness has on environmental actions, the degree to which the Chinese population becomes better informed and more knowledgeable about causes and effects of environmental problems is likely to play a decisive role in the solution of the present environmental predicament. Yet, awareness and knowledge will not be enough if the political climate is not responsive to public pressures, and if no channels exist for people to voice their views.

3.5 Consumption

High growth rates, along with export promotion and the increase of domestic consumption are key current strategies for maintaining economic growth in China. Consumption, in turn, is essential for maintaining employment levels and social stability but can have major impacts on the environment. The direction of demands for industrial products and energy, plastic products, dyes, and electronics, will necessitate an increase in the flow of resources through the economy and exert increasing pressure on the natural resource base. Moreover, as wealth increases, more and more families will demand an increasingly materialistic way of life.

Consumption is an important mechanism through which the rich, middle class and urban population have impacts on the environment. The impacts are indirect, often displaced geographically, and more often than not, it is the poor who suffer a disproportionate share of the burden.

Consumption Levels

In the past, Chinese people consumed much less than the world average for most products, and even today, per capita consumption remains relatively low. For example, per capita electric power consumption in 1997 was less than 1,000 kWh in China, almost 2,500 kWh for the world, and more than 13,000 kWh in the US. But a growing middle class and spiralling economic growth are changing things, and the signs are that consumption will move along paths similar to North America and Europe. The following figures illustrate how overall consumption has grown in China:

- The number of private vehicles quadrupled from 1991 to 1997 to now over 20 million, and could reach as many as 50 million by 2010.
- Between 1980-1998, beef consumption per capita increased an estimated 2.3 times, and consumption of poultry an estimated 4.8 times (Ma Hengyun, 2000).

Most consumer products are following similar paths. Given the prospect of a certain rise in current low per capita levels of consumption, and a huge homogeneous population, China has the potential to consume significant amounts of the world's products in the coming decades.

Consumption Patterns

A look at regional consumption suggests that it too will rise in the coming years. On average, urban areas have more than 10 times as many refrigerators as rural areas. While almost 100 percent of homes in urban Shanghai, Beijing, Tianjin and Guangdong have washing machines, less than 1 in 20 households have this appliance in rural Chongqing, Guangxi, Hainan, Jiangxi, and Tibet (see Annex). These figures suggest that owing to urbanisation and increasing economic wealth, consumption may well increase by orders of magnitude.

Of course, it is possible for consumption to rise without a corresponding increase in the negative impacts on the environment. China, to some extent, has already achieved a significant "de-linking" of environmental impact from GDP growth, notably in the energy sector (see section 3.8 on Energy). The concept of "green consumerism" has also begun to take hold in China, as reflected in a growing interest in organic food, energy-saving light bulbs and household appliances, and biodegradable products. Meanwhile, however, counter-forces are also in play, as urban consumers require more sophisticated and complete packaging, and as consumers with increasing spare cash purchase more and more non-essential goods. Also, whereas recycling in rural areas is high, traditional recycling systems are apt to function less effectively in urban, middle-class areas.

Consumer Pressures

The consumption equation also has another positive side—consumer pressure for an improved environment. Middle-class consumers pay more attention to what they consume, and to its origin. The demand for environmen-

tally clean products carries every potential to grow in line with awareness, and, as in Europe and North America, may one day become a force for better environmental practices.

Nothing suggests that Chinese consumers would be less concerned about the environment than people elsewhere, or less responsive to making environmentally friendly choices. On the contrary, certain cultural and traditional aspects point to a considerable potential for the evolution of consumer pressures in China. The change from low per capita consumption with a high level of reuse and low waste generation did not start until the 1980s and took off only in the 1990s. Insofar as Chinese society has not yet cemented a high consumption pattern, it is possible to implement more resource-efficient development alternatives from scratch. Another positive factor is the importance that Chinese people assign to what they eat, and in particular the traditional link between food and health, which has the potential of translating into strong consumer pressures.

For consumer pressures to develop into a real force for change, it is essential to provide accurate information on the environmental impacts of products, so that consumers can make informed choices. Ongoing initiatives to develop green labels for consumer products are discussed in section 4.3.

Future Trends and Uncertainties

Two divergent trends are driving consumption in China. The first is a combination of higher per capita levels of consumption, consumption patterns with more wear-and-waste mentality, and an increase in consumer products. The second shows up in an increasing attention to what one consumes and heightened awareness of the environmental impacts. At present, the first trend far outpaces the second, and the environmental impacts from increasing consumption are potentially at a similar level of importance as is the growing population pressure. Nevertheless, a clear opportunity beckons to change tracks to more resource-efficient consumption, although this change would demand an active intervention by government to set rules that would promote the evolution of a market for green products.

3.6 Technological Development

The development and deployment of new technologies, and an assessment of their appropriateness to China and the Chinese ecosystems, will be major factors in the sustainability of China's development. Technology development is assumed, overall, to be a positive force. New and improved technologies are more efficient, consume fewer resources, and produce fewer emissions per unit of output. At the same time, however, new technologies also facilitate economic growth and access to new areas, such as the fragile ecosystems of western China. Also, new technologies may bring with them entirely new environmental challenges, with unknown or unproven consequences.

Hard or Soft Technology

It is not only hard technology that will drive China's economy and environment. Soft technology is equally important. For example, urban planning is a form of soft technology that has evolved rapidly in past years. As China develops new towns, great potential exists for technological leapfrogging. China is already experimenting with new forms of urban planning, such as wide-scale greening campaigns in Beijing, and, notably, through its national small-town development pilot programme. This kind of technology, at little cost, can help ensure that future cities in China resemble Sydney, not Bangkok.

China's Technological Future

China continues to depend on imports to a large extent for high technology and for technological upgrades. Over the past two decades, China has emphasised scientific development as a driver for positive change. This strategy will continue particularly in the areas of agriculture, grain, population, health, energy, environment and efficiency, although China invests only 0.6 percent of GDP in research and development (R&D), compared with 2-3 percent in the US, Japan, and European Union countries.

Questions also hang over the quality of Chinese R&D. Approximately 70 percent of R&D spending comes from government, whereas in the US, Japan and Germany, industry is responsible for over 70 percent (SSTC, 1994, 1995). Assuming that industry is commercially oriented and thus more likely to develop technologies that have commercial applications, there is a danger that Chinese R&D will not lead to the development of applicable technologies. The more China can shape its own technological future, the more the technology will be appropriate to Chinese conditions and the less expensive it will be to upgrade.

In a market-oriented economy, government intervention to push and pull technology development is essential. China is already taking steps in this direction. For example, it has developed safety labels for electrical appliances, established environmental standards, and provided extensive government investment in experimentation and commercialisation of renewable energies.

Human resources and capacity development offer another domain in which government can intervene, and Chinese leaders are increasingly interested in foreign co-operation, particularly in ensuring capacity related to soft technologies. In preparation for the World Summit on Sustainable Development in Johannesburg in August/September 2002, the State Development Planning

Commission has launched a programme to send a larger number of central and provincial level planners on international study tours to learn about sustainable development practices abroad.

Areas of Critical Future Technology Development

Energy technology is a crucial area, and some future developments of relevance to China are discussed in section 3.8. Renewable energy technologies comprise an area in which China could well become a world leader, and given its extensive renewable resources, the paybacks could be considerable. Chinese government and enterprises have the financial capacity to invest in developing and commercialising these technologies. If, over the next century, renewable sources become the dominant energy-generation technologies, Chinese enterprises could well belong to the world's leading energy companies by the middle of this century.

Information technology will drive economic and technology development in all sectors. China is well placed to take full advantage of this, as well as the sustainable development opportunities that are associated with information technology.

Biotechnology is a controversial area, with advocates saying it can increase food productivity thereby reducing pressure on land resources, and opponents saying it is the porter of future calamities. Either way, China is again well advanced in this area.

Environmental technologies will be decisive. Owing to limited production capacity at present, China imports expensive technology, often not fully appropriate to Chinese conditions. For example, China imports expensive SO_2 removal systems, which are more efficient than China can afford and do not function well with Chinese boilers. With appropriate incentives, this nascent industry could develop substantially, producing technology that prevents pollution, and employs large numbers of people.

Future Trends and Uncertainties

Technology is crucial to China's pursuit of sustainable development. Still, technology is not an end in itself, nor does it develop and thrive in a vacuum. China is well positioned in various technology areas, and has a longer way to go in others. What is most important as a driver for development of sustainable technologies, however, is the establishment of an environment in which technology development can prosper. With regard to environmental technologies, the key is to create a demand for them by putting a price on environment and internalising environmental costs in production.

Other technologies where China has already a good start will have to rely initially on availability of governmental and/or private R&D financing and increasingly also on risk capital. Here China's failure to come close to matching the spending in developed countries is obvious, which bodes poorly for the future.

Another important but wholly uncertain factor is the ability of China to reduce the "brain-drain" and to attract well-educated people from around the world to take part in technology development for China's benefit. China has a record of significant loss of talented experts, which however, is beginning to show signs of decline as Chinese intellectuals more often than before, return home after completing their higher education abroad.

3.7 Water as a Social Good

Shortage of good-quality water is undoubtedly one of China's most serious problems. Basic facts with regard to water quality and quantity have been presented in chapter 2. On top of the direct environmental impacts of water scarcity and pollution, there are potentially serious societal consequences of China's water problems such as user conflicts, constrained economic development, and migration. In short, societal water-related problems are contributing increasingly to political and social instability.

The seriousness of the problem is recognised at the highest level. Premier Zhu Rongji has warned of "serious limitations" if China neglects its water resources. Vice-Premier Wen Jiabao emphasised that "China has to work hard to deal with its insufficiency of water resources, worsening water pollution, and threats of floods and drought." This awareness is relatively new. Until recently, all China's water policy focused on increasing supply and getting more water to more users. There was no sense that water could become seriously polluted or taps run dry. Unfortunately this new awareness is limited to some levels and sectors of government and is only now being translated into action.

Water-related Conflict

Conflict over water is not new to China. The control of water resources and their allocation has been a central power issue throughout history, with numerous accounts of how droughts, caused by a combination of low precipitation and failure to maintain collective waterworks, have led to open conflict, even armed uprisings. Given the critical northern situation, particularly in the Haihe river basin, where almost 100 million people live on a mere 300 cubic metres per capita annually, it is remarkable how well Chinese society has managed to cope with an increasing water stress without major overt water-related conflicts occurring. By the same token, however, water scarcity is decidedly a major destabilising factor for future prosperous development, particularly in northern China.

China's major water conflicts run along three lines:

- upstream–downstream, especially in China's north and northeast
- north–south
- between different users, particularly thirsty Chinese agriculture and polluting industry/urban areas

Upstream-Downstream

The upstream-downstream conflict is a direct consequence of declining flows along most Chinese rivers and attendant pressures from mounting population and agricultural practices that require more and more irrigation (see box 3.4). This growing upstream–downstream conflict reflects part of the larger development tension between coastal China and its interior. In the rapid economic development process, the coastal areas have had the advantage of a favourable geographical location, the proximity to the sea providing a sink for waste products, while sufficient amounts of reasonably clean water came down from less developed, and thus less polluting, upstream areas. With the drive to develop China's interior, upstream areas withdraw more water and discharge more pollutants, thereby threatening basic water supplies in coastal areas. The risk of conflict escalates, with potentially far-reaching consequences for economic development and political stability both in coastal and inland areas.

North-South

The north- south conflict falls back on China's southern half having abundant water supplies, whereas the north suffers from water scarcity. Until now, the north has managed to achieve rapid economic development by overtaxing groundwater supplies. In order to meet future demands in the north, transfer of large amounts of water from the Yangtze River basin to the Yellow River and up to the North China Plains is under serious consideration. Plans exist to redirect more than 100 km^3 of water per year from the Yangtze basin, or roughly speaking 10 percent of the total flow of the river. Let alone the direct consequences for people living in the Yangtze River valley, including a variety of possible ecological disturbances, or the waste of water due to evaporation in the transferring process, the project involves large-scale, complicated engineering, and the construction costs will divert large amounts of financing thereby diverting public finances from other important undertakings.

Box 3.4 Water Conflict Along the Yellow River

Upstream–downstream conflict is well illustrated by the Yellow River, which currently runs dry, not reaching the sea for about half the year.

For centuries, farmers on fertile land in Shandong province have benefited from the Yellow River's nutrient rich water, which due to the elevation of the riverbed more than ten meters above the farmland level, has been an excellent source of irrigation. Recently, with the lower stretches of the Yellow River running dry for longer and longer periods, the Shandong farmers have to rely increasingly on local precipitation for agriculture, resulting in lower yields.

At the same time, further upstream, along the middle stretches of the Yellow River, large-scale irrigation schemes have been extended over the past two decades, the purpose being to provide sufficient irrigation to areas that would normally be too dry even for traditional rain-fed agriculture. One example, a large irrigation scheme on the Hetao plains in Inner Mongolia supplies almost 6,000 km^2 of farmland with irrigation, without which only marginal farming would have been possible. The Hetao irrigation scheme withdraws 5 km^3 of water each year from the Yellow River—sometimes swallowing half of the river—water that would otherwise have been available to Shandong farmers.

Agriculture-Industry

The conflict between agricultural and industrial uses is visible all over China, with agriculture being threatened by industrial and municipal pollution, and industrial activities being constrained by lack of a secure water supply, since agriculture takes the lion's share. This conflict is sharpening, and may lead to large areas being unsuitable for agriculture and/or industrial activities, with far-reaching economic and political consequences.

Increasing Vulnerability to Water Scarcity

The interrelated processes of declining water sources, intensified water pollution, and degraded ecological conditions mean that increasing numbers of people are becoming more vulnerable to water scarcity. Already a substantial group of "water refugees" are among the over 100 million migrant labour force—people who have lost their basic livelihoods as a result of continuous drought and environmental degradation. Most of the people in this group come from marginal lands in dry, fragile ecosystems. Although this group is bound to increase, its numbers are limited.

As water shortages intensify, they may affect larger groups of people. One such group is the water-intensive farmers in the lower reaches of the northern rivers. If water for irrigation runs out or becomes too polluted to support farming, they may have to move on in search of other livelihoods in other places. An even larger group of people is the urban population in coastal areas. Currently, they receive water from upstream areas, but, as more water is diverted for upstream development purposes, basic conditions in these urban areas will change and large groups of urban people may lose their livelihoods.

At the societal level, shortage of good quality water affects industrial and agricultural production across China and limits the options for urban as well as rural development. Many cities, including important centres such as Beijing and Shanghai, claim lack of water to be a significant factor restricting economic growth.

Drivers of Water Use

Three factors make up the main drivers of inefficient water use in China: artificially low water prices, a formidable water management bureaucracy, and agricultural self-sufficiency policies.

Artificially Low Water Prices

A typical water price in northern China as of 1998 was 0.031 yuan per cubic metre, or the equivalent of 0.3 US cents, which covers about one-tenth of the actual cost to supply the water. As a consequence, little or no incentive exists for users to save on water by investing in water-efficient technologies and no driving forces call for a market that will develop water-saving appliances or commercial recycling of water. There is even less economic support for a much needed structural adjustment in the direction of water-efficient agricultural and industrial production.

This explains the paradox that one of the world's most water-scarce areas shows such low water efficiency. Irrigation in many regions wastes two-thirds of the precious water in the process, for example by sprinkling water during hot summer days, not an uncommon sight on the North China Plains. Drip irrigation, invented in China thousands of years ago, is applied to a mere one-tenth of a percent of Chinese farmland, compared to Israel where half of the farmland is supplied with water-efficient irrigation. The industrial situation is the same, with Chinese industry using up to ten times the amount that Western factories allocate for similar activities.

The Multi-headed Water Dragon

The water sector is managed by many conflicting agencies—resulting in a multi-headed water dragon. Water is managed by the Ministry of Water Resources and by local governments. Pollution falls under SEPA, and soil erosion under the Ministry of Agriculture and the State Forest Administration. The State Power Company and regional authorities share the administration of hydropower stations. Blurred division of responsibilities results in fighting over control of water management and conservation. The legal framework is equally filled with loopholes and contradictions. The existing laws and regulations fail to tackle effectively ecological destruction and aging and out-of-date water conservation works. The Water Law, promulgated in 1988, is skewed towards agricultural water use.

River basin commissions have been established for large drainage areas, but as yet, they enjoy limited coordinating power, especially over provincial governors. Distribution of water resources in river basins that span several provinces is solved through negotiation of provincial quotas, but upstream provinces are allegedly withdrawing more than their allotment, leaving downstream users without water. The river authorities have no powers to act against violators, and so upstream users continue to take as much as they can afford, the only limit being the cost for pumps and piping.

Agricultural Self-Sufficiency Policies

China's agricultural policies since 1949 have developed and cemented an agricultural production system that is far more water intensive than what is sustainable even for the short- or medium-term future. Since the 1990s, the Chinese government has been increasingly concerned with grain production not keeping pace with demand, as farmers have turned to more profitable agricultural production such as fruits and vegetables. The "grain bag" policy of the 1990s, which aimed at regaining govern-

ment command and control over a boost in grain production, has put further pressure on already over-utilised water sources (see section 3.10 Agriculture and Food Production).

Reform of Water Policy and Management

Although the scale and combination of water problems in China may seem uniquely incompatible, alternatives and management solutions to many of the conflicts and challenges do exist, although hard choices are inevitable. As the preceding paragraphs have illustrated, the present pricing and institutional framework and existing processes for long-term and large-scale planning have not been conducive to mitigating the water challenge. Consequently, these are areas in which one might seek the basis for a solution.

The need for more efficient water management as well as the country's WTO accession should provide impetus for China to look for foreign investment and firms to participate in dealing with its water challenges. This is a dramatic departure from the past when such sensitive sectors were closed to outside participation. Already, foreign firms are active in building water supply and sanitation utilities in China—one European water firm has built 106 waterworks in China in the last two decades and directly manages ten of them. Foreign companies operate almost 50 water utilities now in China.

Box 3.5 Water Prices, Changes Afoot

A successful story in Hunan and Hubei provinces signals some hope. In 1993, some farmers were grouped into water-supply companies and water-user associations called self-financing irrigation and drainage districts. Run by farmers elected by secret ballot, these groups made it easier to establish prices for water. The reality shows that when farmers pay by volume, they waste less. There is an immediate 20 percent drop in water use on average. Many cities have adopted fee charge systems, and urban residents now have to pay not only for use of water, but increasingly also for sewage discharge. Levels of charges vary among different cities.

Future Trends and Uncertainties

Although politically difficult to implement, the solutions to many of China's water problems are known, and China is already experimenting with them. These include:

- Full pricing of water, including environmental externalities, will greatly reduce water wastage, water use, and water pollution. Experience from northern China shows that if farmers were charged by volume instead of by irrigated acreage, as is the prevailing practice, water consumption might fall considerably.
- Extending powers to river basin authorities to manage conflicts and to manage existing water resources within the given amount of renewable water in each river basin, and developing capacity to do this in a participatory manner.
- Corporatising or privatising water supply and distribution, initially in city areas can lead to efficiency improvements. However, existing institutional weaknesses, and low prices, provide a disincentive to private-sector investments in what could be a very profitable sector of the economy.
- Providing incentives for agriculture to develop in a water-efficient way based on local conditions, while industrial development should benefit from recent advances in clean and efficient production techniques.
- Introduction of ecological sanitation solutions in order to save water, prevent water pollution, improve human health and recycle nutrients is a particularly promising area of growth.

So, the direction is set, but the social changes that may ride the wake of these reforms are as far-reaching as they are hard to imagine. With water inefficient agriculture being at the core of the problem, any realistic attempt to improve the situation will have to fundamentally change the conditions for Chinese agriculture, and with that, the entire foundation of rural China. In a sense, the dilemma of subsidised water for the Chinese agricultural sector is similar to that of subsidised financing to keep alive the heavy state-owned industry sector. How to then phase out the subsidies without causing social unrest?

The WTO entry is another wild card in making assumptions about China's water future, most of it related to the agricultural changes, as Chinese grain farmers, particularly in the north, will have a hard time competing with grain farmers in countries with better grain-producing conditions, such as abundant water supply. Could Chinese agriculture find overseas markets for more labour-intensive but water-efficient crops?

Yet another critical future uncertainty surrounds possible impacts of climate change. Marginally lower precipitation in northern China could jeopardise the livelihoods of millions of people, whereas increasing variability of rainfall would put larger population groups at risk of both drought and flooding. Calculations from the Max Planck Institute indicate that the 50-year peaks of today could become as common as five-year peaks by 2050, which means one flooding at the 1998 magnitude every five years.

In conclusion, there are no easy fixes to solve China's water situation. Business-as-usual would lead to increasing conflicts, which could well lead to overt conflict and centrifugal effects. At the same time the reforms needed

to solve the water problems will inevitably cause other social problems.

3.8 Energy

Energy use is set to increase up to six-fold by 2050, and energy-related environmental stress could increase likewise. A key challenge is how to provide essential energy services without incurring unacceptable damage to human health and the environment.

Energy and the Environment in China

Until the 1980s, energy policy in China focused on production, mainly of coal, oil, and electricity. Once production was relatively assured, policy turned towards efficiency and power generation. Other important objectives of energy policy include ensuring equitable access to electricity, and facilitating strategic foreign investment and trade in energy commodities. Environmental protection policies are increasingly integrated with energy policies.

China has access to all the energy resources known to humanity, including fossil fuels (coal, oil and gas), biomass (wood, straw and other agricultural by-products), other renewable sources (hydropower, wind, solar and geothermal), and nuclear power. Energy distribution across China is not homogeneous, however. For example, coal is concentrated to the northwest, and hydropower resources to the southwest. Wind and solar energy sources are often found in remote areas.

All methods of producing energy in China have an impact on the environment. Notably, burning fossil fuels leads to emissions of SO_2, NO_X, CO_2, hydrocarbons, and other pollutants, causing localised, national, and global air pollution. In China, as in many countries, fossil fuel energy is one of the main environmental stress factors. Even renewable energy resources can have serious impacts; large-scale hydropower plants require dams, disturbing hydrological flows and destroying terrestrial and aquatic ecosystems. Other renewable sources also cause environmental challenges, although these are generally considered to be localised and small in scale.

The Scale of China's Energy Sector

China is the world's second largest consumer of energy, using about one-third the amount the US does (BP, 2001; CDIAC, 2001). It is the world's largest producer and consumer of coal, although China's production has fallen slightly, and probably temporarily, behind the US since 1998. China is second only to India in its consumption of biomass fuels (China Energy Group, 2001). The energy intensity of China's economy has been and remains high by international standards. Although between 1980 and 1994, the amount of energy needed to produce 1 USD of GDP in China was reduced by more that 50 percent, this was still double that of India, and four times that of industrialised countries (UNDP, 1998b).

At the same time, per capita energy use in China is low by international standards, equivalent to only half the world average, and only 10 percent of the per capita energy use in the US (China Energy Group, 2001). Hence, although energy use has fallen somewhat since the mid-1990s following a continuous increase since the late 1970s (figure 3.2), a variety of reasons, including slower economic growth and widespread factory closures, render it likely that China's appetite for energy will keep growing, and the country may displace the US as the world's number one energy user by the middle of this century (Sinton and Fridley, 2001). Recent long-term scenarios project that energy use by 2050 may be 1.5 times or even double current US levels (Zhou and Zhou, 1999), which is 5-6 times the present consumption figures!

Where Does the Energy Come From?

Coal

Coal accounts for the majority of China's energy, and despite vigorous efforts to develop other sources, most of the growth in energy supply can come only from coal (figure 3.3). Twenty years ago, most coal in China was used directly by consumers and in industrial applications, residential boilers, locomotives, and household stoves. Today, only a third is used directly, with the rest used largely for electrical power generation. As people move from traditional housing into newer centrally heated apartment buildings, for example, gas stoves and water heaters replace small coal stoves. This trend has positive consequences for human health, since it relocates the products of fuel combustion away from the kitchens and living rooms where people spend much of their time.

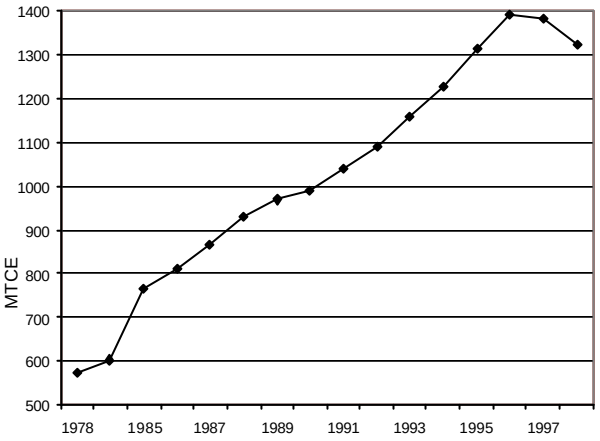


Figure 3.2 Energy Use in China 1978-1998 (ERI, SDPC)

Clean coal technologies, ranging from improved fuel quality to more efficient conversion and end-use equipment, and better control of particulates and other pollutants—e.g. desulphurisation and advanced boiler technologies—should also reduce impacts where coal continues to be burned. Transformation of the coal industry is key, since the very small mines that account for a large

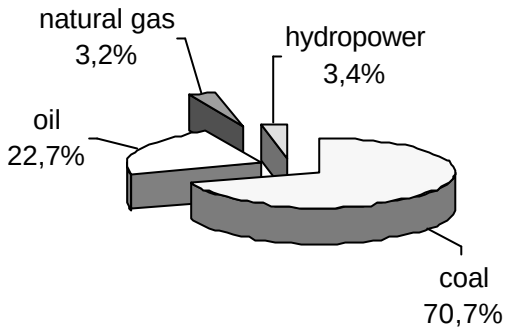


Figure 3.3 Structure of primary energy use by energy sources 1998 (ERI, SDPC)

fraction of current total output, produce low-quality, highly polluting coals. Substituting cleaner coals from large mines will require substantial changes in market and regulatory institutions as well as in transport infrastructure. Unavoidably, however, the reliance on coal will contribute to increase carbon dioxide emissions.

Natural Gas

Natural gas is considered the fuel of choice for replacing coal in boilers, power plants, and other applications because it is so much cleaner and more efficient. Natural gas has long accounted for only about 2 percent of the total energy supply, and until recently, received little attention in China. Most was used to produce fertilisers, but China has now made expansion of natural gas supplies a major strategic goal, and is planning to exploit domestic onshore and offshore resources, as well as to import large quantities via pipeline and LNG terminals.

Current plans call for raising natural gas use from the current level of about 25 billion cubic meters (bcm) per year to 200 bcm by 2020 (NBS, 2000). Although this would constitute only 6 percent of projected energy use in 2020, if it were directed to the household sector, the benefits to human well-being could be substantial. Future supplies of natural gas, especially to households, will depend on numerous uncertain factors: economic competition with other fuels and sectors, availability of technology and financing to develop the necessary gas infrastructure—pipelines, terminals, and distribution systems—and stable political relations with nearby gas-rich nations.

Oil

Oil production has stagnated in China since 1990. Meanwhile, demand continues to grow, particularly for transport fuels, and for fuel oils for industry and power generators in southern China. Hence, by 1999, China's net oil imports were one-fifth of the total oil consumed (NBS, 2000), and China is set to rapidly become a major oil importer. In spite of current high oil prices, the prospects for strong growth in oil-hungry sectors like transport and petrochemicals suggest that net imports should account for half of the total consumption before 2010.

Biomass

Biomass remains a significant source of energy for much of China's rural population, and the total amount used is approximately equivalent to the total national oil consumption. Unlike oil, however, biomass use has been dropping since the 1980s, as greater supplies of coal and electricity have become available to rural residents. Between 1991 and 1996, the ratio of biomass energy use to commercial energy use in rural areas fell from 0.26 to 0.15 (SSB, 1998). Biogas use has been rising, but it still accounts for less than one percent of biomass energy. Use of biomass fuels for household cooking and heating is associated with a variety of ills, from high levels of pollution exposure for women and children, to excess harvesting of marginal biomass resources. Switching to coal often trades one set of problems for another since, for example, exposure to the products of coal combustion can be extremely harmful, and the toll on coal miners is heavy.

Renewable Sources

Other renewable energy sources are available in most areas of China. More than most developing countries, China has made significant and relatively successful efforts to promote renewable energy use, particularly as an adjunct to the overall programmes for rural development and electrification. One-quarter of China's energy is presently supplied by renewable sources, including electricity from large hydropower projects, direct use of biomass fuels and solar heating of water and buildings (RTCCCS, 1999). Although renewable sources are unlikely to substitute for coal and other fossil fuels on a large scale, there is hope that over the next 20 years they will break out of niche markets and represent a growing share of total energy, This, however, requires continued support for the development of renewable energy markets and industries.

Energy Efficiency

Energy efficiency improvements are equivalent to installing new energy production units. Technological improve-

ments and changes in sectoral structure, driven by targeted policies as well as economic growth and transformation, have improved the efficiency of energy use in nearly every application, from biomass and coal stoves to giant furnaces. Since the early 1980s, China has instituted laws, regulations and standards, created new administrative structures, formed new channels of investment, and established a nationwide network of technical assistance centres, all aimed at promoting energy efficiency. Investments in energy efficiency have consistently been equivalent to 5 to 10 percent of investment in energy supply, an impressive record even among developed nations (China Energy Group, 2001). Energy efficiency policies could reduce future energy use by as much as one-third by 2020 (Joint Study Team, 1996).

Forces Driving Changes in Energy Supply and Use

China's rate of growth, integration into global markets, technological change, and transformation of institutions of economic and political governance should continue to be chief factors shaping the national energy system. Some of the major themes directly impacting on energy and human development are pointed out below.

Economic Restructuring

The economic restructuring has been a major force for change over the past two decades, and continues to be so. It has profoundly altered the economics and incentives of energy markets. Hidden and direct subsidies have been reduced or removed, competition introduced, price controls lifted, and soft budget constraints hardened. At the same time that more forms of energy have become more widely available, users have become more sensitive to the economic consequences of using them. Rising energy prices relative to the prices of other goods have helped promote efficiency. Reforms in enterprise management, permitting failing enterprises to go bankrupt, have helped weed out some of the most inefficient ones, and allowed successful ones to grow larger and attain greater economies and efficiencies of scale.

Urbanisation

China's rural energy economy differs greatly from its urban economy. The rural economy is dependent on biomass and direct coal burning while the urban economy relies on grid electricity. Rural and urban differences in energy use are prominent.

Rural residents consume less than 40 percent of the commercial energy used by their urban counterparts (SSB, 1998). However, if biomass is included, the average person in the countryside uses nearly one-third more energy than a city dweller. But much of this is lost in the inefficient and often highly polluting combustion of biomass and coal for cooking, heating, and other basic needs, which takes a particularly heavy toll on women as fuel collectors and consumers.

As part of its integrated rural development efforts, China has already taken major strides in expanding rural electricity grids to reach over 96 percent of rural households and in developing mini-hydroelectric facilities, biogas technologies, cleaner and more efficient stoves, and wood-fuel plantations (Deng, 1995; China Electric Power Yearbook, 1999).

The proliferation of small coal mines across China—despite the recent campaign that has ostensibly closed several tens of thousands of them—has given rural industry and households access to unprecedented supplies of energy—and exposed suppliers, users, and the environment to all of the consequences associated with obtaining, distributing and using coal.

Urbanisation is likely to accelerate the demand for energy; biomass and direct use of coal will fall to be replaced by gas and central heating, while new electricity uses will rise. Burgeoning power demand for homes and commerce will keep the pressure on to build more and larger power plants, so that impacts will be determined by how that need for power will be met.

Technological Development

A consistent theme expressed by China's top decision makers in recent years, to support continued and sustainable economic development, has been the call for technological development. Among China's priorities within the energy sector are:

- improved fossil fuel recovery technologies, including advanced oil extraction and deep-water natural gas recovery techniques;
- cleaner and more efficient ways of generating electricity with coal, such as large circulating fluidised-bed boilers and integrated gasification combined-cycle plants;
- new and renewable energy technologies, for example fuel cells, improved batteries, large wind turbines, solar thermal and photovoltaic technologies, and technologies for using medium-temperature geothermal resources; and
- a wide range of energy-efficient technologies, including motors, lights, industrial process equipment, appliances, stoves, and motor vehicles.

Developing and deploying new technologies is a complex business, and acquiring technologies and making them available takes money and time.

Government Capacity and Policy-Making

Government capacity to drive sustainable energy development is crucial given energy's central role in society and its need to be centrally co-ordinated. As in most countries, China's energy production agencies have tra-

ditionally been strong and well staffed. In contrast, those responsible for energy conservation and environmental protection are weak and capacity is low. There has been some change recently, in part due to public pressure for an improved environment, but also due to foreign involvement.

The Chinese government's ability to develop policies that muster both to support a gradual improvement of existing energy systems, and at the same time to promote renewable energy will be crucial in shaping the energy sector in general and in new power plants in particular. While China has encountered problems in implementing environmental laws and regulations, it has already been largely successful in controlling emissions of some energy-related air pollutants, especially particulate matter from large facilities.

Policies that are currently being put into place could have large effects on the health and environmental impacts of energy use. For example, the two legislatively mandated "sulphur dioxide control zones", established to control acid precipitation in the southern zone and sulphur dioxide pollution in the northern zone, are helping to create markets for lower-sulphur coal, flue-gas desulphurisation equipment, and more efficient, less polluting production technologies. Pilot programmes have introduced sulphur dioxide emissions fees, which, while currently set too low to have a significant impact, may in future be an important tool in encouraging technological change. Prospective technology-forcing policies directly in the energy arena may also have an impact on energy structure, e.g., the Renewable Portfolio Standard now being considered.

Future Trends and Uncertainties

China's per capita energy use is low by international standards, and with further economic development as the main driver, energy consumption may increase five to six times by the middle of the century. This would add considerably to global CO_2 emissions, cause serious deterioration of already inferior urban and rural air quality in China, and accelerate acidification should energy continue to be generated in the same way as today.

But considerable efficiency gains are yet untapped. Although China has reduced the energy needed to produce 1 USD of GDP by more than half since the reforms set off, energy efficiency is still only one-quarter the performance of industrialised countries. Therefore, energy generation need only increase by half in order to satisfy a six times higher demand by mid-century should China manage to reach the energy efficiency standards of industrialised countries.

When it comes to the way energy is generated there is also considerable room for improvements. Although coal is in ample supply and the cheapest and most accessible source of domestic energy, China has access to a wide selection of energy, with considerable potential for renewables, not least in the more than half of the country that is included in the *Great Western Development Strategy*. Still the main addition in power generation comes from coal, but other alternatives are available at least to cover some of the demands for power. With a major breakthrough in technology improvements, solar energy, for example, could prove accessible on a large scale.

So, although the future prospects do not look all too gloomy, there are major uncertainties in terms of the demands for more energy. This depends largely on economic growth and improved energy efficiency, a matter of both governance and knowledge, but also the share of renewables in the energy mix. Technology improvements could provide a major breakthrough, but require access to appropriate knowledge.

The crucial point is the government capacity to promote sustainable energy development. With economic restructuring a major force for change, and environmental protection policies increasingly integrated with energy policies, momentum is increasing to improve energy efficiency and promote renewable sources of energy.

3.9 Transportation

Transport activity has surged in the last 10 years. During the 1990s, the transport sector's share of energy use nearly doubled. Oil is expected to be the fastest growing form of primary energy used in China, propelled by this surge in transport.

Modernisation and Changing Transportation Patterns

Before Deng Xiaoping's reforms took off around 1980, China had pursued a development model based on local self-sufficiency, with strict regulation on travel, let alone relocation. With little pressure for transportation, the networks were weak with a small number of road vehicles, all belonging to enterprises or other work units, a railway with capacity and accessibility similar to late 19th century US, and a few air connections between Beijing and the provincial capitals, mostly operated with outdated Soviet airplanes. In the urban setting, walking was a dominant mode of transport, with buses hopelessly overcrowded, and bicycles being treasured objects for families to save up for. The remarkable economic growth of the past 20 years had not been possible if transportation had not been given top priority.

Now, ever-growing numbers of mainly urban families are able to afford private motor vehicles and motorcycles. Where once trains and ships were the main ways of moving people and goods from place to place, long-dis-

tance buses and trucks are starting to become the dominant mode. More people are travelling further; passenger turnover for all transport modes rose about seven times as fast as population during the 1990s.

With growing demand for speed and comfort, air travel has become commonplace, with regional carriers competing for passengers. New high-speed rail lines are being built; one has already been completed running from Beijing to Guangzhou, and Shanghai has even commissioned a mag-lev train to run from downtown to the airport.

The gradual improvement in the nation's transport infrastructure means that it is now much easier to move goods around, fulfilling one of the necessary conditions for truly national markets. Although strong local protectionism still presents obstacles to free trade, real potential now exists for achieving economies of scale in production and distribution of agricultural, industrial and consumer goods, which would give more people access to a wider variety of cheaper, higher-quality products and services.

Mobility as a Development Force

Improved transportation of people and goods was crucial for maintaining China's economic development over the past two decades. It will play a key role in China's future development process as well.

The increased ability to travel has been one of the factors behind the greater mobility of people seeking employment. The buses and trains pouring into cities are filled with people from the countryside looking for work, providing the low-cost labour that has helped fuel the economic expansion of recent years, swelling urban populations, and providing remittances back to the countryside, where incomes have fallen further and further behind those in the cities. The urbanisation and migration patterns described in section 3.1 would not be possible without this improved transportation system. Alternatively, economic reform and relaxed restrictions on travel have fed migration, which in turn has created a strong demand for transport.

Similarly, the way transportation systems develop will be a key factor in whether or not the *Great Western Development Strategy* achieves its aim of environmental sustainability. The western environment is fragile, and large transportation projects such as gas pipelines, railways and roads could have a direct, negative impact on the environment. Transport infrastructure will also promote and facilitate new economic activities in the west, and the question remains to what extent the new means of transportation will favour low polluting, low resource use activities, or high polluting, high extraction activities.

The Environmental Consequences of Increasing Transport Volumes

The explosion of transport activity has not come without cost, however. With the rapid motorisation of the Chinese transport system, vehicles are superseding coal burning as the main source of air pollution in many areas. Section 2.4 provides further information on air pollution trends. But transportation has other effects on the sustainability of the development process. With new transportation networks come indirect impacts such as added penetration of fragile ecosystems.

And yet another aspect, particularly in the urban setting, is space. In the past, pedestrians, bicycles, carts drawn by animals, and a few buses filled the streets of China's cities. Now traffic congestion has become a fact of life, which reduces transport efficiency and increases pollution discharges per travelled kilometre dramatically. It also causes other problems such as maddening noise pollution, or the increasing numbers of cars that occupy not only streets but also bicycle lanes and paved areas.

The Road Ahead

The outlook for transport is tied to expectations about economic development. With continued strong growth, cars and trucks appear poised to carry China into the future. As people get wealthier, ownership of private cars—the new middle-class status symbol—is likely to rise tremendously, particularly in the mega-cities.

Greater overall demand for goods and services will keep pushing both rail and road freight volumes up. With little alternative to the internal combustion engine available in the near future, gasoline and diesel will probably fuel most vehicles.

Introduction of more efficient engines, other technologies and better emissions controls, along with compressed natural gas- and liquefied petroleum gas-fuelled vehicles and, potentially, fuel cell vehicles, could be applied to avoid the worst impacts that have befallen other countries that have relied heavily on motor vehicles. But technology solutions will not last long without undergrowth of skilled mechanics and quality repair shops, both in short supply today.

The scale of environmental impacts from further motorisation will, however, depend largely on such aspects as improved inspection, better traffic flow management, and, above all, urban planning that has as one goal, the reduction of dependence on motor vehicles.

Lack of Alternative Visions

Chinese decision-makers appear surprisingly indifferent to alternatives to motor vehicles. One explanation may be found in the fascination for cars as symbols of modernisation, and a belief that increasing demand for pri-

vate cars would drive the development of a domestic car industry. Throughout the reform period, different products have successfully been targeted as suitable family investments with the goal to drive domestic demand. Examples include bicycles and sewing machines in the mid-1980s, over to television sets and stereos, to washing machines and refrigerators in the 1990s.

These and other products have served to generate a demand for increasingly more high-tech products that has supported the development of domestic industries, many of which have later developed into major exporters. There have certainly been hopes among Chinese leaders that the same formula could be used both to generate domestic growth and to prepare the Chinese car industry for international competition.

Another factor explaining the limited extension of public transport alternatives such as subways, trams, and light-rail is that development and operation of rail-based public transport would require co-operation between different agencies and bureaus, several of which have conflicting interests. To further complicate the picture the real estate situation in Chinese cities is unclear, with different bureaucratic organisations such as ministries, agencies, bureaus, universities, institutes, as well as state-owned companies claiming sovereignty to urban land parcels that have been at the particular organisation's disposition from before reforms began. This is a classical prisoner's dilemma case, where each organisation is reluctant to engage in, or consent to a venture where the dividends for the own organisation is unclear.

Instead, future visions posted on mammoth size billboards in Chinese cities portray futuristic urban areas with elaborate road traffic apparatus and fancy cars with no bicycles. Nowadays bicyclists are commonly blamed for causing traffic jams, although a bike occupies a fraction of the space that a car does, and space is one resource in short supply in Chinese cities.

Still, there are urban areas in the richer eastern and coastal regions where development of improved public transport systems, including subways, could take off since these areas will be best able to afford such solutions to congestion and air pollution.

Future Trends and Uncertainties

Until now, environmental concerns have had little influence over development of the transport sector. Transport systems have been guided by the strong development symbol that the motorised society represents.

Solutions to urban air pollution, which is increasingly caused by car traffic exhaust, are sought rather in technical improvements than in alternative transport systems; and problems of space and public transport capacity have not yet received much attention among Chinese traffic planners. Examples include recent Beijing traffic management initiatives, which have addressed the serious air pollution by banning older vehicles and introducing taxis and busses fuelled with liquid petroleum gas, in combination with efforts to increase traffic flow around the third ring road. Similarly at the national level, there is a ban on leaded petrol. However, should transportation approach western European or North American levels, even large investments in the cleanest technologies are not sufficient to solve the urban transport problem.

Demand for a clean environment, and the harness on economic development that is soon created by chronic traffic congestion, could influence transport development, particularly in the increasingly crowded wealthier cities. Given that the government could channel demands for alternative transport solutions, this could lead to clean, integrated transit schemes appropriate for a growing middle class and lessen dependence on private vehicles.

3.10 Agriculture and Food Production

By the year 2025, China may have an additional 250 million mouths to feed. Environmental constraints, mainly scarcity of water, may make it impossible to feed China's entire population from domestic agriculture. Balanced agricultural development towards sustainable food production will be possible only with clever use of policy and practices to result in dramatic changes in the agricultural production system. Failure to reform agriculture may lead to severe repercussions for the environment.

Past and Present Food Policy

For the first decades after 1949, the underlying strategy was food self-sufficiency and each area was expected to provide sufficient food for its own population. Only surpluses could be sold, and then at controlled prices. Unable to purchase food through trade, many localities were forced to grow crops on unsuitable land, often with little understanding of carrying capacity, thereby contributing to many ecological problems, notably water shortages and land degradation.

The strategy of food self-sufficiency has been replaced by a strategy of food security. Within China, food can be legally bought and sold freely, and most prices are set by the market. However, strong local and national tendencies against importing food persist. This is linked to a set of incentives and subsidies in the agriculture sector. One effect is that crops are still grown in inappropriate places. Also, agricultural inputs such as water, fertiliser and pesticides, continue to be subsidised. This leads to short-term higher productivities, at the likely cost of later pollution, overuse of water and land degradation. For example:

- Numbers of livestock are often well above established carrying capacities, e.g. more than double the capacity in northern Shaanxi, and more than triple in Ningxia (Zhao Yongxi, 1998).
- Average fertiliser consumption in China is higher than any other country, double world averages, and pesticide use is similarly high.

Drivers of Changing Food Production

Slowly, transformation towards an open market seems to be underway, even in rural and agricultural areas. The WTO entry may speed up this process, even though it will remain very slow. Important components and drivers of this transformation include privatisation of land, termination of subsidies, development of sustainable agriculture, and urbanisation.

Privatisation of Agricultural Land

History shows that ownership of land is a fundamental component in making it worthwhile for farmers to undertake the investments and laborious work needed to ensure long-term agricultural development. This generally unleashes increases in productivity, efficiency and sustainability. The case for privatisation of agricultural land is even stronger in China, given the present situation with a large number of very small farms unable to take advantage of economies of scale, thereby preventing further agricultural modernisation. Box 3.6 delves into the pros and cons of land tenure and the rural environment.

Removing Subsidies and Other Distortions

If water prices are adjusted to reflect scarcity, and the environmental costs of fertilisers and pesticides are internalised into the price of food, food production would change from highly water-consuming and fertiliser-dependent crops, to water-efficient and naturally resistant crops, better adapted for local circumstances.

Development of a Sustainable Food Production System

Given the scarcity of water in China's vast northern agricultural areas, grain production could be substituted by increased imports, in favour of high value crops such as vegetables, fruits and nuts which may be exported. An important task here is for the government to provide the infrastructure that is needed to give agricultural areas access to markets and to promote agricultural extension services.

Urbanisation

A massive wave of migration from rural to urban areas is changing the basic structure of rural China, from having been a predominantly agricultural society based on subsistence farming with low productivity, to a commercial system for food production. In the future, a reducing number of farmers will have to supply a growing number of people.

With migration, economic development, and gradually deregulated agriculture come lifestyle changes, including a change towards a more diversified diet with

Box 3.6 Land Tenure and the Rural Environment

Who owns the natural resources is a key factor influencing management methods and long-term objectives for land exploitation, ultimately affecting land and environment. This is especially true in rural areas. It is often observed that when farm households have secure, long-term control over land and water resources, they take long-term action towards land use and protection, especially investing in agricultural land.

In rural China, in order to stimulate economic growth and improve farmers' living standards, the Household Responsibility System was initiated in the early 1980s, where farmers were guaranteed the right to lease given land for fifteen-year periods. The government is now moving into the next stage of rural land ownership reform, prolonging land-use rights to thirty years. The new law also allows farmers the rights of inheriting, transferring and using their land as mortgage asset. The reform is also extended to cover grassland use rights, by introducing the herdsman contract responsibility system. Potentially, up to 200 million farm households could be stimulated to invest in long-term soil protection and protective measures related to water and air pollution reduction, irrigation, drainage, and soil improvement (Wu, 2000).

Although still in the early stages, evidence to date suggests that farmers with signed copies of the new land-use contract felt their power had increased, with more control over land-use decisions and long-term tenure security. This is in contrast with farmers who either had not signed a contract, or had signed but not received a copy. The written contract has the potential effect of taking power over land-use decisions out of the hands of local cadres and transferring it to farmers. And yet, some preliminary studies show that most farmers suspected there would still occur unexpected land readjustments during the 30-year term. This implies that farmers still lack the assurance of tenure security, the basis for additional land investments (Bledsoe and Prosterman, 2000).

This may have negative impacts on other rural goals. For example, the government hopes to increase food productivity by achieving economies of scale in grain production by converting household production units into large-scale agricultural units. This "conversion" would be most efficiently achieved by the market, but this cannot happen if long-term land tenure is not in place.

more meat, but also more vegetables, fruits, and fish. These trends are likely to drive specialisation in food production and the development of food markets. It will also provide a push for higher agricultural productivity, which, in turn, may have both positive and negative environmental impacts.

The trend towards changing diet is likely to coincide with the rise of much more environmentally concerned and quality oriented consumers, whose requirements may push agriculture towards more qualitative and ecologically sound production.

Environmental Constraints on Food Production and Policy

The lack of arable land was long regarded as one of the main bottlenecks for food security in China. This led to conversion of unsuitable land, former forests, wetlands and grasslands, to agriculture, and ultimately led to the degradation of much of this land. New estimates from the Chinese State Land Administration, however, show that agricultural land was under-reported by almost 50 percent. Today an estimated 132 million hectares are cultivated, but detailed analyses of agro-ecological zones carried out by FAO suggest that another 30 million hectares may be suitable for agriculture.

However, the importance of water as an input to agriculture has still not been fully recognised. Water is unevenly distributed and a larger part of the available farmland is located in the water scarce northern China. *Water, not land, is the major constraint on food production.* This leads to two challenges: how to best utilise the considerable acreage in southern China that has sufficient water resources for farming, and how to adapt dry agriculture in China's northern and western parts to maximise production value per unit of water.

Water *quality* is also an issue as toxic substances enter the food chain from polluted water and soils, not least from the habit of irrigating with sewage water. With numerous cases of agricultural produce being severely polluted by non-degradable toxics, such as cadmium and arsenic, there is a danger of large areas being declared unsuitable for food production.

Although water is the main environmental constraint on productivity, there are many others, some of which are nationwide issues. The major ones are erosion, salinisation and nutrient deficiencies. Others include pollution from pesticides and fertilisers, industrial and municipal solid wastes, acid rain, and the remains of plastic film. Collectively these factors considerably lessen the productivity of vast areas of China's farmland.

Future Trends and Uncertainties

Most of the environmental problems associated with agriculture and food production are results of past and present misguided agricultural policies and programmes, which have led to inappropriate choices of crops, livestock, and practices. Agriculture has been its own worst enemy in China.

A steady trend in the agriculture and food sectors since the very beginning of the reforms has been the shift from centrally planned collectives to household-based agriculture that was initiated with the agricultural reforms in the early 1980s. Since then, agricultural land has been leased to the farmer; and tenancy contracts have been extended from 15 to 50 years with the right of inheritance. It is therefore likely to anticipate further deregulation and privatisation, and today, full-fledged privatisation of land is being discussed, although it seems politically hard to digest.

The WTO entry could have far-reaching impact on the structure of China's domestic food production, with competition from international grain production making commercial agriculture on marginal land a loss-making business. Most likely is that China adapts to the situation by a gradual shift to other agricultural production—a change, however, that would require a combination of further privatisation and forward looking, active agricultural policies, with promotion of markets for green agricultural products, development of agricultural extension services, and propagation of water-efficient irrigation techniques. Still, particularly in the case of increasing inequity, there is a risk that large groups of redundant labour are left without livelihood and forced to take up subsistence farming on marginal land.

Climate change is a major uncertainty for China's agriculture and food production system. Climate models for China indicate increasing precipitation in the water scarce north, which would be positive for agriculture, however the risk of increasing variability makes it unclear if more rain would indeed be favourable for food production.

3.11 Globalisation

Globalisation and China's opening up mean that China is increasingly interacting with its neighbours and with the rest of the world. These economic, political and scientific interactions are happening at all levels and play important roles in pushing environmental and societal change in China. *Vice versa*, with China increasingly integrated with the rest of the world, and with its economic activities growing steadily, China is rapidly becoming one of the most important players on the global environmental scene.

Foreign Direct Investment

In 1998, Foreign Direct Investment (FDI) in China totalled over 45 billion USD (China, 1999) making China one of the world's largest recipients of FDI and the larg-

est recipient among developing countries. FDI can facilitate the deployment and import of hard and soft technology. This newer technology is generally cleaner than the existing technology in China. Often FDI from industrialised countries is subject to the same environmental standards as in the company's home country—which are usually stricter than China's. International companies' investments are usually competitive, and introduce management processes focusing on efficiency and ethical awareness. For these reasons, FDI does stimulate improvements in environmental performance in China's domestic enterprises. Local politicians and enterprises can learn from these investments, and are stimulated to compete with the economic and environmental performance of the FDI investor.

There is a negative side to FDI. When investing in countries with a weak regulatory and administrative framework, some companies may install technologies and processes that are not allowed in other countries, including their home country. There is some evidence that in the early years after the opening up, FDI—particularly through Hong Kong, Taiwan, Korea and some Southeast Asian countries—brought much environmental damage. This no longer seems to be the case, probably due to China's strong FDI legislation, and the relatively effective implementation of its regulations.

FDI in China has been largely focussed into several small geographical areas, mostly along the eastern coast, in some cases into special zones, although almost all provincial capitals have received some significant investments. FDI has been a major factor in the economic success of these areas, whereas many remote and inland counties and provinces that have not received FDI remain poor. The environmental impact of the FDI has been mixed, in general pollution per unit output has dropped, but greatly increased output has led to overall increases in pollution in many areas, and in some cases more complex forms of pollution are associated with the higher tech investments. The increase in prosperity in the areas benefiting most from FDI has led to increased consumption, but also increased financial capacity to improve the local environment, as can be witnessed in cities such as Shenzhen and Fujian.

Recently the international and domestic community assembled to establish the China Business Council for Sustainable Development, along lines similar to the *World Business Council for Sustainable Development* and to Councils in other countries. In China, the members of the council are the heads of Chinese and FDI enterprises. These Councils enable the visionary elements in the business community to co-operate and play a more direct role in shaping a cleaner, better society. They can provide training, equipment, and guidelines for other enterprises in Chinese society and represent businesses in interactions with government. They can help ensure that environmental improvement does not come at the expense of jobs or competitiveness.

International Trade and China's WTO Entry

China's entry into the WTO is anticipated to have a significant impact on Chinese society, but what will be its impact on the environment? Experts differ as to the overall effect of WTO—positive or negative. It is generally recognised that the WTO-entry, rather than create new trends, will speed up and intensify existing ones.

By opening China to international trade in a number of areas, the WTO entry is likely to generate greater competition within China's domestic markets. In general, international competition may decrease domestic production of commodities that use intensively China's scarce resources, while production of commodities that use abundant resources may expand. This may cause China to import more resource-intensive products, such as water-intensive agricultural products, pulp and paper, petroleum and natural gas, and shift domestic production towards more labour-intensive products such as aquaculture, livestock, vegetables and fruits, textiles, and toys. Given outdated technology, low productivity, and inefficiency in much of China's manufacturing industry, items such as autos, chemicals, and machinery are likely to be either imported or manufactured by multinationals in China.

On the positive side, increasing imports of water and land-intensive agricultural products, such as grains, cotton, edible oil, and sugar, may lead to a reduction of water-intensive agriculture and also have positive effects on agricultural pollution. Increased imports of pulp and paper products would reduce the severe environmental problems caused by the highly polluting and inefficient domestic pulp and paper industry. This would also reduce pressure on scarce and expensive domestic pulpwood, and make possible alternative use of agricultural residuals, presently used for straw pulp. Moreover, reduction of industrial pollution is anticipated when outdated manufacturing is substituted by either imports or establishment of modern production units.

On the negative side, increasing production of labour-intensive goods—such as textiles, vegetables and fruits, livestock and aquatics—could become sources of new environmental problems. There is also likely to be an increase in diffuse source pollution associated with the livestock industry, e.g. annual growth rates from 2000 to 2005 for pork and fish production are forecasted to be 3.4 and 5.9 percent, respectively (Chen Chunlai and Huang Jikun, 1999). Vegetable and fruit plantations use chemical fertiliser and pesticides intensively, and there is considerable risk that soil pollution may rise significantly.

The aim of WTO is to establish international competition globally under equal conditions. To be competitive, Chinese industry will have to become more efficient, which, at least in the long run may lead to improved utilisation of resources, conservation, and the import of cleaner, efficient technology. However, competition will increase pressure to cut production costs, and in the short term can lead to increases in pollution discharges and greater exploitation of natural resources. The key here is to ensure that domestic Chinese legislation, enforcement, and practices keep pace with the new competitive situation. WTO obligations promote greater public participation in standards setting and clear and effective notice of environmental standards, as well as the strengthening of these standards particularly in developing countries (Ferris *et al*., 2000). This could well prove to play an important role in reforming environmental governance structure (see section 3.12). Also, WTO accession should increase contacts between China and the international community at all levels. This could lead to increasing the inflow of ideas and information across China's borders—also with possible impacts on society and the environment.

Regional environmental changes in various parts of the world will also influence China. As China's economy becomes more integrated into the world economy, it will become more responsive to global consumers. There is some evidence that such consumers are becoming increasingly sophisticated, for example demanding not just green products, but also that production processes be clean. In order to compete in such an increasingly sophisticated market, Chinese enterprises will have to comply with these forces. It will become necessary for most Chinese companies with large export markets to abide by ISO 14001 standards for environmental reporting.

International Conventions

China plays an active and dynamic role in the preparation and implementation of international environmental conventions. China has ratified all relevant environment conventions, including the *Vienna Convention for the Protection of the Ozone Layer* (and subsequent *Montreal Protocol*), the *UN Framework Convention on Climate Change*, the *UN Convention on Biological Diversity*, and *UN Convention to Combat Desertification*. The process of ratifying and implementing global conventions has been influential in placing environment issues high on the national political and development agenda.

By signing a convention, China commits to taking measures leading to the protection of environmental resources, including current state assessments, sharing of information, engagement in international co-operation, preparation of national action plans, and integration of environmental protection with general development plans and programmes. The convention work raises awareness, generates commitment to environmental protection, and helps identify options that are good for the global and local environments and economy. In many cases, China is stimulated to go beyond the minimal requirements, for example by protecting sites of high biodiversity, and acting to reduce greenhouse gas emissions.

The **Montreal Protocol** targets phasing out of production and consumption of ozone depleting substances (ODS). This has already been achieved in industrialised countries and China remains one of the largest producers and consumers of ODS. The Protocol has made significant funds and technology available to help phase out the use and production of ODS in Chinese state-owned and private enterprises. This has led to increased environmental awareness at the political, enterprise and public levels. Offending technologies are replaced with new technologies that are not only ozone-friendly, but often more environment-friendly and economical.

Development Co-operation

Development co-operation has been a major catalyst of change in China, providing not only financing but even more so a channel to the international community leading to import of new technology. Given the huge increases in trade and foreign direct investment volumes over the past two decades, funds channelled through development co-operation are now marginal in relation to overall international investment volumes, and development co-operation has focused on a limited number of critical areas. Environment and sustainable development is one of these high priority areas, where most donors are active.

The Chinese government uses development co-operation to obtain new technologies, ideas and expertise, examples of lessons learned from other countries, and for experimenting with policies, techniques, and skills. But development co-operation has also been influential in paving the way for changes that have met resistance, such as the introduction of integrated management approaches, strengthened co-ordination among government agencies, private-public partnerships, and allowing civil and non-governmental organisations to play a role in the governance process.

In the mid-to-late 1990s, several donor projects supported reform within the water sector, introducing at an experimental scale the need for full costing and privatisation. This led to the introduction of the new water law in 1999. The donor projects also helped build capacity in the water sector, thus ensuring the ability to respond to high-level political demands. Similarly, the donor community played a major role in moving air pollution to the

centre of the national agenda in the 1990s, by demonstrating its significance.

Despite its good record in exploiting official development assistance, China has not been as successful in co-operation with non-governmental organisations. These are often seen by Chinese government agencies as a competitor for limited funds, rather than a source of unique expertise. International NGOs, particularly in the environmental sector have a lot to offer China that traditional development co-operation financing cannot. If wisely utilised by the Chinese leadership, international NGOs could help drive further positive change.

Global Environmental Issues

Changes in the global and international environment will affect China's economy and environment. Global climate change may lead to warming over the coming century, and altered micro-climates and precipitation patterns, increasing sea levels, frequency of storms and other extreme events. Agriculture will be affected by changes in climate, coastal areas will be affected by sea-water incursions and storms, public health will be affected as climate-related diseases, such as malaria, change their distribution, and urban areas may be affected by changes in water availability. All this could, in turn, affect China's natural resource base. The threat of climate change could help catalyse further natural resource management and environmental protection in China.

China's Agriculture Might Benefit from Climate Change

The literature on climate change in China is inconsistent. While some authors see slight to moderate disadvantages for China's agriculture, others see benefits. According to preliminary assessments from the IIASA AEZ model, the most likely impact of global warming would be slight improvement in the north of China which would benefit from higher temperatures and increased precipitation. The cultivated land in southern China, on the other hand, would only be affected slightly by increased tropical storms. China's south is too far "north" to experience the real effect of increased storms, typical for the hot tropics (Heilig, 1999).

Other global environmental developments will affect China which could strengthen the institutions and mechanisms required to manage these forces. Given the long time spans, it is difficult to predict exactly, but some possibilities are:

- loss of biological diversity in some areas of the world will make remaining centres of biodiversity in China more valuable
- land degradation may affect agricultural yields globally, leading to deficits in global food production, in turn affecting China
- developments and concern over genetically modified organisms (GMOs) will possibly affect global markets and global agro-production patterns

China's Impact on the Regional and Global Environment

The economic activities of China and its enterprises have an impact on the global environment. Although no detailed studies of China's ecological *footprint* have been undertaken, five relevant areas can be named.

Greenhouse Gas Emissions

China produces significant amounts of greenhouse gases (second in the world for carbon dioxide and methane) but also has a high capacity for carbon sequestration. China's development in the coming decades will influence emission levels and global climatic processes.

Biodiversity

China is also a "mega-diversity" country, and this biodiversity is found in many of the more remote, yet sensitive parts of the country. Again, China's development path can lead to either the irreversible loss of this biodiversity, or to long-term conservation.

Transboundary Pollution

China has a long border and many neighbours, and in many cases it may cause trans-boundary environmental problems. For example, there is evidence that SO_2 emissions in China are leading to the export of acid rain to Northeast Asia, and deposition from Chinese coal combustion has even been found as far away as the US. Also, Chinese individuals and companies engage in hunting of animals across the land border thus reducing biodiversity (e.g. tiger in Siberia and gazelle in Mongolia). Mining is also a trans-boundary environmental problem.

Domestic Consumption

As domestic consumption patterns change (see section 3.5), China is likely to import more and more consumer products from other countries. This will influence the environment in the producer countries. China is set to import huge volumes of timber, fossil fuel and possibly food, and is already importing animal and plant products for Chinese medicine. All these have a major impact on the environment in the exporting countries. Yet another notable example is the growing range of China's fishing fleet. As catches become more difficult off China's coast, and temporary bans make it hard to meet domestic demands—especially from the wealthy Chinese coastal

southern cities—the fleet has to go further a field, affecting stocks across the Pacific Ocean.

Chinese Overseas Investments

Chinese enterprises are starting to invest heavily across the world. By 1999, accumulated investments had totalled 6.33 billion USD (China, 1999) in 160 countries. This will have environmental impacts in those countries, which could be positive or negative.

Global Goodwill

China plays two related roles in international relations. First, it provides a model for many developing countries, as illustrated by its position within the group of 77 developing countries (G77). Second, it is an important political player, having one of the five permanent seats on the UN Security Council.

In order to improve its international reputation and provide a good model to developing countries, China is motivated to develop a clean, sustainable development path and reduce its export of environmental problems. It is keen as well to participate in and implement environmental conventions. Another example is Beijing's application to host the 2008 Olympic Games.

Future Trends and Uncertainties

China's open door policy, which has been a central component of the reforms for more than two decades, is very likely to continue, with China playing an increasingly important global role. China's WTO entry and continued growth of the Chinese economy are additional factors. As a result, China's environment and its choice of development path—sustainable or unsustainable—will be increasingly interlinked with global developments.

Box 3.7 The Olympics as a Driver of Environmental Change in China

Beijing narrowly missed being selected as host of the 2000 Olympic Games and launched a successful bid to host them for 2008.

Selection for the 2000 Games took place in 1993. Although the reasoning of the individual voters on the International Olympic Committee is kept secret, it is widely believed that Beijing's poor environment—notably horrendous air pollution—was one of the reasons why the bid failed.

The failure threw Beijing's environment into the limelight resulting in considerable media coverage and high-level political discussions, and the attention led to a general increase in environmental awareness at all levels across the country. It also led to an increased commitment towards environmental improvement.

When Beijing prepared the second bid, it had learned its lesson, and the national and city authorities had initiated environmental improvements in Beijing in time for the visit of the Inspection Committee. These measures included removal of polluting industries and vehicles, planting of trees and greening of parts of the city. Beijing's air quality is affected by municipal, industrial and agricultural activities in the surrounding region, so to improve quality also required regional co-operation. The selection Committee's inspection took place in 2001, and some members informally commented on the improvements. In July 2001, Beijing was officially selected as the host.

To further strengthen the bid's environmental profile, Beijing coined it the "Green Olympics", or the first Olympic Games to be truly environmental. As such, Beijing has invited the whole world to follow the preparations and to evaluate the environmental impacts of the games.

(photo shows home-made kite depicting the Olympic Games logo)

The most noticeable manifestation of China's increasing impact on the global environment is that China is forecasted to pass the US as the world's largest emitter of greenhouse gases within the coming decades. Given the fact that there is considerable room for reducing greenhouse gas emissions in China without compromising energy requirements, makes active involvement in the Kyoto process with binding commitments an opportunity to showcase China as a model for greenhouse gas reductions.

Equally important is China's role as a haven for a considerable part of the world's collective biodiversity. Present trends are not too bright, however, with a large number of threatened species on Chinese territory. As with greenhouse gas emissions, the future is largely dependent on which development path China chooses.

Apart from direct impacts of discharges of global pollutants, the major part of China's global environmental interactions will be connected to changing trade patterns and increasing international competition—both in Chinese markets, where Chinese producers will be challenged by more cost- and resource-efficient production, and in international markets, where consumers' demands for "green products" and more stringent product-oriented regulation will require Chinese producers to comply in order to access the markets.

But there are many uncertainties on how China's development will come to interact with the environment around the world. In a world where everything is connected, it is not necessarily so that environmental improvements in China mean a better global environment. When production leaves China for other places, it may lead to serious environmental problems in those countries, and the resulting increased trade may mean in effect that China is exporting environmental problems.

A more disquieting uncertainty with potentially large regional and global repercussions is the risk for environmentally-related disasters or continued unsustainable development leading to large areas losing carrying capacity and populations their livelihoods. Given China's large population and high population densities in the eastern provinces, seemingly marginal changes in e.g. precipitation, in combination with other development problems such as poverty and inequity could trigger social unrest with regional or global implications, and migration pressures involving tens of millions of people.

3.12 Governance and Institutions

Throughout the different sections of this chapter a recurring theme has been the element of choice when assessing the different paths that China's development could take. Also, China's future relies largely on how its governance and institutions are structured or very broadly speaking, *the way* decisions are formulated and implemented.

Although more cautiously than in the economic arena, governance has undergone reform in recent years in China, with large potential benefits for the environment. This section discusses the current trends as well as future prospects and uncertainties concerning China's environmental governance structure. This section links to the discussion in chapter 4 on how China addresses sustainable development within governmental and nongovernmental sectors.

A Legacy of Arbitrary, Top-down Governance

Traditionally in Chinese society, decisions were taken by influential or respected individuals, rather than through laws or regulations. The Chinese term *guanxi* signifies the power of individual influence. *Guanxi* is the Chinese word for "relation", but in a deeper sense *guanxi* denotes a network of informal personal relationships that forms an invisible bond between different administrative and political bodies. Governance in China appeared quite differently than what it looked like on paper. Hence, to have *guanxi*, or to be "well connected" carried more weight than formal rules, and the context had a significant impact on how rules were interpreted. The precedence of having good connections, and the primacy of circumstantial concerns over rules continued when the People's Republic was formed, but with the ideology of "Marxism, Leninism, and Mao-Zedong-thought" forming the basis for decisions (Hallding, 1991).

The system had its positive aspects, such as the "campaign approach" (further discussed in section 4.2) by which the Party mobilised large numbers of human resources for a cause. For example, it has always been possible for the central and provincial governments to mobilise large numbers of people in back-breaking tree-planting programmes. But the problem has been that without proper consultation and a direct stake in the tree-planting endeavour, people tend not to maintain the trees, leaving meagre results in terms of sustainable forests. The Party's network at the grassroots has also provided a mechanism, albeit uneven, to feed public concerns into decision-making. Still, it is safe to assert that the heavy top-down governance structure that prevailed through the first half-century of the People's Republic by and large has proven counterproductive to sustainable development.

The past two decades, however, have seen continuing changes in governance and institutional structures, characterised by:

- rule of law instead of rule by man
- growing separation between rule-making institutions and rule-implementing functions

- slow but sure integration between sectoral strongholds
- decentralisation giving local leaders increasing power
- increasing reliance on the market instead of command-and-control instruments
- a gradual shift from collective to private ownership
- broadening participation in rule-making and in monitoring implementation
- strengthened technical/academic sector

These factors combine to ensure more responsive decision-making and implementation of environmental programmes, with potentially large benefits for the environment, but also with considerable risks for backlashes and adverse environmental side effects.

Rule of Law

Since 1979, the Chinese government has addressed the old way of arbitrary decision-making by gradually separating the lawmaking process from the political agenda, in order to develop rule of law. Although there is now a fairly comprehensive set of rules and laws, traditional behaviours do not change overnight, and many decisions are still made by important individuals without due respect to the law. A large part of environmental problems being the result of market failures, loyalties, or shortsighted and narrow-minded aims for quick returns, the absence of rule of law will make it difficult to come to grips with China's environmental problems. For example, a local official might ignore the fact that an enterprise is violating air pollution laws if his cousin or friend is the manager. Local officials are also often more concerned with the immediate economic welfare of their communities than with long-term environmental well-being, and decisions frequently go in the direction of allowing pollution to continue, in direct contradiction to the legal set-up.

Although there are still considerable influences from subjectivity in environmental decision-making in China, the trend towards rule of law for more than 20 years is firmly on track. Firstly, an Environmental Committee has been set up under the National People's Congress, which has real authority over environmental legislation. Secondly, environmentally harmful decisions and obvious misconduct that would have been impossible to prosecute only a decade ago, are now being brought to court, which is mirrored in the increasing number of environmental legal cases.

There is a firm conviction within central leadership that legal institutions need to be further strengthened. Still, however, there is a clear tendency to believe in command-and-control regulation and rule by decrees, rather than taking advantage of market forces (see section 4.1 Government Response).

Growing Separation between Rule-making and Implementation

In addition to the politicised and often arbitrary decision-making culture of the Mao era, there has, until recently, been little formal distinction between rule formulation and rule implementation. In general, the organisation responsible for formulating rules was also responsible for implementing and monitoring these. For example, the Ministry of Forestry was responsible for setting forestry objectives for a large part of forestry production and for monitoring the forestry sector. This system was top-down, non-participatory, and provided a hotbed for corruptive behaviour. Decisions were often taken in the national and provincial capitals, with little input from concerned stakeholders. As a result, *production* (e.g. of steel or timber) became the over-riding objective and those affected by environmental impacts were unable to influence the processes.

There is now a clear distinction between rule-making by government departments on the one hand, and implementation by enterprises on the other. There is also a clear distinction between exploitation of natural resources on the one hand—still under the supervision of sectoral ministries—and protection of natural resources and environment on the other, which is entrusted increasingly to the separate and increasingly strong SEPA. SEPA now has a clear mandate and incentive to protect the environment, something no agency had 25 years ago. This is illustrated by the number of environmental impact assessments being carried out, over 78,000 in 1998 (Xie Zhenhua and Song Ruixiang, 1999).

Integration of Sectoral Strongholds, the Streamlining of Environmental Management

The basis of China's more or less unbroken line of strong administrative governance can be traced all the way back to 221 B.C. during the reign of the first emperor of the Qin Dynasty. Through the centuries a deeply stratified form of bureaucratic governance emerged and after 1949, the Communist regime linked to this tradition, setting up a centrally planned vertical power structure geared towards boosting production within a number of ministries, bureaus, agencies, and departments (Hallding, 1991).

With its strong sectoral stratification, this governance model proved effective at preventing and dealing with such environmental disasters as floods, but less successful in managing new or cross-sectoral issues such as sustainable development. When it came to situations where several administrative units were involved with the same issues, and where co-operation would serve the public good best, the traditional administrative governance structure put different bureaucratic strongholds

Box 3.8 China to Commercialise Water Supply

Shijiazhuang, capital city of northern China's Hebei Province adjacent to Beijing, is trying to commercialise water supply to deal with serious water shortages.

A project called China's Urban Water Management in the 21st Century is being carried out in the city with assistance from UNDP and the Australian government. Shijiazhuang has become the first city in China to seek ways to resolve its water shortage through organizational reform.

The project aims to regulate water management in urban China by reforming the administrative structure and price of water (ref. Ying Ruozhi, the project coordinator).

Traditionally there has always been more than one department in charge of water supply in urban China. Taking Shijiazhuang as an example, nine governmental departments have been involved in water management. To produce a medium- or long-term demand and supply plan proved difficult since there was no centrally responsible administration.

Shijiazhuang will have one single department of water management within the next 10 years, according to Ying Ruozhi. "We have worked out a reform plan for government consultation."

Shijiazhuang is among 30 cities in China that suffer most from water shortage. The city's annual water requirement is 400 million cubic meters. To meet this demand, an additional 140 million cubic metres must be further exploited.

Shanghai and Shenzhen are also undertaking similar reforms.

Source: People's Daily Online, November 14, 1999

into conflict with each other. This pattern has been observed in numerous cases since environmental management typically relies on co-operation from several agencies.

The development of Chinese bureaucracies into something close to "independent kingdoms" has been compounded by the procedure of letting sectoral agencies, not neutral bodies, lead the development of laws and regulations. Each agency develops its own laws pertaining to the resources it manages, and each attempts to use the law to strengthen its mandate and increase its regulatory powers.

Gradually the reform process has led to a dismantling of the old sectoral strongholds, and the number of different production-oriented sectoral ministries has been reduced considerably. At the same time, authorities with cross-cutting responsibilities in the area of environment and sustainable development were strengthened after the major 1998 government reform, with the promotion of SEPA to its present semi-ministerial status, and the clear mandate to the SDPC to lead China's sustainable development efforts in close collaboration with a number of ministries and agencies.

A related trend is marked by the efforts to establish a more efficient and responsive organisational structure in managing public utilities. The UNDP-led 21st Century Urban Water Management Project (box 3.8) illustrates the largely untapped potential for making management of both water supply and sanitation considerably more efficient by reducing the number of departments involved and moving towards a straight forward demand-response management strategy.

Decentralisation, the Central–Local Power Struggle

China has a centralised power structure and a deep administrative hierarchy including provinces, cities, counties, towns and a number of other organisational units. Still, the central government has far less influence over the provinces than what could be expected from such a centralised state. Economic reforms have had further decentralising effects mainly as a result of the disbanding of collective agriculture and decreasing the share of state-owned companies.

Local governments have been given not only the authority necessary to reform local industries, but also the power to control financial resources at the local level. As a result, local governments have attained new bargaining powers, which have developed a tendency to sidestep or ignore rules handed down by the central government. Since pressures on local governments to promote development are enormous, central environmental authorities have difficulties imposing environmental regulations, which often justifiably, are seen as impediments to local economic development. It is not always quite clear who is in authority—the central or the local level—and the picture is further muddled by the existence of various local, provincial, and central regulations, guidelines, standards, and other more or less legal documents. SEPA, being a central authority with limited power, and without provincial or local representatives, has particular difficulties in promulgating environmental regulations. The result is that provincial and local units bluntly ignore SEPA's decrees.

Decentralisation as such is a necessary process to reach sustainable development in a country of China's

size, and there are many examples of local governments taking their own initiatives to improve the environmental situation. There is active work to develop local Agenda 21s for a number of counties and municipalities. Still, command-and-control governance requires reform in order to promote sustainable development at the local level, and the changing role of SEPA to more of a policy formulating body is one step towards that end.

From Command-and-Control Towards Market Forces

Well into the early 1990s China was predominantly a planned economy and most decisions were taken in a command-and-control setting. Seen from an environmental perspective this has had two main consequences.

First, prices of basic commodities were decided upon in the plan and geared towards boosting production, which meant low natural resource prices and freedom to pollute. As a result there was little incentive to save on scarce resources and no reason to treat pollutants before discharging them. Second, production was largely supply-side driven with centrally planned public investment decisions—both in terms of labour and capital—aiming to supply society with goods and services. Once investments were in place, however, there was little incentive to care for maintenance, operation, or management, with the result that environmental investments performed sluggishly. The long list of poorly functioning environmental investments includes giant reforestation programmes, where saplings once planted were left without maintenance resulting in high losses. Also are the all too often crumbling, poorly performing environmental installations such as water works, wastewater treatment plants and air scrubbers. Once built, these never perform up to design specifications due to lack of operating and maintenance capacity. They are often left to decay, one of the more well-known traits of the planned economy.

Market reform has been the hallmark of the changes that China has undergone over the last couple of decades, with substantial efficiency gains. China's GDP has increased faster than major emissions (Johnson *et al*., 1997), reflecting some positive environmental effects from market reform. Still, there is a long way to go before environmental governance through market-based instruments will make its effects felt in China. To a large extent, the economic boom of the last two decades has occurred at the expense of environmental values, and a considerable part of the economic growth has been generated in an economic environment where entrepreneurs have benefited from cheap inputs of materials and labour, with-

Box 3.9 Market Based Instruments in a Planned Economy?

Western countries, over many decades, introduced a variety of command and control measures to protect air quality in the urban environment, culminating in a series of far-reaching mandates in the 1960s and 1970s. Although broadly successful, not all environmental goals were achieved. Starting in the late 1970s, as it became more and more expensive to reach ever-smaller emission levels, and as government downsizing became the mode around the world, governments began to shift towards economic efficiency. In this context, pollution is often seen as a "market imperfection" correctable using market-based instruments (MBIs). Such economic thinking predominates today. However, command-and-control mechanisms have not been abandoned—indeed they usually remain the basis for the regulatory infrastructure.

In some ways, environmental management in China has followed a similar path. All traditional measures in the central planning system can be viewed as command/control measures. Tentative modification to this approach began in the late 1970s, starting with the pollution levy system. However, there is a fundamental difference between the Chinese and the Western experience in this area. Starting in the 19th Century, Western economies *first* achieved resource efficiency through market pressures, and *then* developed a comprehensive regulatory framework for environmental management, and *only* then introduced MBIs. By contrast, China is attempting to introduce MBIs *before* most of its industries are anywhere close to international efficiency levels, and *before* there is a comprehensive regulatory framework. Will this work?

For example, Benxi looks to today's Pittsburgh as an example of what can be accomplished environmentally in an iron/steel producing, resource-intensive city. But over several decades, Pittsburgh's steel producers experienced reductions in performance, and were forced to shut down when they become too inefficient in market terms. They also made pollution control decisions in that context, shutting down units if capital investments for pollution control of older technology was simply not warranted. Benxi's State Owned Enterprises (SOEs) are also changing and making capital investments, but they are not subject to the same market pressures. They are driven firstly by demands to maintain steel production and to keep hundreds of thousands of employees. Economic efficiency and environmental protection are still secondary concerns.

There surely is a role for market-based instruments. But Chinese policy makers must consider their implications before relying too heavily on them, and first create a mix of MBIs *appropriate* to China's market and regulatory framework. Also, MBIs often require strong information databases and effective monitoring systems, and most of China does not yet have these.

Source: Raufer and Wang, 1999

out having to pay for effluent discharges or worker's health.

Thus, in a sense China is trapped in between the worst of two worlds: on the one hand a socialist heritage of under-priced natural resources and free right to pollute, and on the other an unrestrained embrace of a market economy where, as Deng Xiaoping stated "it is glorious to be rich".

From Collective Towards Private Ownership

The transition from command-and-control towards market-based governance is intimately related to the shift from collective to private ownership. China's double-digit growth over the past two decades was initiated by increased agricultural output when collective farming was dissolved in the beginning of the 1980s in favour of a household-based land tenure system, the so-called *Household Responsibility System*. This was followed by industrial productivity gains in return for allowing capital and labour to flow into low-end production in the booming non-state industrial sector. All it took to unleash a surge of entrepreneurial spirit was for the government to soften conditions for collective ownership of production units, favouring the individual's right to decide what to produce and to keep part of the profits, but where formal ownership in a legal sense was still collective although with increasingly fuzzy edges. What followed from this governance revolution could in many cases best be described as unrestrained growth, on the one hand generating remarkable development of the economy, and on the other causing the large-scale adverse environmental consequences that have been spelled out above.

The degree of privatisation has increased dramatically throughout the 1980s and 1990s and today well over half of the industrial output is generated in the non-state sector, with the private sector showing the highest growth. Corporative and private enterprises tend to be more profit oriented, and therefore more efficient. This effect has been reinforced by the opening-up of internal and external trade, leading to increased competition and some increases in efficiency.

In the agricultural sector, the Household Responsibility System has been gradually reformed, and land tenure contracts now run for 30- to 50-year terms with increased leeway to trade contracts and hand on land tenure rights to heirs. The ownership of land, however, is still in the hands of the state, and the question of real estate reform is crucial in view of the governance of China's land resources (see box 3.6 for aspects relating to rural China). A key issue in this respect, with potentially far reaching consequences for sustainable development, is how rural China will cope with increased international competition in agricultural products (see section 3.11 on Globalisation).

Privatisation is a hydra, which in the right market-based regulatory context can improve resource use efficiency, but without strong market-based regulation can cause overexploitation of people and natural resources, unchecked pollution and increased inequity. So far, the transition from collective towards private ownership in China—for all its dividends in terms of economic growth—has to a large extent come about at the expense of environmental qualities. Still, if sustainable development is the objective, the future does not lie in a return to collective ownership, but towards stronger market-based governance.

Broadening Participation

One of the most powerful and promising trends in China in the next few decades may be an increasingly stronger civil society, and environmental authorities are now being both challenged and assisted in its tasks by a rising new force—*public participation*. The former environmental administrator, Qu Geping, has stated that public participation in project approval, as well as consumer and investor interest in clean products and enterprises, will be promoted.

This new, burgeoning governance structure for the environmental arena is reflected by the increasing media coverage of environmental issues. This is hard to escape as newspapers, magazines, radio, TV, not to mention the Internet with now over 10 million Chinese users not only report on the environment, but increasingly also question the lack of government action.

The widening room for public participation is reflected also in the remarkably independent grassroots and citizen organisations, which have been formed over the last couple of years. Proudly referred to as NGOs—not only by members but also by officials that fancy this new phenomenon—these organisations do not enjoy quite the same level of freedom as NGOs in other countries, but most of them have some form of financial or administrative dependence on a government agency—sometimes referred to as GONGOs, or governmental NGOs.

Public participation in China is built on a silent mutual agreement between media and NGOs on the one hand, and government ministries and agencies on the other. NGOs and media provide exposure to issues that the environmental authorities are hesitant to raise; and the authorities in return give relative freedom to the environmental organisations. The bottom line of this silent agreement is that media and environmental NGOs that operate responsibly and within a scope acceptable to the Chinese government are likely to be granted increasing freedom and access to the political process. This

may be particularly true for locally active NGOs that promote public awareness and serve as watchdogs for central government. However, government in a subtle way controls NGOs, which have to master the invisible but ever present line between voicing environmental concern on the one hand, and questioning political power on the other. Notably, at present, it seems unlikely that the government would allow for any *nationwide* NGO organisation. Yet, organisations working for the benefit of local environments are being formed all over China, out of which a web of informal networks is growing.

The Birth of Influential, More Neutral Technical and Academic Sectors

The existence of independent and reliable sources of quality advice is crucial to sound decision-making, especially when it comes to the complex issues surrounding sustainable development. In the past, technical and academic institutes were part of or under the supervision of government ministries or agencies, gathering information for that agency. Not surprisingly, the advice produced in these institutes had been carefully tuned to follow the master's voice, with the results that any notion of potentially adverse effects was routinely brushed under the carpet. Recently, many of these institutes have developed increased levels of independence. This, combined with strengthened capacities, means they are now in a position to give objective and even challenging advice to decision makers.

Another aspect of the growing numbers of more independent expert institutions is that a competitive market for environmental knowledge and services is being formed, where government agencies procure decision support such as studies, investigations and feasibility studies on a contractual and increasingly also competitive basis. As a positive side effect, the evolution of a market for environmental services has helped create a higher level of professionalism in the environmental sector.

Finally, the growing pluralism in the technical and academic sectors has improved the opportunities for Chinese institutes to network and collaborate with research institutes and consultancies around the world, where Chinese institutes have begun taking part in bids for overseas consulting as well as international research assignments.

Two Steps Forward – One Step Back

Governance reforms—aiming as they do at the very heart of decision-making—are inherently time-consuming. Although the magnitude of challenges that lie ahead is huge, one must esteem the remarkable progress that has taken place over the last two decades. The massive size of the Chinese land and population is an often overlooked factor—indeed hard to fathom—in determining the extent of, and speed by which new governance structures may be put into place.

The preconditions for, and the clarity of decision-making vary considerably across the country, as well as between urban and rural areas. Urban people compared to rural may be better informed with more opportunities to express their views through non-governmental networks. But rural areas actually have better formal mechanisms for people to influence decision-making processes through the local democratic elections for village chiefs that has been experimented and expanded throughout the country during the 1990s.

But good governance is also a matter of changing the decision-making culture, and new governance structures may prove to increase demands on government officials more than new economic management systems can. More capacity is needed to manage participatory processes in order to make them more transparent and the same goes for working with and making the most of NGOs.

Future Trends and Uncertainties

China is at a juncture of increased scarcity of natural resources with declining environmental quality and intensified societal pressures. Good governance is essential in order to come to grips with this and to steer things towards environmentally sustainable development.

Most governance indicators of present developments in China point in the right direction. These include rule of law, government streamlining, the move towards market forces and increased private ownership, and greater freedom of self-expression, all of which are positive signs of a more efficient, transparent, and pluralistic governance structure. New governance structures have begun to have positive impacts on the environment, e.g. recent measures to control logging and air pollution, partly a response to public and media campaigns. The *Western Development Strategy* has been presented in a more transparent and accountable manner than earlier development initiatives, with sustainability at its core—at least so far on paper.

Over the last two decades, China has suffered from taking "two steps forward and one step back" regarding governance reforms for sustainable development. With all the many possible obstacles hindering progress, governance structures may well continue to develop much in the same gradual way they have done since the late 1970s. In terms of environment and natural resources, however, it is crucial that governance structures do continue to undergo reform, in order for China to come to grips with the accelerating exploitation of scarce but under-priced resources, the adverse result of a half-reformed economy. Also decision-making processes need to be made fair and transparent, allowing for appropriate

SCENARIO BOX 3 KEY ISSUES AND CRITICAL UNCERTAINTIES

Key Issue	Trend	Impact	Data Quality	Critical Uncertainties	Intervention Possibilities	Intervention Costs
Population growth	250 million more people by 2050; 1/5 growth	Increasing pressure on already scarce resources	Good	400 million people in the span between low and high UN projections	Limited due to the dynamics of the population pyramid	Short-term costs low—family planning is good investment / long-term costs high—the burden of aging population
Migration and urbanisation	200 million moving by 2010 to urban areas and towards east	Increasing pressure on eastern areas with already high population pressure	Trend is clear, but statistical accuracy uncertain	Large uncertainties in urban-rural statistical material. Potential risks for large migrant movements due to environmental problems, e.g. water scarcity	Difficult, including combination of regional policies, and improvement of urban infrastructure	Very expensive, involving large scale infrastructure development
Economic Development	Substantial growth, but at slowing rates	Less room for government financed environmental investments	Economic accounting getting better, but predictions very uncertain	• WTO impacts • Ability to internalise environmental costs • Risk for economic backlashes due to environmental constraints	Many possible interventions are manageable, other more difficult. Difficult trade-offs between employment and sustainable development	Many win-win opportunities. Transaction costs in economic restructuring could be high
Poverty and Equity	Increasing equity gap both in terms of wealth and access to clean environment and resources	Vicious cycles of environmental degradation feeding poverty and vice versa	Relatively good	• Uncertain vulnerability thresholds as a result of environmental constraints such as water scarcity • Risk for large migration pressures	• Very difficult, involving broad social reforms beyond environmental policies • Priority on alleviation of the situation for the ecologically and socially most vulnerable groups	• Continued reforms mean establishment of costly transfer payments • Improvements for vulnerable groups involve everything from low to very high cost interventions depending on the actual situation
Awareness	Environmental awareness is on the rise	Increasing public pressures on government and business to take action	Systematic quantitative data largely absent. Trend supported by qualitative observations	• Considerable opportunity for improving environmental situation • Could potentially add to other socially destabilising factors	• Environmental education • Publication of environmental information through media • Encouragement of NGOs	Low costs
Consumption	Increasing per capita consumption dominant trend	Environmental pressures increasing at level of importance similar to population growth	Relatively good indicators from waste generation, energy use, etc.	Far-reaching ecological impacts if Chinese consumers develop western consumerism	Reasonably manageable, but depending on combination of awareness and economic incentive/disincentive system	Efficient consumption in itself of great economic value to society. Interventions not costly by themselves
Technology	Increasing efforts with advanced research in certain key areas, e.g. biotechnology	Technology improvements generally good for environment	Difficult to measure, due to various technology areas, difference between government and private sector spending	• Technology leapfrogging could have fundamental, positive impacts • Technology may lead to higher penetration and exploitation of fragile ecosystems	• Increase demand for environmental technologies by economic incentives • Promote higher education in technology areas • Focus government funding to key technology areas	• Put a price on the environment lead to positive economic results, however initial transaction cost • Education low cost but long-term solution
Water	Increasing scarcity in northern China	• Downstream areas run dry when water is used upstream • Increasing risk for overt conflicts	Relatively good, however better understanding is needed of supply, demand, and hydrology of major basins	• Impact of climate change • South-north water transfer • Large migration due to intensified water scarcity	Manageable, involving: • Scarcities pricing of water, with supply and discharge fully covered by fees • Stronger river basin management • Incentives for water efficient agriculture	• Most proposed interventions increase efficiency and drive economic development • Agricultural transaction costs high • Considerable infrastructure investments needed • The south to north water transfer is extraordinarily expensive
Energy	5-6 times increase in energy consumption by 2050	• Large increases in greenhouse gas emissions • Continued deterioration of air quality, with considerable health effects	Energy information is relatively good	• Large untapped opportunities for further energy efficiency may reduce energy needs to an additional 50% by 2050 • Technology breakthrough in renewable sources	• Better price incentives to promote energy efficiency • Promotion of sustainable energy through education, dissemination, and R&D	• Abolishment of subsidies and introduction of price incentives are associated with transaction costs, but generate economic growth • Promotion of sustainable energy is associated with costs that will reap returns only on long-term
Transportation	Substantial increases in transport volume, largely through road vehicle transport	• Further deterioration of urban air quality with considerable health effects • Increasing greenhouse gas emissions	• Data on present vehicle fleet is reasonably good • Comprehensive information on expansion plans and alternatives are scarce	Overly reliance on road traffic could seriously hamper economic development potential due to • Clogging of urban areas • Air quality impacts	• Development of collective transport systems, in particular for urban areas • Development of rail based transport to integrate China's interior with the coastal areas, and thereby avoid migration pressure	• Involves large scale and very expensive infrastructure development
Agriculture and food	Since reform period: • Gradual privatisation of agricultural land, now with 50-year contracts • Liberalisation of food markets	• Efficiency improvements • Combined effects of privatisation and subsidised prices have led to overly use of water, fertilisers and chemicals	• Difficult to assess trends by data	Large uncertainties due to the central role of agricultural policies • WTO impact • Climate change • Rural surplus labour result of privatisation	• Step-by-step WTO process allowing for higher grain imports, shifting production to labour intensive cash crops • Development of markets • Promotion of agricultural extension services • Propagation of efficient irrigation methods	Most interventions do not rely on large-scale investments

cont'd

SCENARIO BOX 3 cont'd							
Globalisation	Continued integration of China in global community	▪ China makes efforts to act as a globally responsible leader ▪ Increasing international trade could displace environmental problems from China to other parts of the world	▪ Data and information supports trend of continued opening up in terms of trade, ratification of international agreements, etc.	▪ China rises as a haven for a large part of global biodiversity puts the survival of important species in jeopardy ▪ China's energy choices have considerable impact on global warming ▪ Risk of environmentally related disasters having global repercussions in terms of regional instability and considerable migrating pressures	▪ Intensified international collaboration based on international conventions to reduce global environmental problems in China ▪ Recognition of China's water scarcity problem	Low to medium costs activities through international mechanisms for global environmental actions	
Governance	Slow but steady governance reform including cuts by law, sectoral integration, increased reliance on markets, privatisation, and broadening public participation	▪ More responsible use of land resources, utilisation ▪ Critical environmental issues coverage ▪ Public participation	▪ Quantitative data scarce with a reliable evidence	▪ The ability of the political system to handle large scale environmental catastrophes ▪ Impact of global environmental governance, such as WTO	▪ Good governance for sustainable development is feasible, but takes time since it aims at changing and improving the way decisions are being made and implemented	Governance reforms are not expensive as such, and implemented in the proper way they may lead to improved economic performance ▪ However, substantial investment costs are associated with many governance changes	

involvement of relevant stakeholders in a managed way. Only when this is the case, will decision-making become responsible and self-correcting.

Still, there are threatening signs, such as increased water scarcity and inequity, and complete unknowns, such as large-scale natural/environmental catastrophes or deteriorating global politics, which could trigger a return to the strict top-down structure of the past. Such consequences would turn the clock back on China far beyond just the environmental issues.

Chapter 4

Ongoing Response: Towards a Sustainable Future

The review and analysis of the "Society – environment nexus" in chapter 3 provide some direction to identifying the strategies and measures required to reverse environmental decline to help put China onto a sustainable, human development path. In particular it argues that China can choose its own future and that continued reform of governance and institutions is crucial in order to navigate to a more sustainable future. It will obviously be a complex and demanding task to manage the tangle of inter-relationships and feedbacks, while keeping one-step ahead and ensuring initiatives launched today will still be appropriate for tomorrow's challenges. This chapter describes and assesses ongoing efforts to put China on the right path.

The first section of this chapter provides an overview of the administrative set-up of the country, while the two following sections deal with the active responses by government and various players in society to the challenges described in the previous chapters. This leads to the first section of chapter 5 which provides some food for thought as to whether these responses are optimal, or indeed sufficient, to keep China on a sustainable path.

4.1 China's Environmental Administration

China first established an Environmental Protection Office in 1974 as a follow-up to the 1972 Stockholm UN Conference. Housed initially within the State Council, the Office was later moved into the Ministry of Urban Rural Construction and Environmental Protection, reflecting the fact that environment was considered primarily an urban industrial issue at that time. In addition, in 1984, the State Council established the State Commission for Environmental Protection to co-ordinate environmental affairs among ministries. This implicitly recognised that environment was not a separate sectoral issue.

The State Environmental Protection Administration (SEPA)

This Commission was disbanded in 1998, by which time the Environmental Protection Office had evolved, through a number of intermediate stages, into a ministry-level State Administration—the State Environmental Protection Administration. SEPA has most of the responsibilities of an environment ministry, covering brown and green issues, policy making and monitoring, and co-ordination of environmental affairs across ministries. A similar evolution in the environmental framework can be observed at the provincial, county and township levels. By 2001, many agencies had clear responsibilities for the environment.

The National People's Congress (NPC)

NPC is China's legislative body and the highest level of political authority. The NPC's Environmental and Resources Protection Committee (ERPC) is responsible for drafting legislation and the supervision of Government performance in the environmental sector. The NPC and the ERPC are far from the rubber stamp institutions they used to be, and have during the 1990s developed into a forum for debate with environmental issues being of particular concern during NPC sessions.

The State Council—the Chinese Government

The State Council under the present leadership of Premier Zhu Rongji is responsible for the implementation of laws and policies laid down by the NPC. The Council consists of four vice-premiers, the chairmen of government co-ordinating commissions, and the 29 ministers that lead full-fledged line ministries. One of the vice-premiers, Wen Jiabao, is responsible for environmental issues in the Council. Within the government, the highest environmental executive body is SEPA. Though not having a permanent seat on the Council, SEPA's Minister, currently Mr. Xie Zhenhua, participates fully in Council meetings when environmental issues are discussed and addressed.

Other Ministries

A number of state commissions and ministries have considerable responsibilities within the broad subject area of environment and sustainable development (see box 4.1). Over the years, these ministries have identified de-

Box 4.1 Chinese Government Ministries and Agencies with Environmental Responsibilities

State Development Planning Commission (SDPC) has the mandate to control and regulate China's macro economy and future planning, and assumes the main responsibility for sustainable development and the implementation of China's Agenda 21. It is also responsible for regional co-ordination and plays a central role in formulating China's position in international negotiations on climate change.

State Economic and Trade Commission's mandate is to regulate the near-term operations of the national economy with focus on industrial policies. As such, it has responsibilities within regulations of industrial pollution, and has related responsibilities in the areas of environmental technology development, clean technologies, and energy efficiency.

Ministry of Foreign Affairs is involved in the negotiations and ratification of all international conventions and other agreements, including climate change negotiations.

Ministry of Water Resources has responsibilities related to river basin management and water management outside of urban areas.

Ministry of Construction has strong influence and responsibilities in urban infrastructure development, including wastewater treatment and solid waste management.

Ministry of Agriculture assumes overall responsibility for most of what happens outside of urban areas, including regulation of township and village enterprises.

Ministry of Science and Technology has a key role in sustainable development, is involved in climate change negotiations, and has responsibilities within technology research and development.

State Forestry Administration has significant responsibilities related to forest and wetlands management, and to biodiversity conservation.

State Ocean Administration is responsible for management of coastal and marine waters, including biodiversity conservation.

Ministry of Land and Resources is responsible for planning, administration, protection and rational utilisation of such natural resources as land, mineral and marine resources, including mapping and cadastral (land ownership) management.

State Meteorological Administration takes part in climate change negotiations, and has responsibilities in regional air quality management.

Ministry of Communications shares responsibilities with SEPA on vehicle emissions control, the implementation of which falls on the Public Security Bureaus.

partments responsible for environmental issues and for co-ordination with SEPA. They have also strengthened internal capacity in this sector.

Local Governments

Provincial, municipal, and local governments issue environmental legislation and plans affecting their jurisdictions. Provincial environmental protection bureaus (EPBs), as well as county and municipal EPBs, oversee compliance with national and local-level environmental statutes, regulations, rules, methods and standards. They do not take orders from, nor answer to, SEPA – they belong to local level government. SEPA has a limited budget, and little direct influence over provincial budgets. On the positive side, SEPA now participates in the selection of the heads of local EPBs.

Trends in Environmental Administration

Politically, SEPA enjoys the support of both the State Council and the Communist Party, that share environmental concerns and recognise the importance of environmental protection to China's future development. Recently, a dialogue mechanism has been established whereby the President, the Premier, and other Cabinet members sit down annually with SEPA officials to discuss the strategy for environmental protection and the country's sustainability. Such political support is essential if SEPA is to effectively implement policies (Zhang, 2001).

Improving its Position—But Still Understaffed

In 1998, at a time of general government downsizing, SEPA was *upgraded* to a semi-ministry level, with the minister reporting directly to the Vice-Premier in charge of environmental protection. The change of status provided SEPA with more leverage in its dealings with other government departments and agencies, and enhanced its capacity to enforce environmental laws and regulations. Since this upgrade, SEPA has developed ambitious mid- and long-term plans. However, implementation of the plans is constrained by serious lack of staff capacity—the number of core staff is limited to 240 as compared to the 6,000 staff of the Washington headquarters of USEPA. Also capacity is lacking due to uncertain sources of finance, as well as limited leverage over local governments.

Box 4.2 Sustainable Development and China's Agenda 21

Sustainable development has grown into a key national development policy that enjoys strong backing from the political leadership.

After the United Nations Conference on Environment and Development in Rio, 1992, China was the first country to publish a national Agenda 21—an impressive work led by the SDPC and the Ministry of Science and Technology (MOST). With support from UNDP, a white paper on China's Agenda 21 was published in March 1994 (China's Agenda 21, 1994) and a Priority Programme for China's Agenda 21 consisting of 62 projects of demonstration character, building heavily on foreign soft financial support.

The Administrative Centre of China's Agenda 21 (ACCA21) was set up by the SDPC and the MOST for handling day-to-day work with regard to Agenda 21 implementation.

After the reconstruction of the ministerial structure in 1998, a new leading group for sustainable development has been set up under the leadership of SDPC, and sustainable development is now a key national strategy. ACCA21 serves as a secretariat for China's sustainable development, with the task to draft documents, plans and strategies, as well as review and develop new strategies for China's Agenda 21.

China's Agenda 21 work during the 1990s has been characterised by a top-down approach, but with experiences from a number of experimental community-based projects. The aim now is to localise future Agenda 21 activities and bring in citizens and NGOs in the work on the community level. All government departments and all provinces are expected to

Barter or Co-operation for the Environment

Over the past two decades China's institutional framework has been broadened and strengthened, and is now far more responsive and capable of responding than was the case only a decade ago. However, serious weaknesses do exist. A main limitation is collaboration across sectors—essential for making progress towards environmental goals. As box 4.1 well illustrates, mandates run across several agencies, often with unclear division of responsibilities. Whereas, for example, draft sectoral plans and policies should be reviewed by SEPA before passing them to the State Council for approval, SEPA still yields little influence except on issues pre-selected by the State Council. Most of the agencies listed in box 4.1 are more powerful than SEPA.

SEPA has a cross-cutting mandate and needs to collaborate to succeed. However, turf battles and competition for funding make horizontal co-operation among Chinese government bureaus difficult. SEPA has made efforts to increase its influence by improving collaboration with other ministries, in particular for biodiversity and conservation. At the provincial level, EPBs co-operate increasingly with urban construction bureaus on urban pollution control.

Yet, SEPA is challenged by its mandate to co-ordinate, as it is below ministerial level in many respects, and is considered somewhat of a "newcomer". Moreover, it is often perceived by enterprises, local governments and production-oriented ministries as an environmental policeman trying to limit economic growth. Faced with these reactions, SEPA often develops a defensive attitude, and sticks to issues it feels most comfortable with—those which can be addressed without collaboration with other agencies.

Power Moving Away from the Centre

China's economic, social, and political reforms have influenced environmental protection efforts. Provincial authorities now have considerable power, for example through issuing primary directives to local government and environmental protection bureaus. Provincial Planning Commissions—belonging to the SDPC network—are intimately involved in project planning, especially in project selection, design and approval stages. In each province, the Party Standing Committee also influences provincial bureaus, including the Provincial EPBs. Likewise, county and township governments have significant influence over the development process.

At the local level, the over-riding objective is economic growth. Local government officials gain legitimacy by increasing incomes, ensuring low unemployment rates, and maintaining stability. Improving the local environment offers few rewards to local officials. This "incentive" structure may even apply to EPB staff. The result is that local government officials often shun environmental protection responsibilities, and so local level activities do not reflect national priorities regarding environmental protection (Lieberthal, 1997).

Political devolution and decentralisation has shifted implementation of environmental policies more towards local governments. Provincial, city, township and village governments, local environmental protection offices, and other local bureaus are now assuming greater responsibility for environmental protection and resource management (Beach, 2001). In theory, the central gov-

Box 4.3 A Dangerous Profession

Violations against environmental bureau officials probably occur more than is reported. In Qinghai, a bureau official was probably killed by antelope poachers, despite the local government's labelling his death as a suicide (McCarthy and Florcruz, 1999). SEPA has stated that it cannot expect effective government management from its officials if it cannot protect them from such attacks.

ernment could intervene at any time to prevent abuses at the local level. Yet, China's enormous size and complexity makes thorough oversight difficult, if not impossible. Moreover, local and provincial officials complain that they do not always know the content of the latest laws and regulations, and they are unable to interpret the laws they have access to. One result is that local regulations are often issued inconsistent with environmental targets.

4.2 Government Response

Is the environment a priority for the Chinese government? Undoubtedly, over the past two decades, environment has been given increasing priority. In the 10th Five-Year Plan (2001–2005), sustainable development is designated the "guiding principle and strategy" for the country's economic and social development. The Plan also identifies environmental protection as a national priority. Although not quite at the same level as economic growth or poverty alleviation, environment is firmly a national priority. Within this, more specific environmental priorities and targets have been established by concerned government agencies, as illustrated in box 4.4.

The list in box 4.4 exposes several of the challenges facing the government. First, there are many such lists, issued at different times, by different departments. Although the lists are generally coherent, this may be confusing and may lead to difficulties in implementing priorities. Second, the list includes policy objectives, technical targets, and implementation measures. This confusion between means and ends may make it difficult to act strategically and sustainably address root causes. Third, this is only the environmental list. Although the State Council issues general policy objective statements, it does not issue more direct targets, and there is a danger of a disjunction between the State Council's over-riding objectives, and the specific objectives of specific government ministries and agencies.

Over the decades, the government has followed three approaches to addressing environmental challenges. In the early years, the government responded to key national issues, for example acid rain or soil erosion, through targeted administrative and technical measures. This *campaign approach* was inherited from the Mao era, when it was *the* central policy instrument, but has continued to colour the way government conceives to meet various challenges to the present day. However, since China embarked on the reform period in 1979, the leadership has been committed to a new approach, where a *legislative and regulatory framework* forms the basis for government action. The third approach relies on *market-forces and market-based instruments* and has been growing in importance along with the formulation of the "socialist market economy" that now constitutes a basic philosophy in the Chinese reform efforts.

The government has continuously revised and strengthened its institutional framework for environmen-

Box 4.4 SEPA's Environmental Goals for the 10th Five Year Plan

In line with national objectives, for the period 2001 to 2005, SEPA has identified the following specific environmental objectives (Zhang, 2001):

- reduce emissions of sulphur dioxide and total suspended particulates by 10 percent;
- alleviate water quality deterioration in the seven major river basins, major lakes, and key coastal areas;
- designate an increasing number of environmental model cities and counties as "ecological sustainable areas";
- increase the national forest coverage from 14 to 19 percent;
- increase the percentage of land designated as nature reserves from 10 to 13 percent;
- control desertification and soil erosion;
- increase pollution control investment to 1.5 percent of China's GDP;
- increase the number of "major cities for environmental protection" from 47 to 100;
- promote the use of cleaner energy sources - renewables, clean coal technology, and natural gas;
- pass the Environmental Impact Assessment Law, which would require all important macro-economic policies and key regional development projects to complete EIAs; and
- consolidate TVEs in order to facilitate centralised pollution treatment.

tal management in order to implement these approaches. This section first describes this institutional framework, before discussing how each of the three approaches has evolved over the years. The section ends with a discussion of environmental spending.

The First Approach: Campaigns and Administrative Measures

In the 1960s and 1970s the Chinese government's main approach to economic and social challenges was through campaigns. In this approach, policies are set at the central level, and implemented through large government investment programmes supported by administrative control measures and propaganda campaigns. This approach dominated the response to environmental issues in the early 1980s, and continues to be important today, particularly in some localities. The measures implemented include banning of activities, closing down of operations, large-scale physical investments, and mobilising the communities. The approach is illustrated in the following examples.

Pollution Reduction

In 1995 a series of geographical priorities were identified for clean-up: three northern rivers—Huai, Hai, and Liao; three major lakes—Dianchi, Cao, and Tai; two control zones—sulphur dioxide emissions and acid rain; one metropolitan area—Beijing; and one marine area—Bohai Bay. More than 1,500 separate projects have been launched in support of these priorities, with an investment totalling over 18 billion USD. These investments were accompanied by efforts to crack down on heavy polluters. Between 1995 and 2000, China shut down more than 84,000 heavily polluting plants, including oil refineries, cement plants, thermal power plants, and metallurgical mills. Most of the plants closed were privately owned small businesses scattered across the country and far away from the reaches of state-sponsored infrastructure investments (SEPA, 2001).

A good case study is the Huai River. The call to "harness the Huai River" was sounded by the Chinese government more than 30 years ago. The river, which runs through four provinces in China's heavily industrialised eastern coast, remains a major eyesore, despite years of pollution control and reduction. More than 1,000 plants were shut down in the end, as part of the "campaign to control pollution plan" (SEPA, 2000).

Natural Resources Conservation

In the wake of the devastating floods in the summer of 1998, the Chinese government renewed its attention to the conservation of natural resources by issuing new directives to restrict logging and calling for wetland preservation along the middle reaches of the Yangtze River. Wide-ranging banning and restrictions on logging were issued, including bans along the upper Yangtze River basin and the middle and upper Yellow River basin, as were severe restrictions in the Northeast and the forested regions of Inner Mongolia. Also, instructive measures were used to change land-use, focusing on the conversion of steep cropland back to forestland.

These important administrative measures have been backed up by large investments. Some investments are similar to past methods used in the 1980s to reforest or re-grass land. For example, the "shelter forest program" has long been among the priorities, covering the North, Northeast, and Northwest of China, coastal areas, the Pearl Delta, the Huai River basin, the Taihang Mountains, low-lying plains, the Dongting and Boyang lakes, as well as the middle and lower reaches of the Yangtze. Also, to tackle land degradation, anti-erosion has become a top goal to be achieved through afforestation programmes, improving pasture management schemes, terracing projects, silt dam construction, and policies that encourage removal of fragile land from cultivation. Those schemes now cover 41 percent of the eroded land in the country. Improvement in irrigation and drainage system, irrigation management, cropping pattern and management are the main measures to control land salinisation. A very successful effort, the schemes now have 70 percent of the saline land under control (Huang Jikun, 2001).

Other related government funds focus on poverty alleviation, transportation and education, indicating that the government recognises the need to address social issues in conjunction with environmental improvement. Other programmes also aim to protect land resources and biodiversity through the setting up of more nature reserves. Between 1996 and 2000, China set up 1,000 new nature reserves, covering 7.64 percent of the territory, and 112 ecological pilot areas.

Western Development Plan

Realising the importance of narrowing the gap between the Eastern and Western parts of the country, the Chinese government has made the development of the West a top priority for the coming decades. President Jiang Zemin declared that the Western Development Plan was crucial to maintaining China's stability and the Communist Party's hold on power, as well as to the "revitalization" of the Chinese people (He, 2001). This plan is expected to include the construction of 35,000 kms of roads and 4,000 kms of railways over the next decade, as well as the construction of a 14 billion USD, 4,000-km gas pipeline linking Xinjiang to Shanghai.

Part of the plan also focuses on ecological and water resources construction in the West and Northwest. The government is expected to spend 200 billion yuan in ecosystem and environmental protection, natural forest con-

servation, returning steep cultivated land back to forestland or grassland, and controlling desertification. It is believed that the actual investment could be much higher, when increasing interests from both China and abroad are attracted to protecting the region's ecosystems.

Energy Conservation and Efficiency

Since the early 1980s, China has adopted a series of policies and programmes to promote energy efficiency and conservation across different industrial sectors. During this period, more than ten percent of government investments was put into energy-targeted energy efficiency. In the coal sector, thousands of small mines were shut down. Policies in the power sector to eliminate small generators reduced net growth in electricity generation and slowed growth in coal use by getting rid of inefficient units. Residential use of coal also fell as urban dwellers were encouraged to switch to gas and electricity for cooking and water heating and as more people moved into apartments with central heating. These measures contributed substantially to reductions in energy intensity of the economy during the decade, even though the economy grew at a double digital rate. It should be noted, however, that administrative measures in this sector have been strongly supported by regulatory and market-transformation measures (Sinton, 2001).

Campaigns and Administrative Measures—Pros and Cons

The above examples reveal how the campaign approach has evolved over the years. In the 1970s, campaigns were often sectoral and relied purely on administrative bans and investments. Increasingly, they have become inter-sectoral, relying also on a regulatory framework, and complemented by social measures. This "campaign" approach has contributed greatly to improving some aspects of the environment. Its main strength has been its power to mobilise a broad and deep support from across society to address a key issue, often in support of a magic number or a patriotic slogan. Another strength is that it ensures the focus of efforts is on issues that matter to people—such as pollution—rather than on technical challenges or means—such as emissions standards. Also, given the size and complexity of China, it has not been possible to address all issues all over the country simultaneously, and campaigns help set priorities.

There are weaknesses with this approach. In the past, it has not been clear how priorities were set and campaigns initiated. This may have been largely through a closed political process, rather than based on social or economic priorities. Without appropriate checks and balances, in some cases the methods and priorities may seem *ad hoc*. Also, monitoring of programmes has been weak. Implementation starts up with a flurry, but once an issue becomes less fashionable, implementation may fade away. This is demonstrated by the re-opening of many of the closed polluting plants with the support of the local governments. Also, once an issue is identified, insufficient thought is given to determining the most cost-effective method to achieve the goals and there is an automatic focus on big spending schemes (see section 5.1 for more discussion on this). Campaigns tend to work against sectoral co-ordination, as one agency is responsible for each campaign, whereas sustainable development requires a co-ordinated, integrated approach. Finally, the *ad hoc* nature of campaigns makes it difficult for private sector and some government agencies to anticipate their start-up and finish.

The Second Approach: Legislative and Regulatory Frameworks

Since the beginning of the reform period, China has been taking steps to complement and then replace campaigns and administrative measures with a legislative and regulatory framework as a foundation for economic and social behaviour. Two decades of building a legal system have yielded an impressive amount of laws, regulations, and standards in a way that has truly changed basic rules in Chinese society. Still, 20 years is a short time for building a legal system, so the system is still far from complete, and the speed with which it has grown has left significant imperfections behind.

Still, the work so far to create a legislative and regulatory framework carries an imprint of the fact that campaign and administrative measures have continued to play an important role as a tool for environmental actions, and legislation has therefore often been accompanied by large-scale government-funded investment programmes. For example, the government complemented the air and water pollution bills by investing heavily in air and water pollution control, and closing down many polluting enterprises. In a period of transition from command-and-control to a more market-oriented society it is likely, however, that these combined measures have been the best possible choice.

Blizzard of Legislation

Since the promulgation of the first Environmental Protection Law in 1979, China has adopted and enacted more than 20 statutes on pollution control, natural resource conservation, and human health and safety. In addition, dozens of regulations, procedures and initiatives, as well as hundreds of standards have been passed. Most recently, the *Air Pollution Control and Prevention Law* has been amended, and will be followed by two more statutes—the *Environmental Impact Assessment Law*

and the *Clean Production Law*. In comparison, over the last four decades the United States has ratified only 21 major environmental acts. Box 4.5 provides an illustration of the hierarchy of key environmental laws and regulations, and an indication of how national and local laws interrelate.

Impressive in sheer quantity, the Chinese environmental legislative framework has grown into a bush vegetation of different legal acts and other semi-legal documents of various dignities, many of which are not well harmonised with each other. An effort to weed out legislation that is obsolete or even contradictory would help make the legislative framework more efficient.

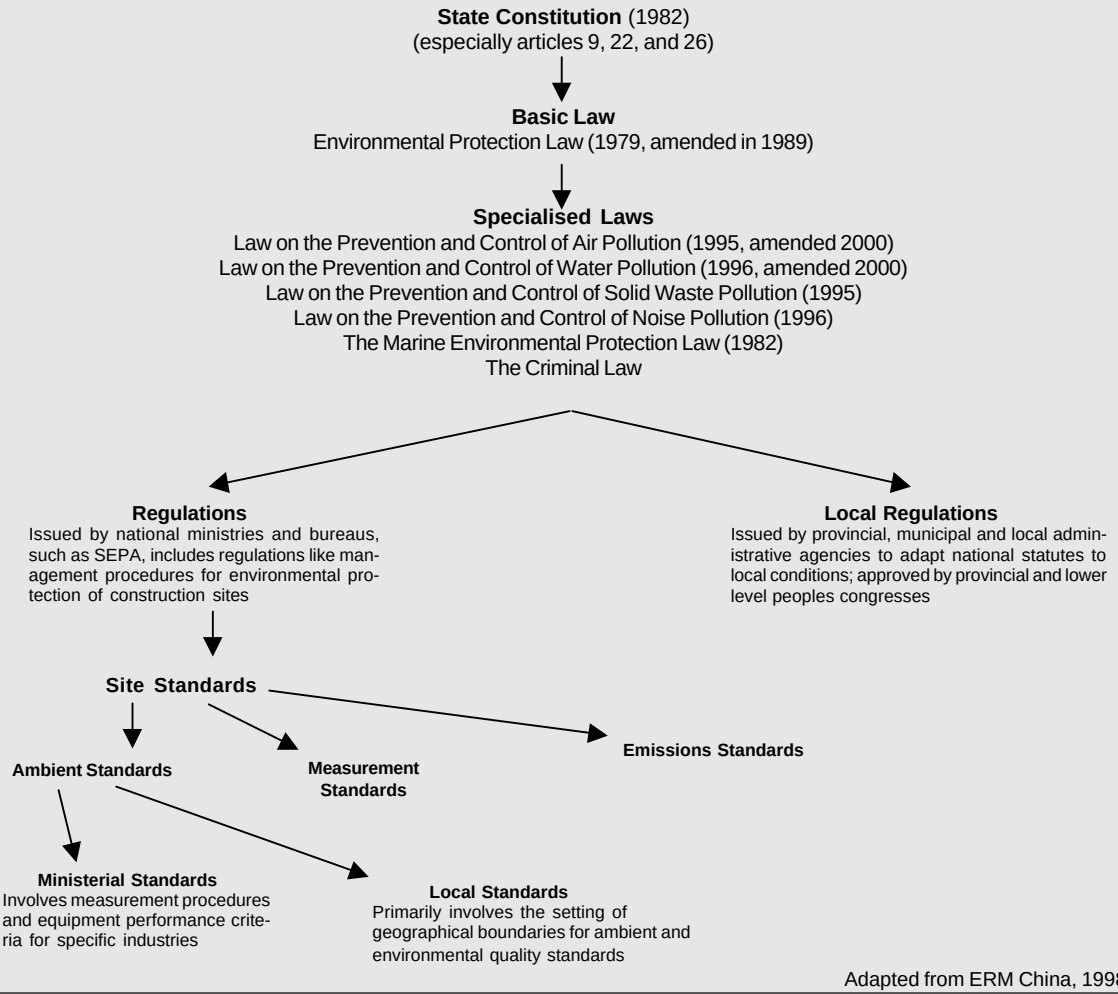
Improving the Quality

Building a legislative framework is an ongoing process, and the trend now is to improve the quality of environmental legislation.

First, an increasing number of laws and regulations take into account the fact that China is moving away from a centrally planned economy, and Chinese enterprises are learning to be more responsive to changes in market and pricing mechanisms.

Second, in the past, the regulatory system focused almost entirely on the control of *emission concentrations*, which allowed enterprises to avoid problems by diluting their emissions. Pollution control efforts are moving from controlling the concentration to controlling *total emission loads*. This has a more direct link with the ambient environmental quality—the ultimate objective of policy. Notably, two of China's pillar environmental protection laws—the *Law on Water Pollution Prevention and Control* and the *Law on Air Pollution Prevention and Control*—were recently amended to include the concept of total mass loading. The April 2000 amendment of the *Air Pollution Law* stipulates that total emissions control be implemented for acid rain and sulphur dioxide control zones and areas not in compliance with ambient air quality standards.

Box 4.5 Environmental Legislation and Regulation in China



Adapted from ERM China, 1998

Third, efforts are being made to enhance the transparency of environmental lawmaking processes by inviting feedback from the public. This helps lawmakers keep up to date with the changes that are taking place across industries and in the marketplace. During the amendment process for the *Law on Air Pollution Prevention and Control*, for example, public hearings were conducted to present the lawmakers with opportunities to hear comments from the general public. Finally, in its efforts to strengthen law enforcement, the NPC has revised the country's criminal codes so that people held responsible for damaging certain kinds of environmental and natural resources can be prosecuted. Many such cases have been reported in the media.

Problems with the Legislative Framework

The legislative framework faces the twin, inter-related problems of an incomplete framework and low enforcement rates.

A close analysis of the volumes of legislation issued over recent years reveals many contradictions in the laws. Notably, there is no clear delineation of roles and responsibilities among central level agencies, nor between central and local level agencies. The Constitution declares that the State shall protect and improve the environment, but little guidance is given on who should do what. Hence turf battles remain, for example, regarding who is responsible for wetlands management, or among the many agencies involved in water supply and sanitation.

In addition to the many contradictions, the existing legislation is often vague. There is considerable scope for interpretation by local level officials, and consequently implementation is often negotiated on a case-by-case basis. Thus local officials, when faced with a trade-off between short-term economic gain and non-monetary, long-term environmental impacts, will often rule in favour of the former. Another critical gap is that most legislative efforts have focused on industrial pollution. As yet, there has been insufficient legislation focusing on urban environment or on challenges to the natural resource base.

Enforcement can be difficult because a number of laws and regulations set impossibly high standards for compliance. The *Law on the Prevention of Environmental Pollution Caused by Solid Waste*, for example, requires that measures be taken for the "safe disposal" of wastes, though solid waste and hazardous waste treatment facilities are virtually non-existent in many locations. Likewise, municipal bans against polystyrene food packaging came into force before any packaging alternatives became available.

There is also an obvious gap between standards for ambient environmental quality, which are at least in line with WHO guidelines, and the regulatory tools provided to control emissions and conserve natural resources. The latter are insufficient to make polluters reduce emissions to the level needed to reach the ambient standards.

These problems are exacerbated by national and local-level capacity constraints. With the rapid and significant changes taking place in China, it is a challenge for lawmakers to simply understand the nature of these changes and their legislative needs. Other constraints hindering effective implementation of environmental laws relate to local government capacity, such as lax fiscal discipline, the lack of proper accounting of local finances, poor administrative capacity, and insufficient technical training of government employees.

The Third Approach: Using Market Forces

Across the world, market-based instruments (MBI) are used increasingly as a way to stimulate clean economic behaviour. It is generally considered that in order for MBIs to function, two necessary—but not sufficient—conditions must be satisfied. First, the economy should be market-oriented and second, regulatory frameworks should be reasonably well established. Despite China's limited progress to meet these conditions through the 1990s, it has increasingly experimented with and developed MBIs to complement campaigns and legislative measures. The impact of some of these experiments is discussed as follows.

The Polluter-Pays-Principle and the Idiosyncrasies of China's Pollution Levy System

Early in the reform period, China developed a pollution levy system based on the principle that polluters, when forced to pay for their pollution, would be motivated to invest in pollution control. Covering wastewater discharges, industrial waste gas emissions and dust, and industrial solid wastes and noise, the levy system charges fees for pollutant discharges and provides penalties for emissions above certain levels. Some provinces have also started charging for sulphur dioxide and total emissions.

After nearly two decades, several major shortfalls can be identified in the system and its enforcement. The level of the fee charged is too low to provide incentive to enterprises to reduce pollution. Enterprises generally carry on polluting and sometimes pay the levy. The World Bank noted in one study that the air pollution levy translates into a value of a single life for urban residents of 270 USD.

Also, the charges are linked to the regulatory framework, and so, based on pollutant concentration rather than on total emissions. Enterprises can thus dilute wastewater to avoid paying the charges, and thereby waste scarce water resources.

But the most peculiar problem with the pollution levy system is that the EPBs that collect the fees through environmental inspection are also largely financed by the same fees. These fees are a main source of financing for environmental authorities. The authorities keep twenty percent of the revenue for their own administration. The remaining eighty percent goes to an environmental protection fund—managed by the EPBs—which is used to subsidise environmental investments in the very same companies that have paid the levies. Hence, the local EPB may actually be pleased to see higher pollution—in order to collect higher fees. Meanwhile, the polluter is also pleased, since its operational costs remain low and it remains on good terms with the EPB.

So, what on paper may look like a polluter-pays-principle is more of an administrative mechanism that transfers some money from polluters to EPBs, which then distributes some of this money back to the polluters in the form of subsidies for environmental investments—a money circuit which is in direct conflict with the polluter-pays-principle. What these funds have provided though is a financial basis for the burgeoning environmental administration. In an economic context where firms are not strongly exposed to market forces, and where real markets only exist weakly, this kind of regulation can create perverse results.

Taxation

There is also a lot of discussion on the suitability of fees versus taxation. Tax collection ostensibly would provide the central government with more resources to back its environmental policies, and to reduce corruption and inconsistent local level enforcement. There is opposition to the introduction of an environmental tax within the government, so it is a wait-and-see situation for the taxation issue to unfold. However, in 1999, the NPC approved a controversial fuel tax—part of the Highway Law passed in October 2000—which was to replace a number of often arbitrary fees assessed on vehicles. Some of the proceeds from this tax may be used to fund improvements in vehicle emissions.

Pricing Energy and Water

As part of the legacy of the planned economy, China's energy and water supplies are priced far below the environmental costs of using these resources, and even below the production cost. The situation is being rectified. One of the motivations behind this is the need to improve the environment—although cost recovery and economic efficiency are the most important motivations.

Additional fees are now beginning to be levied on water supply, wastewater treatment, and solid waste disposal. According to the "*Notice on Increasing Wastewater Treatment Fees and Establishment of Centralised Urban Wastewater Treatment Systems*", effective since November 1, 1999, municipal utilities have been charged with the responsibility to collect wastewater treatment fees and water supply fees from the users on a monthly basis. The funding will be channelled to finance the construction of wastewater treatment facilities. As a result, the price of water supply in Taiyuan, Shanxi Province, has quadrupled to provide funding for water treatment. Tap water prices in Shanghai have risen by between 25 to 40 percent to fund water quality improvement and sewage treatment projects. A host of other cities are following suit (WRI, 1998).

Energy pricing is still the greatest shortcoming in China's energy conservation policy. Current pricing policy does not reflect the environmental costs related to sulphur and ash content of coal. Many small mines ignore safety regulations and environmental damage, selling cheap, dirty coal. Administrative interventions have kept the price of natural gas low, such as price subsidies for the chemical fertiliser industry and for residential use, but at the expense of depriving the industry of the capital it needs to grow in order to replace coal.

Emissions Trading

As mentioned above, China's pollution control efforts are moving from controlling the concentration of pollutants in emissions to controlling total pollutant emissions. Since the early 1990s, numerous pilot projects have studied and tested the applicability of this total emissions control strategy and explored possible policy instruments to assist in its implementation. One such policy instrument, applicable notably to pollutants with a small number of large sources, is an emissions trading system. In this system the government may issue permits to enterprises to emit given quantities. Those enterprises which cannot keep emissions within their permitted levels can purchase, at a price set by the market, additional emission quotas from other enterprises.

Emissions trading provides an economic incentive to enterprises to use less polluting and low-cost technologies. Pilot projects, such as described in box 4.6 will yield experiences and important insights. But overall, lack of effective policy tools hinders the implementation of the total emissions control as well as emissions trading. In other countries, a permit system has operated successfully for several years before introducing a permit-trading system. A successful permitting and trading system requires well co-ordinated efforts among a large number of interests and government agencies ranging from planning, to finance and environment. And successful trading needs complete information on the quantity of pollution emissions across all sectors. This is a difficult task since the existing pollution emissions data have not captured the extent of pollution from TVEs.

Box 4.6 Trying Emissions Trading

A project piloting sulphur emissions trading is now being carried out in two medium-sized cities—Benxi of Liaoning Province and Nantong of Jiangsu Province—as a collaborative effort between Chinese and American experts. In Benxi, the team works with local government and enterprises to develop cap and emissions trading rules and procedures, thus creating a legal basis for total emissions control to provide co-ordination among existing environmental policies, to establish emissions measurement and reporting protocols, and to promote compliance (Dudek *et al*., 2001). While in Nantong, the team has developed emissions trading between a power plant and a light manufacturing facility under existing administrative regulations. The trade allows a cellulose manufacturing plant to expand its operations by acquiring offsetting emissions reductions from a nearby power plant.

The Future of Market-based Instruments

There is a keen interest for market-based instruments in China, as expressed by the flurry of enthusiasm among environmental officials for buzzwords such as PPP—the polluter-pays-principle—or emissions trading. An initial look, however, reveals two basic obstacles to successful use of market forces in controlling environmental behavior. First, the absence of a mature market situation in the Chinese economy limits their use. Second, a lack of understanding for fundamental market principles among Chinese environmental officials tends to produce mechanisms which are in fact administrative measures dressed up as market-based instruments.

Still, as the Chinese economy matures and adopts a stronger market profile, and as the capacity to design and implement market-based interventions grows stronger among the Chinese administration, these are likely to become the basis for environmental administration in the not too distant future. The economic futures of the two scenarios dealt with in this report can be described as in Scenario Box 4.

Box 4.7 Exploring the Market Mechanism

Market-based mechanisms and instruments are on the lips of very many environmental officials today and a lot of discussion and testing is being carried out. The more cutting edge market-based channels being considered or tested include collecting fees through pricing the use of utilities and goods at market values e.g. drinking water; and payments transfers between downstream and upstream, or between industries and local communities, such as a hydropower station in a reservoir in Guangdong that pays the forest owner in the upper watershed in order to prevent soil erosion and sediments in the reservoir. Most of these initiatives are still in early testing stages, but they are expected to becoming more prominent tools in the near future (Sun, 2001).

Rising Environmental Spending

Government or public financing has long been the most important source for environment and conservation financing. Under a centrally planned system, the state takes responsibility for environmental protection. Even though the economy is becoming increasingly market-oriented, rough estimates show that public financing still accounts for 70 percent of the total environmental financing.

Official figures reporting China's environmental spending have shown impressive growth over the last two decades, from barely 0.7 percent of its GDP in the mid-1980s to one percent in 2000. It is expected to rise to about 1.5 percent by 2005. Government spending jumped largely in 1998 and 1999 due to the government's economic stimulus programme, which features large increases in fixed capital investment thanks to a 12 billion USD bond issue aimed at investment in infrastructure. According to the Asian Development Bank, about ten percent of that bond issue was invested in environmental infrastructure facilities (Baldinger, 2000). Despite this large state spending, ambitious programmes are constrained by the limited availability of public financing for the growing environmental challenges.

Moreover, official figures on environmental spending depend very much on the definition of an environmental project. Incentives may exist to label a project "environmental", especially at the local level. Local governments have guidelines on how much of their budget to spend on the environment—and this may not be in line with their own priorities. With slack reporting and monitoring requirements, local governments could channel funds to physical infrastructure or employment-generating projects, and label these "environmental" in order to meet their quotas. Hence, a main task of SEPA has been to push each level of the government to increase the investment in environmental protection.

The central government channelled much of the revenue from the 1998-99 bond sales to provinces for infrastructure investments. The main objective of such "lending and spending" was to generate employment and economic growth. However, these measures may prop-up inefficient production units and distort the market, and so run counter to the market and financial reforms required in China. As is noted in other sections of this report, establishing a market structure is probably the required measure leading to long-term environmental protection.

SCENARIO BOX 4 CHOOSING A FRAMEWORK FOR ECONOMIC CHANGE

The Perilous Path Scenario

The ongoing process of globalisation and the gradual spread of the dominant economic values and consumption patterns of industrial societies shape the future of China in the early 21st century.

As the country moves towards a market-oriented economy, the share of state-owned enterprises continues to decline, and the government continues to recede from economic management, granting micro-economic decision-making authority to private corporations.

In this environment, the strategy of "get rich fast – clean up later" continues, resulting in increasing severity of environmental degradation. Distorting subsidies in the prices of water and energy that do not account for scarcity and externalities further exacerbate environmental conditions.

Economic growth continues to be robust, although at a rate lower than the 8 to 10 percent experienced in the late 20th century, with GDP per capita increasing on the order of 3 to 4 percent per year through 2050. Growth is driven in part by the increase in personal consumption in China. However, income and consumption continue to be unevenly distributed, both between and within regions. The western half of China and poorer populations in the east are particularly disadvantaged.

Rural communities continue to struggle with a lack of the most basic services. The environment, already suffering from serious impairment, as described in chapter 2, is further degraded, as the poor are forced to unsustainably exploit land, water and forest resources.

Environmental impact per unit of activity generally decreases as technology becomes more efficient and pollution control improves. But the exponential increase in the scale of activity overwhelms these improvements and the overall demand for resources and level of environmental pressure continues to rise.

The Green Reform Path Scenario

As the new century unfolds, the gradual deepening of environmental and social stresses are seen to be a Perilous Path for the country, prompting a popular outcry for a new development strategy – one that more truly embodies the "economy and environment developing in tandem."

The market framework predominates, as a tool for promoting efficiency, but the workings of the market are steered towards a sustainable path. Chinese authorities use an array of market-based incentives to spur "green" behaviour and to finance cleanup and prevention. Subsidies on natural resources such as water and energy are lifted, and the prices begin to reflect the true costs of their use, including environmental externalities.

The market economy favours the service sector, which is generally less resource-intensive and polluting than the industrial sector that dominated in the previous century, thus further reducing the burden on the environment.

There is an emphasis on "green" growth. Environmental industries that have both regional and global impacts are significantly developed, leading ultimately to the improvement of environmental standards for products and services on a broad level.

Technological progress, especially in the fields of energy efficiency, transport and information technology, helps secure economic growth without environmental degradation. The impact of industrialisation and urbanisation on the environment is tackled seriously in a series of policy reform packages that effect substantial gains.

The policy of food self-sufficiency is fully replaced by a policy of food security, thus reducing the strain placed on the environment by agriculture – particularly irrigated agriculture – while the transition from collective to private ownership prompts long-term investments in protecting land resources.

In 1983, the State Council, in order to raise more environmental financing, issued "Decisions on Environmental Protection Work", in which it specified eight environmental financing sources. The relative use of these sources has shifted in recent years, reflecting a general shift towards the polluter-pays-principle in China (Wang *et al.*, 2000). This complex array of financing mechanisms, tools and subsidies makes it difficult to quickly channel funds to meriting projects. At the same time, this makes it possible to channel environmental protection funds to other purposes.

Throughout the 9th Five-Year Plan, 1996 – 2000, the government used a large and growing number of infrastructure projects to improve environmental conditions. For example, the central government is significantly increasing its investments in large-scale ecological construction projects. The Reforestation and Greening Program in the Yellow and Yangtze watersheds involves a state investment plan of over 12 billion USD to be used for tree planting and other ecological restoration efforts and began in 2000. An Ecological Compensation Fund, approved recently by the State Council and funded by the Central Financial Transfer, is going to raise two billion yuan each year for managing and protecting the forests classified for nature reserves and water resource conservation (Gao Yuying and Liu Jinfu, 2002; Department of Policy and Legislation officials, State Forestry Administration, pers comm.)

Funding for environmental infrastructure projects already comes primarily from the local level. But municipalities are restricted in their ability to generate funds. They do not yet have the right to issue their own bonds to finance local construction. In line with the transition from the campaign approach to a legislative and market-oriented approach, it should be possible to implement the polluter-pays-principle in reality, where enterprises—and ultimately consumers—pay for environmental improvement directly. For example wastewater treatment is a profit oriented service produced by the private sector in an increasing number of countries, and not an issue for governments to resolve through public spending, although it is still regulated and monitored by government agencies. Resources could also be mobilised by setting up a national environmental investment fund; using bond and stock markets to promote green investment; attracting more FDI to invest in environmental infrastructure; and encouraging privatisation of environmental services and facilities.

4.3 Non-government Response

Whereas the government has been and remains the leading actor on the Chinese environmental stage, other actors are slowly emerging. The media, academic institutes, non-profit organisations, the business community, and the general public are all forces for environmental change. The government generally recognises the potential of these alternative forces, and, as can be seen by the section below, is taking steps to encourage it. The sections that follow discuss the roles played and challenges faced by the different non-governmental actors in the environmental field. The governance aspects of the two scenarios dealt with in this report are described in Scenario Box 5.

Government Increases Dialogue with Civil Society

Recently, government officials, particularly from SEPA, have begun to hold the stakeholders of Chinese society responsible for pollution prevention, control and reduction. This partly reflects recent government downsizing but it is also a result of the recognition that, if wisely managed, stakeholders can help the government achieve social goals such as improving the environment. In the 1990s the government increasingly developed the skills and capacity to work with other forces in society to achieve its goals. In the environmental sector, it is experimenting and developing the skills to manage and utilise, rather than control, the pressures for change emanating from outside the existing political framework.

Facilitating Information Access

Barriers are being dismantled to facilitate public access to government information. SEPA has opened itself to the public since the late 1980s, making information available related to its organisation, staff, structure and work procedures. Information on policies and practices, for example levels of levy charges and pollution penalties, is no longer confidential. According to media reports, the resulting increase in public attention has reduced the abuse of power and misuse of pollution charges. Tests on public access to information have been conducted in five counties in Jiangsu, Shaanxi, and Liaoning Provinces. The initiatives are currently being expanded to the cities of Shanghai, Tianjin, Chongqing and provinces of Hebei, Heilongjiang, Anhui, Shandong, Hubei, Guangdong and Jiangxi. Similar initiatives are being promoted nationwide in 2002.

Environmental Hotlines

At the provincial level, direct telephone hotlines through which ordinary citizens can report environmental violations have been opened. This has proved to be one of the most cost-effective ways to strengthen law enforcement. In 2000, the public reported more than half a million violations through the hotline, and more than 90 percent of these cases were processed. Hebei provincial government has set up a special fund of five million yuan to reward reports that lead to conviction of the most serious environmental violations. This practice is spreading to other levels—upwards and downwards. SEPA is considering setting up its own national level environmental hotline. By the end of 2001, local environmental protection administrations above county level were able to receive violation reports from the hotline. The public with access to the Internet are able to check the status of their reports, and follow up.

Media

Through the 1990s, Chinese media has become increasingly independent of direct government pressures, and more responsive to market forces and sales. Increasingly, media has to address issues in which their audience is interested, in order to remain commercially viable. One result of this is that environment is now a staple part of the Chinese media, as the public want information on their environment. For example, in 1996, the seventy major newspapers published over 17,000 stories on environment (Wen, 1998). This represents a dramatic turnaround compared to only a decade earlier. Media campaigns have been organised every year to support the government's environmental initiatives. A considerable number of veteran journalists familiar with environmental coverage has emerged.

The China Environmental News (CEN) and China Green Times (CGT) are the two major newspaper outlets dedicated to environmental issues. Though both are affiliated with the government—CEN with SEPA and CGT

SCENARIO BOX 5 CHOOSING A PATH OF GOVERNANCE

The Perilous Path Scenario

The emphasis on economic growth allows groups in China that benefit from market-driven development to maintain a strong influence with the central government – a continuation of patterns seen at the end of the 20th century. Concerned with the threat to their incomes, these vested interests successfully thwart major efforts to reduce the degradation of the environment.

The Chinese public continues to perceive environmental protection and preservation as a role for the central government, and not one of personal responsibility. Additionally, there is a perception that environmental problems are a necessary concomitant of economic growth.

Aspirations for a Western lifestyle continue to dominate, and although the ability to reach that lifestyle is limited to only the wealthy part of Chinese society, the sheer number of people in that group results in a significant increase in energy use, solid waste production and air pollution. Incentives for private investment in developing technologies to address the pressing environmental issues are low. Government investment in relevant research and development is also low, and such investments are viewed as too risky for the private sector.

Non-governmental organisations, which were steadily gaining acceptance in the early part of the 21st century, are able to address very localised environmental problems, but not the larger issues, such as energy and transport policies. The government actively prevents NGOs from reaching a national audience, and silences questioning of political processes. NGOs therefore remain largely irrelevant as forces for change in the economic, social or environmental arenas.

The public has a growing awareness that the degraded environment is having negative impacts, particularly with respect to health. But the political climate remains unresponsive to public debate, and there are no alternative channels for people to express their concerns. There is an increasing distrust among the public that the government will protect its interests. Signs of political and social instability increase to near crisis conditions by 2050.

The Green Reform Path Scenario

The Beijing Green Olympics Campaign results in increasing public awareness of the social and economic consequences of environmental degradation.

There is a shift in the social climate toward one that encourages public debate. Civil society responds by becoming more engaged, drawing in many actors. There is a mushrooming of NGOs. The academic community plays an active role, with the Chinese Academy of Sciences serving to manage and disseminate knowledge. Business also actively participates, seeking to promote transparency and participatory processes in the governing of the nation.

Eventually, the Chinese government responds by re-evaluating the path of economic growth taken in the past, and looking for mechanisms to increase the degree of partnership with citizens, corporations and NGOs.

By 2010, with increasing support from citizens, central and local government organisations begin to promote broader access to health and education, particularly in rural and low-income areas. Issues of wealth distribution are discussed in public fora in an attempt to reduce inequalities and social conflict. These discussions lead to pro-active government policies to share more equitably the benefits of the changing economy.

Citizens are empowered by the greater recognition from the central government and the feeling that they have a greater stake in the well-being of their environment. This is bolstered by a return to traditional Chinese values for the land and the environment. These forces act to initiate grassroots movements for environmental conservation. The aspiration for Western lifestyles is tempered by these new values and a respect for non-material values – the beauty of the environment, personal fulfilment and the importance of community.

With higher awareness of the public on environmental issues, China also starts implementing policies to improve degraded environments. Although some of the ecosystem and biodiversity losses from the previous decades are irreversible, by 2025 there is some restoration and the human impact on the environment decreases as a result of the integrated economic and environmental policies. By 2050 China takes a leading role in engaging the region in dialogues on sustainable development.

with the State Forestry Administration, their editorial boards enjoy considerable freedom in what to publish. Importantly, their operating expenses are covered mainly by revenues from advertising and distribution.

The media enjoys considerable flexibility in its environmental coverage, in part explained by the fact that the government believes that such coverage can be used to promote its environmental agenda. Pollution data for 47 major cities are regularly made public through the media. News organisations have also collaborated with the government in creating a national "ésprit de corps", which can be seen in numerous cases such as the forced closing of a rural polluting factory, illegal logging and poaching.

Overall, the response of the media to the environmental challenges has been serious and it has become a major force for positive environmental change. However the media in China remains strongly supervised, and individual publications know the limits they face in reporting on controversial issues.

Institutes and Think-tanks

In the past, Chinese environmental research was mainly concerned with natural science and technology issues conducted in academic seclusion within universities or institutes under the Chinese Academy of Sciences. Given China's isolationistic background and the language barrier, exchange with international academic communities was also limited. More applied environmental research, particularly policy-relevant, was carried out in institutes that belonged to government ministries and agencies. Still, there was some limited room for independent research, and environmental research and studies based on social sciences.

Slowly, these institutions are gaining capacity and ability to influence. Most do not play an official role in determining environmental policy, but they assume a stronger role in advising the public, government and private sectors. The formation that we see today of independent or semi-independent research institutions and think-tanks is partly the result of the increasing demand for independent expert services that has been generated by sharpened environmental policy and legislation, such as environmental impact assessments. But the explosion of international academic exchange and the involvement of Chinese experts in environmental development cooperation projects have also played a decisive role in creating an atmosphere of more independent, critical thinking.

For example, the *Rural Development Institute* of the *People's University* in Beijing is one of many educational institutions that combine academic research and rural development project experience in China's interior. The *Beijing Environment and Development Institute* (BEDI) was established in 1995 by Ma Zhong, a professor of economics, with institutional support from the People's University. BEDI focuses on applied research on environmental issues and seeks to encourage market-based tools to tackle environmental problems. BEDI was instrumental in the re-evaluation of development plans in Heilongjiang's Three Rivers Plain region, where wetland preservation and agricultural development come into direct conflict.

Regionally-based institutions, such as the *Chinese Academy of Sciences' Institute of Geography* and the *Northeast Normal University's Institute of Environmental Sciences*, both based in Changchun, Jilin Province, also have impressive research and training agendas, and have been quite responsive to the specific regional needs.

Government restructuring of 1998, when central government ministries and agencies were downsized by half, was largely a matter of detaching the numerous ministerial research institutes from the government payroll, with the result that these institutions have to survive on the same conditions that similar policy think-tanks do around the world by selling their expert services. Now, these government centres are becoming increasingly independent from government support and control. Many of them have gained something akin to NGO status.

Particularly, environmental and energy policy research tends to be conducted by these government-affiliated research institutions, but also by institutes concerned with capacity development, training, education, and outreach. For instance, the Beijing-based *South North Institute for Sustainable Development* has been very successful in conducting small demonstration projects on biogas energy for small farmers in the Baima Snow Mountain in Sichuan Province. The prestigious Energy Research Institute (ERI) under the SDPC umbrella is an example of a think-tank that has had a lot of influence over China's future energy policies, including its dynamic Centre for Renewable Energy Development (CRED). ERI and CRED work mainly on a consultancy basis, partly for government, international donors, and private sector.

Affiliated with SEPA but "independent without challenging government" the *Centre for Environmental Education and Communications* is an example of a young and dynamic institution working with activities such as training of mayors of key cities, environmental media training for journalists, teachers training within the GLOBE programme, and production of environmental school books.

There are also a number of institutions that play an important role in building and extending environmental management systems within Chinese industry, the *China National Cleaner Production Centre*, under SEPA's *Chinese Research Academy of Environmental Sciences*, is an example of institutions that carry out consultancy business in the field of environmental auditing, clean production, and setting up of ISO 14000 systems.

Although independently financed, largely through sub-contracts, many institutes are sheltered by one government agency. This, combined with China's embryonic bidding procedures, means that open competition among institutes remains rare. Institutes often gain contracts through having contacts, rather than excellence, a situation that does not promote the development of capacity.

NGOs and Government-organised NGOs

China's legal framework does not promote the creation of NGOs in the Western sense, since the government associates these types of groups with political dissent. Legislation enacted in 1998 outlined new regulations on registration and management of NGOs and established the clearest legislative framework for the NGO sector to

date. However, the new regulations fall short of giving NGOs complete independence from government control. While the Communist Party and the government are interested in encouraging the growth of this sector, they are also evidently "concerned about releasing unknown, and potentially uncontrollable, social forces" (Young and Woo, 2000). Notably, many Chinese NGOs have official governmental sponsors who guide them through the registration process and provide political cover and support for their work. Despite the unclear legal situation, China now has more than 200,000 not-for-profit organisations, including a growing number of "people's environmental organisations".

The Formation of Fairly Independent NGOs

Environmentally oriented NGOs, although limited in scale, are beginning to provide Chinese society with a vehicle for expressing environmental concerns and for effecting change. These activities are directed towards environmental education and community development work.

Friends of Nature (FON) focuses primarily on raising environmental awareness among China's public, later extended to cover wildlife and habitat conservation. FON was instrumental in getting a ban on logging in Deqing Prefecture in Yunnan Province, home of the endangered golden monkey. It has also developed and published a primer for school children, organised field trips, and established a "Forest and Kids" summer camp. The members mobilise citizens and the media in support of stated government goals for sustainable development practices, and compel the government to enforce its own policies.

Global-Village Environmental Culture Institute of Beijing (Global Village) was set up in 1996 by Liao Xiaoyi. Primarily using personal savings supplemented by small grants from Western and multilateral organisations, Global Village focuses on two main areas: the production of a series of television programmes, including the weekly "Time for Environment" and efforts to popularise reuse and recycling among the households of Beijing.

Green Earth Volunteers (GEV), co-founded in 1997 by Wang Yongchen, a popular radio personality and board member of FON, is an example of a volunteer organisation. Wang organises activities with volunteers who generally pay their own way to participate. In 1997, 108 volunteers, each paying 78 USD travelled to Inner Mongolia to spend three days planting trees in the Engebie Desert. Some of the activities are designed in particular to get youngsters involved in conservation projects.

In addition, a number of international NGOs have established their presence in China, including WWF-China, Oxfam and LEAD (the latter hosted by IED).

The Power of Government-organised NGOs

There is also an interesting form of professional organisation, which is state-sponsored and often established by state agencies or well-known Chinese leaders or retired officials. Often large, national-level organisations receiving a large part of their funding from the government, though increasingly from various other sources as well, these are not grassroots organisations but focus on an elite audience of scholars, policy-makers, and government officials. The clear advantage of these organisations is their ability to draw together scholars and officials from a wide range of institutions, which normally find it difficult to interact in China's highly vertical bureaucratic structure. This is particularly important in the interdisciplinary field of environmental protection. With prestigious leadership and membership, these organisations can draw attention to environmental issues flowing information and ideas from their members to policy-making bodies in the government. There is a large number of professional organisations involved one way or another with environmental issues. For example:

China Environmental Protection Foundation was founded in 1993 under SEPA (then NEPA) with a donation of UNEP Prize money awarded to Mr. Qu Geping, former NEPA Administrator. The Foundation's stated principle is "to facilitate the donation of funds and goods in order to help develop environmental protection undertakings in China".

National Natural Science Foundation was established in 1986, under the Chinese Academy of Sciences, and views itself as analogous to the National Science Foundation in the United States. More than 70 percent of its 250 members are professors. Its goal is to support basic research in natural sciences.

All China Women's Federation is one of the oldest and most powerful government-organised NGOs. Over the decades, its elite status has improved women's social status, equal employment opportunities, and women's welfare. In recent years, the Federation has become actively involved in environmental education among women.

Future of NGOs

There are far too many NGOs to mention them all here. This recent development is a positive force for environmental change, as recognised by SEPA and other ministries. However, the degree of independence of NGOs is limited. Also, these groups are often small and overly specialised. They may often be "one-man shows" rather than true organisations. If the government can continue to stimulate the growth and activities of these actors, the total contribution to environment could continue to grow impressively.

Chinese NGOs are also concerned about growing too large and being seen as too strong a force. This is a reflection of the incomplete legal framework, but also a reflection of historical legacies. Until NGOs can act independently, with no fear of *ad hoc* reprisals, they will remain cautious of growing, and will shy away from many issues. They will remain subject to the whims of government administrators, and therefore really an extension of government administration, rather than a positive independent force. The role and potential of the NGOs in the Chinese governance model is further discussed in section 3.12 on Governance and Institutions.

Business Community

Until very recently, the business community in China has been hardly concerned with the environment. Starting from this very low point, and with some encouragement from the government, as well as pressure from the public, there have been some recent signs of change.

The following paragraphs illustrate some of these developments, although it must be emphasised that an environmentally conscious enterprise manager is very much an exception to the rule. Most enterprise managers think only about short-term profits, and they continue to work within an economic and administrative framework that does not provide incentives for environmentally oriented activities.

Although the actions described below are limited and dispersed, with penetration of green-labelled products amounting to only fractions of a percent, they show what can be achieved if incentives are provided for environmentally sound products and business patterns. And given the improved efficiency, better quality, and marketing advantages that often come with efforts to green business, the potential for success is immense.

Environmental Management Systems and ISO 14000

The ISO 14000 series, set by the International Standards Organisation (ISO), focuses on encouraging corporations and organisations to establish a management system that protects the environment. China joined the ranks of some 200 countries when it agreed to comply with ISO standards. Twenty Chinese organisations have been authorised to issue ISO certificates, and 710 Chinese enterprises, including Haier Group and Baoshan Iron and Steel Complex, have been awarded the certificates.

The China Accreditation Committee for Environmental Management System Certification Bodies under SEPA has licensed eight environmental management certification centres, and 11 institutes have received SEPA's approval to provide consultancy services on ISO 14000.

The ISO 14001 standards are slowly becoming an important tool for China's environmental managers. They play an important role in improving compliance with domestic environmental laws and policies helping Chinese export industries, particularly medium and large enterprises, deal with environmental challenges in foreign markets.

Eco-labelling

Eco-labelling is used to inform consumers of environmentally friendly products and encourage manufacturers to develop products that do not adversely impact the environment. The National Environmental Labelling Program was founded in 1993. A national committee chaired by SEPA, was set up in 1994 to take charge of developing rules and standards to certify products. This was partly encouraged by local business initiatives that had started to design their own environmental programmes or logos. Suggestions to improve this effort include expanding the programme nation-wide, increasing transparency of the certifying process, and adopting life-cycle assessment in the formulation of product environmental criteria.

Cleaner Production

Cleaner production is another element promoted by government and is being adopted by more enterprises in China. It involves shifting from downstream, end-of-pipe solutions to pollution prevention throughout the whole production process. Beijing, Shanghai, and Benxi of Liaoning Province have carried out a series of experimental projects supported by international organisations. A Clean Production Research Centre was set up to train Chinese specialists in clean production auditing. SEPA has granted 25 certificates for clean production auditing in Beijing. Now the experimental programme is being expanded to 26 enterprises in over 20 locations, representing 14 heavy polluting industries. Experiments show a 10 to 50 percent pollution reduction in these enterprises. The Beijing Beer Brewery, for instance, reduced its water use by one-third and its output rose by 11 percent per year after the factory started the programme. Cleaner production leads to both economic and environmental gains. The fact that it has not been more broadly adopted reflects the fact that many Chinese enterprises are not fully exposed to market forces.

The Clean Development Mechanism

China could also potentially benefit from the Clean Development Mechanism of the Kyoto Protocol on global climate change. While energy efficiency has been improved and greenhouse gas emissions have shown signs of declining, the Chinese energy sector is still inefficient. Investment in the Chinese power sector could reduce carbon dioxide emissions for a fraction of the cost of achieving similar reductions almost anywhere else in the world.

Encouraging Public Participation

Co-operation between government and civil society has become an established principle in the environment sector, and people in general, are not reluctant to speak their mind about the environment, at least in private. Former SEPA Administrator and Chairman of NPC's Environmental and Resources Conservation Committee, Mr. Qu Geping, once noted that "the degree of popular participation in environmental protection work is an important indicator of the success or failure of environmental protection in that country". For example, during the current drafting of the Law on Environmental Impact Assessments, opinions from various institutions, experts and the public are being actively solicited. Lawmakers from the NPC are required to provide feedback in a timely manner. Chinese media, in the coverage of the hearings, touted participation as a "legal right for the public".

The Ghost of the Not Too Distant Past

To achieve public participation is not always easy. In January 2001, in Fuoyang, Jiangsu Province, a SEPA and World Bank Research Group sponsored the township's first public hearing on environmental protection issues. An anxious crowd of citizens came to the meeting with a lot to say, but mostly remained quiet. As the team found out, few would speak up unless repeatedly prodded. Fuoyang is not unique—in general the Chinese public is reluctant, to say the least, to confront the government and voice its concerns openly. In part this reluctance can be explained by cultural heritage and the fact that the public is not accustomed to express views openly. But it also reflects political experiences over the past decades.

The Chinese public, and in particular the intelligentsia, have been encouraged to express their opinion throughout a number of critical junctures during modern Chinese history. Today political openness and guaranteed legal rights to express one's views are slowly being introduced to instil confidence among the Chinese people in order to develop a strong and positive grassroots' movement and to foster a civic sense in the general public.

People Taking Action

Information disclosure contributes to the building of public knowledge. When air quality data in 47 major cities were first made public by the media on a daily basis in 1997, they were immediately used to begin evaluating performances of local officials. The release of drinking water data, originally scheduled for January 2001, was delayed for fear of "serious consequences".

The same pressure can also be applied to manufacturing companies—the major polluters. As a pilot experiment, some are required to release pollution data and pollution control performances of manufacturers in Zhenjiang, Jiangsu Province, and Hohhot, Inner Mongolia Autonomous Region, and ranked black, red, yellow, and green. The changes in rankings are made public on a regular basis. As a result, CEOs of some poor performers have gone directly to the media making commitments towards pollution control. Jiangsu has decided to promote the practice province wide.

There are many other examples of ordinary people taking actions, either as individuals or in groups. Box 4.8 provides a few examples where individuals, often ordinary people, have made a difference. Despite these positive trends, most members of the public are uninformed about the environment, and when informed, believe it is not their responsibility to take action. Culturally, the public tends to lie low and not rock the boat. So, the examples in box 4.8 are still only exceptions, and insufficient to make a wide-scale impact on the degrading environmental situation.

The Future Role of Civil Society

An articulate, knowledgeable and active public is the best insurance for the environmental future, and the NGOs, think-tanks and media are the channels to make that happen. Compared to ten years ago, such non-governmental forces are playing a much bigger role in assuring China's environmental future.

The government clearly recognises the potential of these forces. Particularly SEPA has expressed on many occasion that it sees this as an ally. But fears remain regarding the consequences of unleashing these forces. NGOs are encouraged to act, but in a limited scope within limited methodologies. The public is still cautious about taking initiatives, and the government has not made real efforts to develop the necessary trust. If the results of the recent social experiments are considered positive, the government may be increasingly confident of its ability to work in collaboration with these forces, and this potential will be reached.

Box 4.8 Seeds of Action

There are numerous examples of how individuals and groups of engaged citizens have taken action, often on their own initiative, to solve a problem. Chinese media likes to report on these sometimes seemingly marginal, but yet so encouraging events.

- Since the early 1990s, more than 120 million Chinese women have participated in tree planting campaigns to build shelter forests. From 1990 to 1997, Chinese women established 100,000 green bases that include shelter forests, orchards, and tea farms. A survey shows that the tree survival rate of trees planted by women has reached eighty-five percent.
- In Hunan, one of the most important bread baskets in China, women are encouraged to plant trees—fruits, tea, and medicinal plants—in their backyards. The province has 24,000 households with revenue from family fruit plantations exceeding 100,000 yuan.
- "Little League of Blue Sky and Clear Water" was established in a primary school in Shandong Province after an 11-year-old fellow student started taking waste-sorting boxes to his school to encourage recycling. He and his classmates have been spending weekends and holidays on the streets handing out flyers about the environment.
- Li Shuangliang, an employee of Taiyuan Iron and Steel Company in Shanxi Province, devoted himself to finding solutions to recycling scrap, which not only reduced pollution, but generated economic benefits.
- Xu Xiujuan, a crane breeder in Yancheng Nature Reserve of Jiangsu Province, died when she was trying to save a crane.
- Wang Jiuju, a town EPB director, risked losing her position when she pushed forward the implementation of a government regulation to eliminate small coke-making factories in her town.
- Wang Yangzu, former SEPA Deputy Administrator, won the acknowledgement from his counterparts at USEPA for his leadership in phasing out CFCs and protecting the stratospheric ozone layer.
- Dalian, Liaoning Province, was selected by UNEP as a winner in 2001 of the 500 Roll of Honour for its efforts to reform its old industrial structures and build a green city. Dalian has been the model city for China for years.
- Zhou Meien, a retired school teacher in Xuzhou, won the same UNEP prize, for her devotion to mobilising young students to protect the environment.

Chapter 5

Human Choice and the Path Ahead

5.1 Finding the Optimal Response

Chapter 1 of this report described two possible scenarios for China. In one, the *perilous path*, inappropriate policies, choice and critical uncertainties combine to lead to costly and irreversible damage to China's environment. In the other, the *green reform path*, visionary economic and social governance leads to a slow, but steady improvement in the environment and natural resource base throughout the first decades of the 21st Century. Which path is China on?

Despite many critical uncertainties, many of which were laid out in chapter 3, China's environmental future is largely in the hands of its government and people. This section now asks if the responses described in chapter 4 are adequate to address the present challenges, and how the responses can be optimised. It can be seen from the scenario approach that efforts to improve China's future environment could act at the level of the "current state of the environment", or they could act at the level of the "driving forces". Scenario Box 6 describes the underlying frameworks for environmental change associated with the two scenarios.

Efforts to Improve the State of the Environment

The Government has undertaken many programmes to improve the environment. There have been successes, and many battles have been won, particularly in cleaning up dirty water and controlling air pollution in cities. However, severe problems still remain, and some are growing in scale. Next to the government response, the non-government response has also been admirable, with NGOs sprouting up with media and people taking action. Yet, these non-governmental efforts generally remain quite small, uncoordinated and limited in scope. And despite a small but growing number of exceptions, industrial managers are not interested in the environment.

A crucial aspect of the present response to environmental challenge is that it is mostly aimed directly at changing the state of the environment—or cleaning up existing hotspots, through administrative measures and physical investments. Initially, most countries had similar approaches. Governments tend to favour direct action on environmental hotspots, as this leads to obvious, direct results, and so enjoys broad government and public support. Moreover, this approach is relatively simple to design and monitor. Another reason for the popularity of this approach is that it can be implemented by one sectoral agency—not having to put heavy demand on collaboration between agencies or on inter-sectoral agencies.

A second important aspect of the present response is the low level of effort by non-government forces in China. This is different from many other countries, where public actions often precede those of the government and enterprises.

China's present approach has several weaknesses. Cleaning-up hotspots can be expensive, and administrative measures can lead to employment problems. Even if successful in the short-term, clean-up may not be permanent. If the drivers have not been addressed, things will get dirty again, or the problem may pop up elsewhere. Also, experience shows that governments will always be limited in what they can achieve. The extent of action needed will require large inputs from civil society including large-scale actions by industry.

Efforts to Change Driving Forces

The Chinese government does target the day-to-day drivers of environmental change, but seems to do this from a non-environmental perspective. For example, the Government has a large, co-ordinated programme to manage population growth, but this is not heavily influenced by recent environmental thinking. The Government is also addressing poverty, energy, technology change and the other drivers, but not for environmental reasons. As for the non-governmental response, these are generally very limited. There are non-governmental activities in the population and poverty area, and some industries are making small efforts in water and energy management, but the scope is limited.

SCENARIO BOX 6 CHOOSING A FRAMEWORK FOR ENVIRONMENTAL CHANGE

The Perilous Path Scenario

There are significant impacts on the environment by 2020. The rapid rate of industrialisation continues to put pressure on the environment and natural resources. In particular, China's contribution to greenhouse gas emissions grows significantly, as carbon dioxide emissions from the transport and energy sectors in China more than triple between 1995 and 2050.

The urban environment continues to degrade in most large cities in the region, even as urban populations increase rapidly throughout China, despite environmental regulations and improved enforcement. Sanitation becomes an urgent issue to be tackled in these cities, but policies are poorly implemented due to a lack of political will to shoulder the burden of cost.

The problem of water stress, which has been a contentious regional issue in China, further deepens as demand for water increases across all sectors of the economy. Conflict increases particularly between urban and agricultural interests, and between human and environmental interests. Water is rationed in urban areas on a seasonal basis to allow some form of agriculture to continue. Coastal and marine areas are eroded as sea level rises and coastal cities expand. This degradation, combined with heavy pollution, leads to irreversible ecosystem losses, and significant economic losses in agriculture.

Irreversible terrestrial and marine bio-diversity losses continue under pressure from both monoculture agriculture and demographic changes, as urban areas expand and as populations migrate out of degraded environments.

Air pollution, already in 2000 at levels that cause increased rates of infant mortality, loss in labour productivity due to respiratory disease and shortened life expectancies, becomes drastically worse, with the urban poor the most seriously impacted.

More people are affected by natural disasters due both to a higher frequency caused by climate change, and to more people living in unstable locations due to environmental degradation, particularly in the flood plains of major rivers.

Environmental inequities, with the "haves" that have access to clean water and air and land versus the "have-nots", that are forced to live in polluted conditions, further destabilises the society.

The Green Reform Path Scenario

The market economy promotes efficiency – both economic and environmental – and enables use of an array of market-based instruments (MBIs) to promote sustainable development. By 2050, many of these MBIs have become very sophisticated – supporting economic growth without further destruction of the environment. The government puts reforms in place to reduce the inequities in environmental conditions, thus easing the social tensions between the "haves" and the "have-nots".

Along with improvements in the use of energy and energy resources, policies that encourage clean production, rehabilitation of existing state-owned enterprises and stimulation of economic activities in rural areas are used to reduce concentrated environmental pollution. This is especially noticeable in urban areas, due to the promotion of public, environmental-friendly transit. Emission standards for air pollutants are upgraded, and with the popular initiation of environmental improvements and the active interest of the broader public, implementation is relatively effective. Emissions of SO_x and NO_x from power plants and traffic are reduced by setting and enforcing regulations on type of fuel to be used as well as on technology. China becomes a world leader in renewable energy technologies. As a result of these changes, emissions of SO_2 from China dramatically decline.

Water discharges from industry and urban households are increasingly connected to sewage treatment plants. For marine and coastal environments, steady economic growth leads to increased demands for high-protein food, placing pressures on fishery resources, which is somewhat ameliorated by increased aquaculture. Countering the pressures are improvements to habitats through reduced pollution flows from land-based sources.

Rural China shifts towards eco-agriculture and ecological sanitation. Solid waste is treated as a valuable resource with new processes for composting, re-use of bio-degradables, re-use of effluent and the combination of inert and volatile wastes for product creation.

An alternative approach exists, drawing on some of the experiences of industrialised nations. This *sustainable development* approach focuses on strategic change within the driving factors. It consists of more co-ordinated efforts by the environmental sector to change the processes, policies and programmes (as described in chapter 3). In this approach, the environmental sector works with many partners, not just across government, but broadly across society. As governments become more comfortable with the stakeholders taking actions, and more able to manage and support these, the non-governmental response increases in scope, magnitude and strategic impact. Importantly, if governments put in place a correct incentive framework, enterprises efficiently and quickly adopt different behaviour without significant employment or production losses. Impacts of this approach may not be immediately visible, but spread over the medium-term future.

Addressing the Drivers

The following paragraphs explore an alternative, sustainable development, driver-oriented approach in the China context. As shall be clear from these paragraphs, this approach is already nascent in China.

Population Growth and Migration

The environment is incorporated into population and migration policy, and the agencies responsible for environment, population, migration, and urbanisation co-operate at all levels. The environmental impacts of migration are assessed in advance. The cost of the environmental impact of population growth, urbanisation and migration is considered when making development policy. Migrants are given opportunities and support to find ways of prospering while at the same time minimising damage to the environment.

Economic Growth and Development Strategies

First and foremost, ongoing reforms are consolidated and the market functions more and more freely. This is matched by reforms in the public administration and governance sectors. Ownership rights and responsibilities are clarified. Development policies continue to address inequity and natural resource degradation. Environmental costs are incorporated into economic and development policy, and vice-versa.

Poverty, Equity and Environmental Justice

Environment and poverty policy are integrated. The social and environmental costs of poverty are considered. The poor are supported in managing their environment and given access to a good environment. The environmental costs of inequity are incorporated into development policy making. Environmental justice becomes a strong concept for improving the position of vulnerable groups.

Awareness and Health

Strong campaigns to increase environmental awareness and improve environmental education are undertaken. The people realise that maintaining the environment is their responsibility, they cannot rely on the state. They desire to take action. More information is made more readily available to the public, in an appropriate format. Media and other bodies are encouraged to develop environmental awareness. Business and political decision-makers are key targets for environmental awareness. This raises their commitment to and understanding of the environment.

Consumption Patterns and Consumer Pressure for Change

A debate on future society is initiated. Progressive Western models of less waste and less consumption are observed. Policies that stimulate appropriate consumption, while maintaining economic growth are developed. Waste is disassociated from fashionable or wealthy lifestyles.

Technological Development

The environmental technology industry is stimulated, in order to generate employment and meet local demand at affordable prices. China becomes a major manufacturer and then exporter of appropriate environmental technology.

Water

The price of water is increased to reflect scarcity and clean-up costs. Environment is incorporated in water sector policy. As a result, water thirsty economic activities slowly move to water rich areas, and activities requiring low water use are competitive in areas with limited water supply. Also, finance for recycling and water conservation schemes becomes available.

Energy

Environment becomes one of the core themes in energy sector development, planning and implementation. Environmental considerations have a real influence over development of policy and all energy programmes? through promoting renewables, energy efficiency, price setting, etc. SEPA, rather than monitoring power plants and closing mines, focuses more resources on helping SDPC and SETC map out China's energy future.

Transportation

As with energy, the environment and transport sectors work together to map out a sustainable transport policy for China; with perhaps more emphasis on integrated transport, alternative transport, and low polluting technologies.

Agriculture and Food Production

Environmental concerns become a key factor in agricultural policies. The result is agricultural practices that combine economic efficiency with environmental considerations. Importantly, land tenure policy is revised to incorporate environmental objectives, and the implementation of policy is monitored. Water thirsty agriculture migrates to water rich areas, integrated pest management becomes common, certain food imports increase, whereas other exports also increase.

Globalisation

China continues to play an active role in the globalisation process, and puts environmental protection at the centre of its strategies. Trade and investment policies have environmental considerations. The government continues to utilise foreign direct investment and development assistance in support of domestic policy objectives and as drivers of environmental improvement.

Governance and Institutional Structures

The government moves to clarify the legal framework, and ensure it is implemented, building the public's trust in legal mechanisms. The market economic system is maturing with the result that less resources are wasted. Strong institutions act to utilise the market forces to minimise environmental externalities. Within a clear and comprehensive regulatory framework, the environmental sector increasingly acts as partners, rather than policemen. Governments, although concerned for social stability, empower people and organisations. Partnerships are built between government agencies, with the business community, public, and NGOs. For example, government facilitates development of high-calibre, independent institutes and NGOs, which work in support of government policy objectives. Where necessary, the authorities resort to regulation.

5.2 The Choice Ahead

A choice lies ahead for the Chinese government and people. A choice between sustainable development with an improving environment on the one hand, and short-term economic growth accompanied by a dirty, unhealthy environment, with irreversible damage to the water system, to soil and to biodiversity on the other. Making the right choice will not be easy, it requires sacrifices by individuals and will lead to some disadvantages. Is China up to the challenge? This section provides a recap of some of the key findings of this report, and highlights some of the specific choices facing China's people and government, and the implications of making the right choice.

China at the Dawn of the 21st Century

China's development path is complex, multi-faceted and fast moving. The journey involves a number of transitional pathways. There is the transition from a command economy to the market. There is a demographic transition from "high birth rate, high death rate" to "low birth rate, low death rate". There are epidemiological transitions, with the leading causes of death changing from infectious diseases to other things like cancer, car accidents and welfare-related diseases. Managing these transitional processes is one of the greatest challenges faced by any state government at any time in human history.

At times of such complex transitions, there is always a danger that governmental and societal responses remain one step behind the forces of change. Yesterday's risks and failures lead to today's problems; today's risks and failures lead to tomorrow's problems. If we only respond to immediate symptoms, the longer-term risks will be neglected.

Despite the great social and economic achievements made during the past two decades, the Chinese people and government may be one crucial step behind in dealing with other challenges, particularly in the fight to safeguard the environment. Today, the environmental sector has organised itself to address past and the more traditional risk factors, but it is not well prepared to minimise the risks associated with modern society and the associated long-term problems. Take, for example, the whole complex of challenges associated with rapid urbanisation, increased water conflicts, burgeoning volumes of road traffic, and widening inequity between the *haves* and the *have-nots*. How best to organise to address these new challenges?

The situation is even further complicated by the confluence of two generations of risk spheres in China. Residual risks from the old days still prevail side-by-side current risks associated with modern society. In order to improve urban air quality, European cities first had coal and sulphur-related problems to deal with, and these were pretty well under control before traffic-related emissions became serious. In China both problems co-exist—along with many others—creating compounding risk factors.

Present Challenges and Possible Futures

The environmental situation is already a major concern. Air quality in cities, rural areas and indoors is often appalling, well below all standards, leading to health problems and substantial economic losses. Water quality is equally poor, with large stretches of rivers and lakes incapable of supporting life or providing water for residential, industrial or agricultural use. Many rivers and lakes have gone dry, as groundwater stocks sink to new

depths each year. Likewise, natural capital in the form of land, forest and biodiversity is under a long-term decline. These factors combine synergistically to negatively affect human health and welfare. They increasingly constrain economic prospects and growth, and so pose a serious threat to China's mid and long-term sustainable development and stability. Likewise, the marine and coastal resources have suffered and China contributes significantly to regional and global environmental problems, like acidification and global warming. Yet, as this report has clearly illustrated, there are alternatives. Air and water resources can slowly be restored, forest and land degradation can be interrupted and even reversed, and biodiversity losses can be halted.

The scenarios illustrated in Scenario Box 7, adapted for China from UNEP's GEO-3 process, show how key indicators could evolve over the coming decades. The two scenarios stem from the business as usual path and are thus not unrealistic. They are almost identical in terms of population and economic growth. However, in terms of equity, poverty, air and water pollution and ecosystem integrity, there is a striking difference. And this is where the green options and opportunities to bend these curves in the right direction can be seen.

Maintaining the Reform Process

A common theme throughout this report has been that the reform process has, generally, had a positive impact on the environment. Although reform in the economic, public administration and governance spheres has progressed unevenly, the environmental payoffs are generally large. Increasing the efficiency of the economy has the greatest impact on the environment, by increasing the efficiency of resource use, decreasing waste, and importantly as a basis for introducing a system of incentives that can stimulate further environmental improvements.

Continued reform of public administration towards good governance for sustainable development is essential in order to stimulate economic reform, and is a required basis for enhancing the environmental legislative framework and ensuring its implementation. The developing cadre of more efficient public officials at the national level and across China, with increasingly clearer duties and responsibilities, and with a commitment to the rule of law, is necessary for safeguarding the environment. Deepening this process, with further clarifications and separations of duties, from national to local levels, and between agencies at the same level, will yield similarly impressive results. Notably, SEPA and EPBs efforts to strengthen capacity need to be maintained.

Finally, limited experiments in governance reform show that empowering and liberalising the will of people, within a regulated and monitored framework, can release a strong and comprehensive positive force for environmental change, which can complement rather than threaten government objectives and actions. Notably, experience in China and other countries suggests that the media and NGOs are to be strong weapons in the future. Related to this, continuing progress on ownership structures—notably the ownership of productive units, of profits and of liabilities—is facilitating and stimulating improved behaviour within enterprises. Likewise, experiments show that land tenure systems can make or break efforts to safeguard forests, grasslands and agricultural lands. Related to this are data collection and information management systems. Knowledge of people and government is essential if progress is to be made, and this requires good data availability, in appropriate forms. Although greatly improved over the past decade, these remain weak.

An Increased Effort on All Fronts

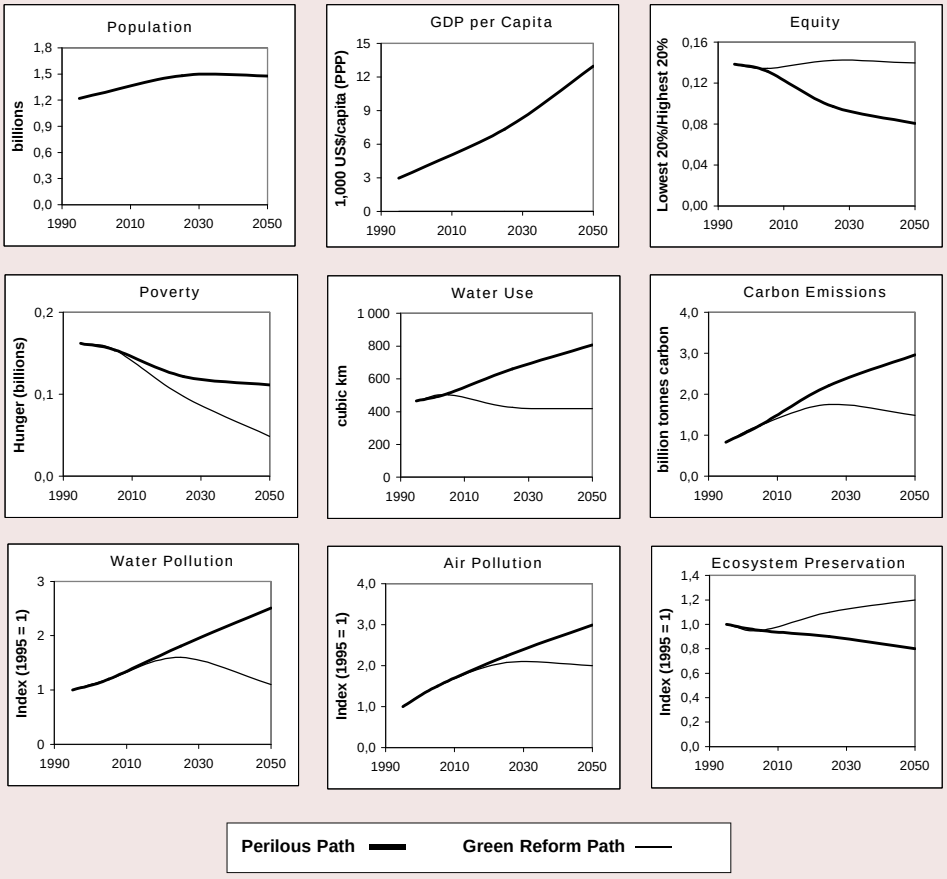
The reform process creates frameworks, foundations and incentives for action. But alone, the reform process is insufficient. Action is still needed, and this requires a major effort and commitment by many actors. In recent years, the scale of action has grown to an impressive level—particularly on the part of the central government. The level of public spending and the intensity of physical investments have probably risen to improved levels already. It will be necessary to maintain this level. Also, the degree of action of the non-governmental spheres has grown, and is still growing. While not quite yet at the level of other countries, there is every sign that the efforts by media, NGOs, institutes and individuals will meet the challenge.

In the future, some actors may have to increase their efforts. As China becomes increasingly market-oriented, and as the state sector accounts for less and less of the GDP, it is the private sector that has to increase its effort. In response to economic and legislative developments and public pressure, as in western countries, the private sector has to significantly upgrade its contribution to environmental improvements. This will largely go hand-in-hand with efforts to increase efficiency and remain competitive, but in many cases may mean sacrificing short-term profits and increasing corporate social responsibility.

Related to effort is capacity. Agencies can only make an effort if they have the right staff and tools. Hence, wide-scale capacity building of individuals, institutions and frameworks is a fundamental requirement to increasing effort.

SCENARIO BOX 7 KEY INDICATORS FOR THE TWO ALTERNATIVE DEVELOPMENT PATH SCENARIOS

A quantitative analysis of the two scenarios developed in this report show a large deviation between each other for the quality of life in the future. Both scenarios start with the same population projections, based on mid-range projections of the United Nations (1998 revision). GDP per capita assumptions are consistent with mid-range economic scenarios from the World Bank and OECD. The fact that the GDP per capita is the same for the two scenarios can be misleading however, because the simple financial calculation of GDP does not address issues of *quality of life*, which is dramatically different between the two scenarios. This is illustrated in the remaining plots, beginning with equity. The "equity" indicator reported is the ratio of the average income of the lowest-earning 20% of the population to that of the highest-earning 20%. As income distribution becomes more equal, the equity indicator increases.



Both the equity and hunger indicators can be taken as indicators of the potential for social instability. Hunger in the scenarios is determined by population, income and the distribution of income. The effects over the course of the scenarios are counteracting, in that while the number of hungry increases with population growth and as income distributions become less equitable, it decreases as incomes rise.

Current water patterns are taken from the Pacific Institute (2000). Water use and water pollution in the scenarios are driven by changes in activity (e.g. population, irrigated agriculture, economic output and power production) and water use intensity (e.g. use per capita for the household sector, use per hectare of irrigated land, use per value added in industry, power plant water cooling requirements, etc.). While water use efficiencies are assumed to increase in the scenarios, the *intensity* of water use, which is affected by both efficiencies and consumption patterns, grows in some sectors. Thus, in the household sector, increasing affluence is associated with higher water intensities, while in the agriculture sector higher-yielding crop varieties require more water per hectare (although the "crop per drop" is higher). In the *Green Reform Path* scenario, water-use intensities tend toward "best practices" in order to meet environmental targets.

Current air emissions are estimated by multiplying energy use by emission coefficients. They are therefore affected by changes in fuel mix, as well as total fuel consumption. Note that the estimated emission levels are consistent with standard sources. Scenario emissions from fuel combustion are affected by consumption patterns and the efficiency of

use. Scenario energy requirements are the sum of sectoral contributions (households, industrial sub-sectors, transportation modes, services, and agriculture). Total requirements are therefore affected by both the increasing scale of the economy and the changing mix of economic activity. This contributes to differences that can be seen between the scenarios. For example, there is a greater contribution from services, and less from agriculture in the *Green Reform Path* compared to the *Perilous Path*, while there is more heavy industry in the *Perilous Path*. Electrification increases in both scenarios, but more rapidly in the *Perilous Path*. Energy efficiency improves in both scenarios, but more rapidly in the *Green Reform Path* in order to meet environmental targets. In the *Green Reform Path* scenario, there is more fuel switching to low-carbon fuels (such as natural gas and renewables) and greater efficiency improvements. *Note: Only carbon emissions from fossil fuels are reported.*

Ecosystem preservation relates to general impacts of pollution and natural resource use that affect the air, land and water, biodiversity and forest area. In the *Perilous Path* scenario, forest area declines due to conversion to agricultural land and the built environment, while it increases in the *Green Reform Path*, due to expansion of plantations and reforestation, and greater reliance on agriculture imports. Due to the considerable uncertainty and controversy regarding the complex relationships in ecosystems, these figures should be taken only as approximate trends.

A More Strategic Form of Environmental Management

Deepening reform and upgrading effort are necessary elements, but even more is needed to safeguard China's environment. There is a need for more strategy and effectiveness. This report has shown that the administrative and campaign approach is increasingly inadequate, and needs to be even more complemented by rule of law and market-based instruments. In order to meet these demands, individual efforts need to be more strategic. With challenges becoming more complex, and with a shift to focus on causal factors and drivers rather than symptoms, it is less and less possible to build or spend the way out of problems.

Implementation of the polluter-pays-principle is underway, but must be deepened in order to move the burden to industries that are able to achieve goals cost effectively. Public participation in priority setting should mean targets are set appropriately, and implementation efficiency-monitored. Long-term thinking and planning should help integrate environment into development plans, policies and programmes, and into all legislation, achieving prevention at a far lower cost than clean-up would have been. Once the price of natural resources fully reflects scarcity, more market-based instruments will have to be introduced to internalise environmental costs. Care must be taken in introducing such instruments. Governance reform will mean that the comparative advantages of the different actors in government, non-government and production units will become increasingly clear. Government will focus on framework and regulation, with some large-scale investments. Non-government will focus on information collection, monitoring, whistle blowing, and providing an alternative voice. And production units will focus on physical clean-up by introducing new, cleaner processes and building efficient treatment facilities.

The grounds for successful green reform in China are there. It is now a matter of making the right choices to help make this happen.

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Annex

Human Development Index and Environmental Indicators in China

1. Introduction

While we recognize that the concept of human development is much richer and broader than what can be captured in any single or composite index, there is a need for indicators to measure human progress. Thus the human development index (HDI) mirrors achievements in the most basic human characteristics: longevity, knowledge and standard of living. As a composite index, the HDI thus contains three variables: life expectancy, educational attainment (adult literacy and combined primary, secondary and tertiary enrolment) and real GDP per capita (in PPP$). The HDI is a broader measure than per capita income. Income is only a means to human development, not an end. By concentrating on aspects beyond income and treating income as a proxy for a decent standard of living, the HDI provides a more comprehensive picture of human life than income only (global Human Development Report 1999, p128). Still the HDI is not a substitute for the fuller treatment of the richness of the concerns of the human development perspective.

2. What is New in the HDI

The Human Development Index used in this report is computed for the provinces of China with the following new data and approaches:

(1) The latest provincial data on economic, social and demographic indicators.

(2) The new method initially adopted in global Human Development Report 1999, proven to be more reasonable in treating adjusted income index.

Also for the first time, environmental indicators are introduced into the CHDR to reflect quality of environment and achievement in environmental protection across provinces.

3. Data Description

The data used to compute provincial HDI in this report include:

(1) the provincial data on life-expectancy at birth in 1995[1], which are estimated by using the data from 1% sampling population survey in 1995

(2) the provincial data on rate of literacy for population aged over 15 years old in 1999 based on a national survey of 0.976‰ sampling of the population[2]

(3) the provincial enrolment ratios of primary, secondary and tertiary education in 1999

(4) the provincial GDP per capita in 1999. The report also includes provincial environmental indicators in latest years[3].

4. Methods for Computing HDI

4.1 For the reasons of consistency and comparability, the report adopts the procedure of computing HDI invented by UNDP teams preparing country HDI for the global Human Development Report 1999, to compute the HDI for every province in mainland China. The computation of provincial HDI is based on three indicators: longevity, as measured by life-expectancy at birth; educational attainment, as measured by a combination of adult literacy (two-thirds weight) and combined primary, secondary and tertiary enrolment ratios (one-third weight); and standard of living, as measured by real GDP per capita in terms of PPP$.

4.2 For the construction of the provincial HDI, fixed minimum and maximum values are established for each of these indicators:

(1) Life-expectancy at birth: 25 years and 85 years.

(2) Adult literacy: 0% and 100%.

(3) Combined enrolment ratio: 0% and 100%

[1] Qi Xin, Ma Jin, Gao Xinhua, Gao Yumei and Ren Huijuan, '1995 Provincial Table of Life Expectancy by Gender in China', Population and Economy (in Chinese), 5-6, 1999 and 1-4, 2000. The 1995 table is the latest published data which can be found for the provinces.

[2] Part of the aggregated data is published in China Statistical Yearbook 2000 (pp 100-109).

[3] The data mainly come from China Statistical Yearbook 2000 (pp 769-785), China Environmental Statistics 1998 and China Environmental Yearbook 1998.

(4) Real GDP per capita (PPP$): 0% and 100%

For any component of the HDI individual indices can be computed according to the general formula:

$$\text{Index} = \frac{\text{Actual Xi value - minimum Xi value}}{\text{Maximum Xi value - minimum Xi value}}$$

Taking Beijing as an example, the 1995 life expectancy at birth in Beijing is 69, so given a minimum value as 25 and maximum value as 85, the index of life expectancy for Beijing can be computed as

$$\text{Life Expectancy Index} = \frac{69 - 25}{85 - 25} = 0.733$$

4.3 Computing the income index for the year of 1999 follows a new approach treating income suggested in the Global Human Development Report 1999. The new methodology is based on a more solid analytical foundation, which is discussed in detail in the report (pp. 159-160). Accordingly, to construct the provincial HDI for this year, income is treated using the following formula:

$$W(y) = \frac{\text{Log}(Y) - \text{Log}(Ymin)}{\text{Log}(Ymax) - \text{Log}(Ymin)}$$

Before treating income, the provincial GDP per capita is converted into real income in terms of PPP$. According to the Human Development Report 1999 (p159), the PPP ratio of Chinese yuan to US dollar in 1999 is estimated as 1:2.0875[4]. This ratio is used for converting the provincial GDP per capita into real income measured in PPP$.

5. Illustration of the HDI Methodology

The construction of the provincial HDI is illustrated with two examples - Guangdong Province and Guizhou Province.

Life Expectancy Index: given that life-expectancy at birth is 74.2 in Guangdong and 66.2 in Guizhou and using the general formula above, the life expectancy index in the two provinces can be computed as follows.

$$\text{Guangdong} = \frac{74.2 - 25}{85 - 25} = 0.82$$

$$\text{Guizhou} = \frac{66.2 - 25}{85 - 25} = 0.69$$

Adult Literacy Index: given that literate ratio is 90.8 in Guangdong and 75.5 in Guizhou and using minimum value as 0 and maximum value as 100, the adult literacy index in the two provinces can be computed as follows.

$$\text{Guangdong} = \frac{90.8 - 0}{100 - 0} = 0.908$$

$$\text{Guizhou} = \frac{75.5 - 0}{100 - 0} = 0.755$$

Combined Gross Enrolment Index: given that the combined gross enrolment ratio is 64.6 in Guangdong and 60.8 in Guizhou and using minimum value as 0 and maximum value as 100, the combined gross enrolment index in the two provinces can be computed as follows.

$$\text{Guangdong} = \frac{64.6 - 0}{100 - 0} = 0.646$$

$$\text{Guizhou} = \frac{60.8 - 0}{100 - 0} = 0.608$$

Educational Attainment Index is derived by computing weighted average of the adult literacy index and the combined gross enrolment index, where two thirds giving to the former index and one thirds to the latter index.

$$\text{Guangdong} = [2\times 0.908 + 0.646]/3 = 0.82$$
$$\text{Guizhou} = [2\times 0.755 + 0.608]/3 = 0.71$$

Adjusted Real GDP per capita (PPS$) index: (the adjusted real GDP per capita in terms of PPP$ in 1999 is 5618 for Guangdong Province and 1186 for Guizhou Province)

$$\text{Guangdong} = \frac{\text{Log}(5618) - \text{Log}(100)}{\text{Log}(40000) - \text{Log}(100)} = 0.67$$

$$\text{Guizhou} = \frac{\text{Log}(1186) - \text{Log}(100)}{\text{Log}(40000) - \text{Log}(100)} = 0.41$$

6. Provincial HDI for Guangdong and Guizhou:

The HDI is a simple average of the life expectancy index, educational attainment index and adjusted real GDP per capita (PPP$) index and so is derived by dividing the sum of these three indices by 3.

Province	Life expectancy index	Educational attainment index	Adjusted real GDP index	Sum of the three indices	HDI
Guangdong	0.82	0.82	0.67	2.31	0.77
Guizhou	0.69	0.71	0.41	1.81	0.60

[4] The figure of GDP per capita in 1999 in Chinese currency is given as 6534 yuan in China Statistical Yearbook 2000, while the Human Development Report 1999 estimates real income for China as 3130 PPP$.

Table A.1 HDI and its Components by Province, 1999

Province	HDI	Life expectancy index	Education index	Income index	Rank of HDI
Shanghai	0.8528	0.8412	0.8837	0.8336	1
Beijing	0.8453	0.8568	0.9188	0.7602	2
Tianjin	0.8008	0.8133	0.8651	0.7240	3
Guangdong	0.7708	0.8194	0.8205	0.6724	4
Liaoning	0.7635	0.7878	0.8555	0.6472	5
Zhejiang	0.7584	0.8132	0.7855	0.6767	6
Jiangsu	0.7500	0.8066	0.7868	0.6565	7
Fujian	0.7326	0.7790	0.760	0.6586	8
Heilongjiang	0.7318	0.7660	0.8281	0.6013	9
Shandong	0.7239	0.8093	0.7403	0.6220	10
Hebei	0.7229	0.7815	0.8026	0.5846	11
Jilin	0.7204	0.7414	0.8500	0.5697	12
Hainan	0.7105	0.7891	0.7716	0.5709	13
Shanxi	0.7101	0.7883	0.8213	0.5207	14
Xinjiang	0.7068	0.7349	0.8124	0.5731	15
Hubei	0.6973	0.7278	0.7899	0.5742	16
Henan	0.6856	0.7672	0.7630	0.5265	17
Chongqing	0.6838	0.7316	0.7957	0.5242	18
Hunan	0.6829	0.7038	0.8113	0.5336	19
Shaanxi	0.6802	0.7599	0.7838	0.4970	20
Guangxi	0.6799	0.7540	0.7868	0.4989	21
Inner Mongolia	0.6790	0.7248	0.7709	0.5414	22
Anhui	0.6747	0.7673	0.7368	0.5200	23
Jiangxi	0.6730	0.7096	0.7911	0.5184	24
Sichuan	0.6711	0.7316	0.7710	0.5107	25
Ningxia	0.6596	0.7549	0.7123	0.5115	26
Yunnan	0.6323	0.6753	0.7108	0.5107	27
Gansu	0.6322	0.7096	0.7088	0.4784	28
Qinghai	0.6249	0.6926	0.6637	0.5184	29
Guizhou	0.6020	0.6872	0.7062	0.4128	30
Tibet	0.5212	0.6421	0.4181	0.5034	31

Sources: (1) Qi Xin, Ma Jin, Gao Xinhua, Gao Yumei, and Ren Huijuan, '1995 Provincial Table of Life Expectancy by Gender in China ', Population and Economy (in Chinese), 5-6, 1999 and 1-4, 2000. (2) China Statistical Yearbook 2000, China Statistical Publisher.

Fig. A.1 Provincial Human Development Index 1999

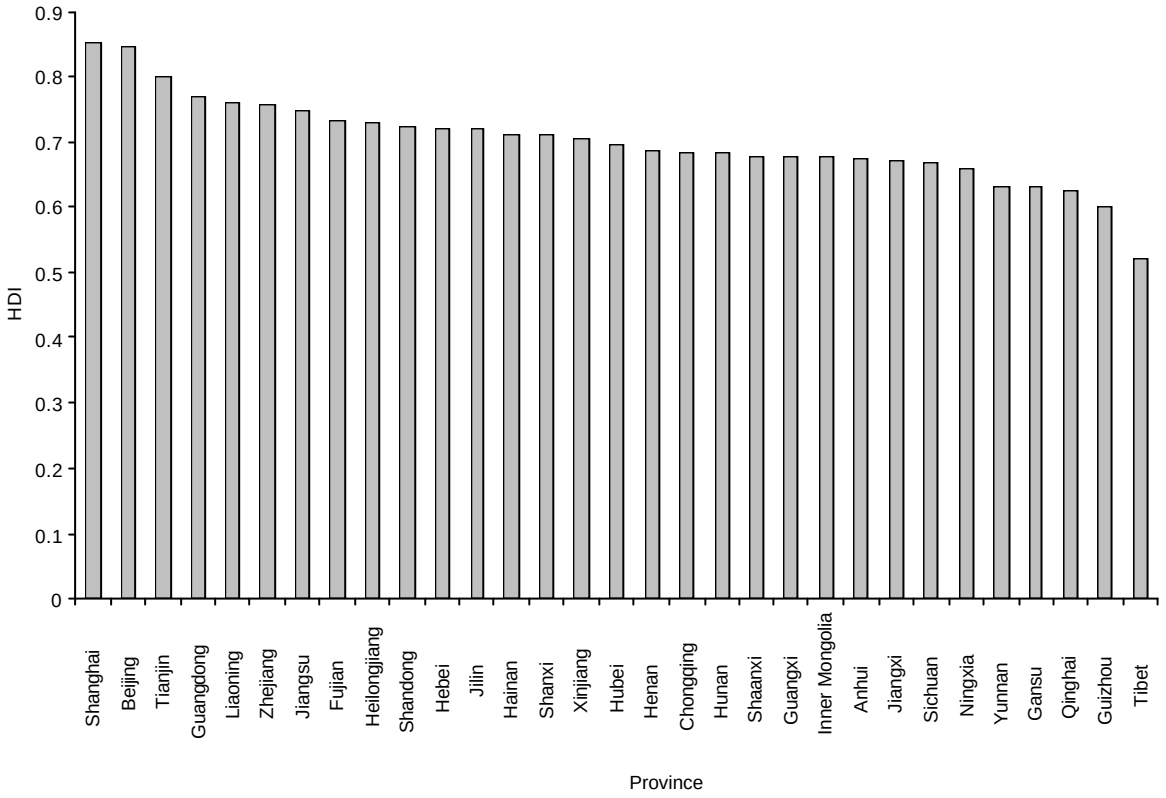

Fig. A.2 Provincial Life Expectancy Index

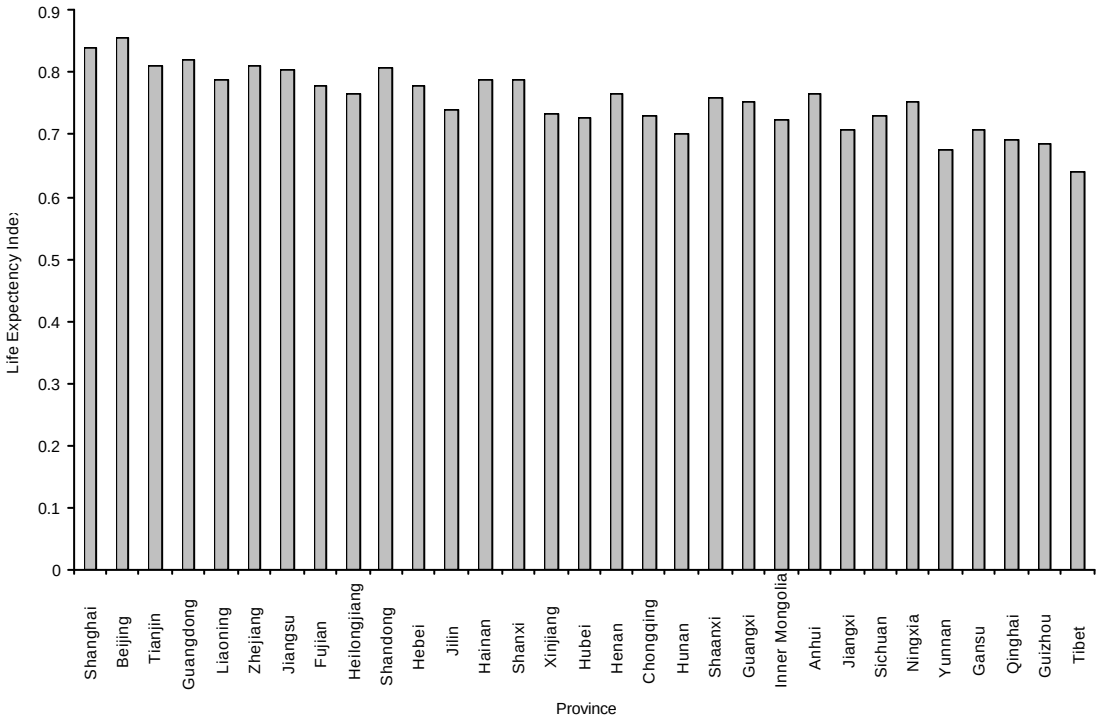

Fig. A.3 Provincial Education Index 1999

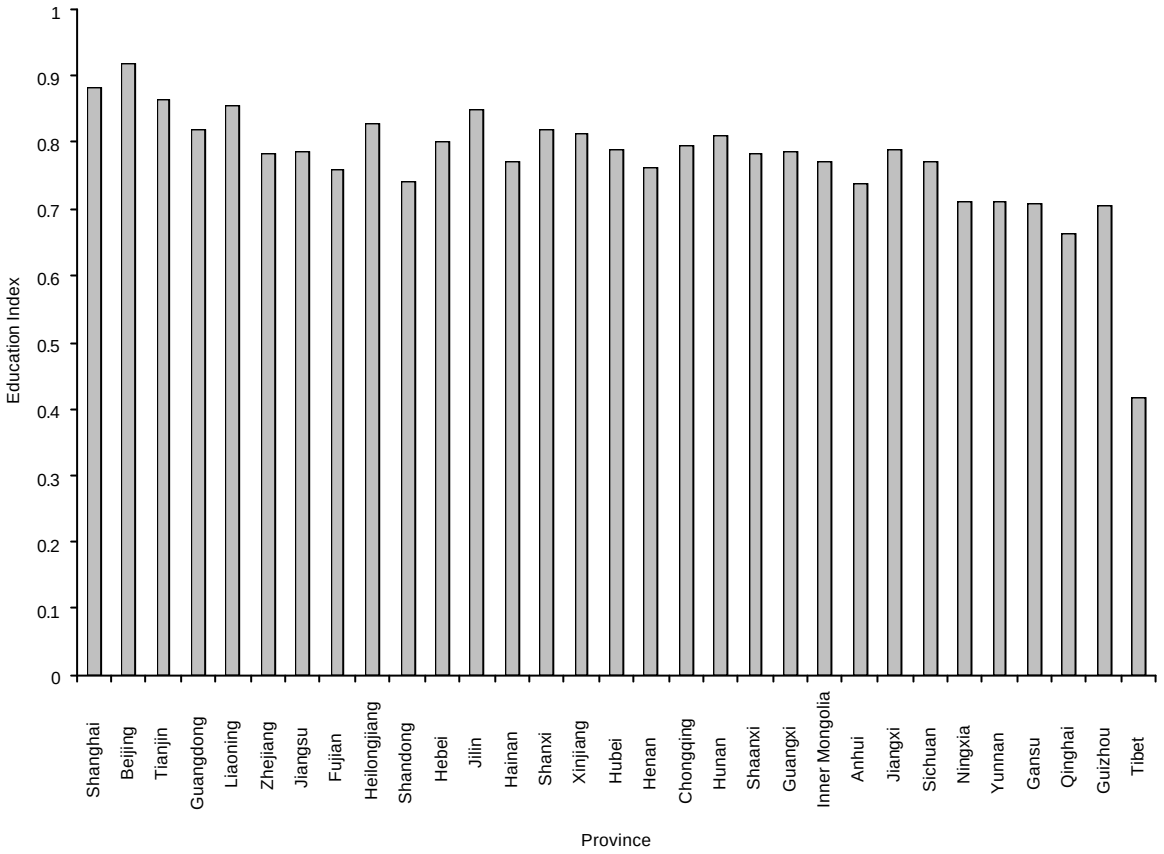

Fig. A.4 Provincial Income Index 1999

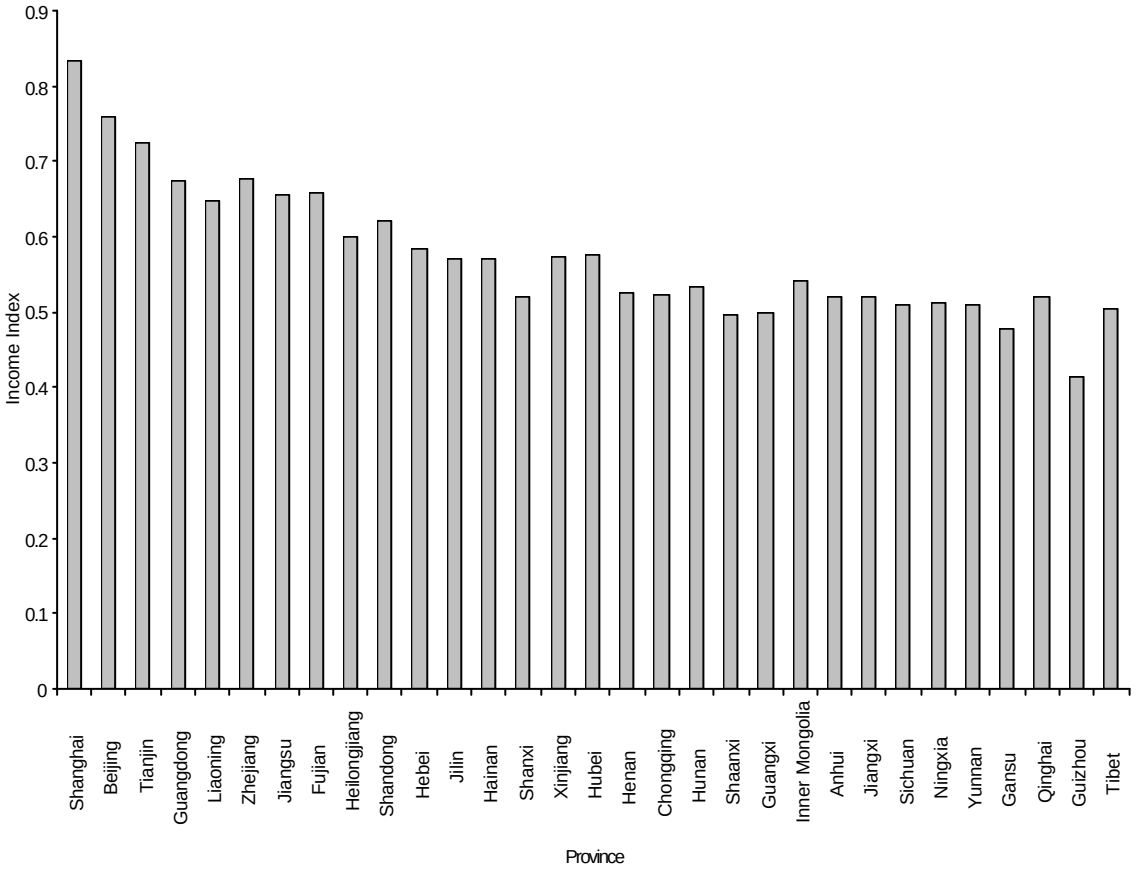

Table A.2 Life Expectancy by Province, 1995

Province	Life expectancy at birth (years) in 1995			Life expectancy Index (1995)		
	Male	Female	All	Male	Female	All
Shanghai	73.46	77.48	75.47	0.8077	0.8747	0.8412
Beijing	74.67	78.15	76.41	0.8278	0.8858	0.8568
Tianjin	72.04	75.56	73.80	0.7840	0.8427	0.8133
Guangdong	71.59	76.74	74.17	0.7765	0.8623	0.8194
Liaoning	70.30	74.24	72.27	0.7550	0.8207	0.7878
Zhejiang	71.35	76.23	73.79	0.7725	0.8538	0.8132
Jiangsu	70.91	75.88	73.40	0.7652	0.8480	0.8066
Fujian	69.36	74.12	71.74	0.7393	0.8187	0.7790
Heilongjiang	69.22	72.70	70.96	0.7370	0.7950	0.7660
Shandong	71.34	75.77	73.56	0.7723	0.8462	0.8093
Hebei	69.84	73.94	71.89	0.7473	0.8157	0.7815
Jilin	68.35	70.62	69.49	0.7225	0.7603	0.7414
Hainan	69.95	74.74	72.35	0.7492	0.8290	0.7891
Shanxi	70.55	74.05	72.30	0.7592	0.8175	0.7883
Xinjiang	70.12	68.07	69.10	0.7520	0.7178	0.7349
Hubei	67.03	70.31	68.67	0.7005	0.7552	0.7278
Henan	69.24	72.82	71.03	0.7373	0.7970	0.7672
Chongqing	67.06	70.73	68.90	0.7010	0.7622	0.7316
Hunan	65.69	68.76	67.23	0.6782	0.7293	0.7038
Shaanxi	68.78	72.41	70.60	0.7297	0.7902	0.7599
Guangxi	68.13	72.35	70.24	0.7188	0.7892	0.7540
Inner Mongolia	67.13	69.85	68.49	0.7022	0.7475	0.7248
Anhui	69.49	72.58	71.04	0.7415	0.7930	0.7673
Jiangxi	65.03	70.12	67.58	0.6672	0.7520	0.7096
Sichuan	67.06	70.73	68.90	0.7010	0.7622	0.7316
Ningxia	68.43	72.16	70.30	0.7238	0.7860	0.7549
Yunnan	63.68	67.35	65.52	0.6447	0.7058	0.6753
Gansu	66.42	68.73	67.58	0.6903	0.7288	0.7096
Qinghai	64.80	68.31	66.56	0.6633	0.7218	0.6926
Guizhou	65.61	66.85	66.23	0.6768	0.6975	0.6872
Tibet	60.33	66.72	63.53	0.5888	0.6953	0.6421

Sources: (1) Qi Xin, Ma Jin, Gao Xinhua, Gao Yumei, and Ren Huijuan, '1995 Provincial Table of Life Expectancy by Gender in China' , Population and Economy (in Chinese), 5-6, 1999 and 1-4, 2000. (2) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.3 GDP per Capita and Income Index by province, 1999

Province	1999		
	GDP per capita in China currency	Real GDP per capita in PPP$	Income index
Shanghai	30805	14756.77	0.8336
Beijing	19846	9507.21	0.7602
Tianjin	15976	7653.33	0.7240
Guangdong	11728	5618.35	0.6724
Liaoning	10086	4831.76	0.6472
Zhejiang	12037	5766.02	0.6767
Jiangsu	10665	5109.01	0.6565
Fujian	10797	5172.16	0.6586
Heilongjiang	7660	3669.48	0.6013
Shandong	8673	4154.96	0.6220
Hebei	6932	3320.70	0.5846
Jilin	6341	3037.52	0.5697
Hainan	6383	3057.72	0.5709
Shanxi	4727	2264.21	0.5207
Xinjiang	6470	3099.27	0.5731
Hubei	6514	3120.47	0.5742
Henan	4894	2344.29	0.5265
Chongqing	4826	2311.94	0.5242
Hunan	5105	2445.38	0.5336
Shaanxi	4101	1964.79	0.4970
Guangxi	4148	1987.04	0.4989
Inner Mongolia	5350	2562.95	0.5414
Anhui	4707	2254.96	0.5200
Jiangxi	4661	2232.98	0.5184
Sichuan	4452	2132.65	0.5107
Ningxia	4473	2142.57	0.5115
Yunnan	4452	2132.81	0.5107
Gansu	3668	1757.02	0.4784
Qinghai	4662	2233.50	0.5184
Guizhou	2475	1185.77	0.4128
Tibet	4262	2041.55	0.5034

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.4 Education Index and Enrolment Rate in Provinces

Province	Enrolment rate in primary education	Enrolment rate in secondary education	Enrolment rate in tertiary education	Combined 1,2,3 level gross Enrolment rate	Adult literacy ratio	Educational index
Shanghai	0.9997	0.8998	0.5747	0.8248	0.9132	0.8837
Beijing	0.9995	0.8908	0.7659	0.8854	0.9355	0.9188
Tianjin	0.9999	0.8029	0.4652	0.7560	0.9197	0.8651
Guangdong	0.9977	0.6676	0.2727	0.6460	0.9077	0.8205
Liaoning	0.9938	0.7127	0.4241	0.7102	0.9282	0.8555
Zhejiang	0.9988	0.7915	0.2208	0.6704	0.8430	0.7855
Jiangsu	0.9984	0.7678	0.3228	0.6963	0.8321	0.7868
Fujian	0.9977	0.6929	0.2599	0.6502	0.8154	0.7603
Heilongjiang	0.9882	0.6674	0.3830	0.6796	0.9023	0.8281
Shandong	0.9962	0.7075	0.1682	0.6240	0.7985	0.7403
Hebei	0.9979	0.7078	0.2025	0.6361	0.8858	0.8026
Jilin	0.9956	0.7378	0.3251	0.6862	0.9319	0.8500
Hainan	0.9939	0.6251	0.2006	0.6065	0.8542	0.7716
Shanxi	0.9965	0.6935	0.2499	0.6466	0.9086	0.8213
Xinjiang	0.9658	0.7302	0.2017	0.6326	0.9023	0.8124
Hubei	0.9962	0.7203	0.2917	0.6694	0.8502	0.7899
Henan	0.996	0.6678	0.1821	0.6153	0.8369	0.7630
Chongqing	0.9574	0.7126	0.3759	0.6820	0.8525	0.7957
Hunan	0.9855	0.6959	0.2885	0.6566	0.8887	0.8113
Shaanxi	0.9925	0.7800	0.3790	0.7172	0.8171	0.7838
Guangxi	0.9854	0.6208	0.2157	0.6073	0.8765	0.7868
Inner Mongolia	0.994	0.7929	0.1374	0.6414	0.8356	0.7709
Anhui	0.9972	0.6828	0.1677	0.6159	0.7972	0.7368
Jiangxi	0.9956	0.6709	0.2427	0.6364	0.8685	0.7911
Sichuan	0.9619	0.7117	0.2717	0.6484	0.8323	0.7710
Ningxia	0.967	0.6668	0.1761	0.6033	0.7668	0.7123
Yunnan	0.9836	0.6480	0.2263	0.6193	0.7566	0.7108
Gansu	0.9768	0.6895	0.2511	0.6391	0.7436	0.7088
Qinghai	0.9046	0.7586	0.1412	0.6014	0.6948	0.6637
Guizhou	0.9738	0.6013	0.2485	0.6079	0.7554	0.7062
Tibet	0.782	0.5652	0.3863	0.5779	0.3382	0.4181

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.5 Population Statistics in Provinces, 1999

Province	Population (thousand)	Birth rate (‰)	Death rate (‰)	Natural growth rate (‰)	Sex ratio (male/female)
Shanghai	14740	5.40	6.50	-1.10	97.65
Beijing	12570	6.50	5.60	0.90	100.79
Tianjin	9590	9.68	6.73	2.95	98.63
Guangdong	72700	15.32	5.40	9.92	102.61
Liaoning	41710	10.38	7.05	3.33	103.16
Zhejiang	44750	10.64	6.35	4.29	102.87
Jiangsu	72130	10.50	6.94	3.56	99.80
Fujian	33160	11.06	5.85	5.21	102.67
Heilongjiang	37920	10.55	5.49	5.06	105.11
Shandong	88830	11.08	6.27	4.81	100.76
Hebei	66140	12.99	6.26	6.73	103.05
Jilin	26580	10.68	5.45	5.23	104.71
Hainan	7620	17.26	5.23	12.03	110.95
Shanxi	32040	15.93	6.07	9.86	105.21
Xinjiang	17740	18.76	6.96	11.80	104.28
Hubei	59380	11.57	6.37	5.20	104.34
Henan	93870	14.07	6.35	7.72	104.81
Chongqing	30750	11.90	6.94	4.96	103.85
Hunan	65320	11.72	7.12	4.60	105.72
Shaanxi	36180	12.51	6.38	6.13	106.38
Guangxi	47130	14.96	6.93	8.03	106.60
Inner Mongolia	23620	13.32	6.08	7.24	105.95
Anhui	62370	15.10	6.50	8.60	105.97
Jiangxi	42310	16.51	7.02	9.49	106.39
Sichuan	85500	13.80	7.02	6.78	104.28
Ningxia	5430	17.97	5.65	12.32	102.63
Yunnan	41920	19.48	7.82	11.66	101.42
Gansu	25430	15.61	6.44	9.17	103.32
Qinghai	5100	20.68	6.78	13.90	103.50
Guizhou	37100	21.92	7.68	14.24	109.91
Tibet	2560	23.20	7.40	15.80	97.50
National	**1259090**	**15.23**	**6.46**	**8.77**	**103.86**

Sources: (1) China Statistical Yearbook 2000. China Statistical Publisher.

Fig. A.5 Provincial Natural Growth Rate of Population 1999

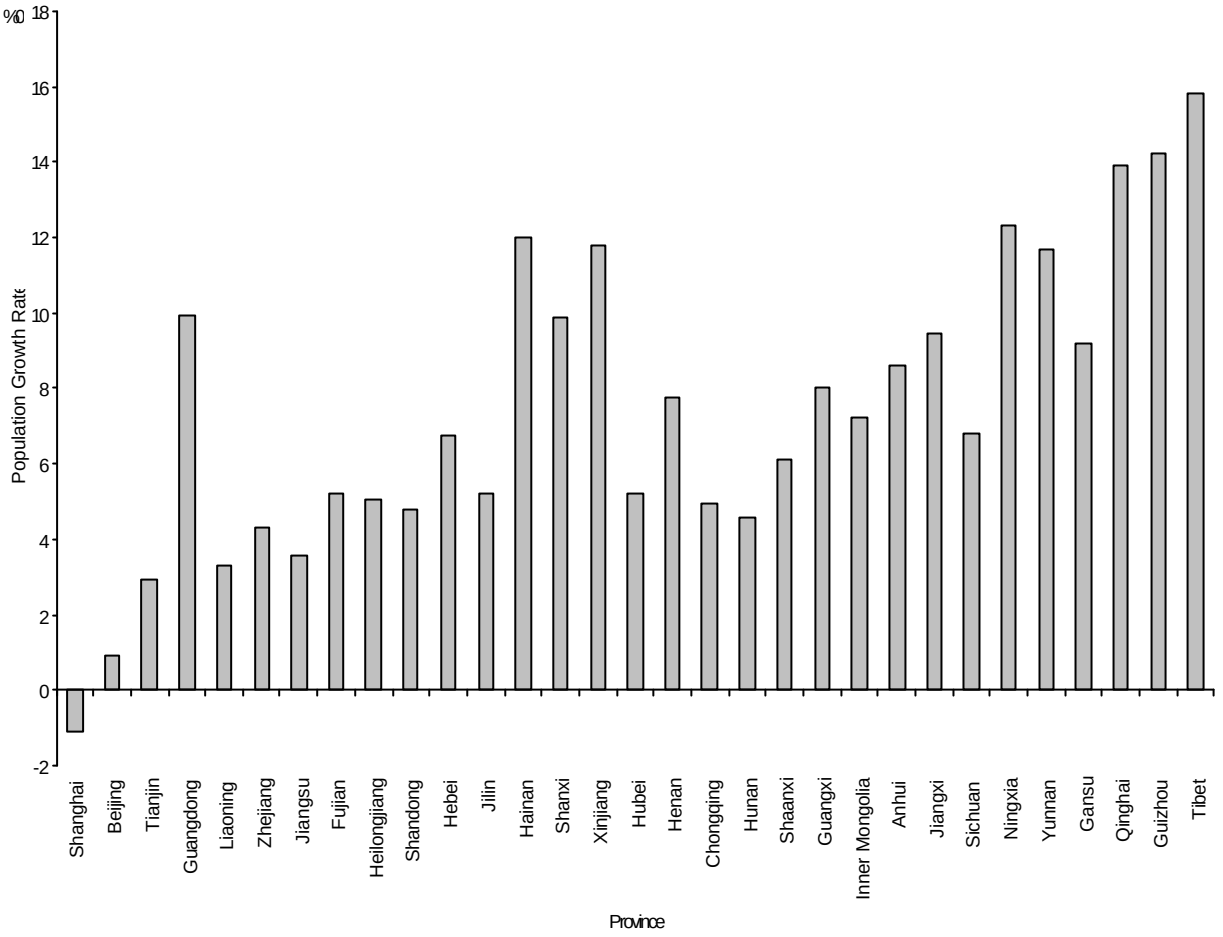

Fig. A.6 Provincial GDP per Capita, 1999

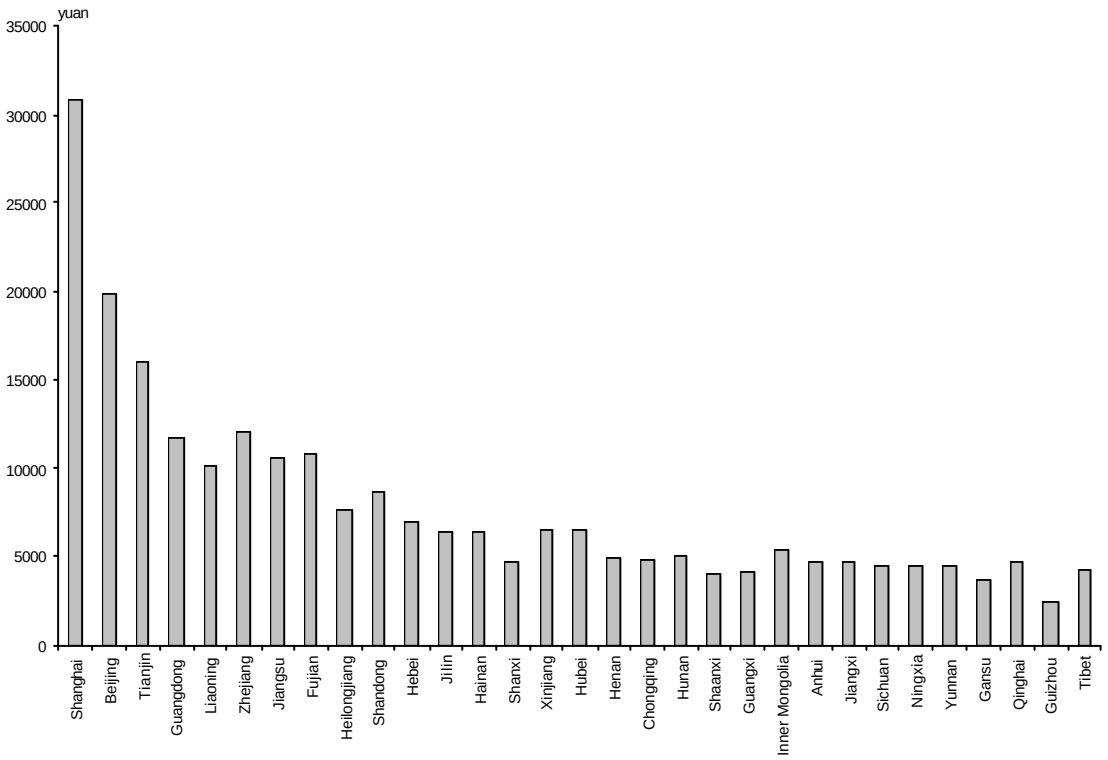

Table A.6 Provincial GDP per Capita and its Components, 1999

Province	GDP per capita in yuan	Share of Primary industry (%)	Share of secondary industry (%)	Share of Tertiary industry (%)
Shanghai	30805	2.0	48.4	49.6
Beijing	19846	4.0	38.7	57.3
Tianjin	15976	4.9	49.1	46.0
Guangdong	11728	12.1	50.4	37.6
Liaoning	10086	12.5	48.0	39.5
Zhejiang	12037	11.8	54.1	34.1
Jiangsu	10665	13.0	50.9	36.1
Fujian	10797	17.7	42.5	39.8
Heilongjiang	7660	13.0	54.8	32.2
Shandong	8673	15.9	48.4	35.7
Hebei	6932	17.6	49.1	33.3
Jilin	6341	25.4	40.2	34.4
Hainan	6383	37.4	20.1	42.4
Shanxi	4727	10.6	50.5	38.9
Xinjiang	6470	23.0	39.4	37.6
Hubei	6514	17.0	48.9	34.1
Henan	4894	24.5	45.3	30.2
Chongqing	4826	19.2	40.8	39.9
Hunan	5105	23.4	39.0	37.6
Shaanxi	4101	18.0	43.1	38.9
Guangxi	4148	28.4	35.6	36.0
Inner Mongolia	5350	27.0	40.6	32.3
Anhui	4707	25.5	44.0	30.5
Jiangxi	4661	23.7	38.6	37.7
Sichuan	4452	25.4	41.9	32.7
Ningxia	4473	19.9	42.5	37.6
Yunnan	4452	22.2	44.5	33.3
Gansu	3668	20.5	45.5	34.0
Qinghai	4662	17.0	41.1	41.9
Guizhou	2475	29.3	38.2	32.4
Tibet	4262	32.4	22.7	44.9
National	**6534**	**17.7**	**49.3**	**33.0**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.7 Proportion of Employees with Different Education Level, 1999 (%)

Province	Illiterate	Primary school	Lower middle school	Upper middle school	College
Shanghai	3.2	11.3	40.6	29.8	15.1
Beijing	1.5	8.1	39.4	28.1	23.0
Tianjin	2.9	19.1	41.7	25.1	11.1
Guangdong	4.1	32.0	44.1	14.8	5.0
Liaoning	2.9	26.6	50.2	13.3	7.0
Zhejiang	10.3	34.9	39.4	12.4	3.0
Jiangsu	11.5	29.4	40.1	14.0	5.0
Fujian	12.4	39.5	33.0	11.9	3.2
Heilongjiang	4.9	27.5	48.3	14.3	4.9
Shandong	13.9	29.0	44.4	10.4	2.2
Hebei	6.4	30.4	46.7	12.6	3.9
Jilin	3.5	29.0	42.9	18.7	5.9
Hainan	11.6	28.6	40.2	14.4	5.1
Shanxi	5.3	25.8	49.7	14.1	5.1
Xinjiang	7.1	32.4	33.4	16.7	10.5
Hubei	10.9	32.8	39.6	12.7	4.0
Henan	12.4	27.0	47.7	10.6	2.3
Chongqing	10.9	44.3	33.2	9.0	2.7
Hunan	6.9	36.7	39.8	13.2	3.4
Shaanxi	14.0	27.4	39.3	15.1	4.2
Guangxi	8.1	42.5	40.2	8.2	0.9
Inner Mongolia	12.7	29.1	36.6	16.4	5.1
Anhui	16.2	35.6	39.4	6.8	2.0
Jiangxi	8.1	43.0	33.7	11.9	3.3
Sichuan	13.4	43.4	33.5	7.5	2.2
Ningxia	22.0	26.9	35.1	11.6	4.4
Yunnan	20.5	47.7	25.3	5.1	1.4
Gansu	23.6	30.9	31.1	11.3	3.2
Qinghai	29.6	30.1	23.5	11.5	5.3
Guizhou	22.8	40.7	26.0	7.8	2.7
Tibet	67.4	28.5	4.0	0.1	0.0
National	**11.0**	**33.3**	**39.9**	**11.9**	**3.9**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Fig. A.7 Provincial Illiterate Ratio, 1999

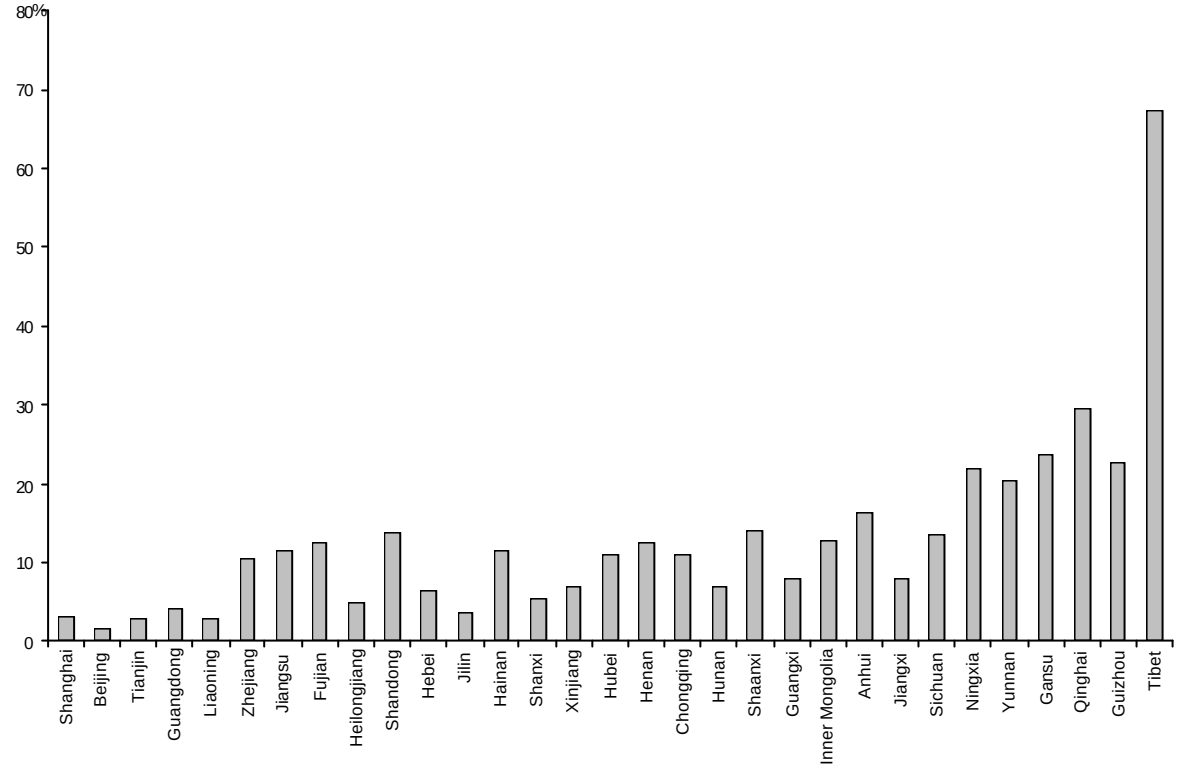

Fig. A.8 Provincial Illiterate Ratio of Female Population, 1999

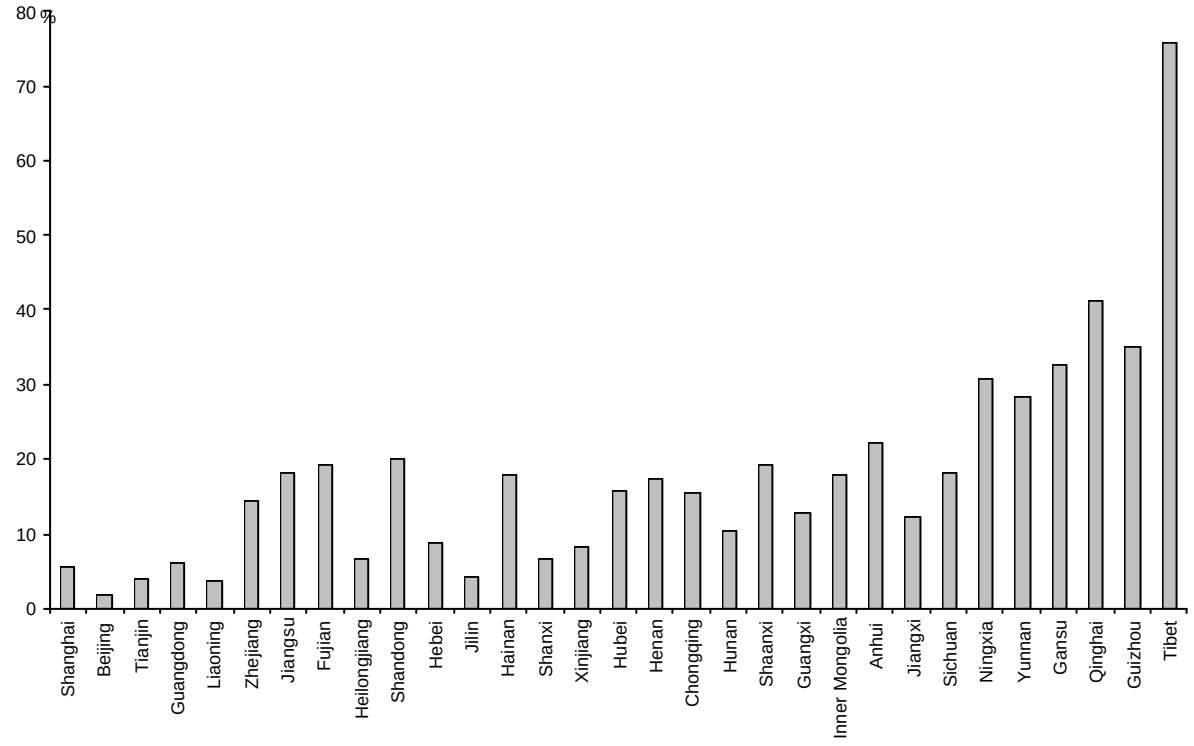

Table A.7a Proportion of Male Employees with Different Education Level, 1999 (%)

Province	Illiterate	Primary school	Lower middle school	Upper middle school	College
Shanghai	1.3	10.8	41.5	29.3	17.1
Beijing	1.2	8.2	42.7	25.2	22.7
Tianjin	2.2	19.1	44.3	23.5	10.9
Guangdong	2.4	27.2	46.8	17.4	6.2
Liaoning	2.1	24.6	52.4	13.5	7.4
Zhejiang	7.0	34.0	42.4	13.0	3.6
Jiangsu	5.5	26.7	45.2	16.2	6.3
Fujian	6.8	35.6	39.9	13.6	4.0
Heilongjiang	3.7	25.2	51.4	14.7	5.0
Shandong	8.5	25.9	49.7	13.1	2.8
Hebei	4.5	27.0	50.4	13.7	4.4
Jilin	2.8	26.8	45.4	18.7	6.2
Hainan	6.1	24.3	44.3	18.2	7.1
Shanxi	4.4	23.1	52.4	14.8	5.3
Xinjiang	6.1	30.2	36.8	16.5	10.4
Hubei	6.7	29.6	44.5	14.3	4.9
Henan	7.9	24.7	52.0	12.5	2.8
Chongqing	6.7	43.1	36.9	10.0	3.3
Hunan	3.9	34.2	42.7	14.8	4.3
Shaanxi	9.7	25.4	42.6	17.2	5.1
Guangxi	3.8	38.6	46.5	10.0	1.1
Inner Mongolia	8.8	28.2	40.6	16.9	5.6
Anhui	11.0	30.7	47.3	8.4	2.5
Jiangxi	4.7	36.6	40.4	14.3	4.0
Sichuan	8.9	42.4	37.6	8.5	2.6
Ningxia	14.2	27.5	39.9	12.8	5.6
Yunnan	13.3	49.8	29.5	5.7	1.6
Gansu	15.1	29.6	37.6	13.6	4.0
Qinghai	19.2	33.1	29.3	12.0	6.4
Guizhou	12.1	42.5	32.9	9.2	3.3
Tibet	59.1	36.5	4.2	0.1	0.0
National	**6.9**	**30.8**	**44.4**	**13.4**	**4.5**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.7b Proportion of Female Employees with Different Education Level, 1999 (%)

Province	Illiterate	Primary school	Lower middle school	Upper middle school	College
Shanghai	5.5	11.9	39.5	30.5	12.6
Beijing	1.8	8.1	35.2	31.6	23.3
Tianjin	3.9	19.0	38.4	27.2	11.4
Guangdong	5.9	37.2	41.3	11.9	3.7
Liaoning	3.8	29.1	47.5	13.1	6.5
Zhejiang	14.3	36.0	35.7	11.6	2.4
Jiangsu	18.1	32.3	34.6	11.6	3.5
Fujian	19.3	44.4	24.5	9.7	2.1
Heilongjiang	6.6	30.5	44.1	13.8	4.8
Shandong	20.0	32.6	38.4	7.5	1.5
Hebei	8.7	34.3	42.4	11.4	3.2
Jilin	4.3	31.7	39.9	18.7	5.5
Hainan	18.0	33.4	35.6	10.1	3.0
Shanxi	6.6	29.3	46.1	13.1	4.9
Xinjiang	8.2	35.0	29.3	16.9	10.6
Hubei	15.7	36.5	34.0	10.8	2.9
Henan	17.2	29.6	43.0	8.5	1.7
Chongqing	15.5	45.6	29.0	7.8	2.0
Hunan	10.3	39.7	36.4	11.2	2.4
Shaanxi	19.0	29.7	35.4	12.7	3.1
Guangxi	12.8	46.7	33.5	6.3	0.7
Inner Mongolia	17.8	30.3	31.5	15.8	4.6
Anhui	22.0	41.1	30.5	5.1	1.3
Jiangxi	12.3	50.7	25.6	9.0	2.3
Sichuan	18.2	44.5	29.1	6.4	1.8
Ningxia	30.7	26.2	29.8	10.2	3.1
Yunnan	28.2	45.4	20.7	4.5	1.2
Gansu	32.8	32.2	24.0	8.8	2.2
Qinghai	41.4	26.7	16.7	10.9	4.2
Guizhou	35.1	38.6	18.2	6.1	2.0
Tibet	75.7	20.6	3.7		
National	**15.8**	**36.1**	**34.8**	**10.2**	**3.1**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.8 Fiscal Revenue and Expenditure by Province, 1999

Province	Total revenue (million)	Total expenditure (million)	Fiscal revenue per capita (yuan)	Fiscal expenditure per capita (yuan)
Shanghai	41995.13	53353.64	2849.1	3619.6
Beijing	28136.61	35519.32	2238.4	2825.7
Tianjin	11280.73	15741.22	1176.3	1641.4
Guangdong	76618.82	96589.90	1053.9	1328.6
Liaoning	27963.90	45790.16	670.4	1097.8
Zhejiang	24547.21	34404.24	548.5	768.8
Jiangsu	34336.47	48465.06	476.0	671.9
Fujian	20892.18	27923.61	630.0	842.1
Heilongjiang	17012.76	33903.42	448.6	894.1
Shandong	40448.29	55000.34	455.3	619.2
Hebei	22327.57	35079.69	337.6	530.4
Jilin	10128.21	23462.31	381.0	882.7
Hainan	3614.41	5678.31	474.3	745.2
Shanxi	10917.85	18533.88	340.8	578.5
Xinjiang	7131.10	16627.88	402.0	937.3
Hubei	19444.25	33645.52	327.5	566.6
Henan	22335.08	38431.57	237.9	409.4
Chongqing	7673.41	15023.65	249.5	488.6
Hunan	16649.94	31312.40	254.9	479.4
Shaanxi	10640.33	20651.73	294.1	570.8
Guangxi	13356.47	22497.75	283.4	477.4
Inner Mongolia	8657.14	19979.64	366.5	845.9
Anhui	17429.17	28860.31	279.4	462.7
Jiangxi	10513.71	20782.93	248.5	491.2
Sichuan	21147.56	36349.81	247.3	425.1
Ningxia	1883.93	4953.46	346.9	912.2
Yunnan	17266.90	37804.68	411.9	901.8
Gansu	5836.57	14778.68	229.5	581.2
Qinghai	1417.36	5571.91	277.9	1092.5
Guizhou	7426.18	17071.63	200.2	460.2
Tibet	457.31	5325.44	178.6	2080.3
National	**559486.55**	**899114.09**	**444.4**	**714.1**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Fig. A.9 Per Capita Fiscal Revenue and Expenditure by Province 1999 (yuan)

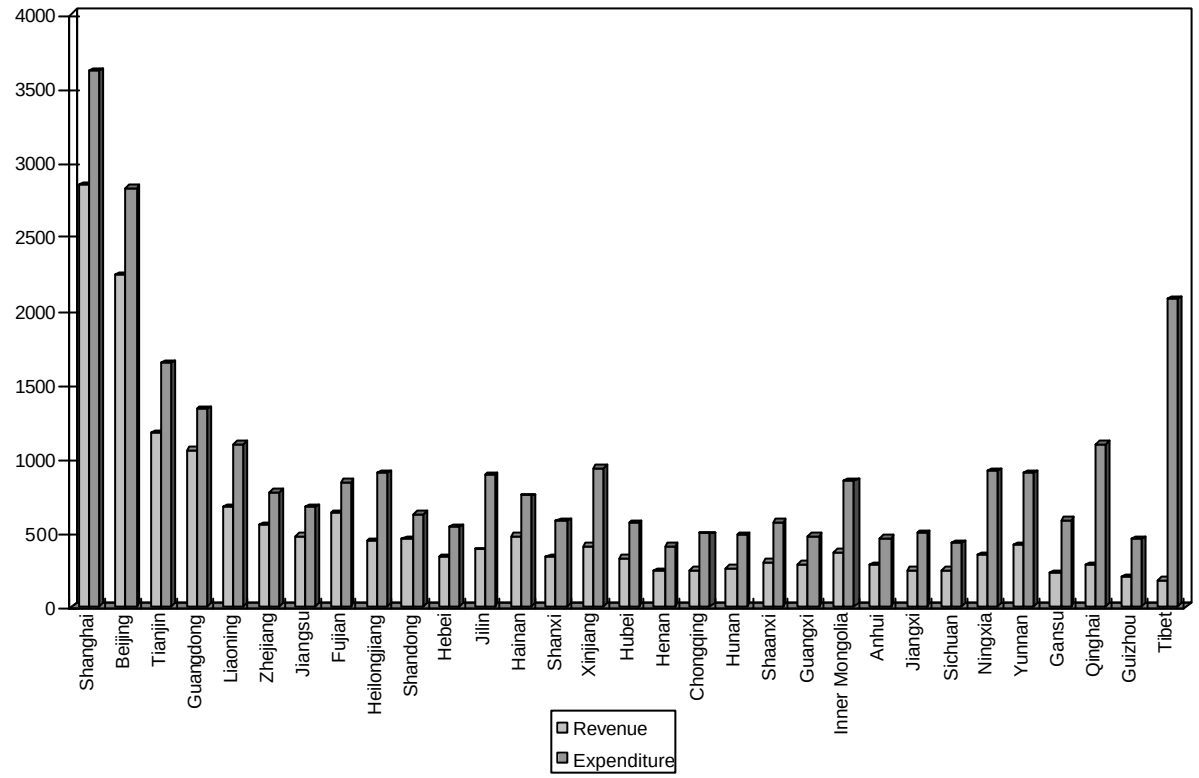

Fig. A.10 Household Income per Capita in Rural and Urban Areas, 1999

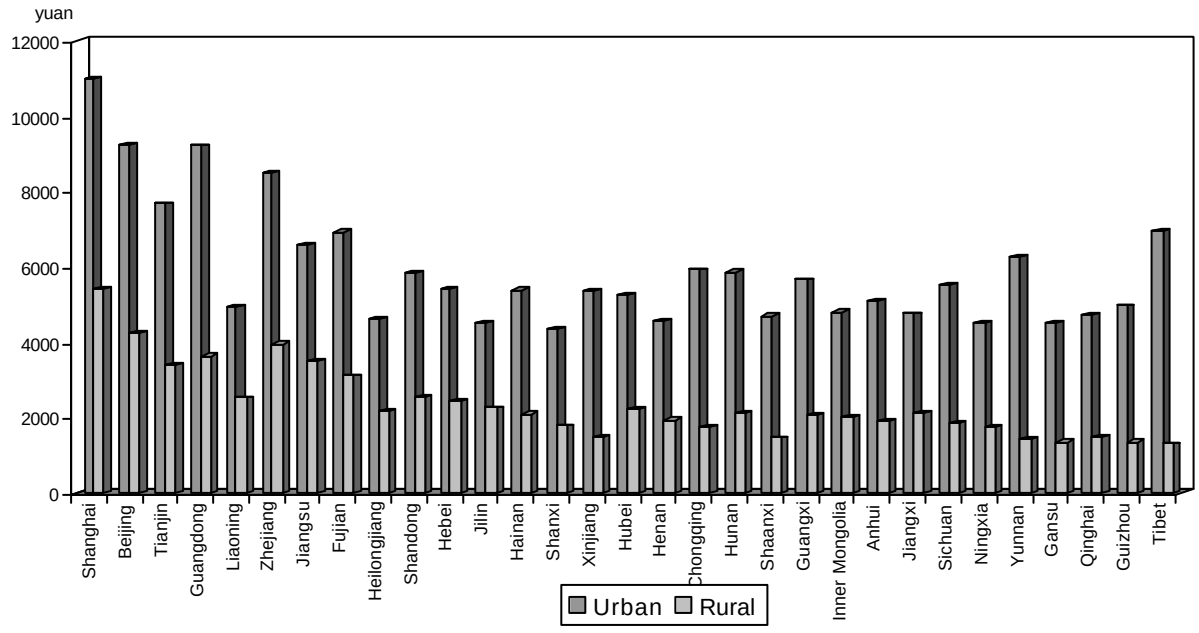

Table A.9 Urban Household Income per Capita and its Components, 1999

Province	Household income per capita (yuan)	Income of Staff & Workers in State- owned Units	Income of Staff & Workers in Collective owned Units	Income of Staff & Workers in Other Types of Ownership	Income from Property	Transfer Income
Shanghai	10988.90	4951.22	301.03	1027.32	68.32	3411.25
Beijing	9238.80	5146.22	296.64	736.87	91.91	2467.26
Tianjin	7670.94	3715.91	123.88	443.92	138.14	2352.18
Guangdong	9205.60	5090.94	784.08	760.25	432.77	1261.88
Liaoning	4924.55	2399.45	449.58	118.64	50.00	1297.24
Zhejiang	8476.41	4045.14	690.28	967.54	179.98	1748.20
Jiangsu	6587.35	3213.34	737.14	213.04	112.20	1891.78
Fujian	6913.91	3631.62	547.46	268.27	176.31	1339.69
Heilongjiang	4619.51	2601.34	193.43	21.32	43.59	1216.30
Shandong	5840.54	4263.24	479.37	175.27	108.08	661.83
Hebei	5394.61	3547.31	245.94	46.96	131.45	1032.47
Jilin	4499.10	2715.81	277.69	18.05	31.39	982.83
Hainan	5384.96	3348.09	109.25	36.70	90.40	1242.03
Shanxi	4362.13	2549.62	133.65	148.38	75.81	1184.18
Xinjiang	5359.70	3734.96	110.38	11.60	45.00	1176.81
Hubei	5234.54	3426.05	310.93	75.38	137.78	917.58
Henan	4553.74	2916.06	184.22	14.47	210.59	1008.41
Chongqing	5915.55	3972.83	376.56	123.28	104.68	1024.44
Hunan	5855.81	4121.52	331.22	134.36	153.86	925.83
Shaanxi	4678.81	2707.02	118.11	32.77	213.69	1318.22
Guangxi	5648.46	3764.87	188.75	42.24	289.45	866.50
Inner Mongolia	4798.52	2919.83	143.38	31.49	79.60	936.49
Anhui	5101.77	3032.84	482.58	143.85	69.95	962.26
Jiangxi	4746.30	3221.46	231.55	19.07	197.00	825.79
Sichuan	5510.00	3656.62	311.83	145.16	152.68	847.42
Ningxia	4508.88	2570.31	178.22	41.85	82.33	1141.33
Yunnan	6234.59	4301.42	447.17	57.54	112.77	978.30
Gansu	4502.26	3236.23	210.57	17.70	35.31	700.84
Qinghai	4727.42	3011.22	123.33	4.49	50.66	1136.42
Guizhou	4953.17	3316.14	182.91	15.64	44.69	977.40
Tibet	6955.62	5946.64	307.74	31.13	85.06	417.66
National	**5888.77**	**3448.40**	**345.24**	**214.76**	**128.65**	**1257.17**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher.

Table A.10 Rural Household Income per Capita and its Components, 1999

Province	Household net income per capita	Basic income	Labor wages	Income from Household business	Transfer income	Property income
Shanghai	5409.11	5048.50	4191.80	856.69	233.26	127.36
Beijing	4226.59	3912.11	2600.60	1311.51	209.38	105.11
Tianjin	3411.11	3271.65	1444.73	1826.92	89.93	49.52
Guangdong	3628.95	3340.15	1104.17	2235.98	229.84	58.96
Liaoning	2501.04	2403.97	816.38	1587.59	70.34	26.73
Zhejiang	3948.39	3634.27	1737.81	1896.46	219.51	94.61
Jiangsu	3495.20	3313.23	1620.65	1692.58	134.78	47.19
Fujian	3091.39	2786.16	981.20	1804.96	263.74	41.49
Heilongjiang	2165.93	2088.52	285.32	1803.20	57.19	20.22
Shandong	2549.58	2390.90	791.15	1599.75	89.79	68.89
Hebei	2441.50	2328.65	896.28	1432.37	60.30	52.56
Jilin	2260.59	2220.59	283.02	1937.57	29.75	10.25
Hainan	2087.46	1895.79	54.23	1841.56	145.63	46.04
Shanxi	1772.62	1696.10	682.36	1013.74	60.79	15.73
Xinjiang	1473.17	1408.65	109.19	1299.46	29.83	34.69
Hubei	2217.08	2092.98	496.40	1596.58	107.62	16.47
Henan	1948.36	1856.56	408.33	1448.22	64.62	27.18
Chongqing	1736.63	1557.09	451.32	1105.77	168.33	11.21
Hunan	2127.46	2057.63	706.75	1350.88	59.29	10.55
Shaanxi	1455.86	1358.75	438.04	920.71	71.06	26.05
Guangxi	2048.33	1918.41	395.75	1522.66	117.33	12.59
Inner Mongolia	2002.93	1948.61	259.38	1689.23	41.07	13.24
Anhui	1900.29	1790.36	470.69	1319.67	92.33	17.61
Jiangxi	2129.45	2011.63	614.98	1396.65	98.57	19.25
Sichuan	1843.47	1722.00	530.40	1191.60	101.74	19.74
Ningxia	1754.15	1680.97	460.14	1220.83	58.03	15.15
Yunnan	1437.63	1334.43	215.26	1119.16	77.17	26.03
Gansu	1357.28	1277.46	278.10	999.36	72.52	7.30
Qinghai	1466.67	1410.49	277.16	1133.33	45.57	10.60
Guizhou	1363.07	1282.62	263.50	1019.12	74.65	5.80
Tibet	1309.46	1242.87	98.21	1144.66	62.10	4.49
National	**2210.34**	**2078.62**	**630.26**	**1448.36**	**100.17**	**31.55**

Table A.11 Number of Selected Durable Consumer Goods Owned in Rural Areas (per 100 households), 1999

Province	Electric fan	Washing machine	Refrigerator	Motorcycle	Black & white TV	Color TV
Shanghai	306.17	71.50	72.83	60.67	66.33	83.33
Beijing	156.00	87.60	78.00	36.67	37.20	101.33
Tianjin	148.17	76.50	49.00	30.50	40.83	90.17
Guangdong	294.26	22.07	11.88	40.74	42.07	63.09
Liaoning	42.12	56.14	13.12	14.97	53.60	58.73
Zhejiang	262.89	26.96	36.63	22.48	61.74	66.63
Jiangsu	207.71	45.71	20.06	24.91	75.71	44.56
Fujian	176.63	30.74	15.14	36.51	53.03	58.23
Heilongjiang	7.25	43.55	3.90	9.25	64.35	46.10
Shandong	141.55	14.90	16.62	30.12	68.10	43.17
Hebei	135.48	53.26	19.52	27.95	66.60	52.86
Jilin	11.56	47.25	5.44	15.38	59.31	48.13
Hainan	99.86	3.33	2.22	28.75	16.94	31.94
Shanxi	31.19	34.38	6.52	13.62	58.38	41.43
Xinjiang	11.00	20.87	8.53	17.73	62.20	28.27
Hubei	140.50	15.31	5.09	13.16	76.31	24.09
Henan	130.00	20.40	5.90	9.60	63.95	32.93
Chongqing	107.13	4.27	3.53	2.27	68.53	21.67
Hunan	135.46	7.46	3.22	7.49	71.24	16.41
Shaanxi	57.03	25.86	4.28	9.14	57.97	37.03
Guangxi	166.75	2.99	2.16	9.87	65.93	18.18
Inner Mongolia	6.84	21.50	4.03	19.22	58.16	36.94
Anhui	159.68	10.03	6.52	5.29	78.68	28.52
Jiangxi	129.92	2.45	3.96	15.59	78.78	24.61
Sichuan	111.98	15.65	3.43	7.15	70.60	25.90
Ningxia	13.33	30.67	5.67	11.50	49.83	51.00
Yunnan	6.71	12.38	2.13	3.75	43.29	31.21
Gansu	7.39	15.89	1.89	6.50	49.83	30.28
Qinghai	0.83	12.67	1.67	9.00	51.17	23.83
Guizhou	20.36	10.22	1.16	5.45	50.40	12.28
Tibet	0.83	4.17	0.83	0.21	4.38	10.00
National	**116.07**	**24.32**	**10.64**	**16.49**	**62.35**	**38.24**

Source: China Statistical Yearbook, 2000

Table A.12 Number of Selected Durable Consumer Goods Owned in Urban Areas (per 100 households), 1999

Province	Motorcycle	Auto-mobile	Washing Machine	Electric Fan	Refrigerator	Color TV Set
Shanghai	2.00	0.00	93.40	230.80	103.00	144.20
Beijing	6.00	2.50	99.60	145.40	102.80	141.40
Tianjin	10.20	0.00	97.40	131.40	98.80	131.20
Guangdong	51.08	0.69	97.06	325.62	81.03	130.34
Liaoning	6.96	0.49	85.51	69.03	78.38	109.04
Zhejiang	14.45	0.37	92.37	271.86	98.71	130.86
Jiangsu	18.63	0.00	97.05	271.02	81.51	113.48
Fujian	27.51	0.39	93.99	240.49	84.78	115.42
Heilongjiang	5.38	0.11	87.31	42.95	59.17	99.44
Shandong	25.50	0.05	89.62	193.56	87.04	110.72
Hebei	30.79	0.32	93.72	177.42	83.00	107.96
Jilin	4.06	0.17	90.77	59.34	61.20	99.17
Hainan	36.33	0.00	76.55	187.39	50.52	106.42
Shanxi	15.58	0.28	94.54	78.28	71.10	106.25
Xinjiang	7.65	1.11	91.29	44.79	77.97	104.08
Hubei	8.49	0.08	92.99	238.09	85.77	103.80
Henan	14.15	0.06	89.59	221.09	70.20	101.85
Chongqing	1.00	0.67	95.00	210.67	99.33	120.67
Hunan	13.47	0.23	94.05	252.21	85.45	106.68
Shaanxi	6.59	0.14	93.49	150.01	72.42	112.20
Guangxi	31.01	0.44	92.49	316.53	79.05	109.71
Inner Mongolia	22.91	0.62	89.79	44.35	66.65	104.91
Anhui	11.28	0.28	87.43	242.02	78.35	99.08
Jiangxi	11.03	0.32	80.39	263.51	73.03	100.18
Sichuan	7.57	0.63	94.51	199.22	81.56	116.26
Ningxia	11.21	0.00	89.84	64.51	68.60	110.95
Yunnan	10.96	0.29	96.03	29.39	65.17	109.94
Gansu	7.38	0.41	95.73	38.87	67.17	111.25
Qinghai	9.09	0.00	98.18	2.18	69.82	107.82
Guizhou	13.49	0.00	95.08	100.17	78.81	109.30
Tibet	6.00	3.00	81.00	4.00	69.00	119.00
National	**15.12**	**0.34**	**91.44**	**171.73**	**77.74**	**111.57**

Sources: (1) China Statistical Yearbook 2000, China Statistical Publisher

Table A.13 Tap Water Supply in Cities by Province, 1999

Province	Production capacity of tap water (10000 tons/day)	Total annual volume of water supply (10000 tons)	For residential use	For production Use	Number of residents with access to tap water (10000)	Per capita daily residential consumption of tap water (liter)
Shanghai	1428.63	289648	110434	115630	1127.22	268.41
Beijing	507.25	110744	73459	27863	764.19	263.36
Tianjin	320.20	65334	28025	26375	521.91	147.12
Guangdong	1982.07	440042	236959	181993	1883.44	344.69
Liaoning	1389.18	311418	109187	169552	1705.92	175.36
Zhejiang	954.11	176228	71920	84742	974.95	202.10
Jiangsu	1585.48	339066	138264	173487	1425.36	265.76
Fujian	621.46	128678	53275	66565	560.26	260.52
Heilongjiang	670.42	155923	56005	87308	1027.77	149.29
Shandong	1140.72	240016	90748	138097	1673.04	148.61
Hebei	995.88	198156	90096	97536	1053.19	234.37
Jilin	684.72	152151	39462	97107	708.29	152.64
Hainan	145.33	25787	15640	4904	169.51	252.78
Shanxi	350.70	88000	34579	48338	667.23	141.99
Xinjiang	286.74	47771	23562	19871	402.13	160.53
Hubei	1512.80	348126	133520	186517	1445.51	253.07
Henan	915.64	195184	79271	100733	1183.31	183.54
Chongqing	324.72	59838	34162	24888	559.75	167.21
Hunan	1242.26	283226	89522	168247	847.69	289.33
Shaanxi	306.63	79742	38984	30800	554.40	192.65
Guangxi	609.72	138248	58640	67409	529.05	303.67
Inner Mongolia	237.26	61916	21596	36692	425.74	138.97
Anhui	941.38	194832	60687	122185	768.87	216.25
Jiangxi	622.71	130998	48524	71503	564.20	235.63
Sichuan	882.19	195831	76324	107286	1027.23	203.56
Ningxia	104.00	25165	8429	13278	107.89	214.04
Yunnan	210.75	49270	28036	15846	379.65	202.32
Gansu	293.63	78636	19391	51394	362.54	146.54
Qinghai	59.59	14107	6033	7416	88.14	187.53
Guizhou	211.97	46009	17989	19710	356.76	138.15
Tibet	13.80	4986	3502	1484	20.60	465.75
National	**21551.94**	**4675076**	**1896225**	**2364756**	**23885.74**	**217.50**

Source: China Statistical Yearbook, 2000

Table A.14 Supply and Use of Gas in Cities by Province, 1999

Province	Production capacity of coal gas (10000 cu.m/day)	Total gas supply			Population with access to gas (10000 persons)		
		Coal gas (10000 cu.m)	Liquefied petroleum gas (ton)	Natural gas(10000 cu.m)	Coal gas	Liquefied petroleum gas	Natural gas
Shanghai	684.00	207056	192951	9813	561.70	328.70	32.70
Beijing	205.00	61549	173042	64833	109.81	256.30	242.07
Tianjin	68.00	10085	53342	17882	72.20	109.52	273.64
Guangdong	68.00	10956	2183087	453	139.55	1206.17	6.59
Liaoning	198.80	80116	336906	24440	423.52	574.93	378.19
Zhejiang	34.00	25766	614278		44.74	525.34	
Jiangsu	170.27	350299	695826		323.88	814.09	
Fujian	10.00	3683	269246		11.39	343.09	
Heilongjiang	209.00	24842	507414	3907	198.28	541.72	41.83
Shandong	151.00	40665	281750	79970	328.43	853.41	40.33
Hebei	112.80	43730	181860	4581	250.99	460.23	24.66
Jilin	64.50	16009	154205	10194	158.26	340.52	61.72
Hainan			74922			114.80	
Shanxi	114.23	50469	29932	4762	277.40	106.01	34.06
Xinjiang			204344	3453		310.21	12.06
Hubei	135.80	24720	272579	2360	178.83	798.54	9.00
Henan	22.80	77831	151220	55326	106.60	423.63	169.15
Chongqing	10.00	2	49576	111001	0.16	28.81	290.47
Hunan	38.00	74550	189579		72.82	432.45	
Shaanxi	17.40	6313	61353	9853	44.28	179.17	84.67
Guangxi		2764	186693		14.43	361.95	
Inner Mongolia	16.40	7238	49320		67.80	178.09	
Anhui	70.72	27773	374899		166.61	352.35	
Jiangxi	37.00	38746	75533		116.68	200.04	
Sichuan		105868	66137	395711	29.29	83.79	516.74
Ningxia		2783	22340	6	9.31	66.13	0.35
Yunnan	65.00	14588	72425	33	89.56	138.35	1.60
Gansu	55.80	5685	34945		55.01	83.43	
Qinghai		24	11025	1560	2.50	31.10	3.10
Guizhou	34.80	6815	26275	418	64.29	82.93	2.20
Tibet			15680			10.46	
National	**2593.32**	**1320925**	**7612684**	**800556**	**3918.32**	**10336.26**	**2225.13**

Source: China Statistical Yearbook, 2000

Table A.15 Sanitation Statistics in Cities by Province, 1999

Province	Length of sewer pipelines (km)	Daily disposal capacity of sewage (10000 tons)	Volume of garbage disposal (10000 tons)	Volume of excrement & urine disposal (10000 tons)	Number of public lavatories (unit)	Water closet
Shanghai	4577.00	524.30	499.80	217.00	1150	1150
Beijing	4067.47	14.87	449.50	273.50	5900	5482
Tianjin	6731.00	95.00	211.30	19.10	2610	1480
Guangdong	14903.46	176.58	840.65	125.11	4150	3598
Liaoning	8098.52	107.43	878.91	152.21	10862	994
Zhejiang	6587.95	115.78	413.87	118.07	2808	2313
Jiangsu	10382.05	366.76	505.06	309.66	7337	5467
Fujian	3400.30	50.76	230.44	33.52	1352	1308
Heilongjiang	4678.57	199.00	943.82	237.38	10386	806
Shandong	11682.23	30.70	711.70	133.41	5063	2952
Hebei	6873.69	87.34	544.99	118.88	6385	1538
Jilin	3530.78	2.98	646.47	133.73	6942	623
Hainan	1496.19	10.78	67.28	8.56	403	381
Shanxi	2488.01	7.83	365.38	160.92	3508	887
Xinjiang	1915.48	37.80	267.36	25.17	1640	1053
Hubei	6363.10	237.78	599.29	70.39	4747	3146
Henan	5761.47	38.86	535.83	70.79	4255	2524
Chongqing	1954.42	54.97	144.20	187.05	2816	1543
Hunan	4921.89	67.60	316.82	23.21	2922	1762
Shaanxi	1810.57	23.10	204.92	17.50	1388	662
Guangxi	2788.70	113.49	171.73	21.26	1170	984
Inner Mongolia	2442.18	3.52	312.54	98.12	3826	436
Anhui	3998.17	160.90	327.31	52.05	4790	2298
Jiangxi	1983.91	16.15	175.51	24.79	1871	1027
Sichuan	5012.18	20.12	360.22	78.30	3322	2363
Ningxia	460.00	7.89	77.45	9.31	939	260
Yunnan	1912.10	57.40	147.47	61.85	1483	819
Gansu	1645.08	23.92	223.62	37.52	956	405
Qinghai	206.06		92.30	7.64	259	132
Guizhou	1593.44	0.90	120.35	15.61	1733	825
Tibet	220.00		29.10	2.11	91	70
National	**134485.97**	**2654.51**	**11415.19**	**2843.72**	**107064**	**49288**

Source: China Statistical Yearbook, 2000

Table A.16 Public Facilities in Cities by Province, 1999

Province	Percentage of population with access to tap water	Percentage of population with access to gas	Number of public buses and trolley buses per 10000 persons	Per capita public green areas (sq.m)
Shanghai	100.00	99.99	19.46	3.44
Beijing	100.00	97.10	23.98	7.96
Tianjin	100.00	94.97	9.81	4.87
Guangdong	97.47	93.00	8.46	10.11
Liaoning	97.72	88.90	7.95	6.09
Zhejiang	99.79	97.11	12.75	6.96
Jiangsu	99.10	94.87	9.69	7.99
Fujian	98.01	87.26	9.78	7.02
Heilongjiang	85.57	69.65	6.59	6.58
Shandong	97.31	87.93	7.52	7.30
Hebei	99.45	91.01	7.59	6.16
Jilin	88.08	72.69	7.25	5.99
Hainan	94.40	91.80	13.45	13.30
Shanxi	97.03	73.71	5.48	4.07
Xinjiang	98.14	92.47	12.82	6.21
Hubei	98.34	83.47	11.91	9.15
Henan	94.89	68.74	6.58	5.99
Chongqing	96.53	73.03	8.62	2.37
Hunan	97.85	75.54	10.32	4.87
Shaanxi	97.85	64.88	7.10	5.02
Guangxi	98.67	89.72	5.44	7.44
Inner Mongolia	88.62	54.11	3.71	5.99
Anhui	92.80	73.20	6.98	6.67
Jiangxi	93.23	65.80	6.17	5.78
Sichuan	96.85	72.43	7.13	4.38
Ningxia	97.72	76.63	6.47	4.25
Yunnan	98.02	78.76	12.88	7.76
Gansu	94.24	43.92	6.54	3.60
Qinghai	97.54	48.89	9.39	3.22
Guizhou	94.34	50.72	13.83	7.61
Tibet	74.72	65.13	28.21	29.38
National	**96.30**	**81.74**	**9.36**	**6.54**

Source: China Statistical Yearbook, 2000

Fig. A.11 Per Capita Daily Residential Consumption of Tap Water in Cities, 1999

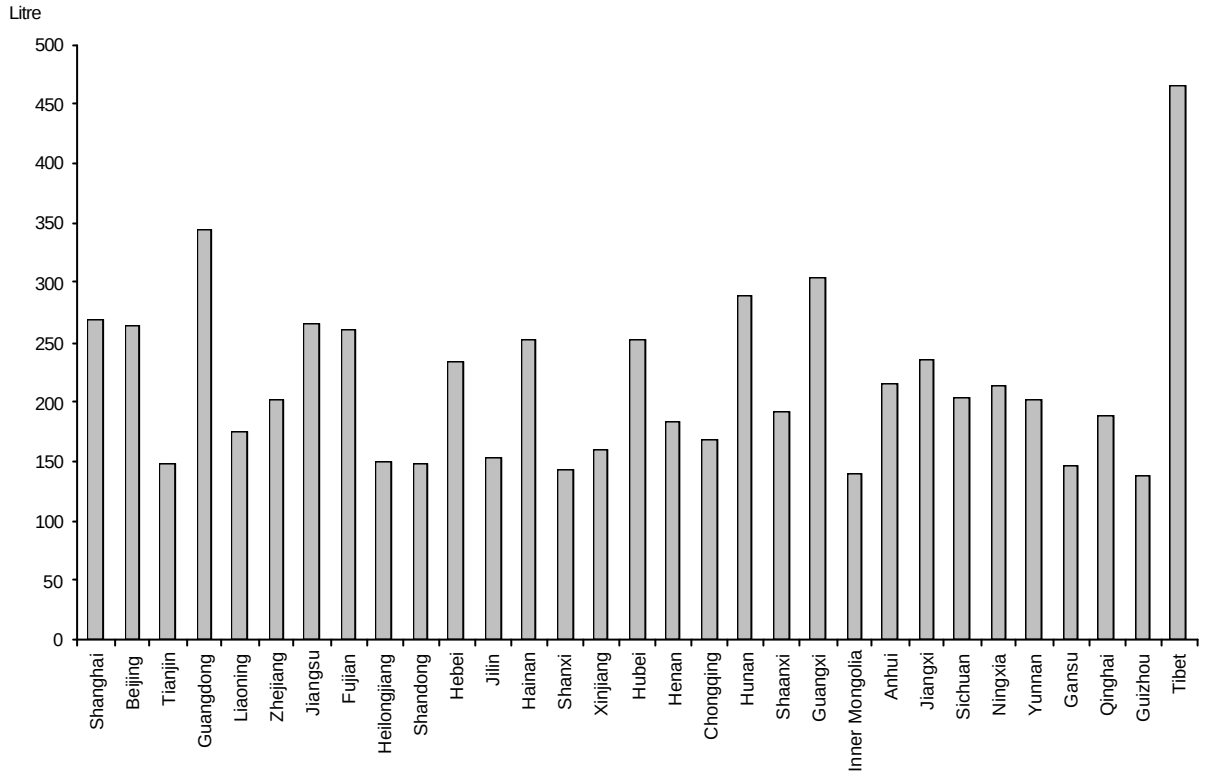

Fig. A.12 Percentage of Population with Access to Gas in Cities, 1999

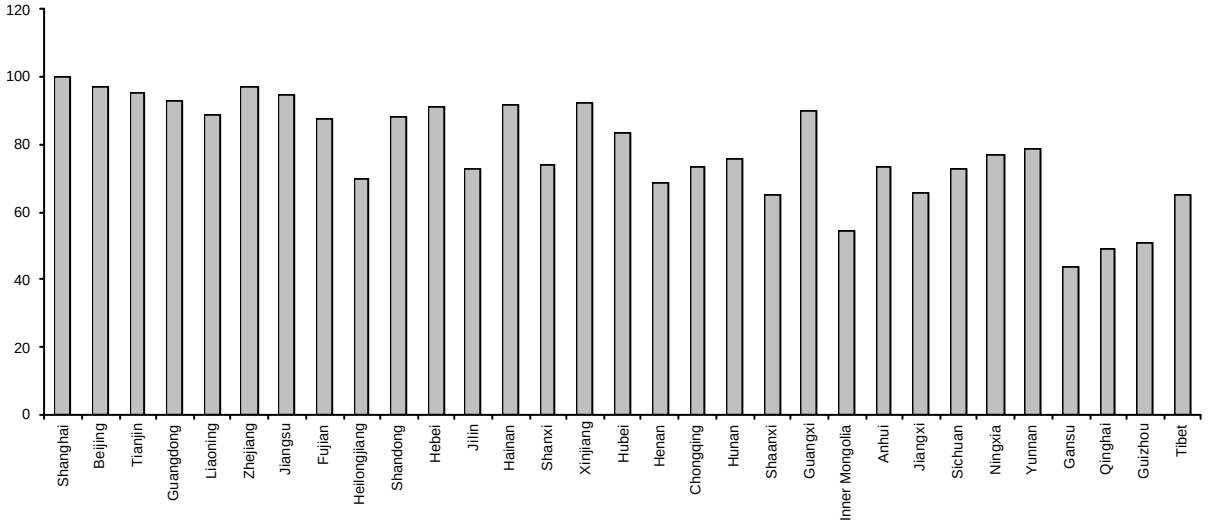

Table A.17 Consumption of Chemical Fertilizers in Rural Areas by Province, 1999

Province	Total consumption (10000 tons)	Nitrogenous fertilizer	Phosphate fertilizer	Potash fertilizer	Compound fertilizer
Shanghai	20.4	16.0	1.7	0.5	2.3
Beijing	19.0	11.6	1.1	0.4	5.9
Tianjin	15.8	8.8	1.8	0.8	4.5
Guangdong	172.8	95.3	18.6	34.2	24.8
Liaoning	116.3	73.0	11.2	7.8	24.3
Zhejiang	92.7	61.9	12.7	5.7	12.4
Jiangsu	335.4	191.3	52.4	15.2	76.6
Fujian	124.3	56.7	17.2	24.1	26.3
Heilongjiang	126.3	55.2	31.0	10.6	29.6
Shandong	419.3	201.1	57.9	34.5	125.9
Hebei	272.4	151.2	44.1	16.2	61.0
Jilin	116.2	69.3	5.7	8.5	32.7
Hainan	19.4	5.7	1.6	2.6	9.5
Shanxi	86.0	42.3	20.1	4.9	18.7
Xinjiang	78.3	42.5	18.4	2.4	15.1
Hubei	251.5	128.2	62.6	16.8	44.0
Henan	399.9	200.4	91.3	34.4	73.8
Chongqing	71.0	45.8	15.6	2.5	7.0
Hunan	180.9	98.0	24.5	30.4	28.0
Shaanxi	132.0	75.1	17.7	6.9	32.4
Guangxi	153.8	55.2	22.4	35.3	40.8
Inner Mongolia	76.0	45.0	13.2	2.8	15.0
Anhui	255.7	121.0	44.6	24.7	65.4
Jiangxi	116.7	55.1	21.3	19.2	21.1
Sichuan	210.3	124.2	40.4	9.3	36.4
Ningxia	29.3	21.4	3.0	0.1	4.8
Yunnan	90.5	52.9	15.3	7.8	14.5
Gansu	64.5	30.9	18.4	2.4	12.8
Qinghai	7.3	3.5	1.3	0.3	2.2
Guizhou	67.7	41.2	10.5	4.6	11.4
Tibet	2.7	1.3	0.4	0.2	0.9
National	**4124.3**	**2180.9**	**697.8**	**365.6**	**880.0**

Source: China Statistical Yearbook, 2000

Table A.18 Areas Covered and Affected by Natural Disasters by Province, 1999

Province	Areas covered (1000 ha)	Areas affected (1000 ha)	Flood		Drought	
			Areas covered	Areas affected	Areas covered	Areas affected
Shanghai	259	110	85	36		
Beijing	123	73			97	60
Tianjin	226	125			190	110
Guangdong	1580	687	85	27	507	197
Liaoning	1280	1020	21	5	1190	964
Zhejiang	757	459	539	336		
Jiangsu	3190	1290	549	254	1110	474
Fujian	876	580	314	159	17	10
Heilongjiang	1440	650	142	83	809	388
Shandong	3000	1230	231	121	2570	1000
Hebei	3620	2170	12	9	3090	1870
Jilin	1124	698	14	7	980	628
Hainan	363	166	17	10	212	55
Shanxi	3000	2090	45	28	2710	1910
Xinjiang	865	523	126	87.4	166	121
Hubei	2830	1330	1366	731	1102	511
Henan	3670	1890	73	37	2960	1680
Chongqing	1850	820	387	198	952	437
Hunan	1530	936	1070	689	218	110
Shaanxi	2520	1490	185	101	2120	1268
Guangxi	2200	918	372	149	1020	392
Inner Mongolia	3840	1980	52	35	3470	1745
Anhui	2860	1560	947	605	1480	770
Jiangxi	747	456	638	399	45	13
Sichuan	976	512	468	281	351	171
Ningxia	347	261	77	48	233	187
Yunnan	1410	836	429	239	545	367
Gansu	1810	1060	178	70	1310	867
Qinghai	420	217	47	27	340	177
Guizhou	1230	575	529	283	362	132
Tibet	36.5	21.7	22	16		
National	**49981**	**26731**	**9020**	**5071**	**30156**	**16614**

Source: China Statistical Yearbook, 2000

Table A.19 Environmental Protection Agencies and Staff by Province, 1999

Province	Number of agencies (unit)	Number of staff & workers	Scientific & technical staff	Monitoring personnel	Supervising & administrative personnel
Shanghai	86	1987	188	804	391
Beijing	65	1136	184	375	148
Tianjin	73	1418	189	562	78
Guangdong	1001	6269	220	1702	1340
Liaoning	459	6376	626	2109	1641
Zhejiang	302	3718	240	1832	563
Jiangsu	880	6637	181	2664	1502
Fujian	349	3046	199	1091	701
Heilongjiang	414	4110	168	1468	1033
Shandong	601	10364	262	3423	2651
Hebei	604	8186	205	1607	1803
Jilin	265	3998	209	1289	1491
Hainan	66	1161	30	366	256
Shanxi	429	7243	148	2396	1877
Xinjiang	206	1811	89	678	343
Hubei	420	6366	246	1930	1916
Henan	617	11815	289	3209	3551
Chongqing	151	1694	12	654	363
Hunan	541	5974	240	2019	1103
Shaanxi	341	3985	99	1378	1034
Guangxi	263	1853	115	764	248
Inner Mongolia	513	2995	164	1044	261
Anhui	362	3872	166	1437	825
Jiangxi	346	3166	169	1075	764
Sichuan	428	3942	144	1836	818
Ningxia	62	602	52	156	98
Yunnan	344	1278	170	730	189
Gansu	227	2136	98	642	557
Qinghai	78	337	21	129	59
Guizhou	275	1802	146	591	435
Tibet	19	137		50	
National	**10811**	**121049**	**5269**	**40010**	**28039**

Source: China Statistical Yearbook, 2000

Table A.20 Discharge and Treatment of Industrial Wastewater by Province, 1999

Province	Number of surveyed enterprises (unit)	Total volume of waste water discharged (10000 ton)	Of which volume up to the discharge standards	Number of facilities for treating waste water	Volume of waste water treated (10000 ton)	Volume of waste water reused after treatment	Volume of treated waste water up to the discharge standards (10000 ton)
Shanghai	2045	85280	76664	2079	122495	82407	36958
Beijing	1211	28085	23493	793	105493	91054	12417
Tianjin	1404	14185	11568	829	29039	22440	4570
Guangdong	6763	114844	70062	6646	128068	54629	49930
Liaoning	2525	116040	83280	2214	180902	126418	46922
Zhejiang	5239	117170	94166	4397	95476	36577	52311
Jiangsu	6724	201039	175983	4301	193051	106784	79317
Fujian	3687	53620	35980	3000	58834	27906	22241
Heilongjiang	1936	53736	36608	1278	96305	74850	15072
Shandong	5543	107975	84116	3944	303303	231246	62120
Hebei	2915	97420	61549	3258	282681	240310	37068
Jilin	1111	38795	24241	870	38384	22278	13261
Hainan	303	7114	3823	236	5024	1214	2938
Shanxi	2773	42588	21280	2064	98648	82810	11379
Xinjiang	810	16919	7348	430	19314	11303	4492
Hubei	2147	115985	69385	1970	160710	117642	30346
Henan	3401	94952	67413	3368	228477	175686	42575
Chongqing	1327	90220	58380	1207	107366	68006	32901
Hunan	3103	126146	73510	2955	141629	74090	43625
Shaanxi	1824	31569	18900	1641	39582	25633	11094
Guangxi	1828	87542	42536	1958	97538	57088	21570
Inner Mongolia	1142	22954	11000	590	42921	35794	4307
Anhui	1834	63616	50407	1608	127526	98726	26423
Jiangxi	1054	42493	26222	1300	55626	32507	15932
Sichuan	3377	94536	46696	3313	100936	69468	19574
Ningxia	235	8954	2801	274	11112	7987	1192
Yunnan	1347	37123	11592	1391	77292	62914	5277
Gansu	1247	29576	16395	824	40172	27170	8623
Qinghai	221	4093	2862	116	2989	1208	1501
Guizhou	1858	26067	7768	1156	39970	31148	3991
Tibet	63	2398	12	25	1509	1506	
National	**70997**	**1973036**	**1316043**	**60035**	**3032373**	**2098802**	**719927**

Source: China Statistical Yearbook, 2000

Table A.21 Emission and Treatment of Industrial Waste Gas by Province, 1999

Province	Number of surveyed enterprises (unit)	Number of facilities for treating waste gas	Total volume of waste gas emission (100 million cu.m)	Volume of waste gas in the process of fuel burning	Volume of gas with soot & dust removed	Volume of waste gas from the process of production	Volume of gas purified
Shanghai	2045	4034	4947	2821	2417	2126	1896
Beijing	1211	3660	3083	1777	1586	1306	1202
Tianjin	1404	2520	1570	1132	1031	438	389
Guangdong	6763	10771	7165	4312	3730	2853	2606
Liaoning	2525	7260	8880	5586	4616	3295	2753
Zhejiang	5239	8618	5417	3570	3244	1847	1511
Jiangsu	6724	10221	8343	6373	6049	1970	1561
Fujian	3687	5072	2321	1118	1054	1203	911
Heilongjiang	1936	4741	4059	3287	3172	771	662
Shandong	5543		9841	6443	6008	3398	2903
Hebei	2915	8342	9032	4577	4221	4456	3866
Jilin	1111	3709	3008	2107	2000	901	507
Hainan	303	328	341	210	199	131	129
Shanxi	2773	5471	6287	3899	3407	2388	1397
Xinjiang	810	2144	1839	1210	1141	629	556
Hubei	2147	5111	5566	2492	2308	3075	2444
Henan	3401	7157	6943	4136	3603	2807	2237
Chongqing	1327	2133	1839	1047	897	792	646
Hunan	3103	5645	3787	1870	1674	1917	1648
Shaanxi	1824	3583	2337	1476	1380	860	627
Guangxi	1828	4345	4397	1651	1497	2746	2497
Inner Mongolia	1142	3298	5023	3629	2919	1393	1100
Anhui	1834	3341	3682	2089	1863	1593	1358
Jiangxi	1054	2326	1934	1124	907	809	648
Sichuan	3377	5510	4671	2244	1552	2427	1677
Ningxia	235	622	1102	766	753	336	122
Yunnan	1347	3016	2268	1125	861	1143	870
Gansu	1247	2757	2659	1344	1243	1315	1006
Qinghai	221	434	606	183	167	423	265
Guizhou	1858	2243	3845	2312	1521	1533	847
Tibet	63	47	16	9	3	7	3
National	**70997**	**138934**	**126807**	**75919**	**67026**	**50887**	**40843**

Source: China Statistical Yearbook, 2000

Table A.21 continued

Province	Volume of Sulphur dioxide emission (ton)	Volume of Sulphur dioxide removed (ton)	Volume of industrial soot emission (ton)	Volume of industrial soot removed (ton)	Volume of industrial dust emission (ton)	Volume of industrial dust removed (ton)
Shanghai	310865	33616	90038	2610372	40649	1846108
Beijing	161674	6143	56345	1660157	100235	886618
Tianjin	151769	24649	57841	1507656	21123	170902
Guangdong	669396	135903	335173	4240968	944190	2772746
Liaoning	723645	570961	623436	7742012	453101	3243255
Zhejiang	608138	77245	325283	3445968	690385	2024451
Jiangsu	934906	153152	423320	6853927	457945	1467117
Fujian	169564	23043	80424	1274331	377426	1184903
Heilongjiang	214774	19731	422304	5889536	117624	664439
Shandong	1451547	265529	581024	7831317	786656	6138329
Hebei	1116566	181009	714483	6978661	906916	3309836
Jilin	210021	62913	307370	4680323	134390	1236453
Hainan	22148	915	21738	223634	21308	170736
Shanxi	932251	105659	800500	5450937	616868	1459751
Xinjiang	197909	28399	125381	619896	120404	525516
Hubei	503788	299217	309339	2213220	483803	1823260
Henan	678391	124962	658361	6204566	1004254	2459517
Chongqing	758755	147859	140645	1104036	182431	333317
Hunan	606373	518981	420543	3967711	783784	1700838
Shaanxi	572642	42279	394794	2764518	393867	539144
Guangxi	548499	282700	320340	2265741	458441	2277125
Inner Mongolia	521816	80809	346786	4216527	169100	470647
Anhui	364298	490380	320236	3227888	450900	1579530
Jiangxi	236745	403110	184851	2631229	357010	920967
Sichuan	526157	195282	534426	2194821	665424	1433244
Ningxia	175741	25186	92296	1083254	80309	92620
Yunnan	276596	245965	256596	1434695	234712	1243992
Gansu	257282	366705	134957	1377874	148681	842646
Qinghai	18992	209	52502	344950	63985	88858
Guizhou	678810	97206	401724	2902969	483670	457574
Tibet	892		1269	729	3399	19
National	**14600949**	**5009717**	**9534322**	**98944420**	**11752990**	**43364459**

Source: China Statistical Yearbook, 2000

Table A.22 Discharge, Treatment and Utilization of Industrial Solid Wastes by Province, 1999

Province	Number of surveyed enterprises (unit)	Volume of industrial solid wastes produced (10000 tons)	Dangerous waste	Volume of industrial solid wastes utilized (10000 tons)	Annual volume of industrial solid wastes accumulated (10000 tons)	Volume of industrial solid wastes treated (10000 tons)
Shanghai	2045	1211	26	1287	4	67
Beijing	1211	1161	10	840	309	3
Tianjin	1404	407	8	472	11	26
Guangdong	6763	1877	59	1024	412	172
Liaoning	2525	7545	66	2540	3481	1019
Zhejiang	5239	1361	11	1011	176	104
Jiangsu	6724	2907	95	2432	330	72
Fujian	3687	1590	10	1082	440	121
Heilongjiang	1936	2881	4	1911	434	654
Shandong	5543	5166	70	3877	1198	190
Hebei	2915	7156	38	2971	1680	1381
Jilin	1111	1770	17	817	816	55
Hainan	303	69		30	38	1
Shanxi	2773	6242	20	1461	1089	2373
Xinjiang	810	702	56	267	174	84
Hubei	2147	2511	26	1494	838	129
Henan	3401	3477	13	1790	1189	1078
Chongqing	1327	1511	52	655	311	42
Hunan	3103	1869	47	1049	628	188
Shaanxi	1824	2624	6	367	1627	342
Guangxi	1828	2068	23	1173	683	296
Inner Mongolia	1142	2510	42	573	1632	246
Anhui	1834	2974	38	2081	484	719
Jiangxi	1054	3984	1	695	3154	57
Sichuan	3377	4396	47	1526	1738	123
Ningxia	235	419	1	148	236	24
Yunnan	1347	3117	111	908	1238	239
Gansu	1247	1699	13	438	1075	49
Qinghai	221	305	2	111	171	5
Guizhou	1858	2925	101	726	688	905
Tibet	63	6	1		10	
National	70997	78442	1015	35756	26295	10764

Source: China Statistical Yearbook, 2000

Table A.22 continued

Province	Volume of industrial solid wastes Discharged (10000 tons)	Dangerous waste	Total volume of industrial solid wastes accumulated (10000 tons)	Areas occupied by industrial solid wastes (10000 sqm)	Output value products made from utilization of 'three wastes' (10000 yuan)	Profits obtained from utilization of 'three wastes' (10000 yuan)
Shanghai			554	119	86926	48093
Beijing	35		11672	290	41403	13584
Tianjin	2		1196	1191	22784	1018
Guangdong	58		22205	3033	130915	21681
Liaoning	134	4	124253	4668	170260	36621
Zhejiang	11		5451	754	118244	55239
Jiangsu	7		9943	2489	191672	35955
Fujian	18		4162	12859	65395	21607
Heilongjiang	1		23842	2587	82302	10322
Shandong	3		33122	3452	323559	58825
Hebei	247		65153	3675	124158	16510
Jilin	26		18921	2009	89806	37285
Hainan			2137	316	1548	626
Shanxi	718		27078	2025	49553	6963
Xinjiang	111		4057	545	37776	7016
Hubei	28		12020	1807	90382	16734
Henan	31		26437	2070	165881	15570
Chongqing	291	1	7434	775	80554	11719
Hunan	59	1	25628	2214	103071	20635
Shaanxi	160		16547	1079	38589	4742
Guangxi	82		8531	925	102100	9775
Inner Mongolia	60		26354	2706	21153	12161
Anhui	37		11424	1849	77884	17333
Jiangxi	34		53324	3317	30777	6436
Sichuan	476	0	31118	794	157526	43125
Ningxia	10		4306	611	15485	4214
Yunnan	567		20662	1858	83313	11462
Gansu	64	1	18940	2193	37820	5463
Qinghai	1		6225	120	953	188
Guizhou	610	30	14918	475	31751	4064
Tibet	1		6	1	162	41
National	**3880**	**36**	**637624**	**62808**	**2573700**	**555003**

Source: China Statistical Yearbook, 2000

Table A.23 Pollution Accidents by Province, 1999

Province	Number of Pollution accidents (times)	Water pollution	Air pollution	Solid waste pollution	Pollution damage converted into cash (10000 yuan)	Amount of reparations and fines (10000 yuan)
Shanghai						
Beijing						
Tianjin						
Guangdong	171	120	44	2	239.6	163.9
Liaoning	89	31	35	17	182.0	210.0
Zhejiang	44	30	14		27.1	8.8
Jiangsu	103	61	35	4	370.9	70.6
Fujian	28	18	10		41.5	19.5
Heilongjiang	4	2	1		22.4	10.8
Shandong	148	36	86	25	122.7	111.1
Hebei	11	8	1	1	30.5	29.8
Jilin	18	6	8	1	17.4	16.0
Hainan	9	8	1		4.7	4.5
Shanxi	10	4	4		318.1	163.7
Xinjiang	14	11	3		11.3	8.4
Hubei	18	7	11		36.5	34.6
Henan	25	10	13	1	24.1	21.5
Chongqing	37	27	8	1	27.5	18.7
Hunan	13	10	3		228.6	202.7
Shaanxi	65	38	18	5	61.0	27.2
Guangxi	280	141	129	7	1364.8	293.2
Inner Mongolia	11	7	2		19.3	
Anhui	51	39	10	2	1049.0	62.5
Jiangxi	97	56	32	3	172.7	101.4
Sichuan	90	51	25	3	243.6	193.0
Ningxia	6	3	3		5.3	
Yunnan	148	72	64	5	205.2	160.4
Gansu	99	83	8	2	773.2	132.8
Qinghai	8	1	6		91.8	40.3
Guizhou	17	8	8	1	19.6	11.1
Tibet						
National	**1614**	**888**	**582**	**80**	**5710.6**	**2116.3**

Source: China Statistical Yearbook, 2000

Table A.24 Discharge of Pollutants from Domestic Sources by Province, 1999

Province	Volume of waste water discharged (10000 tons)	Absorption of oxygen by waste water (ton)	Emission of sulfur dioxide (ton)	Emission of dust (ton)
Shanghai	117559	260605	92259	45667
Beijing	54118	139828	71813	22442
Tianjin	22369	118400	90654	51508
Guangdong	313918	509945	25547	12097
Liaoning	96241	382215	213721	192595
Zhejiang	75018	274775	28283	10527
Jiangsu	134994	377360	44750	15763
Fujian	47945	169917	20800	16250
Heilongjiang	57964	350748	79290	104617
Shandong	116160	484087	378205	132056
Hebei	62791	217841	209592	199891
Jilin	48467	222825	83727	79696
Hainan	15826	57941	243	20
Shanxi	50168	176485	307245	124965
Xinjiang	28564	92844	139187	118541
Hubei	117476	373846	49466	26697
Henan	120613	428291	171356	98074
Chongqing	42574	138382	182371	95517
Hunan	88571	301969	152020	12464
Shaanxi	35368	160735	75202	40071
Guangxi	78310	261273	34957	3408
Inner Mongolia	22844	120057	169039	202923
Anhui	71389	277300	45545	34860
Jiangxi	52794	296967	47556	4955
Sichuan	74606	312767	286592	31346
Ningxia	4042	33689	32111	25971
Yunnan	29386	146470	59986	123758
Gansu	15988	83240	55137	43808
Qinghai	7282	29127	12038	17815
Guizhou	33778	171230	815662	167502
Tibet	558	496		
National	**2037681**	**6971651**	**3974354**	**2055804**

Source: China Statistical Yearbook, 2000

Fig. A.13 Volume of Domestic Wastewater Discharged as Percentage of Total, by Province

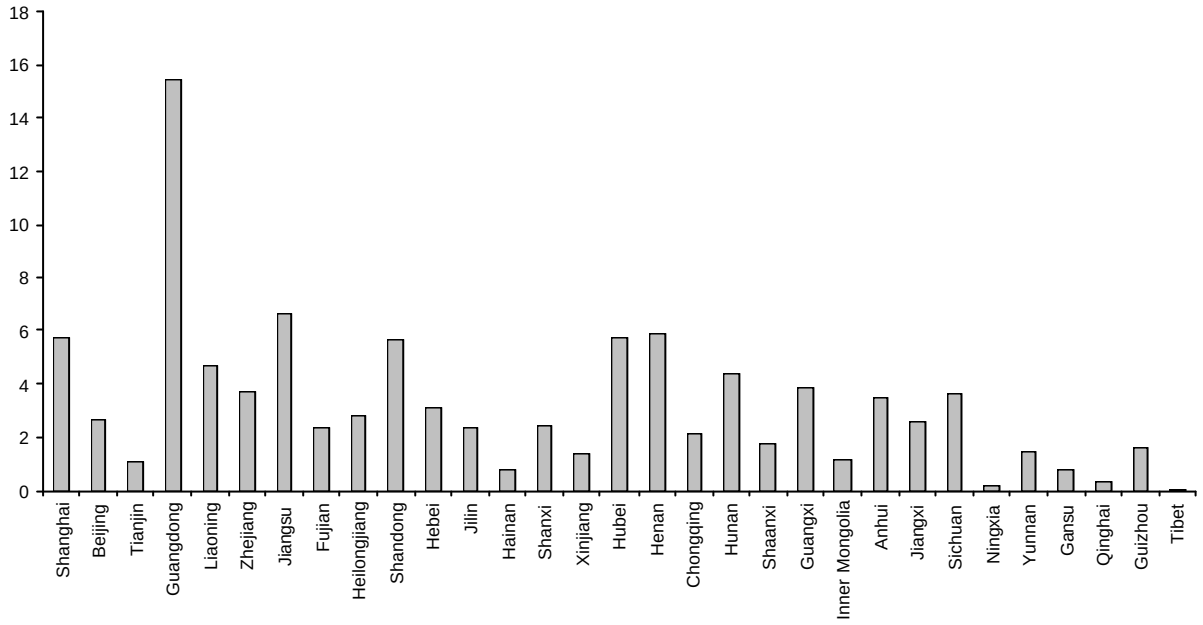

Fig. A.14 Consumption of Oxygen by Domestic Wastewater as Percentage of Total, by Province

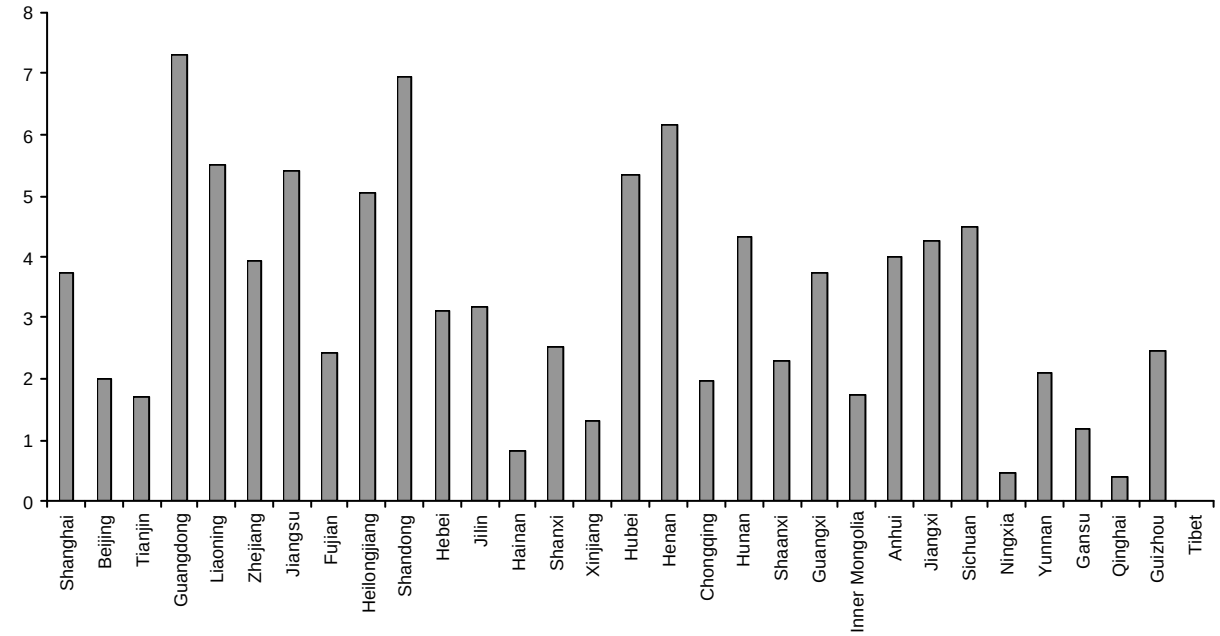

Table A.25 Investment in Industry Anti-pollution Projects by Province, 1999

Province	Number of surveyed enterprises (unit)	Number of projects under construction	For treating waste water	For treating waste gas	For treating Solid wastes	For treating other pollution
Shanghai	389	568	262	241	11	54
Beijing	367	465	129	284	10	42
Tianjin	488	600	204	301	37	58
Guangdong	885	1132	693	349	13	77
Liaoning	409	584	210	304	27	43
Zhejiang	1484	1747	1227	410	36	74
Jiangsu	1368	1849	774	803	41	231
Fujian	1222	1604	832	644	40	88
Heilongjiang	326	424	128	256	20	20
Shandong	1229	1605	603	839	29	134
Hebei	452	545	220	290	11	24
Jilin	260	281	93	151	11	26
Hainan	31	37	17	18	1	1
Shanxi	434	621	231	328	24	38
Xinjiang	79	108	24	74	5	5
Hubei	354	503	205	203	25	70
Henan	2552	2677	348	298	24	35
Chongqing	233	300	106	137	21	36
Hunan	431	581	213	267	60	41
Shaanxi	311	404	166	159	34	45
Guangxi	405	596	299	242	30	25
Inner Mongolia	215	248	72	156	7	13
Anhui	468	666	353	257	25	31
Jiangxi	110	166	64	56	13	33
Sichuan	464	608	268	254	43	43
Ningxia	52	71	11	40	11	9
Yunnan	265	393	165	180	25	23
Gansu	174	225	74	122	17	12
Qinghai	15	22	7	11	3	1
Guizhou	137	236	76	111	24	25
Tibet						
National	**15609**	**19866**	**8074**	**7785**	**678**	**1357**

Source: China Statistical Yearbook, 2000

Table A.25 Continued

Province	Investment completed in anti-pollution projects (10000 yuan)	For treating waste water	For treating waste gas	For treating Solid wastes	For treating other pollution	Number of projects completed
Shanghai	58714	24462	16101	4302	13849	364
Beijing	137591	10052	50154	2555	74830	433
Tianjin	34485	21278	10936	489	1782	498
Guangdong	78877	39707	37041	306	1823	935
Liaoning	67610	30400	28422	4538	4250	528
Zhejiang	134494	90251	22896	7435	13912	1299
Jiangsu	116959	61009	31679	2337	21934	1280
Fujian	45191	19456	14152	5393	6190	876
Heilongjiang	50097	24243	15541	10099	214	370
Shandong	230235	115414	56029	8385	50408	1392
Hebei	58689	23981	32806	918	985	463
Jilin	34134	18094	13022	1765	1253	227
Hainan	2403	1751	362	290	0	21
Shanxi	41734	16073	11222	7167	7273	478
Xinjiang	13520	2756	9978	435	351	101
Hubei	31804	13288	11439	1894	5182	367
Henan	58384	35078	18170	716	2904	492
Chongqing	10733	5181	4495	413	645	229
Hunan	33711	14600	13548	1509	4055	491
Shaanxi	32530	12829	16033	886	2782	332
Guangxi	36746	15838	13535	1352	6022	454
Inner Mongolia	20541	2792	17304	294	151	173
Anhui	43543	23885	14897	2532	2230	360
Jiangxi	9025	6223	1841	343	618	152
Sichuan	37398	17333	11587	7632	846	535
Ningxia	10853	4204	1920	3407	1322	65
Yunnan	26385	11838	11496	2716	335	349
Gansu	45628	22507	6380	781	15960	195
Qinghai	3924	336	3529	39	20	17
Guizhou	21369	3445	13332	2429	2163	196
Tibet						
National	**1527307**	**688302**	**509847**	**83354**	**244288**	**13672**

Source: China Statistical Yearbook, 2000

Fig. A.15 Emission of Sulfur Dioxide from Domestic Sources as Percentage of Total, by Province

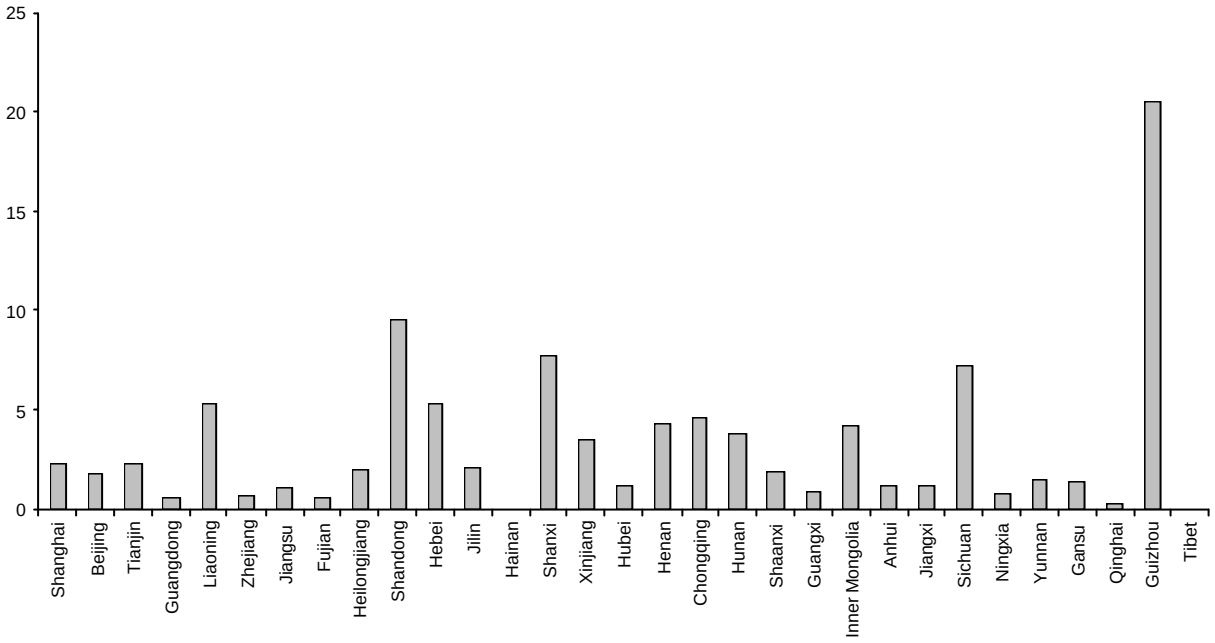

Fig. A.16 Emission of Dust from Domestic Sources as Percentage of Total, by Province

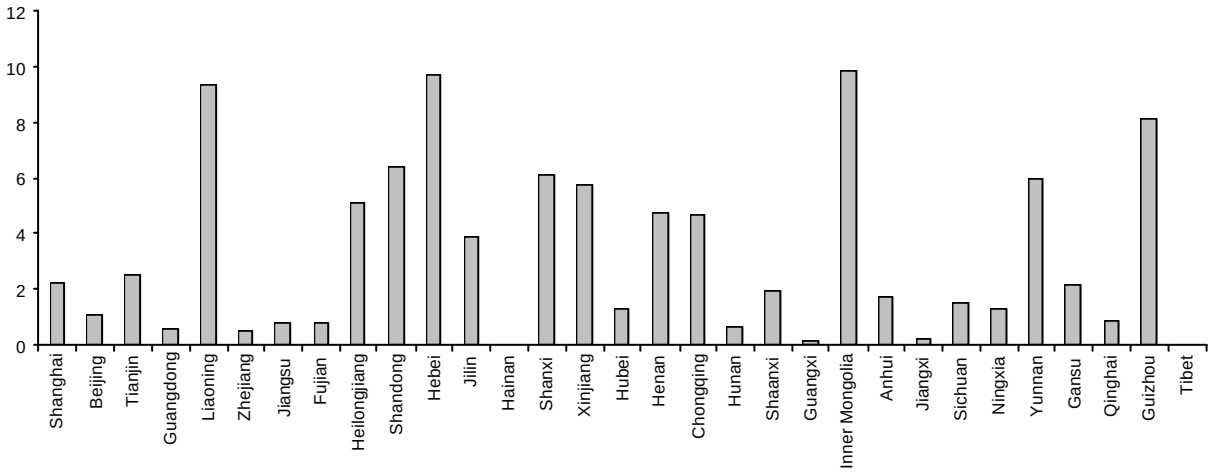

Table A.26 Areas of Planting Trees by Province, 1997

Province	Areas of planting trees in 1997 (1000 ha)	For timber	Economic forest	For environmental protection
Shanghai	2.08	0	1.91	0.17
Beijing	37.56	0.06	2.36	33.74
Tianjin	8.99	0.26	3.37	5.36
Guangdong	4.96	2.35	1.35	0.96
Liaoning	154.82	33.74	30.83	63.1
Zhejiang	37.15	11.81	21.87	2.31
Jiangsu	19.21	9.2	5.92	3.71
Fujian	29.99	13.05	7.55	5.26
Heilongjiang	278.00	169.21	21.74	65.97
Shandong	174.20	25.28	100.88	47.17
Hebei	386.16	84.99	115.84	176.27
Jilin	62.87	22.73	19.37	19.7
Hainan	15.24	7.13	4.93	3.03
Shanxi	430.74	98.08	128.13	202.18
Xinjiang	50.51	3.24	16.13	27.12
Hubei	223.61	90.79	112.66	14.14
Henan	139.84	89.43	21.84	27.7
Chongqing	108.98	28.24	48.68	28.66
Hunan	42.94	26.25	12.99	3.26
Shaanxi	271.81	73.73	97.26	90.85
Guangxi	112.84	48.78	54.62	6.57
Inner Mongolia	464.41	93.87	81.81	286.55
Anhui	86.89	35.08	42.23	8.09
Jiangxi	81.00	46.92	25.11	7.18
Sichuan	281.50	105.43	95.72	76.39
Ningxia	24.09	2.71	6.62	14.11
Yunnan	376.36	161.19	146.02	58.23
Gansu	156.82	30.63	65.09	38.17
Qinghai	35.57	4.94	1.94	17.98
Guizhou	235.52	126.46	76.54	30.94
Tibet	13.00	12	0	1
National	**4354.93**	**1465.05**	**1371.31**	**1366.23**

Source: China Environmental Yearbook, 1998

7. Provincial Health Risk Index for China*

Introduction

The Health Risk Index (HRI) can be estimated using similar approaches used by UNDP and the World Resources Institute in calculating the Human Development Index (HDI) in measuring potential exposure to health risks from environmental threats.

The HRI appears to be inversely proportional to the HDI (see box 2.5). According to WRI, the quality of air, water, and food resources within a country can influence the health and potential exposure of populations to environmental health risks. In China, it is proposed to use potential exposure to air pollution, water pollution, poor nutrition, and access to health services, as components of the Health Risk Index. Confounding factors, though important, were not considered here. Future refinement of the HRI methodology involves using more variables depending on availability of data.

As in other developing countries, there is scarcity of data in China for both environment and health statistics. In many cases, proxy indicators for human-environment relationships were applied as well as the best available database such as published yearbooks, even if they may be of low quality or incomplete. In this section, we describe the methods in developing the indicators of environmental health risk using the best data available between 1995-1999.

Methods

For the 27 provinces and 3 autonomous cities (excluding Chongqing) of China, there are four indicators to estimate their likely health risk potential: exposure to polluted indoor and outdoor air, polluted water, poor nutrition and access to health services. The fourth one, though not due to environmental conditions, can influence the total risk potential in terms of being able to provide timely medical attention. The following were found important in China:

Calculation of index for each province/city

1. Potential exposure to air pollution (indoor and outdoor)

a) Indoor air pollution

$$\text{Residential coal consumption per family}$$

b) Outdoor air pollution

$$\% = \frac{\text{Population living in cities exceeding the WHO air quality guidelines}}{\text{Total population}}$$

Or in China, it becomes

$$\% = \frac{\text{urban population}}{\text{total population}} \times 100$$

Based on 1999 Environment Statistical Yearbook, almost all cities exceeded in at least one parameter (TSP, SO_2, NO_2).

2. Potential exposure to polluted water

a) Percentage of population without access to safe water

$$\% = \frac{100\ [(\text{urban population} \times \%\text{ of urban water samples exceeding standard}) + (\text{rural population} \times \%\text{ of rural water samples exceeding standard})]}{\text{Total population}}$$

3. Poor nutrition

Percentage of children below 5 years whose weight-for-age is less than the weight median -2SD

4. Capacity of health services

a) ‰ = Number of hospital beds, doctors and nurses per 1000 persons

b) $$\% = \frac{\text{Population without health units}}{\text{Total population in the province/city}} x100$$

Linear transformation using the formula below was applied to each of the calculated values to obtain the respective index value. All the indicators were assigned equal weights and the HRI was computed by getting the average of the four indices.

$$\text{Index} = \frac{\text{Actual } X_i \text{ value} - \text{minimum } X_i \text{ value}}{\text{Maximum } X_i \text{ value} - \text{minimum } X_i \text{ value}}$$

Plotting the infant mortality rate (IMR) versus HRI validated the computed HRI since a positive correlation was obtained, i.e., a province with a high health risk also had high infant mortality. The same strong correlation was also found if UMR (under 5 mortality rate) and MMR (maternal mortality rate) were used instead of IMR.

Example of the HRI Methodology

The calculation of the provincial HRI is illustrated with two examples - Shanghai and Guizhou provinces.

1. Potential exposure to air pollution (indoor and outdoor air pollution)

a) Indoor air pollution

$$\text{Shanghai} = \frac{\text{Total amount of residential coal consumption}}{\text{Total number of families}} = \frac{1549700}{4394000} = 0.35$$

*based on the UNDP-WHO Project (2001) *Environment and People's Health in China*

$$\text{Guizhou} = \frac{\text{Total amount of residential coal consumption}}{\text{Total number of families}} = \frac{11315000}{8595200} = 1.32$$

The minimum and maximum values of residential coal consumption per household in China are 0 and 1.7 ton, respectively.

Indoor air pollution index:

$$\text{Shanghai} = \frac{0.35 - 0}{1.70 - 0} = 0.21$$

$$\text{Guizhou} = \frac{1.32 - 0}{1.70 - 0} = 0.77$$

b) Outdoor air pollution

$$\text{Shanghai} = \frac{\text{Urban population}}{\text{Total population}} \times 100\% = \frac{1184}{1413.50} = 83.76\%$$

$$\text{Guizhou} = \frac{\text{Urban population}}{\text{Total population}} \times 100\% = \frac{793}{3508.08} = 22.60\%$$

The minimum and maximum values of potential exposure to outdoor air pollution in China are 0% and 83.76%, respectively.

Outdoor air pollution index:

$$\text{Shanghai} = \frac{83.76 - 0}{83.76 - 0} = 1.00$$

$$\text{Guizhou} = \frac{22.60 - 0}{83.76 - 0} = 0.27$$

Air pollution index:

$$\text{Shanghai} = \frac{0.21 + 1.00}{2} = 0.61$$

$$\text{Guizhou} = \frac{0.77 + 0.27}{2} = 0.55$$

2. Potential exposure to polluted water

$$\text{Shanghai} = \frac{1184 \times 0.0288 + 229.5 \times 0.0358}{1413.50} \times 100\% = 2.99\%$$

$$\text{Guizhou} = \frac{793 \times 0.1353 + 2715.1 \times 0.3469}{3508.08} \times 100\% = 29.91\%$$

The minimum and maximum values of potential exposure to water pollution in China are 0.94% and 81.50%, respectively.

Water pollution index:

$$\text{Shanghai} = \frac{2.99 - 0.94}{81.50 - 0.94} = 0.03$$

$$\text{Guizhou} = \frac{29.91 - 0.94}{81.50 - 0.94} = 0.36$$

3. Poor nutrition

The minimum and maximum values of poor nutrition in China are 0.24% and 12.56%, respectively.

Poor nutrition index:

$$\text{Shanghai} = \frac{0.24 - 0.24}{12.56 - 0.24} = 0.00$$

$$\text{Guizhou} = \frac{6.12 - 0.24}{12.56 - 0.24} = 0.48$$

4. Capacity of the health services

a) Population without access to health units:
The minimum and maximum values of population without access to health units in China are 0.49% and 38.89%, respectively.

Population without access to health units index:

$$\text{Shanghai} = \frac{0.49 - 0.49}{38.89 - 0.49} = 0.00$$

$$\text{Guizhou} = \frac{17.18 - 0.49}{38.89 - 0.49} = 0.43$$

b) Number of hospital beds, doctors and nurses per 1000 persons
The minimum and maximum values for the number of hospital beds, doctors and nurses per 1000 persons in China are 3.38 and 14.36, respectively.

$$\text{Shanghai} = 1 - \frac{11.81 - 3.38}{14.36 - 3.38} = 0.23$$

$$\text{Guizhou} = 1 - \frac{3.38 - 3.38}{14.36 - 3.38} = 1.00$$

Access to health services index:

$$\text{Shanghai} = \frac{0.00 + 0.23}{2} = 0.12$$

$$\text{Guizhou} = \frac{0.43 + 1.00}{2} = 0.72$$

5. Provincial HRI

The HRI is a simple average of the air pollution index, water pollution index, poor index and access to health service index.

$$\text{Shanghai} = \frac{0.61 + 0.03 + 0.00 + 0.12}{4} = 0.19$$

$$\text{Guizhou} = \frac{0.52 + 0.36 + 0.48 + 0.72}{4} = 0.52$$

Province	Air pollution	Water pollution	Poor Nutrition	Capacity of health services	HRI
Shanghai	0.61	0.03	0.00	0.12	0.19
Guizhou	0.52	0.36	0.48	0.72	0.52

Table A.27 Data Tabulation for Provincial Health Risk Index

	Total (10,000)	Urban (10,000)	Rural (10,000)	Household (number)	Poor nutrition % (children < 5 yr)	Poor nutrition Index	Village without health units %	Population without health units %	Index	Hospital beds (per 1 000)	Doctors and assistant doctors (per 1 000)	Senior nurses and nurses (per 1 000)	Population with Hosp.beds &oct. Nur. (per 1 000)	Irdex	Access to health service Index
Tibet	238.90	32	206.9	460000	6.26	0.49	44.9	38.89	1.00	2.57	2.07	0.72	5.36	0.82	0.91
Ningxia	509.37	147	362.4	1193600	12.56	1.00	7.8	5.55	0.13	2.43	1.95	1.24	5.63	0.80	0.46
Guizhou	3508.08	793	2715.1	8595200	6.12	0.46	22.2	17.18	0.43	1.54	1.25	0.59	3.38	1.00	0.72
Henan	9100.00	1559	7541.0	23270000	5.17	0.46	2.5	2.07	0.04	1.92	1.14	0.85	3.71	0.97	0.51
Gansu	2437.95	562	1876.0	5959000	5.69	0.44	8.0	6.16	0.15	2.23	1.54	0.85	4.62	0.89	0.52
Yunnan	3971.31	651	3320.3	9472400	7.97	0.63	1.3	1.09	0.02	2.18	1.49	0.85	4.51	0.90	0.46
Zhejiang	4312.00	1450	2862.0	13308642	1.55	0.11	35.5	25.55	0.65	2.33	1.58	0.87	4.78	0.87	0.76
Guangxi	4527.40	835	3692.4	10393000	4.97	0.38	2.9	2.37	0.05	1.76	1.30	0.84	3.90	0.85	0.50
Shanxi	3077.28	917	2160.3	8103800	4.11	0.31	9.9	6.85	0.17	3.33	2.30	1.23	3.63	0.68	0.43
Qinghai	481.20	136	345.2	1039200	5.84	0.45	4.0	2.87	0.06	3.49	2.07	1.35	3.91	0.68	0.37
Shaanxi	3499.82	903	2596.8	9004300	3.20	0.24	13.5	10.02	0.25	2.80	1.80	0.94	3.94	0.82	0.53
Jiangxi	4046.69	915	3131.7	9253200	3.21	0.40	4.8	3.71	0.08	2.05	1.29	0.87	4.21	0.92	0.50
Sichuan	11281.00	2903	8378.0	33520000	2.72	0.20	15.5	11.51	0.29	2.05	1.53	0.89	4.27	0.92	0.60
Heilongjiang	3690.00	1717	1973.0	16247000	1.36	0.06	5.0	2.68	0.06	3.12	2.09	1.42	6.63	0.70	0.36
Hubei	5755.67	1796	3959.6	15213700	2.60	0.19	12.0	8.25	0.20	2.21	1.72	1.24	5.17	0.84	0.52
Anhui	6013.00	1154	4859.0	15770000	2.75	0.20	5.7	4.61	0.11	1.86	1.10	0.84	3.60	0.98	0.54
Jilin	2587.50	1212	1375.9	7311000	4.63	0.36	9.2	3.30	0.07	3.33	2.25	1.58	7.17	0.65	0.56
Shandong	8691.40	2776	5915.4	25074000	1.78	0.13	7.3	4.97	0.12	2.21	1.50	0.98	4.69	0.88	0.50
Inner Mongolia	2277.68	971	1406.7	6226100	2.64	0.19	7.2	4.45	0.10	2.71	2.27	1.13	6.11	0.75	0.43
Hainan	723.79	157	566.8	1611200	4.69	0.36	17.5	13.46	0.34	2.82	1.72	1.30	5.84	0.78	0.56
Hunan	6386.53	1469	4917.9	17690600	2.66	0.20	8.0	6.16	0.15	2.07	1.44	0.83	4.34	0.91	0.53
Tianjin	940.50	657	283.5	2801400	0.79	0.04	7.8	2.29	0.05	4.30	3.45	2.29	10.06	0.39	0.22
Hebei	6436.51	1354	5082.5	17256100	3.71	0.28	5.5	4.34	0.10	2.21	1.59	0.75	4.55	0.89	0.50
Guangdong	8638.00	2005	6633.0	16939000	2.25	0.16	8.5	5.16	0.12	2.07	1.48	1.08	4.63	0.89	0.50
Liaoning	4066.00	2130	1936.0	11870000	1.67	0.13	2.5	1.20	0.02	4.31	2.41	1.84	8.56	0.53	0.27
Xinjiang	1654.33	540	1114.3	4036600	2.78	0.21	12.9	8.69	0.21	3.84	2.49	1.73	8.06	0.57	0.39
Fujian	3228.00	732	2496.0	7850000	2.70	0.20	3.5	2.71	0.06	2.51	1.29	0.85	4.65	0.68	0.47
Jiangsu	7055.28	1926	5127.3	20089400	1.51	0.10	4.7	3.42	0.08	2.28	1.67	1.02	4.97	0.85	0.47
Beijing	1251.10	872	379.1	3940965	0.61	0.03	7.4	0.27	0.12	6.10	4.72	3.54	14.36	0.00	0.66
Shanghai	1413.50	1184	229.5	4594000	0.24	0.00	3.0	0.49	0.30	5.23	3.85	2.73	11.91	0.23	0.12

Table A.27 continued

	Residential coal consumption (10 000 tons)	Coal consumption (ton per household)	Indoor air pollution index	Population exposure to outdoor air pollution (%)	Outdoor air pollution index	Air Pollution Index	Water sample investigated		Water sample up to standard		% of unsafe water sample		Urban Population without safe water (10 000)	Rural Population without safe water (10 000)	Population exposure to unsafe water %	Water pollution index	Total Index
							Urban	Rural	Urban	Rural	Urban	Rural					
Tibet	78.10	1.70	1.30	13.39	0.16	0.56	79	34	34	5	56.96	85.29	18.23	176.47	51.50	1.00	0.748
Ningxia	87.90	0.74	0.43	28.85	0.34	0.38	750	326	590	214	21.33	34.36	31.36	124.51	33.60	0.37	0.555
Guizhou	1131.90	1.32	0.77	22.50	0.27	0.52	6451	8696	5578	5679	13.53	34.69	107.31	941.98	29.91	0.35	0.519
Henan	827.90	0.35	0.21	17.13	0.20	0.21	7825	53843	6527	20186	17.64	62.49	275.01	4712.44	54.81	0.67	0.466
Gansu	411.70	0.73	0.43	23.05	0.28	0.35	1381	1178	1584	772	15.79	34.13	88.74	840.20	29.90	0.35	0.418
Yunnan	227.00	0.24	0.14	16.39	0.20	0.17	8545	7684	6115	4697	21.65	36.27	142.24	1204.28	33.91	0.41	0.415
Zhejiang	209.80	0.16	0.09	33.63	0.40	0.25	21571	9447	19946	6038	16.34	36.09	296.95	1032.77	29.45	0.35	0.407
Guangxi	115.31	0.11	0.07	18.44	0.22	0.14	3329	8231	2915	5584	19.67	32.04	154.28	1182.95	29.76	0.36	0.346
Shanxi	502.25	0.62	0.36	29.80	0.36	0.35	5530	10226	5930	7440	9.19	27.24	84.28	506.58	21.86	0.26	0.340
Qinghai	122.00	1.17	0.69	28.26	0.34	0.51	181	114	175	114	3.31	6.00	4.51	0.00	0.94	0.00	0.335
Shaanxi	319.10	0.35	0.21	25.80	0.31	0.26	2766	1792	2359	1271	14.35	29.07	129.61	754.98	25.28	0.30	0.334
Jiangxi	196.15	0.21	0.13	22.61	0.27	0.20	4128	6068	3698	4967	10.66	19.23	97.53	602.29	17.29	0.20	0.327
Sichuan	852.28	0.25	0.15	25.73	0.31	0.23	6588	6810	5704	5302	13.39	19.79	338.77	1657.86	18.14	0.21	0.312
Heilongjiang	583.90	0.55	0.32	46.49	0.55	0.44	8508	3299	7460	2170	12.32	34.13	211.50	674.64	23.99	0.29	0.299
Hubei	828.20	0.41	0.24	31.20	0.37	0.31	27410	5824	22718	5006	17.12	14.05	307.44	556.14	15.00	0.17	0.298
Anhui	362.10	0.23	0.14	19.19	0.23	0.18	6290	5405	5395	4130	14.21	23.59	164.02	1146.20	21.79	0.26	0.297
Jilin	152.68	0.21	0.12	16.83	0.20	0.34	10589	8579	8742	7620	8.00	11.14	86.96	153.32	9.57	0.11	0.292
Shandong	1156.50	0.46	0.27	31.94	0.38	0.33	11780	16261	8770	15689	25.55	14.08	709.32	883.16	17.75	0.21	0.290
Inner Mongolia	195.29	0.31	0.18	38.24	0.46	0.32	707	597	533	532	23.76	10.69	206.97	153.16	15.81	0.18	0.282
Hainan	0.22	0.00	0.00	0.00	0.00	0.00	3407	8946	2838	8096	31.38	12.25	52.40	68.22	16.66	0.20	0.278
Hunan	688.80	0.39	0.23	23.00	0.27	0.25	8618	14278	7665	12812	10.01	10.27	147.11	534.95	10.21	0.12	0.273
Tianjin	305.05	1.10	0.65	60.85	0.83	0.74	3713	1122	3680	885	0.80	21.03	5.84	59.03	6.90	0.07	0.270
Hebei	583.33	0.34	0.20	21.04	0.25	0.22	7639	25252	7391	23345	3.25	7.58	43.79	335.48	6.67	0.07	0.269
Guangdong	87.27	0.06	0.03	39.27	0.47	0.25	12396	14936	11346	12574	8.32	15.75	223.50	654.42	12.84	0.15	0.266
Liaoning	476.14	0.41	0.24	52.13	0.62	0.43	6939	4324	6525	2870	5.97	33.46	127.08	654.58	19.13	0.23	0.265
Xinjiang	146.70	0.36	0.21	32.64	0.39	0.30	1825	1445	1655	1220	8.77	15.63	47.34	174.16	13.39	0.15	0.264
Fujian	155.30	0.20	0.12	22.68	0.27	0.19	34832	10009	33749	9586	3.11	19.67	22.78	490.93	15.91	0.19	0.263
Jiangsu	448.52	0.22	0.13	27.31	0.33	0.23	2900	4211	2790	3474	5.85	17.50	112.90	887.37	14.32	0.17	0.241
Beijing	361.90	0.92	0.54	69.70	0.83	0.69	4216	1591	3971	1447	8.18	23.48	71.36	80.01	12.82	0.15	0.231
Shanghai	154.97	0.35	0.21	83.76	1.00	0.60	79550	41462	77260	39995	2.88	3.58	34.08	8.23	2.99	0.03	0.186

Table A.28 Summary Of Provincial Health Risk Index (HRI)

	Index				HRI
	Air Pollution	Water pollution	Poor nutrition	Access to health service	
Shanghai	0.61	0.03	0.00	0.12	0.19
Beijing	0.69	0.15	0.03	0.06	0.23
Jiangsu	0.23	0.17	0.10	0.47	0.24
Xinjiang	0.30	0.15	0.21	0.39	0.26
Tianjin	0.74	0.07	0.04	0.22	0.27
Liaoning	0.43	0.23	0.13	0.27	0.27
Hebei	0.23	0.07	0.28	0.50	0.27
Guangdong	0.25	0.15	0.16	0.50	0.27
Fujian	0.20	0.19	0.20	0.47	0.27
Inner Mongolia	0.32	0.18	0.19	0.43	0.28
Hunan	0.25	0.12	0.20	0.53	0.28
Hainan	0.00	0.20	0.36	0.56	0.28
Shandong	0.33	0.21	0.13	0.50	0.29
Jilin	0.34	0.11	0.36	0.36	0.29
Hubei	0.31	0.17	0.19	0.52	0.30
Heilongjiang	0.44	0.29	0.09	0.38	0.30
Anhui	0.18	0.26	0.20	0.54	0.30
Sichuan	0.23	0.21	0.20	0.60	0.31
Shaanxi	0.26	0.30	0.24	0.53	0.33
Qinghai	0.51	0.00	0.45	0.37	0.33
Jiangxi	0.20	0.20	0.40	0.50	0.33
Shanxi	0.36	0.26	0.31	0.43	0.34
Guangxi	0.15	0.36	0.38	0.50	0.35
Zhejiang	0.25	0.35	0.11	0.76	0.37
Yunnan	0.17	0.41	0.63	0.46	0.42
Gansu	0.35	0.36	0.44	0.52	0.42
Henan	0.21	0.67	0.48	0.51	0.47
Guizhou	0.52	0.36	0.48	0.72	0.52
Ningxia	0.39	0.37	1.00	0.46	0.56
Tibet	0.58	1.00	0.49	0.91	0.75

Table A.29 Major Laws, Measures and Regulations in China for Conserving Biodiversity

Constitution 1982	Laid down by the National People's Congress, is the fundamental law of China and provides a legal basis for making other laws. Article 9 of the Constitution provides that the "State ensure rational utilisation of the natural resources, protect any animals and plants, and prohibit any forms of encroachment and damage of the natural resources by any groups or individuals." Article 26 provides that the "State shall protect and improve the people's living environment and ecological environment and control pollution and other public nuisance; organize and encourage afforestation and protection of trees".
Laws	*Marine Environmental Protection Law (1982)* *Forest Law (1984)* *Grasslands Law (1985)* *Fishery Law (1986)* *Wildlife Protection Law (1988)* *Environmental Protection Law (1989)* *Water and Soil Conservation Law (1991)* *Law on Quarantine of Imported and Exported Animals and Plants* *Supplementary Rules about Punishing Crimes for Hunting Rare and Endangered Wild Animals of National Priority Protection*
Administrative Regulations	*Regulations about Aquatic Resources Conservation (1979)* *Plant Quarantine Regulations (1983)* *The State Council's General Order of Strictly Protecting Rare Wild Animals (1983)* *Temporary Regulations on Management of Scenic Spots (1985)* *Regulations for the Implementation of the Forest Law (1986)* *Regulations for the Implementation of the Fishery Law (1987)* *Regulations about Control of Forest Fires (1988)* *Regulations about Control of Forest Pests (1989)* *Regulations about Seed Management (1989)* *Regulations about Protection and Administration of Wild Medicinal Material Resources (1987)* *Administrative Regulations about Prevention of Pollution and Damage of Marine Environment by Seashore Construction Projects (1983)* *Regulations on Afforestation in Urban Areas (1992)* *Regulations Regarding the Protection of Terrestrial Wild Animals (1992)* *Regulations for the Protection of Aquatic Wild Animals (1993)* *The State Council's Decision on Further Strengthening Environmental Protection (1990)* *Regulations on Management of Breeding Livestock and Poultry (1994)* *Regulations about Nature Reserves (1994)* *Regulations Regarding the Nature Reserves of the P.R.C.* *Regulations on Protection of Wild Plants (1996)* *The State Council's Decision on Several Environmental Protection Issues (1996)*

Table A.29 (contd.) Major Laws, Measures and Regulations in China for Conserving Biodiversity

Local regulations and laws	Formulated by provincial Peoples' Congresses (autonomous regions and municipalities directly under the central government) and their standing committees. For example: *Enforcement Regulations Regarding Management of Forests in Guangdong Province* *Regulations about Management of Grasslands in Inner Mongolia* *Provisional Rules Regarding the Protection of Rare and Endangered Wild Plants in Liaoning Province* *Provisional Rules Regarding Management of Wildlife in Jilin Province* *Regulations on Nature Reserves in Zhejiang Province*	
Rules	Drawn up by relevant departments in charge of the Rules of the State Council and that of provincial governments, for instance:	
	SFA	*Rules about Management of Nature Reserves for Forests and Wild Animals* *Regulations about Some Issues Concerning Strengthening Management of Forest Resources* *Rules for the Implementation of the Plant Quarantine Regulations*
	MOA	*Rules for the Implementation of the Plant Quarantine Regulations* *Report on Preventing Uncontrolled Collection of Hair grass and Licorice to Protect Pasture Resources*
	Ministry of Foreign Trade and Economic Cooperation	*Circular about Ceasing Purchasing and Exporting Rare Wild Animals*
	SOA	*Rules about Management of Marine Nature Reserves*
	General Customs Administration and MOA	*Circular about Strengthening Supervision and Management of Passengers Carrying Animal and Plant Specimens Abroad*
	SFA and MOA	*State Key Protected Species List of Wildlife*
	SPC	*Circular about According to Law Severely Punishing Criminals Hunting Panda and Illegally Dealing in and Smuggling Panda Hides*
	SPC, the Supreme People's Procuratorate, SFA, the Ministry of Public Security and the State Administration for Industry and Commerce	*Circular Regarding Cracking Down on Crimes of Illegal Hunting, Purchasing and Selling Wild Animals*

This third *China Human Development Report 2002*, **Making Green Development a Choice,** looks at the environmental challenges facing China today especially in the context of its WTO entry and efforts towards a green and clean 2008 Olympics. The report argues that it is now time for the government and people to respond to these challenges and make the right choices to achieve green development and a sustainable future.

What impacts do environmental changes have on people's health and livelihoods? How do environmental issues affect overall governance structure? The *Report's* first chapter begins with a review of China's people and their history and culture as the resource and foundation to build and modernise this vast land. Chapter two assesses the current status of the environment and chapter three examines the forces and trends that determine environmental changes including the linkages between society and environment. Chapter four analyzes the ongoing efforts to put China on the right path and discusses how the responses can be optimized. Chapter five concludes that today's decisions will have significant influence on the degree of sustainability in China's future development. A scenario approach is provided describing two alternatives: today's *perilous path* and tomorrow's *green reform path*.

Informative and readable, the *China Human Development Report 2002* is an invaluable collection of solid statistics, in-depth analysis and thought-provoking ideas for people all over the world to better understand the general system of societal, environmental and economic factors that together make China what it is today and what it can become in the future.

The *China Human Development Report 2002* was commissioned by UNDP China and was prepared by a team of eminent development professionals under the leadership of Stockholm Environment Institute, an independent, international research institute specializing in sustainable development and environment issues at the local, national, regional and global policy levels.

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